

TED-ED 英文本



**P1 2013-10-01 The uncertain location of electrons - George Zaidan and Charles Morto**

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You probably know that all stuff is made up of atoms and that an atom is a really, really, really, really tiny particle. Every atom has a core, which is made up of at least one positively charged particle called a proton, and in most cases, some number of neutral particles called neutrons. That core is surrounded by negatively charged particles called electrons. The identity of an atom is determined only by the number of protons in its nucleus. Hydrogen is hydrogen because it has just one proton, carbon is carbon because it has six, gold is gold because it has 79, and so on. Indulge me in a momentary tangent. How do we know about atomic structure? We can't see protons, neutrons, or electrons. So, we do a bunch of experiments and develop a model for what we think is there. Then we do some more experiments and see if they agree with the model. If they do, great. If they don't, it might be time for a new model. We've had lots of very different models for atoms since Democritus in 400 BC, and there will almost certainly be many more to come. Okay, tangent over. The cores of atoms tend to stick together, but electrons are free to move, and this is why chemists love electrons. If we could marry them, we probably would. But electrons are weird. They appear to behave either as particles, like little baseballs, or as waves, like water waves, depending on the experiment that we perform. One of the weirdest things about electrons is that we can't exactly say where they are. It's not that we don't have the equipment, it's that this uncertainty is part of our model of the electron. So, we can't pinpoint them, fine. But we can say there's a certain probability of finding an electron in a given space around the nucleus. And that means that we can ask the following question: If we drew a shape around the nucleus such that we would be 95% sure of finding a given electron within that shape, what would it look like? Here are a few of these shapes. Chemists call them orbitals, and what each one looks like depends on, among other things, how much energy it has. The more energy an orbital has, the farther most of its density is from the nucleus. By they way, why did we pick 95% and not 100%? Well, that's another quirk of our model of the electron. Past a certain distance from the nucleus, the probability of finding an electron starts to decrease more or less exponentially, which means that while it will approach zero, it'll never actually hit zero. So, in every atom, there is some small, but non-zero, probability that for a very, very short period of time, one of its electrons is at the other end of the known universe. But mostly electrons stay close to their nucleus as clouds of negative charged density that shift and move with time. How electrons from one atom interact with electrons from another determines almost everything. Atoms can give up their electrons, surrendering them to other atoms, or they can share electrons. And the dynamics of this social network are what make chemistry interesting. From plain old rocks to the beautiful complexity of life, the nature of everything we see, hear, smell, taste, touch, and even feel is determined at the atomic level.

**P2 2013-10-03 Why extremophiles bode well for life beyond Earth - Louisa Preston**

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We've all seen movies about terrible insects from outer space or stories of abduction by little green men, but the study of life in the universe, including the possibility of extraterrestrial life, is also a serious, scientific pursuit. Astrobiology draws on diverse fields, such as physics, biology, astronomy, and geology, to study how life was formed on Earth, how it could form elsewhere, and how we might detect it. Many ancient religions described other worlds inhabited by known human beings, but these are more like mythical realms or parallel universes than other planets existing in the same physical world. It is only within the last century that scientists have been able to seriously undertake the search for extraterrestrial life. We know that at the most basic level organisms on Earth need three things: liquid water, a source of energy, and organic, carbon-based material. We also know that the Earth is just the right distance from the Sun, so as not to be either frozen or molten. So, planets within such a habitable range from their own stars may be able to support life. But while we used to think that life could only exist in such Earth-like environments, one of the most amazing discoveries of astrobiology has been just how versatile life is. We now know that life can thrive in some of the most extreme environments that'd be fatal for most known organisms. Life is found everywhere, from black smoke of hydrothermal vents in the dark depths of Earth's oceans, to bubbling, hot, acidic springs on the flanks of volcanoes, to high up in the atmosphere. Organisms that live in these challenging environments are called extremophiles, and they can survive at extremes of temperature, pressure, and radiation, as well as salinity, acidity, and limited availability of sunlight, water, or oxygen. What is most remarkable about these extremophiles is that they are found thriving in environments that mimic those on alien worlds. One of the most important of these worlds is our red and dusty neighbor, Mars. Today, astrobiologists are exploring places where life might once have existed on Mars using NASA's Curiosity rover. One of these is Gale Crater, an impact crater created when a meteor hit the surface of Mars nearly 3.8 billions years ago. Evidence from orbit suggest past traces of water, which means the crater might once have supported life. Planets are not the only places astrobiologists are looking at. For example, Europa, one of the moons of Jupiter, and Enceladus and Titan, two of Saturn's moons, are all exciting possibilities. Although these moons are extremely cold and two are covered in thick ice, there is evidence of liquid oceans beneath the shell. Could life be floating around in these oceans, or could it be living around black smoker vents at the bottom? Titan is particularly promising as it has an atmosphere and Earth-like lakes, seas, and rivers flowing across the surface. It is very cold, however, too cold for liquid water, so these rivers may instead be flowing with liquid hydrocarbons such as methane and ethane. These are composed of hydrogen, and, more importantly, carbon, which is the basic building block of all life as we know it. So, could life be found in these lakes? Although instruments are being designed to study these distant worlds, it takes many years to build them and even longer to get them where they need to be. In the meantime, astrobiologists work in our own natural laboratory, the Earth, to learn about all the weird and wonderful forms of life that can exist and to help us one day answer one of humanity's oldest questions: Are we alone?

**P3 2013-10-08 The operating system of life - George Zaidan and Charles Morton**

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Every chicken was once an egg, every oak tree an acorn, every frog a tadpole. The patch of mold on that old piece of bread in the back of your fridge, not so long ago that was one, solitary cell. Even you were once but a gleam in your parents' eyes. All these organisms share the same basic goal: to perpetuate their own existence. All lifeforms that we've discovered so far stay alive by using basically the same rules, materials, and machinery. Imagine a factory full of robots. These robots have two missions: one, keep the factory running, and two, when the time is right, set up an entirely new factory. To do those things, they need assembly instructions, raw materials, plenty of energy, a few rules about when to work normally, when to work quickly, or when to stop, and some exchange currencies because even robots need to get paid. Each factory has a high security office with blueprints for all the possible factory configurations and complete sets of instructions to make all the different types of robots a factory could ever need. Special robots photocopy these instructions and send them off to help make the building blocks of more robots. Their colleagues assemble those parts into still more robots, which are transported to the right location in the factory and given the tools they need to start working. Every robot draws energy from the central power plant, a giant furnace that can burn regular fuel but also scrap materials if not enough regular fuel is available. Certain zones in the factory have harsher working conditions, so these areas are walled off. But the robots inside can at least communicate with the rest of the factory through specialized portals embedded directly into the walls. And as you've probably figured out, what we're describing here is a cell. The high security office is the nucleus. It stores the blueprints and instructions as deoxyribonucleic acid, or DNA. The photocopied instructions are RNA. The robots themselves are mostly proteins built from amino acids, but they'll often use special tools that are, or are derived from, vitamins and minerals. The walls between factory zones and around the factory itself are mostly made up of lipids, a.k.a. fats. In most organisms, the primary fuel source are sugars, but in a pinch, fats and proteins can be broken down and burned in the furnace as well. The portals are membrane proteins which allow very specific materials and information to pass through the walls at the right times. Many interactions between robot proteins require some kind of push, think robot minimum wage. A few small but crucial forms of money are transferred between proteins to provide this push. Electrons, protons, oxygen, and phosphate groups are the main chemical currencies, and they're kept in small molecular wallets or larger tote bags to keep them safe. This is biochemistry, the study of how every part of the factory interacts to keep your life running smoothly in the face of extreme challenges. Maybe there's too much fuel; your body will store the excess as glycogen or fat. Maybe there's not enough; your body will use up those energy reserves. Maybe a virus or bacteria tries to invade; your body will mobilize the immune system. Maybe you touched something hot or sharp; your nerves will let you know so you can stop. Maybe it's time to create a new cell or a new person. Amazingly, oak trees, chickens, frogs, and, yes, even you share so many of the same basic robot and factory designs that biochemists can learn a lot about all of them all at the same time.

**P4 2013-10-08 What is the shape of a molecule - George Zaidan and Charles Morton**

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What is the shape of a molecule? Well, a molecule is mostly empty space. Almost all of its mass is concentrated in the extremely dense nuclei of its atoms. And its electrons, which determine how the atoms are bonded to each other, are more like clouds of negative charge than individual, discrete particles. So, a molecule doesn't have a shape in the same way that, for example, a statue has a shape. But for every molecule, there's at least one way to arrange the nuclei and electrons so as to maximize the attraction of opposite charges and minimize the repulsion of like charges. Now, let's assume that the only electrons that matter to a molecule's shape are the outermost ones from each participating atom. And let's also assume that the electron clouds in between atoms, in other words, a molecule's bonds, are shaped kind of like sausages. Remember that nuclei are positively charged and electrons are negatively charged, and if all of a molecule's nuclei were bunched up together or all of its electrons were bunched up together, they would just repel each other and fly apart, and that doesn't help anyone. In 1776, Alessandro Volta, decades before he would eventually invent batteries, discovered methane. Now, the chemical formula of methane is CH4. And this formula tells us that every molecule of methane is made up of one carbon and four hydrogen atoms, but it doesn't tell us what's bonded to what or how they atoms are arranged in 3D space. From their electron configurations, we know that carbon can bond with up to four other atoms and that each hydrogen can only bond with one other atom. So, we can guess that the carbon should be the central atom bonded to all the hydrogens. Now, each bond represents the sharing of two electrons and we draw each shared pair of electrons as a line. So, now we have a flat representation of this molecule, but how would it look in three dimensions? We can reasonably say that because each of these bonds is a region of negative electric charge and like charges repel each other, the most favorable configuration of atoms would maximize the distance between bonds. And to get all the bonds as far away from each other as possible, the optimal shape is this. This is called a tetrahedron. Now, depending on the different atoms involved, you can actually get lots of different shapes. Ammonia, or NH3, is shaped like a pyramid. Carbon dioxide, or CO2, is a straight line. Water, H2O, is bent like your elbow would be bent. And chlorine trifluoride, or ClF3, is shaped like the letter T. Remember that what we've been doing here is expanding on our model of atoms and electrons to build up to 3D shapes. We'd have to do experiments to figure out if these molecules actually do have the shapes we predict. Spoiler alert: most of the do, but some of them don't. Now, shapes get more complicated as you increase the number of atoms. All the examples we just talked about had one obviously central atom, but most molecules, from relatively small pharmaceuticals all the way up to long polymers like DNA or proteins, don't. The key thing to remember is that bonded atoms will arrange themselves to maximize the attraction between opposite charges and minimize the repulsion between like charges. Some molecules even have two or more stable arrangements of atoms, and we can actually get really cool chemistry from the switches between those configurations, even when the composition of that molecule, that's to say the number and identity of its atoms, has not changed at all.

**P5 2013-10-09 Why don't oil and water mix - John Pollard**

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Why does salt dissolve in water but oil doesn't? Well, in a word, chemistry, but that's not very satisfying, is it? Well, the reason salt dissolves and oil does not comes down to the two big reasons why anything happens at all: energetics and entropy. Energetics deals primarily with the attractive forces between things. When we look at oil or salt in water, we focus on the forces between particles on a very, very, very small scale, the molecular level. To give you a sense of this scale, in one glass of water, there are more molecules than known stars in the universe. Now, all of these molecules are in constant motion, moving, vibrating, and rotating. What prevents almost all of those molecules from just flying out of the glass are the attractive interactions between molecules. The strength of the interactions between water, itself, and other substances is what we mean when we say energetics. You can think of the water molecules engaging in a constant dance, sort of like a square dance where they constantly and randomly exchange partners. Put simply, the ability for substances to interact with water, balanced with how they disrupt how water interacts with itself, plays an important role in explaining why certain things mix well into water and others don't. Entropy basically describes the way things and energy can be arranged based on random motion. For example, think of the air in a room. Imagine all the different possible arrangements in space for the trillions of particles that make up the air. Some of those arrangments might have all the oxygen molecules over here and all the nitrogen molecules over there, separated. But far more of the possible arrangements have those molecules mixed up with one another. So, entropy favors mixing. Energetics deals with attractive forces. And so, if attractive forces are present, the probability of some arrangements can be enhanced, the ones where things are attracted to each other. So, it is always the balance of these two things that determines what happens. On the molecular level, water is comprised of water molecules, made up of two hydrogen atoms and an oxygen atom. As liquid water, these molecules are engaged in a constant and random square dance that is called the hydrogen bonding network. Entropy favors keeping the square dance going at all times. There are always more ways that all the water molecules can arrange in a square dance, as compared to if the water molecules did a line dance. So, the square dance constantly goes on. So, what happens when you put salt in the water? Well, on the molecular level, salt is actually made up of two different ions, chlorine and sodium, that are organized like a brick wall. They show up to the dance as a big group in formation and sit on the side at first, shy and a bit reluctant to break apart into individual ions to join the dance. But secretly, those shy dancers just want someone to ask them to join. So, when a water randomly bumps into one of them and pulls them into the dance away from their group, they go. And once they go into the dance, they don't come back out. And in fact, the addition of the salt ions adds more possible dance positions in the square dance, so it is favored for them to stay dancing with water. Now, let's take oil. With oil, the molecules are sort of interested in dancing with water, so entropy favors them joining the dance. The problem is that oil molecules are wearing gigantic ballgowns, and they're way bigger than water molecules. So, when an oil molecule gets pulled in, their size is really disruptive to the dance and the random exchange of partners that the waters engage in, a very important part of the dance. In addition, they are not great dancers. The water molecules try to engage the oil molecules in the dance, but they just keep bumping into their dresses and taking up all the room on the dance floor. There are way more ways the waters can dance when the oil gets off the floor, so the waters squeeze out the oil, pushing it back to the bench with the others. Pretty soon, when a large number of oils have been squeezed over to the side, they band together to commiserate about how unfair the waters are being and stick together as a group. So, it is this combination of the interactions between molecules and the configurations available to them when they're moving randomly that dictates whether they mix. In other words, water and oil don't mix because they just don't make great dance partners.

**P6 2013-10-14 Mysteries of vernacular - Lady - Jessica Oreck and Rachael Teel**

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Mysteries of vernacular: Lady, woman. Lady is tied to a number of words that seem at first glance etymologically unrelated. She traces her roots back to the Old English words hlaf, which referred to a loaf of bread and is the direct ancestor of our modern word loaf, and daege, which meant maid and is the root of our word dairy, the place where the dairymaid works. Together, hlaf and daege became hlafdige, literally loaf maid, or, more figuratively, kneader of bread. As early as the ninth century, hlafdige was the name for a mistress of servants, or the female head of the household. The Old English word for a male head of household was hlafweard, a compound of hlaf, loaf, and weard, which meant keeper and is the word of modern words like ward and warden. Both hlafweard, the breadwinner, and hlafdige, the bread kneader, came to be titles of respect, referring to citizens of higher social standing. Through a process known as syncopation, both words lost their internal sounds to become lord and lady, respectively. Though still an expression of courtesy, lady has since moved down the ladder of social standing and is now often used to mean simply a woman.

**P7 2013-10-14 Mysteries of vernacular - Yankee - Jessica Oreck and Rachael Teel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=7)

Mysteries of vernacular: Yankee, a New England resident or, more generally, a person who lives in or is from the United States. Though the origin of Yankee is uncertain, this all-American word most likely descended from the Dutch moniker Janke, a diminutive meaning little Jan, or little John. In the 17th century, Janke was the common nickname of Dutch sailors, pirates in particular. A Dutch pirate ship operating in the West Indies was even called the Yankee. Over the years, Yankee transformed from a pirate's nickname into a general term of contempt. In 1758, British general James Wolfe used Yankee as a pejorative term for the colonists under his supervision. But the insult wasn't limited to soldiers. Yankee quickly came to mean New Englander, and by the 1780s, it was used to look down upon any American. During the Revolution, colonists co-opted Yankee and transformed it into a mark of national honor. The Civil War, however, intensified the derisive definition when it was used by Southerners to mock members of the Union. Today, it carries much less emotion, unless, of course, we're talking about baseball.

**P8 2013-10-15 How atoms bond - George Zaidan and Charles Morton**

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Most atoms don't ride solo, instead they bond with other atoms. And bonds can form between atoms of the same element or atoms of different elements. You've probably imagined bonding as a tug of war. If one atom is really strong, it can pull one or more electrons off another atom. Then you end up with one negatively charged ion and one positively charged ion. And the attraction between these opposite charges is called an ionic bond. This is the kind of sharing where you just give away your toy to someone else and then never get it back. Table salt, sodium chloride, is held together by ionic bonds. Every atom of sodium gives up one electron to every atom of chlorine, ions are formed, and those ions arrange themselves in a 3D grid called a lattice, in which every sodium ion is bonded to six chloride ions, and every chloride ion is bonded to six sodium ions. The chlorine atoms never give the sodium atoms their electrons back. Now, these transactions aren't always so cut-and-dried. If one atom doesn't completely overwhelm the other, they can actually share each other's electrons. This is like a pot luck where you and a friend each bring a dish and then both of you share both dishes. Each atom is attracted to the shared electrons in between them, and this attraction is called a covalent bond. The proteins and DNA in our bodies, for example, are held together largely by these covalent bonds. Some atoms can covalently bond with just one other atom, others with many more. The number of other atoms one atom can bond with depends on how its electrons are arranged. So, how are electrons arranged? Every atom of a pure, unbonded element is electrically neutral because it contains the same number of protons in the nucleus as it does electrons around the nucleus. And not all of those electrons are available for bonding. Only the outermost electrons, the ones in orbitals furthest from the nucleus, the ones with the most energy, only those participate in bonding. By the way, this applies to ionic bonding too. Remember sodium chloride? Well, the electron that sodium loses is the one furthest from its nucleus, and the orbital that electron occupies when it goes over to chlorine is also the one furthest from its nucleus. But back to covalent bonding. Carbon has four electrons that are free to bond, nitrogen has three, oxygen two. So, carbon is likely to form four bonds, nitrogen three, and oxygen two. Hydrogen only has one electron, so it can only form one bond. In some special cases, atoms can form more bonds than you'd expect, but they better have a really good reason to do so, or things tend to fly apart. Groups of atoms that share electrons covalently with each other are called molecules. They can be small. For example, every molecule of oxygen gas is made up of just two oxygen atoms bonded to each other. Or they could be really, really big. Human chromosome 13 is just two molecules, but each one has over 37 billion atoms. And this neighborhood, this city of atoms, is held together by the humble chemical bond.

**P9 2013-10-17 How we conquered the deadly smallpox virus - Simona Zompi**

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10,000 years ago, a deadly virus arose in northeastern Africa. The virus spread through the air, attacking the skin cells, bone marrow, spleen, and lymph nodes of its victims. The unlucky infected developed fevers, vomiting, and rashes. 30% of infected people died during the second week of infection. Survivors bore scars and scabs for the rest of their lives. Smallpox had arrived. In 1350 B.C., the first smallpox epidemics hit during the Egypt-Hittite war. Egyptian prisoners spread smallpox to the Hittites, which killed their king and devastated his civilization. Insidiously, smallpox made its way around the world via Egyptian merchants, then through the Arab world with the Crusades, and all the way to the Americas with the Spanish and Portuguese conquests. Since then, it has killed billions of people with an estimated 300 to 500 million people killed in the 20th century alone. But smallpox is not unbeatable. In fact, the fall of smallpox started long before modern medicine. It began all the way back in 1022 A.D. According to a small book, called "The Correct Treatment of Small Pox," a Buddhist nun living in a famous mountain named O Mei Shan in the southern providence of Sichuan would grind up smallpox scabs and blow the powder into nostrils of healthy people. She did this after noticing that those who managed to survive smallpox never got it again, and her odd treatment worked. The procedure, called variolation, slowly evolved and by the 1700's, doctors were taking material from sores and putting them into healthy people through four or five scratches on the arm. This worked pretty well as inoculated people would not get reinfected, but it wasn't foolproof. Up to three percent of people would still die after being exposed to the puss. It wasn't until English physician Edward Jenner noticed something interesting about dairy maids that we got our modern solution. At age 13, while Jenner was apprentice to a country surgeon and apothecary in Sodbury, near Bristol, he heard a dairy maid say, "I shall never have smallpox, for I have had cowpox. I shall never have an ugly, pockmarked face." Cowpox is a skin disease that resembles smallpox and infects cows. Later on, as a physician, he realized that she was right, women who got cowpox didn't develop the deadly smallpox. Smallpox and cowpox viruses are from the same family. But when a virus infects an unfamiliar host, in this case cowpox infecting a human, it is less virulent, so Jenner decided to test whether the cowpox virus could be used to protect against smallpox. In May 1796, Jenner found a young dairy maid, Sarah Nelmes, who had fresh cowpox lesions on her hand and arm caught from the utters of a cow named Blossom. Using matter from her pustules, he inoculated James Phipps, the eight-year-old son of his gardener. After a few days of fever and discomfort, the boy seemed to recover. Two months later, Jenner inoculated the boy again, this time with matter from a fresh smallpox lesion. No disease developed, and Jenner concluded that protection was complete. His plan had worked. Jenner later used the cowpox virus in several other people and challenged them repeatedly with smallpox, proving that they were immune to the disease. With this procedure, Jenner invented the smallpox vaccination. Unlike variolation, which used actual smallpox virus to try to protect people, vaccination used the far less dangerous cowpox virus. The medical establishment, cautious then as now, deliberated at length over his findings before accepting them. But eventually vaccination was gradually accepted and variolation became prohibited in England in 1840. After large vaccination campaigns throughout the 19th and 20th centuries, the World Health Organization certified smallpox's eradication in 1979. Jenner is forever remembered as the father of immunology, but let's not forget the Buddhist nun, dairy maid Sarah Nelmes, and James Phipps, all heroes in this great adventure of vaccination who helped eradicate smallpox.

**P10 2013-10-18 Is time travel possible - Colin Stuart**

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Have you ever daydreamed about traveling through time, perhaps fast forward in the centuries and seeing the distant future? Well, time travel is possible, and what's more, it's already been done. Meet Sergei Krikalev, the greatest time traveler in human history. This Russian cosmonaut holds the record for the most amount of time spent orbiting our planet, a total of 803 days, 9 hours, and 39 minutes. During his stay in space, he time traveled into his own future by 0.02 seconds. Traveling at 17,500 miles an hour, he experienced an effect known as time dilation, and one day the same effect might make significant time travel to the future commonplace. To see why moving faster through space affects passage of time, we need to go back to the 1880s, when two American scientists, Albert Michelson and Edward Morley, were trying to measure the effect of the Earth's movement around the Sun on the speed of light. When a beam of light was moving in the same direction as the Earth, they expected the light to travel faster. And when the Earth was moving in the opposite direction, they expected it to go slower. But they found something very curious. The speed of light remained the same no matter what the Earth was doing. Two decades later, Albert Einstein was thinking about the consequences of that never-changing speed of light. And it was his conclusions, formulated in the theory of special relativity, that opened the door into the world of time travel. Imagine a man named Jack, standing in the middle of a train carriage, traveling at a steady speed. Jack's bored and starts bouncing a ball up and down. What would Jill, standing on the platform, see through the window as the train whistles through? Well, between Jack dropping the ball and catching it again, Jill would have seen him move slightly further down the track, resulting in her seeing the ball follow a triangular path. This means Jill sees the ball travel further than Jack does in the same time period. And because speed is distance divided by time, Jill actually sees the ball move faster. But what if Jack's bouncing ball is replaced with two mirrors which bounce a beam of light between them? Jack still sees the beam dropping down and Jill still sees the light beam travel a longer distance, except this time Jack and Jill cannot disagree on the speed because the speed of light remains the same no matter what. And if the speed is the same while the distance is different, this means the time taken will be different as well. Thus, time must tick at different rates for people moving relative to each other. Imagine that Jack and Jill have highly accurate watches that they synchronize before Jack boards the train. During the experiment, Jack and Jill would each see their own watch ticking normally. But if they meet up again later to compare watches, less time would have elapsed on Jack's watch, balancing the fact that Jill saw the light move further. This idea may sound crazy, but like any good scientific theory, it can be tested. In the 1970s, scientists boarded a plane with some super-accurate atomic clocks that were synchronized with some others left on the ground. After the plane had flown around the world, the clocks on board showed a different time from those left behind. Of course, at the speed of trains and planes, the effect is minuscule. But the faster you go, the more time dilates. For astronauts orbiting the Earth for 800 days, it starts to add up. But what affects humans also affects machines. Satellites of the global positioning system are also hurdling around the Earth at thousands of miles an hour. So, time dilation kicks in here, too. In fact, their speed causes the atomic clocks on board to disagree with clocks on the ground by seven millionths of a second daily. Left uncorrected, this would cause GPS to lose accuracy by a few kilometers each day. So, what does all this have to do with time travel to the far, distant future? Well, the faster you go, the greater the effect of time dilation. If you could travel really close to the speed of light, say 99.9999%, on a round-trip through space for what seemed to you like ten years, you'd actually return to Earth around the year 9000. Who knows what you'd see when you returned?! Humanity merged with machines, extinct due to climate change or asteroid impact, or inhabiting a permanent colony on Mars. But the trouble is, getting heavy things like people, not to mention space ships, up to such speeds requires unimaginable amounts of energy. It already takes enormous particle accelerators like the Large Hadron Collider to accelerate tiny subatomic particles to close to light speed. But one day, if we can develop the tools to accelerate ourselves to similar speeds, then we may regularly send time travelers into the future, bringing with them tales of a long, forgotten past.

**P11 2013-10-22 The strengths and weaknesses of acids and bases - George Zaidan and C**

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Acids and bases are everywhere. They're used to make foods, soaps and detergents, fertilizers, explosives, dyes, plastics, pesticides, even paper. Our stomachs are very acidic. Our blood is slightly basic. Our proteins are made up of amino acids, and the letters in our genetic code, those As, Ts, Cs, and Gs, are all bases. You were probably taught how acids and bases behave on the molecular level. You were probably never taught that a long time ago, like ancient Greek ago, before anyone knew about atoms or molecules, acids and bases were defined by how they behaved. Acids tasted sour and corroded metal. Bases felt slippery and could somehow counteract acids. When molecules dissolved in water interact, they are exchanging two main currencies with their surroundings: protons, also known as hydrogen ions, and electrons. Depending on how a molecule is composed or shaped, it may be willing to donate or accept either protons or electrons with some other community member. And some molecules are far more aggressive than others when it comes to donating or accepting either currency. Remember that protons are positively charged and electrons are negatively charged. So, if a molecule is willing to give up a proton, that's not too different from it being willing to accept an electron -- either way it's becoming more negatively charged. Other molecules are willing to accept a proton or give up an electron. These are becoming more positively charged. Some substances are so aggressive about donating their protons that when they get a chance, all of the molecules in a sample will dump a proton, sometimes more than one, to the surrounding water molecules. We call these strong acids. Meanwhile, some compounds are so ready to accept a proton that they won't wait around, they'll just rip one off water, which usually has two protons but is generous enough to hang out with just one. We call these strong bases. Other acids and bases are not so strong. They may donate just a few of their protons to water or accept just a few protons from water, but most of their molecules stay exactly the same. If left alone in water, they'll reach some equilibrium point where maybe only one out of a hundred or one out of ten thousand of their molecules has exchanged currency with water. As you might guess, we label these acids and bases weak, but in the common sense of the word, they're not weak. The vinegar in your salad dressing that you can smell from across the room, that is a weak acid. The ammonia you spray on glass for a streak-free shine, that is a weak base. So, it doesn't take much to be an active player in the chemical economy. Most acid-base chemistry takes place in water, which can act as either an acid or a base, accepting deposits and enabling withdrawals like a 24-hour molecular ATM. And when a proton-deposit customer, that's an acid, and a proton-withdrawal customer, the base, shop at the same time, their net effect on water's account may cancel out, and we call this neutralization. Now, certain molecules can behave as acids or bases without water, but that's another story. Let's end by saluting water as the resilient and fair banker for acids and bases. It's always open for business, doesn't charge interest, and will never foreclose on your molecules, which is more than I can say for [bleep]. Waah-waah.

**P12 2013-10-29 Vampires - Folklore, fantasy and fact - Michael Molina**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=12)

Good evening! What's the matter? Are you afraid of vampires? He he, no need to worry, I'm not staying for dinner. (Laughter) I'm here to guide you through a brief history of vampires, illustrating how our image has changed from a shambling corpse to the dapper gentleman you see before you. Vampires are nearly as old as you humans. Stories about us, revenants, appear in cultures extending as far back as prehistoric times. But we weren't called vampires back then and most of us did not look the way we imagine vampires today. Ha, far from it! For example, the Mesopotamian Lamashtu was a creature with the head of a lion and the body of the donkey, and the ancient Greek striges were simply described as bloodthirsty birds. Others were even stranger. The Philippine manananggal would sever her upper torso and sprout huge, bat-like wings to fly. The Malaysian penanggalan was a flying female head with dangling entrails. (Laughter) And the Australian Yara-ma-yha-who was a little red guy with a big head, a large mouth, and bloodsuckers on his hands and feet. Oh, and let's not forget the Caribbean's soucouyant, the West African obayifo, and the Mexican Tlahuelpuchi. (Laughter) Charming, aren't they? Though they may look vastly different, all of these beings have one common characteristic: They sustain themselves by consuming the life force of a living creature. This shared trait is what defines a vampire -- all the other attributes change with the tides. So, how do we arrive at the reanimated fellow you see before you? Our modern ideal emerges in 18th-century Eastern Europe. With the dramatic increase of vampire superstitions, stories of bloodsucking, shadowy creatures become nightly bedside terrors. And popular folklore, like the moroi among the Romani people and the lugat in Albania, provide the most common vampire traits known today, such as vampires being undead and nocturnal and shape-shifting. You see, Eastern Europe in the 18th century was a pretty grim place with many deaths occurring from unknown diseases and plagues. Without medical explanations, people searched for supernatural causes and found what looked like evidence in the corpses of the victims. When villagers dug up bodies to discern the cause of the mysterious deaths, they would often find the cadavers looking very much alive -- longer hair and fingernails, bloated bellies, and blood at the corners of mouths. (Laughter) Clearly, these people were not really dead. Heh, they were vampires! And they had been leaving their graves to feast on the living. (Grunt) The terrified villagers would quickly enact a ritual to kill the undead. The practices varied across the region, but usually included beheadings, burnings, and staking the body to the coffin to prevent it from getting up. (Laughter) Grizzly stuff! But what the villagers interpreted as unholy reanimation were actually normal symptoms of death. When a body decomposes, the skin dehydrates, causing the hair and fingernails to extend. Bacteria in the stomach creates gases that fill the belly, which force out blood and matter through the mouth. Unfortunately, this science was not yet known, so the villagers kept digging. In fact, so many bodies were dug up that the Empress of Austria sent her physician around to disprove the vampire stories, and she even established a law prohibiting grave tampering. Still, even after the vampire hunts had died down, the stories of legends survived in local superstition. This led to works of literature, such as Polidori's "The Vampyre," the Gothic novel "Carmilla," and, most famously, Bram Stoker's "Dracula." Although Stoker incorporated historical material, like Elizabeth Báthory's virgin blood baths and the brutal executions of Vlad Dracul, it was these local myths that inspired the main elements of his story: the Transylvanian setting, using garlic to defend oneself, and the staking of the heart. While these attributes are certainly familiar to us, elements he invented himself have also lasted over the years: fear of crucifixes, weakness in sunlight, and the vampire's inability to see their reflection. By inventing new traits, Stoker perfectly enacted the age-old tradition of elaborating upon and expanding the myth of vampires. As we saw, maybe you met my relatives, a huge of variety of creatures stalked the night before Dracula, and many more will continue to creep through our nightmares. Yet, so long as they subsist off a living being's life force, they are part of my tribe. Even sparkling vampires can be included. After all, it's the continued storytelling and reimagining of the vampire legend that allows us to truly live forever. (Ominous laughter)

**P14 2013-11-04 The deadly irony of gunpowder - Eric Rosado**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=14)

Everybody loves fireworks -- the lights, the colors, and, of course, the big boom. But the history of fireworks isn't all hugs and celebrations. Long before epic fireworks displays, chemists in China invented the key ingredient that propels those bright lights into the sky. That invention was what we now call gunpowder. Our story begins back in ancient China in the mid-ninth century where early Chinese alchemists were trying to create a potion for immortality. Instead, what they created was a flammable powder that burned down many of their homes. They quickly realized that this black powder, which they called fire medicine, was precisely the opposite of something that would make you live forever. In these early days, the Chinese hadn't yet figured out how to make the powder explode; it was simply very flammable, and their armies used it to make flaming arrows and even a flamethrower. But once they figured out the right proportions of ingredients to create a blast, they began using the powder even more, creating fireworks to keep evil spirits away and bombs to defend themselves against Mongol invaders. It was these Mongols, most likely, who spread the invention of gunpowder across the world. After fielding Chinese attacks, they learned how to produce the powder themselves and brought it with them on their conquests in Persia and India. William of Rubruck, a European ambassador to the Mongols, was likely responsible for bringing gunpowder back to Europe around 1254. From there, engineers and military inventors created all kinds of destructive weapons. From bombs to guns to cannons, gunpowder left its mark on the world in some pretty terrible ways, in contrast to the beautiful marks it can leave in the air. So, how does black powder propel fireworks into the sky? You might have seen old Westerns or cartoons where a trail of gunpowder is lit and it leads to a large and obviously explosive barrel. Once the fire gets to the barrel, a large boom occurs. But why doesn't the trail itself explode? The reason is that burning the powder releases energy and gases. While the trail is burning, these are easily released into the surrounding air. But when the gunpowder is contained within the barrel, the energy and gases cannot easily escape and build up until BOOM! Firework canisters provide a single, upward-facing outlet to channel this explosive energy. The wick ignites the gunpowder and the energy takes the easiest exit from the canister, launching the firework high into the sky. The flame then makes its way through the firework's encasing and the same reaction occurs high above our heads. So, while the Chinese alchemists never found the compound for eternal life, they did find something that would go on to shape all of civilization, something that has caused many tragic moments in human history, and yet still gives us hope when we look up in celebration at the colorful night sky.

**P15 2013-11-05 Why is yawning contagious - Claudia Aguirre**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=15)

Oh, excuse me! Have you ever yawned because somebody else yawned? You aren't especially tired, yet suddenly your mouth opens wide and a big yawn comes out. This phenomenon is known as contagious yawning. And while scientists still don't fully understand why it happens, there are many hypotheses currently being researched. Let's take a look at a few of the most prevalent ones, beginning with two physiological hypotheses before moving to a psychological one. Our first physiological hypothesis states that contagious yawning is triggered by a specific stimulus, an initial yawn. This is called fixed action pattern. Think of fixed action pattern like a reflex. Your yawn makes me yawn. Similar to a domino effect, one person's yawn triggers a yawn in a person nearby that has observed the act. Once this reflex is triggered, it must run its course. Have you ever tried to stop a yawn once it has begun? Basically impossible! Another physiological hypothesis is known as non-conscious mimicry, or the chameleon effect. This occurs when you imitate someone's behavior without knowing it, a subtle and unintentional copycat maneuver. People tend to mimic each other's postures. If you are seated across from someone that has their legs crossed, you might cross your own legs. This hypothesis suggests that we yawn when we see someone else yawn because we are unconsciously copying his or her behavior. Scientists believe that this chameleon effect is possible because of a special set of neurons known as mirror neurons. Mirror neurons are a type of brain cell that responds equally when we perform an action as when we see someone else perform the same action. These neurons are important for learning and self-awareness. For example, watching someone do something physical, like knitting or putting on lipstick, can help you do those same actions more accurately. Neuroimaging studies using fMRI, functional magnetic resonance imaging, show us that when we seem someone yawn or even hear their yawn, a specific area of the brain housing these mirror neurons tends to light up, which, in turn, causes us to respond with the same action: a yawn! Our psychological hypothesis also involves the work of these mirror neurons. We will call it the empathy yawn. Empathy is the ability to understand what someone else is feeling and partake in their emotion, a crucial ability for social animals like us. Recently, neuroscientists have found that a subset of mirror neurons allows us to empathize with others' feelings at a deeper level. (Yawn) Scientists discovered this empathetic response to yawning while testing the first hypothesis we mentioned, fixed action pattern. This study was set up to show that dogs would enact a yawn reflex at the mere sound of a human yawn. While their study showed this to be true, they found something else interesting. Dogs yawned more frequently at familiar yawns, such as from their owners, than at unfamiliar yawns from strangers. Following this research, other studies on humans and primates have also shown that contagious yawning occurs more frequently among friends than strangers. In fact, contagious yawning starts occurring when we are about four or five years old, at the point when children develop the ability to identify others' emotions properly. Still, while newer scientific studies aim to prove that contagious yawning is based on this capacity for empathy, more research is needed to shed light on what exactly is going on. It's possible that the answer lies in another hypothesis altogether. The next time you get caught in a yawn, take a second to think about what just happened. Were you thinking about a yawn? Did someone near you yawn? Was that person a stranger or someone close? And are you yawning right now? (Yawn) (Lip smacking)

**P16 2013-11-08 The chemistry of cookies - Stephanie Warren**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=16)

In a time-lapse video, it looks like a monster coming alive. For a moment, it sits there innocuously. Then, ripples move across its surface. It bulges outwards, bursting with weird boils. It triples in volume. Its color darkens ominously, and its surface hardens into an alien topography of peaks and craters. Then, the kitchen timer dings. Your cookie is ready. What happened inside that oven? Don't let the apron deceive you! Bakers are mad scientists. When you slide the pan into the oven, you're setting off a series of chemical reactions that transform one substance, dough, into another, cookies. When the dough reaches 92 degrees Fahrenheit, the butter inside melts, causing the dough to start spreading out. Butter is an emulsion, or mixture of two substances that don't want to stay together, in this case, water and fat, along with some dairy solids that help hold them together. As the butter melts, its trapped water is released. And as the cookie gets hotter, the water expands into steam. It pushes against the dough from the inside, trying to escape through the cookie walls like Ridley Scott's chest-bursting alien. Your eggs may have been home to squirming salmonella bacteria. An estimated 142,000 Americans are infected this way each year. Though salmonella can live for weeks outside a living body and even survive freezing, 136 degrees is too hot for them. When your dough reaches that temperature, they die off. You'll live to test your fate with a bite of raw dough you sneak from your next batch. At 144 degrees, changes begin in the proteins, which come mostly from the eggs in your dough. Eggs are composed of dozens of different kinds of proteins, each sensitive to a different temperature. In an egg fresh from the hen, these proteins look like coiled up balls of string. When they're exposed to heat energy, the protein strings unfold and get tangled up with their neighbors. This linked structure makes the runny egg nearly solid, giving substance to squishy dough. Water boils away at 212 degrees, so like mud baking in the sun, your cookie gets dried out and it stiffens. Cracks spread across its surface. The steam that was bubbling inside evaporates, leaving behind airy pockets that make the cookie light and flaky. Helping this along is your leavening agent, sodium bicarbonate, or baking soda. The sodium bicarbonate reacts with acids in the dough to create carbon dioxide gas, which makes airy pockets in your cookie. Now, it's nearly ready for a refreshing dunk in a cool glass of milk. One of science's tastiest reactions occurs at 310 degrees. This is the temperature for Maillard reactions. Maillard reactions result when proteins and sugars break down and rearrange themselves, forming ring-like structures, which reflect light in a way that gives foods like Thanksgiving turkey and hamburgers their distinctive, rich brown color. As this reaction occurs, it produces a range of flavor and aroma compounds, which also react with each other, forming even more complex tastes and smells. Caramelization is the last reaction to take place inside your cookie. Caramelization is what happens when sugar molecules break down under high heat, forming the sweet, nutty, and slightly bitter flavor compounds that define, well, caramel. And, in fact, if your recipe calls for a 350 degree oven, it'll never happen, since caramelization starts at 356 degrees. If your ideal cookie is barely browned, like a Northeasterner on a beach vacation, you could have set your oven to 310 degrees. If you like your cookies to have a nice tan, crank up the heat. Caramelization continues up to 390 degrees. And here's another trick: you don't need that kitchen timer; your nose is a sensitive scientific instrument. When you smell the nutty, toasty aromas of the Maillard reaction and caramelization, your cookies are ready. Grab your glass of milk, put your feet up, and reflect that science can be pretty sweet.

**P17 2013-11-13 The chemical reaction that feeds the world - Daniel D. Dulek**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=17)

What would you say is the most important discovery made in the past few centuries? Is it the computer? The car? Electricity? Or maybe the discovery of the atom? I would argue that it is this chemical reaction: a nitrogen gas molecule plus three hydrogen gas molecules gets you two ammonia gas molecules. This is the Haber process of binding nitrogen molecules in the air to hydrogen molecules, or turning air into fertilizer. Without this reaction, farmers would be capable of producing enough food for only 4 billion people; our current population is just over 7 billion people. So, without the Haber process, over 3 billion people would be without food. You see, nitrogen in the form of nitrate, NO3, is an essential nutrient for plants to survive. As crops grow, they consume the nitrogen, removing it from the soil. The nitrogen can be replenished through long, natural fertilization processes like decaying animals, but humans want to grow food much faster than that. Now, here's the frustrating part: 78% of the air is composed of nitrogen, but crops can't just take nitrogen from the air because it contains very strong triple bonds, which crops cannot break. What Haber did basically was figure out a way to take this nitrogen in the air and put it into the ground. In 1908, the German chemist Fritz Haber developed a chemical method for utilizing the vast supply of nitrogen in the air. Haber found a method which took the nitrogen in the air and bonded it to hydrogen to form ammonia. Ammonia can then be injected into the soil, where it is quickly converted into nitrate. But if Haber's process was going to be used to feed the world, he would need to find a way to create a lot of this ammonia quickly and easily. In order to understand how Haber accomplished this feat, we need to know something about chemical equilibrium. Chemical equilibrium can be achieved when you have a reaction in a closed container. For example, let's say you put hydrogen and nitrogen into a closed container and allow them to react. In the beginning of the experiment, we have a lot of nitrogen and hydrogen, so the formation of ammonia proceeds at a high speed. But as the hydrogen and nitrogen react and get used up, the reaction slows down because there is less nitrogen and hydrogen in the container. Eventually, the ammonia molecules reach a point where they start to decompose back into the nitrogen and hydrogen. After a while, the two reactions, creating and breaking down ammonia, will reach the same speed. When these speeds are equal, we say the reaction has reached equilibrium. This might sound good, but it's not when what you want is to just create a ton of ammonia. Haber doesn't want the ammonia to break down at all, but if you simply leave the reaction in a closed container, that's what will happen. Here's where Henry Le Chatelier, a French chemist, can help. What he found was that if you take a system in equilibrium and you add something to it, like, say, nitrogen, the system will work to get back to equilibrium again. Le Chatelier also found that if you increase the amount of pressure on a system, the system tries to work to return to the pressure it had. It's like being in a crowded room. The more molecules there are, the more pressure there is. If we look back at our equation, we see that on the left-hand side, there are four molecules on the left and just two on the right. So, if we want the room to be less crowded, and therefore have less pressure, the system will start combining nitrogen and hydrogen to make the more compact ammonia molecules. Haber realized that in order to make large amounts of ammonia, he would have to create a machine that would continually add nitrogen and hydrogen while also increasing the pressure on the equilibrium system, which is exactly what he did. Today, ammonia is one of the most produced chemical compounds in the world. Roughly 131 million metric tons are produced a year, which is about 290 billion pounds of ammonia. That's about the mass of 30 million African elephants, weighing roughly 10,000 pounds each. 80% of this ammonia is used in fertilizer production, while the rest is used in industrial and household cleaners and to produce other nitrogen compounds, such as nitric acid. Recent studies have found that half of the nitrogen from these fertilizers is not assimilated by plants. Consequently, the nitrogen is found as a volatile chemical compound in the Earth's water supplies and atmosphere, severely damaging our environment. Of course, Haber did not foresee this problem when he introduced his invention. Following his pioneering vision, scientists today are looking for a new Haber process of the 21st century, which will reach the same level of aid without the dangerous consequences.

**P18 2013-11-13 The five major world religions - John Bellaimey**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=18)

Transcriber: Andrea McDonough Reviewer: Jessica Ruby In all times and places in our history, human beings have wondered, "Where did we come from? What's our place in the world? What happens to us after we die?" Religions are systems of belief that have developed and evolved over time in response to these and other eternal mysteries, driven by the feeling that some questions can only be answered by faith and based on an intuition that there is something greater than ourselves, a higher power we must answer to, or some source we all spring from and to which we must return. Hinduism means the religions of India. It's not a single religion but rather a variety of related beliefs and spiritual practices. It dates back five millennia to the time of Krishna, a man of such virtue that he became known as an avatar of Vishnu, an incarnation of the god in human form. He taught that all life follows karma, the law of cause and effect, and our job is to do our duty, or dharma, according to our place in society without worrying how things turn out. When we die, we are reincarnated into a new body. If we followed our dharma and did our proper duty in our past life, we get good karma, which sends our soul upward in the social scale. Our rebirth into the next life is thus determined by what we do in this one. The wheel of rebirths is called samsara. It's possible for a very holy person to lead a life with enough good karma to escape the wheel. This escape is called moksha. Hinduism teaches that everything is one. The whole universe is one transcendent reality called Brahman, and there's just one Brahman but many gods within it, and their roles, aspects, and forms differ according to various traditions. Brahma is the creator, Vishnu is the preserver who sometimes takes on human form, and Shiva is the transformer, or Lord of the Dance. Durga is the fiercely protective divine mother. Ganesha has an elephant head and is the wise patron of success. Hinduism is the third largest religion in the world. And although most Hindus live in India, they can be found on every continent, one billion strong. Now, let's travel west, across deserts and mountains to the fertile crescent about 4,000 years ago. Judaism began with God calling Abraham and Sarah to leave Mesopotamia and migrate to the land of Canaan. In return for their faith in the one true God, a revolutionary concept in the polytheistic world of that time, they would have land and many descendants. From this promise came the land of Israel and the chosen people, but staying in that land and keeping those people together was going to be very difficult. The Israelites were enslaved in Egypt, but God freed them with the help of the prophet Moses, who received the Ten Commandments and later hundreds more. They conquered the Promised Land, but could only keep it for a few hundred years. Israel sits at a crossroads through which many armies marched over the centuries. And in the year 70, the Romans destroyed the temple in their capital, Jerusalem. So, the religion transformed itself from a temple religion with sacrifices and priests to a religion of the book. Because of this, Judaism is a faith of symbolism, reverence, and deep meanings tied to the literature of its history. The many sacred scriptures make up the Hebrew bible, or Tanakh, and hundreds of written discussions and interpretations are contained in an expansive compendium of deeper meanings, called the Talmud. Jews find rich, symbolic meaning in daily life. At the Passover meal, every item on the menu symbolizes an aspect of the escape from slavery. The importance of growing up is emphasized when young people reach the age of bar and bat mitzvah, ceremonies during which they assume responsibility for their actions and celebrate the weaving of their own lives into the faith, history, and texts of the Jewish people. There are 14 million Jews in the world today, 6 million in Israel, which became independent following the horrors of genocide in World War II, and 5 million in the United States. But now let's go back 2500 years and return to India where Buddhism began with a young prince named Siddhartha. On the night he was conceived, his mother, Queen Maya, is said to have been visited in her sleep by a white elephant who entered her side. Ten months later, Prince Siddartha was born into a life of luxury. Venturing forth from his sheltered existence as a young man, he witnessed the human suffering that had been hidden from him and immediately set out to investigate its sources. Why must people endure suffering? Must we reincarnate through hundreds of lives? At first he thought the problem was attachment to material things, so he gave up his possessions. He became a wandering beggar, which he discovered certainly made him no happier. Then he overheard a music teacher telling a student, "Don't tighten the string too much, it will break. But don't let it go too slack, or it will not sound." In a flash, he realized that looking for answers at the extremes was a mistake. The middle way between luxury and poverty seemed wisest. And while meditating under a bodhi tree, the rest of the answer came to him. All of life abounds with suffering. It's caused by selfish craving for one's own fulfillment at the expense of others. Following an eight-step plan can teach us to reduce that craving, and thus reduce the suffering. On that day, Siddhartha became the Buddha, the enlightened one. Not the only one, but the first one. The Buddhist plan is called the Eightfold Path, and though it is not easy to follow, it has pointed the way for millions to enlightenment, which is what Buddhahood means, a state of compassion, insight, peace, and steadfastness. From the time he got up from under that tree to the moment of his death as an old man, the Buddha taught people how to become enlightened: right speech, right goals, a mind focused on what is real, and a heart focused on loving others. Many Buddhists believe in God or gods, but actions are more important than beliefs. There are nearly a billion Buddhists in the world today, mostly in East, Southeast, and South Asia. 2,000 years ago in Judaism's Promised Land, Christianity was born. Just as Hindus called Krishna "God in Human Form," Christians say the same thing about Jesus, and Christianity grew out of Judaism just as Buddhism grew out of Hinduism. The angel Gabriel was sent by the God of Abraham to ask a young woman named Mary to become the mother of his son. The son was Jesus, raised as a carpenter by Mary and her husband Joseph, until he turned 30, when he began his public career as the living word of God. Less interested in religiousness than in justice and mercy, Jesus healed the sick in order to draw crowds and then taught them about his heavenly father -- affectionate, forgiving, and attentive. Then, he would invite everyone to a common table to illustrate his Kingdom of God, outcasts, sinners, and saints all eating together. He had only three years before his unconventional wisdom got him into trouble. His enemies had him arrested, and he was executed by Rome in the standard means by which rabble-rousers were put to death, crucifixion. But shortly after he was buried, women found his tomb empty and quickly spread word, convinced that he had been raised from the dead. The first Christians described his resurrected appearances, inspiring confidence that his message was true. The message: love one another as I have loved you. Christians celebrate the birth of Jesus in December at Christmas, and his suffering, death, and resurrection during Holy Week in the spring. In the ceremony of baptism, a washing away of sin and welcoming into the Christian community, recall Jesus's own baptism when he left his life as a carpenter. In the rite of Communion, Christians eat the bread and drink the wine blessed as the body and blood of Jesus, recalling Jesus's last supper. There are two billion Christians worldwide, representing almost a third of the world's people. Islam began 1400 years ago with a man of great virtue, meditating in a mountain cave in the Arabian desert. The man was Muhammad. He was visited by a divine messenger, again the angel Gabriel, in Arabic, Jibril, delivering to him the words of Allah, the one God of Abraham. In the next few years, more and more messages came, and he memorized and taught them. The verses he recited were full of wise sayings, beautiful rhymes, and mysterious metaphors. But Muhammad was a merchant, not a poet. Many agreed the verses were indeed the words of God, and these believers became the first Muslims. The word Muslim means one who surrenders, meaning a person who submits to the will of God. A Muslim's five most important duties are called the Five Pillars: Shahada, Muslims declare publicly, there is no other God but Allah, and Muhammad is his final prophet; Salat, they pray five times a day facing Mecca; Zakat, every Muslim is required to give 2 or 3% of their net worth to the poor; Sawm, they fast during daylight hours for the lunar month of Ramadan to strengthen their willpower and their reliance on God; and Hajj, once in a lifetime, every Muslim who is able must make a pilgrimage to the holy city of Mecca, rehearsing for the time when they will stand before God to be judged worthy or unworthy of eternal life with Him. The words of God, revealed to the prophet over 23 years, are collected in the Quran, which literally translates into "the recitation." Muslims believe it to be the only holy book free of human corruption. It's also considered by many to be the finest work of literature in the Arabic language. Islam is the world's second largest religion, practiced by over one and a half billion Muslims around the globe. Religion has been an aspect of culture for as long as it has existed, and there are countless variations of its practice. But common to all religions is an appeal for meaning beyond the empty vanities and lowly realities of existence, beyond sin, suffering, and death, beyond fear, and beyond ourselves.

**P19 2013-11-22 Making a TED-Ed Lesson - Visualizing big ideas**

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Do you ever struggle to find the perfect description when trying to convey an idea? Like a foggy picture, adjectives and modifiers fail to depict what's in your mind. Illustrators often face a similar challenge, especially when attempting to explain complex and difficult concepts. Sometimes the imagery is intangible or way too complicated to explain with a picture. Although complex information could be relayed using charts and stats, this could get pretty boring. Instead, just like when writing an essay to describe, for example, emotions, illustrators can use visual metaphors to bring to life difficult concepts. Just as a written metaphor is a description that relates one object to another, a visual metaphor uses imagery to suggest a particular association or point of similarity. Our lesson "Big Data" is a great example of a situation where visual metaphors played a huge role in explaining the concept. What is Big Data in the first place? Good question! Big Data is a huge amount of digital information produced worldwide on a daily basis, challenging us to find solutions for storing, analyzing, and also imagining it visually. Quite an elusive concept! How should we depict this? Let's take a look at our "Big Data" script. We start with smaller computer servers that branch out into bigger networks to produce data, then even bigger networks and production of even more data. You see where we're going with this -- an object growing and branching out in many directions and producing something as a result? Does that remind you of something? Just like those computer networks, a tree grows and branches out to produce more leaves each year. And every year, just as the data accumulates and faces us with a challenge to find storage solutions, it gets harder to collect those piles of leaves when they fall off the tree. Aha! There's our visual metaphor! Okay, so we have the script, audio, and a visual metaphor. The next step in visual development is to design the characters and environments of the animation. To do so, we think of an appropriate and appealing style to illustrate the ideas and help the viewer better understand what they're hearing. Let's go back to the script and see if we can find any clues there. Our story starts in the 1960s when the first computer networks were built. This decade will serve as a good point to make the stylistic choice for our animation as it will allow us to refer to artwork from that era. You may want to start by looking at some art books (design, illustrations, cartoons, etc.) from that era and find a style that may our own purpose. Look closely, study the material, and try to understand the choices artists of that time made and why. For example, the 1960s minimalist animation style was a significant departure from the cinematic realism that was popular in animated films at the time. The choice to use limited animation techniques was originally made for budgetary reasons, but it became a signature style that influenced many future generations of animators. In this stylistic approach, the simplified characters, flat backgrounds, and angular shapes come together to create new interpretations of reality, which also sounds like a good place to begin visualizing our own Big Data. Well, let's try an experiment. "In the 1980s islands of similar networks speaking different dialects sprung up all over Europe and the States, making remote access possible but tortuous." Is this better? "In the 1980s islands of similar networks speaking different dialects sprung up all over Europe and the States, making remote access possible but tortuous. To make it easy for our physicists across the world to access the ever-expanding Big Data stored at CERN without traveling, the networks needed to be talking with the same language." As you probably observed, graphic representations are a great way to capture the interest of your audience. By depicting what you want to present and explain with strong, memorable visuals, you can communicate your idea more effectively. So, now, challenge yourself. Think of an abstract concept that cannot be explained with simple words. Go ahead and try your hand at visually developing that idea.

**P20 2013-11-27 Music and creativity in Ancient Greece - Tim Hansen**

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We live in a society obsessed with music. We use music to worship, tell stories, to celebrate, to work, exercise, declare our love and sometimes our hatred, and, arguably most importantly, to dance. And, of course, we play music ourselves because, well, it's a pleasant thing to do. Thousands of years ago in Ancient Greece, when it came to music, things weren't much different. They might have had lyres and tunics instead of MP3 players and jeans, but the Ancient Greeks were just as obsessed with music as we are today. In fact, music was such an important part of Ancient Greek society that it makes us seem tame by comparison. To really understand just how integral music was to the Ancient Greeks, let's begin by acquainting ourselves with a bit of their mythology. In Ancient Greek mythology, it was believed that human creativity was the result of divine inspiration from a group of goddesses known as the Muses. While scholars have argued over the years that there are anything between 3 and 13 Muses, the standard number accepted today is 9. Each Muse oversees her own specific area of artistic expertise, ranging from song and dance to history and astronomy. It might seem strange to categorize history and astronomy as creative pursuits, but the Ancient Greeks saw these disciplines as more than just school subjects. These were the hallmarks of civilization in what, to their eyes, was a pretty barbaric world. An educated, civilized person was expected to be proficient in all aspects of creative thought inspired by the Muses, and the common medium through which these disciplines were taught, studied, and disseminated was music. You see, it's no coincidence that the word Muse is very similar to the word music. It's where the word originates. Poetry, be it a love poem or an epic poem about a dragon-slaying hero, was sung with a musical accompaniment. Dancing and singing, obviously, were accompanied by music. Theater was always a combination of spoken word and music. History was recounted through song. Even the study of astronomy was linked to the same physical principles as musical harmony, such as the belief held by many Greek thinkers that each of the planets and stars created their own unique sound as they traveled through the cosmos, thrumming like an enormous guitar string light-years long. However, music pervaded more aspects of their lives than just education. Ancient Greeks considered music to be the basis for understanding the fundamental interconnectedness of all things in the universe. This concept of connectivity is known as harmonia, and it's where we get the word harmony. Music was used as a form of medicine to treat illnesses and physical complaints, as a vital accompaniment to sporting contests, and as a means to keep workers in time as they toiled away on monotonous or menial tasks. One of the most important applications of music in Ancient Greek society is found in the belief that music can affect a person's ethos. A word we still use today, ethos is a person's guiding beliefs or personal ethics, the way that one behaves towards oneself and others. The Greek philosopher Plato, one of the most famous and influential Greek thinkers of the time, asserted that music had a direct effect on a person's ethos. Certain kinds of music could incite a person to violence while others could placate a person into a benign, unthinking stupor. According to Plato, only very specific types of music were beneficial to a person's ethos. One should only listen to music that promotes intelligence, self-discipline, and courage, and all other kinds of music must be avoided. Furthermore, Plato fervently denounced any music that deviated from established musical conventions, fearing that doing so would lead to the degradation of the standards of civilization, the corruption of youth, and eventually complete and utter anarchy. While Plato's fears can seem extreme, this argument has appeared in modern times to condemn musical trends such as jazz or punk or rap. What do you think Plato would say about the music you listen to? Is it beneficial to your ethos, or will it degenerate you into a gibbering, amoral barbarian?

**P21 2013-11-27 The loathsome, lethal mosquito - Rose Eveleth**

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What's the worst bug on the planet? You might vote for the horsefly or perhaps the wasp, but for many people, the worst offender is by far the mosquito. The buzzing, the biting, the itching, the mosquito is one of the most commonly detested pests in the world. In Alaska, swarms of mosquitos can get so thick that they actually asphyxiate caribou. And mosquito-borne diseases kill millions of people every year. The scourge that is the mosquito isn't new. Mosquitoes have been around for over a hundred million years and over that time have coevolved with all sorts of species, including our own. There are actually thousands of species of mosquitos in the world, but they all share one insidious quality: they suck blood, and they're really, really good at sucking blood. Here's how they do it. After landing, a mosquito will slather some saliva onto the victim's skin, which works like an antiseptic, numbing the spot so we don't notice their attack. This is what causes the itchy, red bumps, by the way. Then the bug will use its serrated mandibles to carve a little hole in your skin, allowing it to probe around with its proboscis, searching for a blood vessel. When it hits one, the lucky parasite can suck two to three times its weight in blood. Turns out we don't really like that too much. In fact, humans hate mosquitos so much that we spend billions of dollars worldwide to keep them away from us -- from citronella candles to bug sprays to heavy-duty agricultural pesticides. But it's not just that mosquitos are annoying, they're also deadly. Mosquitos can transmit everything from malaria to yellow fever to West Nile virus to dengue. Over a million people worldwide die every year from mosquito-borne diseases, and that's just people. Horses, dogs, cats, they can all get diseases from mosquitoes too. So, if these bugs are so dastardly, why don't we just get rid of them? We are humans after all, and we're pretty good at getting rid of species. Well, it's not quite so simple. Getting rid of the mosquito removes a food source for lots of organisms, like frogs and fish and birds. Without them, plants would lose a pollinator. But some scientists say that mosquitos aren't actually all that important. If we got rid of them, they argue, another species would simply take their place and we'd probably have far fewer deaths from malaria. The problem is that nobody knows what would happen if we killed off all the mosquitos. Something better might take their spot or perhaps something even worse. The question is, are we willing to take that risk? (Buzzing)

**P22 2013-12-06 From DNA to Silly Putty, the diverse world of polymers - Jan Mattingl**

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What do silk, DNA, wood, balloons, and Silly Putty all have in common? They're polymers. Polymers are such a big part of our lives that it's virtually impossible to imagine a world without them, but what the heck are they? Polymers are large molecules made of small units called monomers linked together like the railroad cars from a train. Poly means many, and mono means one, and mers or mero means parts. Many polymers are made by repeating the same small monomer over and over again while others are made from two monomers linked in a pattern. All living things are made of polymers. Some of the organic molecules in organisms are small and simple, having only one of a few functional groups. Others, especially those that play structural roles or store genetic information, are macromolecules. In many cases, these macromolecules are polymers. For example, complex carbohydrates are polymers of simple sugars, proteins are polymers of amino acids, and nucleic acids, DNA and RNA, which contain our genetic information, are polymers of nucleotides. Trees and plants are made of the polymer cellulose. It's the tough stuff you find in bark and stems. Feathers, fur, hair, and fingernails are made up of the protein keratin, also a polymer. It doesn't stop there. Did you know that the exoskeletons of the largest phylum in the animal kingdom, the arthropods, are made of the polymer chitin? Polymers also form the basis for synthetic fibers, rubbers, and plastics. All synthetic polymers are derived from petroleum oil and manufactured through chemical reactions. The two most common types of reactions used to make polymers are addition reactions and condensation reactions. In addition reactions, monomers simply add together to form the polymer. The process starts with a free radical, a species with an unpaired electron. The free radical attacks and breaks the bonds to form new bonds. This process repeats over and over to create a long-chained polymer. In condensation reactions, a small molecule, such as water, is produced with each chain-extending reaction. The first synthetic polymers were created by accident as by-products of various chemical reactions. Thinking they were useless, chemists mostly discarded them. Finally, one named Leo Baekeland decided maybe his useless by-product wasn't so useless after all. His work resulted in a plastic that could be permanently squished into a shape using pressure and high temperatures. Since the name of this plastic, polyoxybenzylmethylenglycolanhydride, wasn't very catchy, advertisers called it Bakelite. Bakelite was made into telephones, children's toys, and insulators for electrical devices. With its development in 1907, the plastics industry exploded. One other familiar polymer, Silly Putty, was also invented by accident. During World War II, the United States was in desperate need of synthetic rubber to support the military. A team of chemists at General Electric attempted to create one but ended up with a gooey, soft putty. It wasn't a good rubber substitute, but it did have one strange quality: it appeared to be extremely bouncy. Silly Putty was born! Synthetic polymers have changed the world. Think about it. Could you imagine getting through a single day without using plastic? But polymers aren't all good. Styrofoam, for example, is made mainly of styrene, which has been identified as a possible carcinogen by the Environmental Protection Agency. As Styrofoam products are being made, or as they slowly deteriorate in landfills or the ocean, they can release toxic styrene into the environment. In addition, plastics that are created by addition polymerization reactions, like Styrofoam, plastic bags, and PVC, are built to be durable and food-safe, but that means that they don't break down in the environment. Millions of tons of plastics are dumped into landfills every year. This plastic doesn't biodegrade, it just breaks down into smaller and smaller pieces, affecting marine life and eventually making their way back to humans. Polymers can be soft or hard, squishy or solid, fragile or strong. The huge variation between means they can form an incredibly diverse array of substances, from DNA to nylon stockings. Polymers are so useful that we've grown to depend on them every day. But some are littering our oceans, cities, and waterways with effects on our health that we're only beginning to understand.

**P23 2013-12-10 The death of the universe - Renée Hlozek**

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Looking up at the night sky, we are amazed by how it seems to go on forever. But what will the sky look like billions of years from now? A particular type of scientist, called a cosmologist, spends her time thinking about that very question. The end of the universe is intimately linked to what the universe contains. Over 100 years ago, Einstein developed the Theory of General Relativity, formed of equations that help us understand the relationship between what a universe is made of and its shape. It turns out that the universe could be curved like a ball or sphere. We call this positively curved or closed. Or it could be shaped like a saddle. We call this negatively curved or open. Or it could be flat. And that shape determines how the universe will live and die. We now know that the universe is very close to flat. However, the components of the universe can still affect its eventual fate. We can predict how the universe will change with time if we measure the amounts or energy densities of the various components in the universe today. So, what is the universe made of? The universe contains all the things that we can see, like stars, gas, and planets. We call these things ordinary or baryonic matter. Even though we see them all around us, the total energy density of these components is actually very small, around 5% of the total energy of the universe. So, now let's talk about what the other 95% is. Just under 27% of the rest of the energy density of the universe is made up of what we call dark matter. Dark matter is only very weakly interacting with light, which means it doesn't shine or reflect light in the way that stars and planets do, but, in every other way, it behaves like ordinary matter -- it attracts things gravitationally. In fact, the only way we can detect this dark matter is through this gravitational interaction, how things orbit around it and how it bends light as it curves the space around it. We have yet to discover a dark matter particle, but scientists all over the world are searching for this elusive particle or particles and the effects of dark matter on the universe. But this still doesn't add up to 100%. The remaining 68% of the energy density of the universe is made up of dark energy, which is even more mysterious than dark matter. This dark energy doesn't behave like any other substance we know at all and acts more like anti-gravity force. We say that it has a gravitational pressure, which ordinary matter and dark matter do not. Instead of pulling the universe together, as we would expect gravity to do, the universe appears to be expanding apart at an ever-increasing rate. The leading idea for dark energy is that it is a cosmological constant. That means it has the strange property that it expands as the volume of space increases to keep its energy density constant. So, as the universe expands as it is doing right now, there will be more and more dark energy. Dark matter and baryonic matter, on the other hand, don't expand with the universe and become more diluted. Because of this property of the cosmological constant, the future universe will be more and more dominated by dark energy, becoming colder and colder and expanding faster and faster. Eventually, the universe will run out of gas to form stars, and the stars themselves will run out of fuel and burn out, leaving the universe with only black holes in it. Given enough time, even these black holes will evaporate, leaving a universe that is completely cold and empty. That is what we call the heat death of the universe. While it might sound depressing living in a universe that will end its lifetime cold and devoid of life, the end fate of our universe actually has a beautiful symmetry to its hot, fiery beginning. We call the accelerating end state of the universe a de Sitter phase, named after the Dutch mathematician Willem de Sitter. However, we also believe that the universe had another phase of de Sitter expansion in the earliest times of its life. We call this early period inflation, where, shortly after the Big Bang, the universe expanded extremely fast for a brief period. So, the universe will end in much the same state as it began, accelerating. We live at an extraordinary time in the life of the universe where we can start to understand the universe's journey and view a history that plays itself out on the sky for all of us to see.

**P24 2013-12-11 My glacier cave discoveries - Eddy Cartaya**

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So how many of you have ever been in a cave before? Okay, a few of you. When you think of a cave, most of you think of a tunnel going through solid rock. In fact, that's how most caves are. Around this half of the country, most of your caves are made of limestone. Back where I'm from, most of our caves are made from lava rock because we have a lot of volcanoes out there. But the caves I want to share with you today are made completely of ice, specifically glacier ice as formed in the side of the tallest mountain in the state of Oregon called Mount Hood. Now, Mount Hood's only one hour's drive from Portland, the largest city in Oregon where over two million people live. Now, the most exciting thing for a cave explorer is to find a new cave and be the first human to ever go into it. The second most exciting thing for a cave explorer is to be the first one to make a map of a cave. Now, these days, with so many people hiking around, it's pretty hard to find a new cave, so you can imagine how excited we were to find three new caves within sight of Oregon's largest city and realize that they have never been explored or mapped before. It was kind of like being an astronaut because we were getting to see things and go places that no one had ever seen or gone before. So, what is a glacier? Well, those of you that have ever seen or touched snow, you know that it's really light because it's just a bunch of tiny ice crystals clumped together and it's mostly air. If you squish a handful of snow to make a snowball, it gets really small, hard, and dense. Well, in a mountain like Hood where it snows over twenty feet a year, it crushes the air out of it and gradually forms it into hard, blue ice. Now, each year more and more ice stacks up on top of it and eventually gets so heavy that it starts to slide down the mountain under its own weight, forming a slow-moving river of ice. When an ice pack like that starts to move, we call it a glacier and we give it a name. The name of the glacier these caves were formed is the Sandy Glacier. Now, each year as new snow lands on the glacier, it melts in the summer sun, and it forms little rivers of water on the flow along the ice and they start to melt and bore their way down through the glacier, forming big networks of caves, sometimes going all the way down to the underlying bedrock. Now, the crazy thing about glacier caves is that each year new tunnels form, different waterfalls pop up or move around from place to place inside the cave. Warm water from the top of the ice is boring its way down, and warm air from below the mountain actually rises up, gets into the cave, and melts the ceilings back taller and taller. But the weirdest thing about glacier caves is that the entire cave is moving because it's formed inside a block of ice the size of a small city that's slowly sliding down the mountain. Now, this is Brent McGregor, my cave exploration partner. He and I have both been exploring caves a long time and we've been climbing mountains a long time, but neither of us have ever really explored a glacier cave before. Back in 2011, Brent saw a YouTube video of a couple of hikers that stumbled across the entrance to one of these caves. There were no GPS coordinates for it, and all we knew was that it was somewhere out on the Sandy Glacier. So, in July of that year, we went out on the glacier, and we found a big crack in the ice. We had to build snow and ice anchors, so we could tie off ropes and repel down into the hole. This is me looking into the entrance crevasse. At the end of this hole, we found a huge tunnel going right up the mountain underneath thousands of tons of glacier ice. We followed this cave back for about a half mile until it came to an end. And then with the help of our survey tools, we made a three-dimensional map of the cave on our way back out. So, how do you map a cave? Well, cave maps aren't like trail maps or road maps because they have pits and holes going to overlapping levels. To make a cave map, you have to set up survey stations every few feet inside the cave, and you use a laser to measure the distance between those stations. And you use a compass and an inclinometer to measure the direction the cave is headed and measure the slope of the floor and the ceilings. Now, those of you taking trigonometry, that particular type of math is very useful for making maps like this because it allows you to measure heights and distances without actually having to go there. In fact, the more I mapped and studied caves, the more useful I found all that math that I originally hated in school to be. So, when you're done surveying, you take all this data, you punch it into the computer, and you find someone that can draw really well, and you have them draft up a map that looks something like this. And it will show you both a bird's eye view of the passage as well as a profile view of the passage, kind of like an ant farm view. We named this cave Snow Dragon Cave because it was like a big dragon sleeping under the snow. Now, later this summer as more snow melted off the glacier, we found more caves, and we realized they were all connected. Not long after we mapped Snow Dragon, Brent discovered this new cave not very far away. The inside of it was coated with ice so we had to wear big spikes in our feet called crampons, so we could walk around without slipping. This cave was amazing! The ice in the ceiling was glowing blue and green because the sunlight from far above was shining through the ice and lighting it all up. Now, we couldn't understand why this cave was so much colder than Snow Dragon until we got to the end, and we found out why. There was a huge pit or shaft called a moulin going a 130 feet straight up to the surface of the glacier. Cold air from the top of the mountain was flowing down this hole, blasting through the cave, freezing everything inside of it. And we were so excited about finding this new pit, we actually came back in January the following year so we could be the first ones to explore it. It was so cold outside, we actually had to sleep inside the cave. Here's our camp on the left side of this entrance room. The next morning we climbed out of the cave and hiked all the way to the top of the glacier where we finally rigged and repelled this pit for the very first time. Brent named this cave Pure Imagination, I think, because the beautiful sights we saw in there were beyond what we could have ever imagined. So, besides really cool ice, what else is inside these caves? Well, not too much lives in them because they're so cold, and the entrance is actually covered up with snow for about eight months of the year, but there are some really cool things in there. There's weird bacteria living in the water that actually eat and digest rocks to make their own food to live under this ice. In fact, this past summer scientists collected samples of water and ice specifically to see if things called extremophiles, tiny lifeforms that have evolved to live in a completely hostile conditions, might be living under the ice, kind of like what they hope to find in the polar ice caps of Mars some day. Another really cool thing is that as seeds and birds land on the surface of the glacier and die, they get buried in the snow and gradually become part of the glacier, sinking deeper and deeper into the ice. As these caves form and melt their way up into the ice, they make these artifacts rain down from the ceiling and fall into the cave floor where we end up finding them. For example, this is a nodal first seed we found. It's been frozen in ice for over a hundred years, and it's just now starting to sprout. This mallard duck feather was found over 1800 feet in the back of Snow Dragon Cave. This duck died on the surface of the glacier long, long ago, and its feathers have finally made it down through over a hundred feet of ice before falling inside the cave. And this beautiful quartz crystal was also found in the back of Snow Dragon. Even now Brent and I find it hard to believe that all these discoveries were essentially in our own backyard, hidden away just waiting to be found. Like I said earlier, the idea of discovery in this busy world we live in kind of seems like something you can only do with space travel now, but that's not true. Every year new caves get discovered that no one has ever been in before. So, it's actually not too late for one of you to become a discoverer yourself. You just have to be willing to look and go where people don't often go and focus your eyes and your mind to recognize the discovery when you see it because it might be in your own backyard. Thank you very much.

**P25 2013-12-16 The popularity, plight and poop of penguins - Dyan deNapoli**

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Penguins have long captured the imagination and the hearts of people the world over. But while popular culture depicts them as clumsy, adorable birds with endlessly abundant populations, the truth is that penguins are exceedingly graceful, often ornery, and their populations are in rapid free fall. Their real life situation is far more precarious than people think. And if current trends do not change, it may not be long before penguins can only be found in movies. There are many things about penguins that make them odd birds, so to speak. For one thing, they are one of the few bird species that cannot fly, having evolved from flight-capable birds about 60 million years ago. Surprisingly, their closest living relative is the albatross, a bird known for its enormous wingspan and extraordinary soaring abilities. It may seem strange that losing the ability to fly would be an evolutionary advantage, but the penguin's short, flipper-like wings and solid bones allow them to swim faster and dive deeper than any other bird on Earth, filling an ecological niche that no other bird can. Penguins inhabit the southern hemisphere, being one of the few bird species able to breed in the coldest environments. But contrary to popular belief, they are not restricted to cold regions nor are there any at the North Pole. In fact, only 4 of the 18 penguin species regularly live and breed in Antarctica. Most penguins live in subtemperate to temperate regions. And the Galapagos penguin even lives and breeds right near the equator off the coast of South America. They are also found in South Africa, Namibia, Australia, and New Zealand, as well as on a number of islands in the southern Atlantic, Pacific, Indian, and Antarctic Oceans. Although penguins spend 75% of their lives at sea, they must come to shore every year to reproduce and to molt their feathers. They do this in a variety of places, from the temporary ice sheets of the Antarctic to the beaches of South Africa and Namibia, to the rocky shores of subantarctic islands, to the craggy lava surfaces in the Galapagos. Different penguin species have different nesting practices. Some dig burrows into dirt, sand, or dried guano; some nest in tussock grasses; some build nests out of small rocks, sticks, and bones; while others don't build any nests at all. Although most penguins lay a clutch of two eggs, the two largest species, the King and the Emperor, lay a single egg that they incubate on top of their feet for approximately two months. Unfortunately, 15 of the 18 penguin species are currently listed as threatened, near-threatened, or endangered by the International Union for Conservation of Nature. In the last several decades, we have seen the world populations of most penguin species decline by up to 90%, with two of them, the Yellow-eyed and Galapagos penguins, down to just a few thousand birds. Penguins are an indicator species, the proverbial "canary in the coal mine." Simply put, if penguins are dying, it means our oceans are dying. And sadly, most of this decline is attributable to human activities. Historically, penguins have had to deal with multiple disturbances. The mass collection of penguin eggs and the harvesting of the seabird guano they nested in caused the dramatic decline of several penguin species. If you're wondering what humans would want with seabird poop, it was used as an ingredient in fertilizer and in gunpowder, being so valuable that in the 19th century, it was known as white gold. Current threats to penguins include the destruction of both marine and terrestrial habitats, introduced predators, entrapment in fishing nets, and pollution from plastics and chemicals. There have also been several large-scale oil spills over the past 50 years that have killed or impacted tens of thousands of penguins around the world. But the two major threats to penguins today are global warming and overfishing. Global warming impacts penguins in multiple ways, from interrupting the production of krill due to decreased sea ice formation in the Antarctic, to increasing the frequency and severity of storms that destroy nests, to shifting the cold water currents carrying the penguins' prey too far away from penguin breeding and foraging grounds. Even though humans may be the greatest threat to penguins, we are also their greatest hope. Many research and conservation projects are underway to protect penguin habitats and restore vulnerable populations. With a little help from us and some changes in the practices that impact our planet and oceans, there is hope that our tuxedo-clad friends will still be around in the next century.

**P26 2013-12-16 The true story of 'true' - Gina Cooke**

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Everyone knows that stories are made up of words, from short poems to epic novels. But did you know that a single word itself can tell an entire story? You see, just as we can look at a story's plot, setting, and characters, we can also study the history of an individual word, where it developed, and the cultures and people who helped shape it. Looking into the story of a word is like counting the rings of a tree. Newer words, like Google or cyborg, have shorter stories. But the older the word, the longer the story and the more it stands to reveal to us not only about itself, but about ourselves and our history. The oldest words in present-day English are those that come from Old English, the ancestor of our modern language whose first seeds were planted about 1500 years ago. Compared to languages like Greek or Chinese that date back thousands of years, English is just a sapling in the lexical forest. But the stories of its words often start long before English itself took root. One such word is the familiar word true, as in true stories. Let's take a look. True usually means factual, correct, or faithful to reality. It can also mean exact, properly positioned, upright, or straight. A true friend is loyal, reliable, faithful, and steadfast. The word true is a simple word, and we can add some affixes to grow its family tree with words like truer, truest, truly, truth, and untruth. But if we go in the other direction to look at the roots of true itself, we find even more relatives further up the family tree. The words trust, bethroth, and truce all derive from the same source as true, and these words all denote faithfulness or confidence. A thousand years ago, the word true looked and sounded different than it does today. In several Old English dialects, the word treow was a noun that meant good faith or trust, a pledge or a promise. But it also had another definition, tree, and that's no coincidence. If we trace the roots back even farther, we find that both meanings derive from a common origin, where some of the earliest expressions of the concept of truth were associated with the uprightness of an oak, the steadiness of a silver birch, and the fidelity of an orchard baring fruit year after year. This may sound like a stretch at first, but trees are the oldest living organisms on this planet. Some that would have been called treow long ago still stand today. The Fortingall Yew in Scotland is more than 2,000 years old. A Californian Bristlecone Pine is more than 5,000. And Utah's Pando-quaking Aspen Grove has a single root system that dates back more than 80 millennia. Trees have also held a sacred place in many cultures throughout history. The Celtic peoples who first inhabited the British Isles believed that trees housed deities. And, in fact, the ancient Druids take their name from the same ancient root as tree. Planting a tree is itself an act of faith and commitment. Not only are trees upright and prototypically straight, but they are actual, solid, and real, something you can see and touch. And they are as reliable and steadfast to us today as they were a millennium ago, nurturing us, sheltering us, and providing the pages of our books. Philosophers and poets, people in search of the truth, have often sought it in trees. "What did the tree learn from the Earth to be able to talk with the sky?" asked Pablo Neruda. "A tree falls the way it leans," says an old proverb. Just as trees mark our landscapes and witness our histories, the stories of words landscape our language, capturing the rains and sunshine of generations and sending roots and branches far and wide. As there is a whole orchard in a single seed, there is a whole story in a single word, and that's the truth.

**P27 2013-12-18 How do we smell - Rose Eveleth**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=27)

It's the first sense you use when you're born. One out of every fifty of your genes is dedicated to it. It must be important, right? Okay, take a deep breath through your nose. It's your sense of smell, and it's breathtakingly powerful. As an adult, you can distinguish about 10,000 different smells. Here's how your nose does it. Smell starts when you sniff molecules from the air into your nostrils. 95% of your nasal cavity is used just to filter that air before it hits your lungs. But at the very back of your nose is a region called the olfactory epithelium, a little patch of skin that's key to everything you smell. The olfactory epithelium has a layer of olfactory receptor cells, special neurons that sense smells, like the taste buds of your nose. When odor molecules hit the back of your nose, they get stuck in a layer of mucus covering the olfactory epithelium. As they dissolve, they bind to the olfactory receptor cells, which fire and send signals through the olfactory tract up to your brain. As a side note, you can tell a lot about how good an animal's sense of smell is by the size of its olfactory epithelium. A dog's olfactory epithelium is 20 times bigger than your puny human one. But there's still a lot we don't know about this little patch of cells, too. For example, our olfactory epithelium is pigmented, and scientists don't really know why. But how do you actually tell the difference between smells? It turns out that your brain has 40 million different olfactory receptor neurons, so odor A might trigger neurons 3, 427, and 988, and odor B might trigger neurons 8, 76, and 2,496,678. All of these different combinations let you detect a staggeringly broad array of smells. Olfactory neurons are always fresh and ready for action. They're the only neuron in the body that gets replaced regularly, every four to eight weeks. Once they are triggered, the signal travels through a bundle called the olfactory tract to destinations all over your brain, making stops in the amygdala, the thalamus, and the neocortex. This is different from how sight and sound are processed. Each of those signals goes first to a relay center in the middle of the cerebral hemisphere and then out to other regions of the brain. But smell, because it evolved before most of your other senses, takes a direct route to these different regions of the brain, where it can trigger your fight-or-flight response, help you recall memories, or make your mouth water. But even though we've all got the same physiological set-up, two nostrils and millions of olfactory neurons, not everybody smells the same things. One of the most famous examples of this is the ability to smell so-called "asparagus pee." For about a quarter of the population, urinating after eating asparagus means smelling a distinct odor. The other 75% of us don't notice. And this isn't the only case of smells differing from nose to nose. For some people, the chemical androstenone smells like vanilla; to others, it smells like sweaty urine, which is unfortunate because androstenone is commonly found in tasty things like pork. So with the sweaty urine smellers in mind, pork producers will castrate male pigs to stop them from making androstenone. The inability to smell a scent is called anosmia, and there are about 100 known examples. People with allicin anosmia can't smell garlic. Those with eugenol anosmia can't smell cloves. And some people can't smell anything at all. This kind of full anosmia could have several causes. Some people are born without a sense of smell. Others lose it after an accident or during an illness. If the olfactory epithelium gets swollen or infected, it can hamper your sense of smell, something you might have experienced when you were sick. Not being able to smell anything can mess with your other senses, too. Many people who can't smell at all also can't really taste the same way the rest of us do. It turns out that how something tastes is closely related to how it smells. As you chew your food, air is pushed up your nasal passage, carrying with it the smell of your food. Those scents hit your olfactory epithelium and tell your brain a lot about what you're eating. Without the ability to smell, you lose the ability to taste anything more complicated than the five tastes your taste buds can detect: sweet, salty, bitter, sour, and savory. So, the next time you smell exhaust fumes, salty sea air, or roast chicken, you'll know exactly how you've done it and, perhaps, be a little more thankful that you can.

**P28 2013-12-24 Should we eat bugs - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=28)

[Why don't we eat bugs?] For centuries, people have consumed bugs, everything from beetles to caterpillars, locusts, grasshoppers, termites, and dragonflies. The practice even has a name: entomophagy. Early hunter-gatherers probably learned from animals that foraged for protein-rich insects and followed suit. As we evolved and bugs became part of our dietary tradition, they fulfilled the role of both staple food and delicacy. In ancient Greece, cicadas were considered luxury snacks. And even the Romans found beetle larvae to be scrumptious. Why have we lost our taste for bugs? The reason for our rejection is historical, and the story probably begins around 10,000 BC in the Fertile Crescent, a place in the Middle East that was a major birthplace of agriculture. Back then, our once-nomadic ancestors began to settle in the Crescent. And as they learned to farm crops and domesticate animals there, attitudes changed, rippling outwards towards Europe and the rest of the Western world. As farming took off, people might have spurned bugs as mere pests that destroyed their crops. Populations grew, and the West became urbanized, weakening connections with our foraging past. People simply forgot their bug-rich history. Today, for people not accustomed to entomophagy, bugs are just an irritant. They sting and bite and infest our food. We feel an "ick factor" associated with them and are disgusted by the prospect of cooking insects. Almost 2,000 insect species are turned into food, forming a big part of everyday diets for two billion people around the world. Countries in the tropics are the keenest consumers, because culturally, it's acceptable. Species in those regions are also large, diverse, and tend to congregate in groups or swarms that make them easy to harvest. Take Cambodia in Southeast Asia where huge tarantulas are gathered, fried, and sold in the marketplace. In southern Africa, the juicy mopane worm is a dietary staple, simmered in a spicy sauce or eaten dried and salted. And in Mexico, chopped jumiles are toasted with garlic, lemon, and salt. Bugs can be eaten whole to make up a meal or ground into flour, powder, and paste to add to food. But it's not all about taste. They're also healthy. In fact, scientists say entomophagy could be a cost-effective solution for developing countries that are food insecure. Insects can contain up to 80% protein, the body's vital building blocks, and are also high in energy-rich fat, fiber, and micronutrients like vitamins and minerals. Did you know that most edible insects contain the same amount or even more mineral iron than beef, making them a huge, untapped resource when you consider that iron deficiency is currently the most common nutritional problem in the world? The mealworm is another nutritious example. The yellow beetle larvae are native to America and easy to farm. They have a high vitamin content, loads of healthy minerals, and can contain up to 50% protein, almost as much as in an equivalent amount of beef. To cook, simply sauté in butter and salt or roast and drizzle with chocolate for a crunchy snack. What you have to overcome in "ick factor," you gain in nutrition and taste. Indeed, bugs can be delicious. Mealworms taste like roasted nuts. Locusts are similar to shrimp. Crickets, some people say, have an aroma of popcorn. Farming insects for food also has less environmental impact than livestock farms do because insects emit far less greenhouse gas and use up less space, water, and food. Socioeconomically, bug production could uplift people in developing countries since insect farms can be small scale, highly productive, and yet relatively inexpensive to keep. Insects can also be turned into more sustainable food for livestock and can be reared on organic waste, like vegetable peelings, that might otherwise just end up rotting in landfills. Feeling hungry yet? Faced with a plate of fried crickets, most people today would still recoil, imagining all those legs and feelers getting stuck between their teeth. But think of a lobster. It's pretty much just a giant insect with legs and feelers galore that was once regarded as an inferior, repulsive food. Now, lobster is a delicacy. Can the same paradigm shift happen for bugs? So, give it a try! Pop that insect into your mouth, and savor the crunch.

**P29 2014-01-06 How sugar affects the brain - Nicole Avena**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=29)

Picture warm, gooey cookies, crunchy candies, velvety cakes, waffle cones piled high with ice cream. Is your mouth watering? Are you craving dessert? Why? What happens in the brain that makes sugary foods so hard to resist? Sugar is a general term used to describe a class of molecules called carbohydrates, and it's found in a wide variety of food and drink. Just check the labels on sweet products you buy. Glucose, fructose, sucrose, maltose, lactose, dextrose, and starch are all forms of sugar. So are high-fructose corn syrup, fruit juice, raw sugar, and honey. And sugar isn't just in candies and desserts, it's also added to tomato sauce, yogurt, dried fruit, flavored waters, or granola bars. Since sugar is everywhere, it's important to understand how it affects the brain. What happens when sugar hits your tongue? And does eating a little bit of sugar make you crave more? You take a bite of cereal. The sugars it contains activate the sweet-taste receptors, part of the taste buds on the tongue. These receptors send a signal up to the brain stem, and from there, it forks off into many areas of the forebrain, one of which is the cerebral cortex. Different sections of the cerebral cortex process different tastes: bitter, salty, umami, and, in our case, sweet. From here, the signal activates the brain's reward system. This reward system is a series of electrical and chemical pathways across several different regions of the brain. It's a complicated network, but it helps answer a single, subconscious question: should I do that again? That warm, fuzzy feeling you get when you taste Grandma's chocolate cake? That's your reward system saying, "Mmm, yes!" And it's not just activated by food. Socializing, sexual behavior, and drugs are just a few examples of things and experiences that also activate the reward system. But overactivating this reward system kickstarts a series of unfortunate events: loss of control, craving, and increased tolerance to sugar. Let's get back to our bite of cereal. It travels down into your stomach and eventually into your gut. And guess what? There are sugar receptors here, too. They are not taste buds, but they do send signals telling your brain that you're full or that your body should produce more insulin to deal with the extra sugar you're eating. The major currency of our reward system is dopamine, an important chemical or neurotransmitter. There are many dopamine receptors in the forebrain, but they're not evenly distributed. Certain areas contain dense clusters of receptors, and these dopamine hot spots are a part of our reward system. Drugs like alcohol, nicotine, or heroin send dopamine into overdrive, leading some people to constantly seek that high, in other words, to be addicted. Sugar also causes dopamine to be released, though not as violently as drugs. And sugar is rare among dopamine-inducing foods. Broccoli, for example, has no effect, which probably explains why it's so hard to get kids to eat their veggies. Speaking of healthy foods, let's say you're hungry and decide to eat a balanced meal. You do, and dopamine levels spike in the reward system hot spots. But if you eat that same dish many days in a row, dopamine levels will spike less and less, eventually leveling out. That's because when it comes to food, the brain evolved to pay special attention to new or different tastes. Why? Two reasons: first, to detect food that's gone bad. And second, because the more variety we have in our diet, the more likely we are to get all the nutrients we need. To keep that variety up, we need to be able to recognize a new food, and more importantly, we need to want to keep eating new foods. And that's why the dopamine levels off when a food becomes boring. Now, back to that meal. What happens if in place of the healthy, balanced dish, you eat sugar-rich food instead? If you rarely eat sugar or don't eat much at a time, the effect is similar to that of the balanced meal. But if you eat too much, the dopamine response does not level out. In other words, eating lots of sugar will continue to feel rewarding. In this way, sugar behaves a little bit like a drug. It's one reason people seem to be hooked on sugary foods. So, think back to all those different kinds of sugar. Each one is unique, but every time any sugar is consumed, it kickstarts a domino effect in the brain that sparks a rewarding feeling. Too much, too often, and things can go into overdrive. So, yes, overconsumption of sugar can have addictive effects on the brain, but a wedge of cake once in a while won't hurt you.

**P30 2014-01-06 How to fossilize...yourself - Phoebe A. Cohen**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=30)

Imagine being a fossil: touring the world's great museums, inspiring awe in onlookers of all ages, posing for hordes of fawning photographers. Sound like something you'd like? Well, good luck! At least 99.9% of creatures that have ever lived aren't preserved in the fossil record. But forget about them, everyone else will, and listen up! If you want your corpse in the exclusive 0.01% Club, the Hall of Preserved Fossil Fame, it will not be easy. You better work! Step one: die. It's a cold, hard fact of fossilization. Everything paleontologists find was once alive and, at some point, died. We'll skip the details and assume you had a long, fulfilling life so we can get to what is really important -- how you die. There are many ways to become a fossil, so let's highlight your top death options. You could get yourself trapped in tree sap, which, when hardens, turns into amber and can survive intact for millions of years. But unless you find a really big tree to sit under, amber preservation will likely remain the domain of insects and other very small animals. Generally, the right place to be if you want to end up a fossil is wherever sediment is actively being deposited, like a lake or an ocean floor. A mountaintop or prairie? Not good! You need to get buried, the faster the better, because the longer you hang around on the surface, the more likely you'll get eaten, scavenged, or otherwise destroyed before ever having a chance to get preserved. If you can get buried someplace with little to no oxygen, like a bog or a deep lake bottom, even better. That lack of oxygen will slow down your decay and give you more time to fossilize. So, let's say you're lucky enough to die and get buried in a shallow sea under muddy, sandy sediments. What's your next move? One option is a process called permineralization. While all your soft parts decay away, your bones get saturated with mineral-rich waters. Bit by bit, microscopic crystals precipitate out of these waters to fill in the empty spaces and pores in your bones. Otherwise, you'd better hope the sediments around you harden while your bones decay away and another sediment or mineral fills in the spaces your bones leave behind, creating a perfect cast of your skeleton. Over time, the sediments around your fossil will lithify or turn into rock. But you're not in the clear yet! Many things could happen to those sedimentary rocks that might destroy your chances of getting discovered. They could get uplifted into a mountain range and eroded away or carried along in an oceanic plate and subducted back into the Earth's mantle, melting your fossil into hot mush. Fingers crossed your rock surroundings will get gently lifted up by plate tectonics, sea levels will change, and you'll end up under dry land close to the surface, but not so close that erosion from wind and rain wipes you away before someone can come find you. The last step in this long process, an intrepid paleontologist has to come find you. Maybe she's a research scientist scouting for fossils your age and type or just an amateur collector hoping for a fortuitous find. She whacks away at layers of rock above you or spots your fossil exposed in a creek bank after a flood. And there you are, a magnificent scientific discovery, millions of years in the making! She and her colleagues gently extract you from the surrounding sediment, measure and photograph all the bits and pieces they find, and begin the complex task of reconstructing how and when you lived based on the evidence they find in your bones. Paleontologists will be some of your biggest fans along with all those admiring crowds at the museum. You made it! You spent years underground in obscurity, shedding blood, sweat, tears, and your internal organs. You worked yourself to the bone until your bones disintegrated and were replaced by minerals and sediments. But it was all worth it because you're a famous fossil! Now, you better hold that pose!

**P31 2014-01-08 How to build a fictional world - Kate Messner**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=31)

In J.R.R.'s world, Gandalf is one of five wizards sent by the Valar to guide the inhabitants of Middle Earth in their struggles against the dark force of Sauron. Gandalf's body was mortal, subject to the physical rules of Middle Earth, but his spirit was immortal, as seen when he died as Gandalf the Grey and resurrected as Gandalf the White. According to the Wachowski's script, an awakened human only has to link up and hack the neon binary code of the Matrix to learn how to fly a helicopter in a matter of seconds. Or if you are the One, or one of the Ones, you don't even need a helicopter, you just need a cool pair of shades. Cheshire cats can juggle their own heads. iPads are rudimentary. No Quidditch match ends until the Golden Snitch is caught. And the answer to the ultimate question of life, the universe, and everything is most certainly 42. Just like real life, fictional worlds operate consistently within a spectrum of physical and societal rules. That's what makes these intricate worlds believable, comprehensible, and worth exploring. In real life, the Law of Gravity holds seven book sets of "Harry Potter" to millions of bookshelves around the world. We know this to be true, but we also know that ever since J.K. typed the words wizard, wand, and "Wingardium Leviosa," that Law of Gravity has ceased to exist on the trillions of pages resting between those bookends. Authors of science fiction and fantasy literally build worlds. They make rules, maps, lineages, languages, cultures, universes, alternate universes within universes, and from those worlds sprout story, after story, after story. When it's done well, readers can understand fictional worlds and their rules just as well as the characters that live in them do and sometimes, just as well or even better than the reader understands the world outside of the book. But how? How can human-made squiggles on a page reflect lights into our eyes that send signals to our brains that we logically and emotionally decode as complex narratives that move us to fight, cry, sing, and think, that are strong enough not only to hold up a world that is completely invented by the author, but also to change the reader's perspective on the real world that resumes only when the final squiggle is reached? I'm not sure anyone knows the answer to that question, yet fantastical, fictional worlds are created everyday in our minds, on computers, even on napkins at the restaurant down the street. The truth is your imagination and a willingness to, figuratively, live in your own world are all you need to get started writing a novel. I didn't dream up Hogwarts or the Star Wars' Cantina, but I have written some science thrillers for kids and young adults. Here are some questions and methods I've used to help build the worlds in which those books take place. I start with a basic place and time. Whether that's a fantasy world or a futuristic setting in the real world, it's important to know where you are and whether you're working in the past, present, or future. I like to create a timeline showing how the world came to be. What past events have shaped the way it is now? Then I brainstorm answers to questions that draw out the details of my fictional world. What rules are in place here? This covers everything from laws of gravity, or not, to the rules of society and the punishments for individuals who break them. What kind of government does this world have? Who has power, and who doesn't? What do people believe in here? And what does this society value most? Then it's time to think about day-to-day life. What's the weather like in this world? Where do the inhabitants live and work and go to school? What do they eat and how do they play? How do they treat their young and their old? What relationships do they have with the animals and plants of the world? And what do those animals and plants look like? What kind of technology exists? Transportation? Communication? Access to information? There's so much to think about! So, spend some time living in those tasks and the answers to those questions, and you're well on your way to building your own fictional world. Once you know your world as well as you hope your reader will, set your characters free in it and see what happens. And ask yourself, "How does this world you created shape the individuals who live in it? And what kind of conflict is likely to emerge?" Answer those questions, and you have your story. Good luck, future world-builder!

**P32 2014-01-10 Start a TED-Ed Club today!**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=32)

There are over two billion school-aged individuals living in the world today. That's more young people than any other time in human history. That's billions of minds teaming with uninhibited creativity. That's billions of curious souls. The world's youth is the embodiment of the world's future, and that future has no limits because each and every young person brings a completely new and a completely unique perspective to the world around them. Ayana is passionately pursuing the meaning of life, among other things. What will life come to mean to her and to her closest friends? Will future smartphone owners download a student-built mood app, and will they prefer iteration number one or number two? Will Sophia become an Olympian, a teacher, an advocate for world peace, or will she become all three? And will Tyler's obsession with space and his pursuit of infinity lead him to travel beyond the world his ideas and the ideas of his peers will most certainly define? Picture the collective potential and the ideas of over two billion passionate young people. TED-Ed is thrilled to announce a new program that aims to give them the space and time to pursue those passions and to support them in presenting those ideas in the form of short, TED-like talks. The program is called TED-Ed Clubs. The mission: to celebrate the best ideas of young people around the world. Here's how it works. Visit ed.ted.com and fill out the club facilitator application. Once approved, you'll receive access to a set of free tools designed to help you start a TED-Ed Club at your school. There are 13 suggested meetings. Each meeting helps club members gain a discrete presentation skill. In the final meetings, club members present their ideas in the form of short, TED-like talks. Teachers, you can nominate presentations to be featured on TED-Ed or at the annual TED Youth conference. And students, the world is waiting to be redefined by your biggest, smallest, boldest, quirkiest, bravest, most inspiring, and most brilliant ideas!

**P33 2014-01-10 The mystery of motion sickness - Rose Eveleth**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=33)

Can you read in the car? If so, consider yourself pretty lucky. For one-third of the population, looking at a book while moving along in a car or a boat or train or plane quickly makes them sick to their stomach. But why do we get motion sickness in the first place? Well, believe it or not, scientists aren't exactly sure. The most common theory has to do with mismatched sensory signals. When you travel in a car, your body gets two different messages. Your eyes are seeing the inside of a vehicle, which doesn't seem to be moving. Meanwhile, your ear is telling your brain you're accelerating. Wait, your ear? Your ear has another important function besides hearing. In its innermost part lies a group of structures known as the vestibular system, which gives us our sense of balance and movement. Inside there are three semicircular tubules that can sense rotation, one for each dimension of space. And there are also two hair-lined sacks filled with fluid. When you move, the fluid shifts and tickles the hairs, telling your brain if you're moving horizontally or vertically. All this tells your body which direction you're moving in, how much you've accelerated, even at what angle. In a car, your vestibular system correctly senses your movement, but your eyes don't see it, especially when glued to a book. The opposite can happen. You're at the movies, and the camera makes a sweeping move. This time, your eyes think you're moving while your ear knows you're sitting still. But why does this conflicting information make us feel so terrible? Scientists aren't sure, but they think there's an evolutionary explanation. Fast moving vehicles and video recordings have only existed in the last couple of centuries, a blink in evolutionary time. For most of our history, there wasn't that much that could cause this sensory mix-up, except for poisons. And because poisons are not the best thing for survival, our bodies evolved a direct but unpleasant way to get rid of what we ate that was causing the confusion. It's a pretty reasonable theory, but it leaves things unexplained, like why women are more affected by motion sickness than men, or why passengers get more nauseous than drivers. Another theory suggests that the cause is more about the way some unfamiliar situations make it harder to maintain our natural body posture. Studies show that being immersed in water or just changing your stance can greatly reduce the effects of motion sickness. But we don't really know what's going on. We know the more common remedies for car queasiness -- looking at the horizon, over-the-counter pills, chewing gum, but none are totally reliable nor can they handle intense motion sickness and sometimes the stakes are far higher than just not being bored during a long car ride. At NASA, where astronauts are hurled into space at 17,000 miles per hour, motion sickness is a serious problem. In addition to researching the latest space-age technologies, NASA also spends a lot of time figuring out how to keep astronauts from vomiting up their space rations. Like understanding the mysteries of sleep or curing the common cold, motion sickness is one of those seemingly simple problems that, despite amazing scientific progress, we still know very little about. Perhaps one day the exact cause of motion sickness will be found, and with it, a completely effective way to prevent it, but that day is still on the horizon.

**P34 2014-01-16 The Infinite Hotel Paradox - Jeff Dekofsky**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=34)

In the 1920's, the German mathematician David Hilbert devised a famous thought experiment to show us just how hard it is to wrap our minds around the concept of infinity. Imagine a hotel with an infinite number of rooms and a very hardworking night manager. One night, the Infinite Hotel is completely full, totally booked up with an infinite number of guests. A man walks into the hotel and asks for a room. Rather than turn him down, the night manager decides to make room for him. How? Easy, he asks the guest in room number 1 to move to room 2, the guest in room 2 to move to room 3, and so on. Every guest moves from room number "n" to room number "n+1". Since there are an infinite number of rooms, there is a new room for each existing guest. This leaves room 1 open for the new customer. The process can be repeated for any finite number of new guests. If, say, a tour bus unloads 40 new people looking for rooms, then every existing guest just moves from room number "n" to room number "n+40", thus, opening up the first 40 rooms. But now an infinitely large bus with a countably infinite number of passengers pulls up to rent rooms. countably infinite is the key. Now, the infinite bus of infinite passengers perplexes the night manager at first, but he realizes there's a way to place each new person. He asks the guest in room 1 to move to room 2. He then asks the guest in room 2 to move to room 4, the guest in room 3 to move to room 6, and so on. Each current guest moves from room number "n" to room number "2n" -- filling up only the infinite even-numbered rooms. By doing this, he has now emptied all of the infinitely many odd-numbered rooms, which are then taken by the people filing off the infinite bus. Everyone's happy and the hotel's business is booming more than ever. Well, actually, it is booming exactly the same amount as ever, banking an infinite number of dollars a night. Word spreads about this incredible hotel. People pour in from far and wide. One night, the unthinkable happens. The night manager looks outside and sees an infinite line of infinitely large buses, each with a countably infinite number of passengers. What can he do? If he cannot find rooms for them, the hotel will lose out on an infinite amount of money, and he will surely lose his job. Luckily, he remembers that around the year 300 B.C.E., Euclid proved that there is an infinite quantity of prime numbers. So, to accomplish this seemingly impossible task of finding infinite beds for infinite buses of infinite weary travelers, the night manager assigns every current guest to the first prime number, 2, raised to the power of their current room number. So, the current occupant of room number 7 goes to room number 2^7, which is room 128. The night manager then takes the people on the first of the infinite buses and assigns them to the room number of the next prime, 3, raised to the power of their seat number on the bus. So, the person in seat number 7 on the first bus goes to room number 3^7 or room number 2,187. This continues for all of the first bus. The passengers on the second bus are assigned powers of the next prime, 5. The following bus, powers of 7. Each bus follows: powers of 11, powers of 13, powers of 17, etc. Since each of these numbers only has 1 and the natural number powers of their prime number base as factors, there are no overlapping room numbers. All the buses' passengers fan out into rooms using unique room-assignment schemes based on unique prime numbers. In this way, the night manager can accommodate every passenger on every bus. Although, there will be many rooms that go unfilled, like room 6, since 6 is not a power of any prime number. Luckily, his bosses weren't very good in math, so his job is safe. The night manager's strategies are only possible because while the Infinite Hotel is certainly a logistical nightmare, it only deals with the lowest level of infinity, mainly, the countable infinity of the natural numbers, 1, 2, 3, 4, and so on. Georg Cantor called this level of infinity aleph-zero. We use natural numbers for the room numbers as well as the seat numbers on the buses. If we were dealing with higher orders of infinity, such as that of the real numbers, these structured strategies would no longer be possible as we have no way to systematically include every number. The Real Number Infinite Hotel has negative number rooms in the basement, fractional rooms, so the guy in room 1/2 always suspects he has less room than the guy in room 1. Square root rooms, like room radical 2, and room pi, where the guests expect free dessert. What self-respecting night manager would ever want to work there even for an infinite salary? But over at Hilbert's Infinite Hotel, where there's never any vacancy and always room for more, the scenarios faced by the ever-diligent and maybe too hospitable night manager serve to remind us of just how hard it is for our relatively finite minds to grasp a concept as large as infinity. Maybe you can help tackle these problems after a good night's sleep. But honestly, we might need you to change rooms at 2 a.m.

**P35 2014-01-21 Biodiesel - The afterlife of oil - Natascia Radice**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=35)

Just a minute ago, this oil helped make a delicious meal possible. But now, it's just some nasty goop. What should we do with it? Well, the easiest thing would be to pour it down the drain; that makes it seem like it's gone, but it's not really gone. Instead, it's collecting bits of food and other random stuff, producing monstrous, greasy blockages that clog not only your own drain but entire sewage systems, causing flooding and pollution. Many places have laws for proper disposal of grease, but we can go one step further. Instead of just throwing it away safely, we can turn it into something useful. And if you're wondering what anyone could possibly want with a bunch of digusting, used cooking oil, the answer is: biodiesel. You've probably heard of diesel engines. They power farming and construction equipment, trucks, buses, ships, trains, backup generators, and even some cars. Most of the fuel that feeds these engines is refined from petroleum, which comes from long-dead dinosaurs and other ancient fossils. But diesel fuel can also be derived from more recently-dead organisms, like plants and animals. And this type of fuel is what we call biodiesel. Biodiesel is a biodegradable energy source, made from plant oils or animal fats, that can usually be burned in regular diesel engines. You guessed it, it's the 'bio' version of diesel. It's cleaner than normal diesel, so there has been a push to generate it from crops like soybeans. Now, growing plants for fuel, instead of food, comes with its own problems. But fortunately, we already have some oils and fats right here. Preparing your used cooking grease for recycling is easy. First, let it cool down to room temperature. Then, transfer it to a clean container. You can use any old bottles you have lying around, like milk jugs, as long as they're completely empty, rinsed, and dried. Use a funnel to avoid spills and a sieve to filter out any small food particles. You can even add bacon grease and other animal fats or the excess oil from canned food, like tuna or sardines, just make sure it's really oil and not brine. So, what happens now that your oil is safely contained? Well, many cities have recycling services that will pick up large amounts of grease from restaurants and other establishments. But there are locations where individuals can drop off their containers, as well. All of this grease will end up at a processing plant, where it can be converted to useable biodiesel. How does this conversion work? Well, all these oils and fats you donated are made up of triglycerides, a glycerol molecule connected to three fatty acid chains. To convert fats to fuel, they react with an alcohol, usually methanol or ethanol, which produces long-chain esters and glycerol. To compare, here are some molecules of regular diesel fuel. Now, here are the molecules we created by breaking apart the triglycerides. Glycerol is the odd man out, so it's removed at the end of the process. But look at these esters! If you squint, their structures look pretty similar to those of the long-chain hydrocarbons in regular diesel. And diesel engines, with a few small modifications, can also be made to squint and burn these esters like regular diesel fuel. Et voila! Biodiesel. Now, you might be wondering whether all this hassle over recycling used cooking oil is even worth it. After all, how much energy can it possibly generate? Well, if all the grease that New Yorkers throw away in one day were converted to jet fuel, it would be enough to power several hundred flights from New York to Los Angeles. And let's not forget that using waste oil instead of burning more fossil fuels will limit our negative effects on the environment. Recycling used cooking grease turns goop into good. By contributing a little bit, individuals and businesses can help create an alternative, stable source of diesel oil, while protecting the environment and keeping our cities cleaner. And that's pretty slick.

**P36 2014-01-21 History vs. Andrew Jackson - James Fester**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=36)

A national hero? Or public enemy number one? Historical figures are often controversial, but few were as deified or vilified in their lifetime as the seventh President of the United States. This is History vs. Andrew Jackson. "Order, order, hm, uh, what were we...ah yes, Mr. Jackson! You stand accused of degrading the office of the presidency, causing financial collapse and wanton cruelty against American Indians. How do you plead?" "Now, Your Honor, I am not a big city lawyer, but I do know a few things. And I know that President Jackson was a self-made frontiersman, a great general, a real man of the people." "Your Honor, this 'man of the people' was a gambler, a drunk, and a brawler. Why, I've heard it said that he would fight at the drop of the hat and then drop the hat himself. I ask you, was such a man fit for the most distinguished office in the nation? Can we forget the debacle of his inauguration? Who ever heard of inviting a drunken mob into the White House? It took ages to get the upholstery clean." "That drunken mob, sir, was the American people, and they deserve to celebrate their victory." "Order, order! Now, did this celebration have pie?" "Very well. Mr. Jackson, is it not the case that immediately upon assuming office you introduced the spoils system, replacing hundreds of perfectly good federal employees with incompetent party loyalists?" "Your Honor, the President did no such thing. He tried to institute rotation in office to avoid any profiteering or funny business. It was the rest of the party who insisted on giving posts to their lackeys." "But Mr. Jackson complied, did he not?" "Now, uh, see here." "Moving on. Mr. Jackson, did you not help to cause the financial Panic of 1837, and the ensuing economic depression with your obsessive war against the Bank of the United States? Was not vetoing its reauthorization, as you did in 1832, an act of irresponsible populace pandering that made no economic sense?" "Your Honor, the gentleman has quite the imagination. That bank was just a way for rich Yanks to get richer. And all that money panic was caused when British banks raised interest rates and cut lending. To blame it on the President is preposterous, I say." "But if Mr. Jackson had not destroyed the National Bank, it would have been able to lend to farmers and businesses when other credit dried up, would it not?" "Hm, this is all highly speculative. Can we move on?" "Certainly, Your Honor. We now come to Mr. Jackson's most terrible offense: forcing entire tribes out of their native lands via the Indian Removal Act." "I resent that accusation, sir. The U.S. of A. bought that land from the Indians fair and square." "Do you call coercion and threats by a nation with a far more powerful army fair and square? Or signing a treaty for removing the Cherokee with a small group that didn't include their actual leaders? They didn't have time to properly supply themselves before the army came and forced them to march the Trail of Tears." "Now, hold on a minute. This was all Van Buren's doing after President Jackson left office." "But Mr. Jackson laid the groundwork and made sure the treaty was ratified. All President Van Buren had to do afterwards was enforce it." "Look here, Your Honor. Our government's been purchasing Indian land since the beginning, and my client was negotiating these deals even before he was President. President Jackson truly believed it was best for the Indians to get compensated for their land and move out West, where there was plenty of space for them to keep living the way they were accustomed, rather than stick around and keep butting heads with the white settlers. Some of whom, I remind our court, wanted to exterminate them outright. It was a different time." "And yet, even in this different time, there were many in Congress and even the Supreme Court who saw how wrong the Removal Act was and loudly opposed it, were there not?" "My client was under a great deal of pressure. I say, do you think it's easy governing such a huge country and keeping the Union together, when states are fixing to nullify federal laws? President Jackson barely got South Carolina to back down over those import tariffs, and then Georgia had to go discover gold and start grabbing up Cherokee land. It was either get the Indians to move or get in another fight with a state government." "So, you admit that Mr. Jackson sacrified moral principles to achieve some political goals?" "I do declare, show me one leader who hasn't." As societies change and morals evolve, yesterday's hero may become tomorrow's villain, or vice versa. History may be past, but our understanding of it is always on trial.

**P37 2014-01-24 How fast are you moving right now - Tucker Hiatt**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=37)

How fast are you moving right now? That seems like an easy question. The first tempting answer is, "I'm not moving." Upon further reflection, you realize that maybe the Earth's motion counts. So, a second tempting answer is, "19 miles/second around the Sun." But then you recall learning that the Sun moves around the center of the Milky Way galaxy, and the Milky Way moves within the Local Group of galaxies, and the Local Group moves within the Virgo Cluster, and the Virgo Cluster moves within... "How fast are you moving?" is not an easy question. When Mission Control tells astronauts how fast they're going, there's always an assumed standard of rest. At the start of the voyage, speeds are given relative to the launchpad. But later, when the launchpad is just one more arbritrary place down there on Earth's spinning surface, speeds are given relative to the idealized, non-spinning pinpoint center of Earth. On their way to the Moon, Apollo astronauts had a hard time answering the question, "How fast are you moving?" Speed away from Earth was one thing, and speed toward the Moon was quite another. That's because the Earth and the Moon move relative to one another. Ah, of course! Speed is a relative quantity. When Captain Kirk ask Lieutenant Sulu if the Starship Enterprise has reached a speed of warp 7, Sulu should reply, "Relative to what, Captain?" Such a sassy reply may get subordinate Starfleet officers in trouble, but it is the only good answer to the question, "How fast are you moving?" This is basic relatively talking. Not fancy Einsteinian relativity, but good old fashioned (and still correct) Galilean relativity. Galileo seems to have been the first person to realize that there is no such thing as an absolute speed. Speeds are relative. This means that speeds only have meaning when they are referred to a reference frame. Presumably that reference frame is itself at rest. But then we have to ask again, "At rest relative to what?" Because even the concept of rest has lost any hint of absolute meaning. Speed is relative, and rest is relative. Earth's speed is 19 miles/second relative to the Sun. The Enterprise's speed is warp 7 relative to the center of the Milky Way galaxy. Your speed is zero relative to your easy chair. But depending on where you sit, it is hundreds of miles/hour relative to Earth's center. When we furrow a brow and ask, "But how fast is Earth really moving?" we imagine Spaceship Earth plowing through the ocean of space as it orbits the Sun. But space is not an ocean. It has no substance as water does. Space is not a thing; space is nothing. Space is no thing. You can move between two points in space, say between Earth and Mars, but you can't move through space. There's nothing to move through. It's like trying to say how much a hole weighs. A hole weighs exactly nothing because a hole is nothing. It's a void, and so is space. To move relative to nothing is meaningless. The concepts of speed and of rest have only relative meaning. They are absolutely meaningless. They mean something only with respect to arbitrarily chosen, artificial frames of reference. If, someday, you are buckled into your spaceship, and you see from the side window, say, a space station whizz by at constant speed, there is no way to know which of you is really moving. Neither of you is really moving because there is no deep reality about constant speed. Constant speed in a straight line has only relative meaning, a kind of relative reality. Does this mean that all motion is relative? No! Some motions have only relative meaning, but some motions have absolute meaning, are absolutely real. For example, constant speed is relative, but change in speed is absolute. Calling something absolute in science means that arbitrary standards are not used in its measurement. It is unambiguously measurable. When your spaceship fires its engines, your change in speed is beyond doubt. You feel it in your stomach, and your ship's sensors can measure it. Outside your window, the passing space station may seem to be changing speed, but the beings inside the station will not feel it. And no sensors can measure it. You are really changing speed, and they are really are not. There's something absolutely real about changes in speed. The same goes for rotation. If your spaceship is spinning, you can feel it, and your ship's sensors can measure it. The space station outside may seem to be going around you, but it is you who feels queasy, not the folks in the space station. You are really spinning, and they really are not. There's something absolutely real about rotation. So, some motions are relative, and some are not. There is no deep reality about constant speed, but changes in speed are deeply real, and so are rotations. We have to be thoughtful in our analysis of everyday experience in order to identify what is deeply real. Since we can be fooled by perceptions as basic as speed, maybe every perception deserves careful scrutiny. This is what inspired Einstein to his incredible insights about the speed of light and forward time travel. Knowing how to identify what is deeply real is tough and important work. If a police officer ever pulls you over for speeding and asks, &quot;Do you know how fast you were going?&quot; an insightful, though perhaps unwise, reply would be, "Relative to what?" And then, as you sit in the backseat of the police car and feel it accelerate toward jail, you can add, &quot;But some things are absolute!&quot;

**P38 2014-01-28 Animation basics - The art of timing and spacing - TED-Ed**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=38)

Norman McLaren, the great 20th century pioneer of animation technique, once said, "Animation is not the art of drawings that move, but the art of movements that are drawn. What happens between each frame is more important than what exists on each frame." What did he mean? Well, for an object to appear in motion, it necessarily has to change in position over time. If time passes and no change in position occurs, the object will appear to be still. This relationship between the passage of time and the amount of change that occurs in that time is at the heart of every time-based art form, be it music, dance, or motion pictures. Manipulating the speed and amount of change between the frames is the secret alchemy that gives animation the ability to convey the illusion of life. In animation, there are two fundamental principles we use to do this: timing and spacing. To illustrate the relationship between them, we'll use a timeless example: the bouncing ball. One way to think about timing is that it's the speed, or tempo, at which an action takes place. We determine the speed of an action by how many pictures, or frames, it takes to happen. The more frames something takes to happen, the more time it spends on screen, so the slower the action will be. The fewer frames something takes to happen, the less screen time it takes, which gives us faster action. The timing is about more than just speed, it's also about rhythm. Like a drumbeat or melody only exists when a song is being played, the timing of an action only exists while it's happening. You can describe it in words, say, something will take 6 frames, 18 frames, or so on. But to really get a sense of it, you need to act it out or experience it as it would happen in, well, real time. Now, the timing of an action all depends on the context of the scene and what you're trying to communicate. What is doing the acting, and why? Let's take our example. What makes a ball bounce? The action we're talking about here is a result of interacting physical forces, a moving ball's tendency to stay in motion, or its force of momentum vs. the constant force of gravity bringing it back down Earth. The degree to which these invisible forces apply, and the reason why the ball behaves the way it does, all depends on the physical properties of the ball. A golf ball is small, hard and light. A rubber ball is small, soft and lighter. A beach ball is large, soft and light. And a bowling ball is large, hard and heavy. So, each ball behaves very differently, according to its properties. Let's get a sense of the visual rhythm of each. Each ball plays its own beat and tells us something about itself and the time it takes to travel across the screen. The visual rhythm of these hits is the timing. Okay, let's start animating our ball, bouncing up and down with a simple cycle of drawings. We'll draw a circle here, call it point A, our starting point. We'll have it hit the ground here, point B. Let's say it takes about a second to hit the ground and come back up again. This is our timing. Our spacing is where we position the circle in the frames between point A and point B. If we were to move our ball in evenly-spaced increments, we'd get something like this. It's not really telling us anything about itself. Is it a bouncing ball or a circle on an elevator? Let's look at our footage again and think about what's going on as each ball bounces. Following each impact with the ground, the ball's upward momentum is eventually overcome by gravity. This happens at the peak of each arc. As things change direction, the motion is slowest. We see here the successive positions of the ball are close together. The ball then speeds up as it falls, and is at its fastest when it's approaching and hitting the ground. We can see here each position is further apart. The change in position between frames is the spacing. The smaller the change, the slower the action will appear. The greater the change, the faster it will appear. For an action to decelerate, each change in position must be less than the change before it. Likewise, for an action to speed up, or accelerate, each successive change must be greater. Let's change the mechanical spacing of our animated bounce to reflect what we observed in the footage. Slow at the top, fast when it's hitting the ground. Simply by adjusting the spacing, we've succeeded in suggesting the forces of momentum and gravity at play and achieved a much more realistic motion. Same timing but different spacing gives us vastly different results. And in reality, as a ball bounces, the physics of gravity eventually defeat the tendency of the ball to stay in motion. You can see this here in the decreasing height of each successive bounce. However, again, this decrease varies according to the properties of the ball. Even though these circles are the same size here, they're each telling us a different story about themselves, purely in how they move. The relationship between these principles of timing and spacing can be applied in countless ways and used to animate all types of action: a yo-yo, a punch, a gentle tap, a push, a saw, the Sun traveling across the sky, a pendulum. Animation is a time-based art form. It may incorporate the aesthetic elements of other graphic arts, like illustration or painting, but what sets animation apart is that, here, what you see is less important that what you don't see. An object's superficial appearance only tells us so much about itself. It's only when it's in motion that we really understand its nature.

**P39 2014-01-28 Want to be an activist Start with your toys - McKenna Pope**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=39)

I'm McKenna Pope. I'm 14 years old. And when I was 13, I convinced one of the largest toy companies, toy makers in the world, Hasbro, to change the way that they marketed one of their best-selling products. So, allow me to tell you about it. So, I have a brother, Gavin. When this whole shebang happened, he was four. He loved to cook. He was always getting ingredients out of the fridge and mixing them into these, needless to say, uneatable concoctions or making invisible macaroni and cheese. He wanted to be a chef really badly. And, so what better gift for someone, for a kid who wanted to be a chef, than an Easy Bake Oven, right? I mean, we all had those when we were little. And he wanted one so badly. But then, he started to realize something. In the commercials and on the boxes for the Easy Bake Oven, Hasbro marketed them specifically to girls. And the way that they did this was they would only feature girls on the boxes or in the commercials, and there would be flowery prints all over the ovens, and it would be in bright pink and purple. Very gender-specific colors to females, right? So, it kind of was sending a message that only girls are supposed to cook. Boys aren't. And this discouraged my brother a lot. He thought that he wasn't supposed to want to be a chef. because that was something girls did. Girls cooked, boys didn't. Or so, the message that Hasbro was sending. And this got me thinking, "God, I wish there was a way I could change this, that I could have my voice heard by Hasbro, so I could ask them and tell them what they were doing wrong and ask them to change it." And that got me thinking about a website that I had learned about a few months prior called Change.org. Change.org is an online petition-sharing platform, where you can create a petition and share it across all these social media networks, through Facebook, through Twitter, through YouTube, through Reddit, through Tumblr, through whatever you can think of. And so, I created a petition, along with a YouTube video that I added to the petition, basically asking Hasbro to change the way that they marketed it, in featuring boys in the commercials and on the boxes, and most of all creating them in less gender-specific colors. So, this petititon started to take off, like humongously fast, you have no idea. I was getting interviewed by all these national news outlets and press outlets, and it was amazing. In three weeks, maybe three and a half, I had 46,000 signatures on this petition. (Applause) Thank you. So, needless to say, it was crazy. Eventually, Hasbro themselves invited me to their headquarters so they could go and unveil their new Easy Bake Oven product to me, in black, silver and blue. It was literally one of the best moments of my life. It was like "Willy Wonka and the Chocolate Factory." That thing was amazing. What I didn't realize at the time, however, was that I had become an activist. I could change something that, even as a kid, or maybe even especially as a kid, my voice mattered. And your voice matters, too! I want to let you know that it's not going to be easy, and it wasn't easy for me because I faced a lot of obstacles. People online, and sometimes even in real life, were disrespectful to me and my family and talked about how the whole thing was a waste of time, and it really discouraged me. And actually, I have some examples because what's better revenge than displaying their idiocy? So, let's see. From username Liquidsword29, interesting usernames we have here, "Disgusting liberal moms making their son's gay." Liquidsword29, really? Really? Okay, how about from Whiteboy77AGS, "People always need something to 'female dog' about." From Jeffrey Gutierrez, "OMG shut up! You just want money and attention." So, it was comments like these that really discouraged me from wanting to make change in the future because I thought, "People don't care. People think it's a waste of time. And people are going to be disrespectful to me and my family." It hurt me. And it made me think, "What's the point in making change in the future?" But then I started to realize something. Haters gonna hate. Come on, say it with me! One, two, three, Haters gonna hate! So let your haters hate, you know what! And make your change because I know you can. I look out into this crowd, and I see 400 people who came out because they wanted to know how they could make a change. And I know that you can, and all of you watching at home can, too, because you have so much that you can do and that you believe in. And you can trade it across all the social media, through Facebook, through Twitter, through YouTube, through Reddit, through Tumblr, through whatever else you can think of. And you can make that change. You can take what you believe in and turn it into a cause and change it. And that spark that you've been hearing about all day today you can use that spark that you have within you and turn it into a fire. Thank you. (Applause)

**P40 2014-01-28 What percentage of your brain do you use - Richard E. Cytowic**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=40)

An enduring myth says we use only 10% of our brain, the other 90% standing idly by for spare capacity. Hucksters promised to unlock that hidden potential with methods "based on neuroscience," but all they really unlock is your wallet. Two-thirds of the public and nearly half of science teachers mistakenly believe the 10% myth. In the 1890s, William James, the father of American psychology, said, "Most of us do not meet our mental potential." James meant this as a challenge, not an indictment of scant brain usage. But the misunderstanding stuck. Also, scientists couldn't figure out for a long time the purpose of our massive frontal lobes or broad areas of the parietal lobe. Damage didn't cause motor or sensory deficits, so authorities concluded they didn't do anything. For decades, these parts were called silent areas, their function elusive. We've since learned that they underscore executive and integrative ability, without which, we would hardly be human. They are crucial to abstract reasoning, planning, weighing decisions and flexibly adapting to circumstances. The idea that 9/10 of your brain sits idly by in your skull looks silly when we calculate how the brain uses energy. Rodent and canine brains consume 5% of total body energy. Monkey brains use 10%. An adult human brain, which accounts for only 2% of the body's mass, consumes 20% of daily glucose burned. In children, that figure is 50%, and in infants, 60%. This is far more than expected for their relative brain sizes, which scale in proportion to body size. Human ones weigh 1.5 kilograms, elephant brains 5 kg, and whale brains 9 kg, yet on a per weight basis, humans pack in more neurons than any other species. This dense packing is what makes us so smart. There is a trade-off between body size and the number of neurons a primate, including us, can sustain. A 25 kg ape has to eat 8 hours a day to uphold a brain with 53 billion neurons. The invention of cooking, one and half million years ago, gave us a huge advantage. Cooked food is rendered soft and predigested outside of the body. Our guts more easily absorb its energy. Cooking frees up time and provides more energy than if we ate food stuffs raw and so we can sustain brains with 86 billion densely packed neurons. 40% more than the ape. Here's how it works. Half the calories a brain burns go towards simply keeping the structure intact by pumping sodium and potassium ions across membranes to maintain an electrical charge. To do this, the brain has to be an energy hog. It consumes an astounding 3.4 x 10^21 ATP molecules per minute, ATP being the coal of the body's furnace. The high cost of maintaining resting potentials in all 86 billion neurons means that little energy is left to propel signals down axons and across synapses, the nerve discharges that actually get things done. Even if only a tiny percentage of neurons fired in a given region at any one time, the energy burden of generating spikes over the entire brain would be unsustainable. Here's where energy efficiency comes in. Letting just a small proportion of cells signal at any one time, known as sparse coding, uses the least energy, but carries the most information. Because the small number of signals have thousands of possible paths by which to distribute themselves. A drawback of sparse coding within a huge number of neurons is its cost. Worse, if a big proportion of cells never fire, then they are superfluous and evolution should have jettisoned them long ago. The solution is to find the optimum proportion of cells that the brain can have active at once. For maximum efficiency, between 1% and 16% of cells should be active at any given moment. This is the energy limit we have to live with in order to be conscious at all. The need to conserve resources is the reason most of the brain's operations must happen outside of consciousness. It's why multitasking is a fool's errand. We simply lack the energy to do two things at once, let alone three or five. When we try, we do each task less well than if we had given it our full attention. The numbers are against us. Your brain is already smart and powerful. So powerful that it needs a lot of power to stay powerful. And so smart that it has built in an energy-efficiency plan. So don't let a fraudulent myth make you guilty about your supposedly lazy brain. Guilt would be a waste of energy. After all this, don't you realize it's dumb to waste mental energy? You have billions of power-hungry neurons to maintain. So hop to it!

**P41 2014-01-31 How one teenager unearthed baseball's untold history - Cam Perron**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=41)

I've always collected baseball cards. I first started playing baseball when I was eight years old, and when my hometown, Red Sox won the World Series in 2004, I began meeting many of the players at autograph signings and events around Boston. But I noticed a few things in common. These players weren't very friendly, they were all quite overpaid and they acted more like celebrities. In middle school, a friend introduced me to a new way to collect autographs: writing the players through the mail. In doing so, I would write a letter, send a self-addressed stamped envelope, and send a few baseball cards. Within a few weeks, I'd often get a response. But it was never the modern players that would send back. It was always the players from the 50s and 60s, who were much friendlier, and much less recognized during their career. So, I continued to write letters to these retired ball players, and in 2007, Topps Baseball Cards came out with a set where they included a few Negro league baseball player cards. Negro league was a period from 1920 to the 1960s where blacks who were segregated from playing in the Major Leagues played in their own baseball league, often busing around the country, playing two to three games a day, under much less glamorous conditions. But over time, due to the lack of glamorization and public interest, everything just kind of faded away, leaving the history of the Negro leagues behind. So, I ended up writing to these players in this set and within a few weeks, they signed my cards. From here, I began writing to Negro leaguers who didn't have baseball cards. Guys that were, you know, even less recognized. And in my letters, I'd often include my phone number, and a few of them began reaching out to me. When I started speaking with them, I noticed they all had a few things in common. None of them had baseball cards, none of them had any documentation, no newspaper articles, no sorts of photos from their career, just nothing tying them to the game. And lastly, they had just left all their teammates behind. They hadn't stayed in touch with any of their teammates. So, I tried to change this, and I started off by making baseball cards on my home computer. Printing them out, designing them and sending them to ball players. And what I also did is I began signing up for newspaper archive websites where I'd find old newspaper articles that would give these guys the recognition that, you know, tied them to the game. And lastly, I began becoming kind of like a private investigator, tracking down their former teammates and trying to get these guys back in touch. From here, I went on and I just spoke to these players. It got to the point where I actually had players calling me up, asking me for information. And by the time I was a freshman in high school, it was no longer a hobby at all. I had gone from an autograph collector to this Negro league research obsession. I even asked for Negro league autographs and stamps for Christmas. So, going on through high school, I began to take this work in the Negro league much more seriously. I started working with adult Negro league researchers where I began working on a few different programs. The first being the Negro League Annual Reunion in Birmingham, Alabama. At the reunion, we'd have about 50 to 60 Negro league ball players from around the country, and they'd all come together, and these players would just, you know, sit in the hotel lobby for me from 8am until the late hours of the night just catching up, telling stories, and here we just had a week of events and these guys got some of this recognition and honor that they never really had before. The second program that I began working on was the Negro League Pension Program. And the Pension Program was a program that was offered by Major League Baseball, and if you played four years in the Negro league, and you can document it, these players would be entitled to 10,000 dollars a year. This meant a lot for these players. Many of these guys never really did much after baseball, they didn't make much money. So, when I was able to get these players pensions, it really made a difference. When I started doing this, I encountered a lot of difficulty. I had to go through hundreds and hundreds of newspaper articles trying to find this documentation to prove they played, and in many cases I did. Also I want to mention, when I was speaking with these players on the phone, tracking them down, it wasn't easy either. I would go through hundreds of articles trying to look for names, find information, and I encountered quite a lot of failure. I would call people up, it would be the wrong person. It would be really awkward. I'd also have a lot of times where I'd call players up, and they didn't want to speak at all to me. They would hang up. When I said the word baseball, they would just refuse to talk altogether. This was because they faced a lot of segregation during their careers. Along with the lack of glamorization that they faced, they also dealt with a lot of racism on and off the baseball field, which just lasted with them throughout their whole lives. These guys, you know, it was very emotional for them to talk about baseball, and it was really hard to kind of get these guys back, you know, talking about this game that they had kind of left behind. Lastly though, I encountered, you know, quite a lot of success as well. Some of these guys I'd call up, I'd talk to them for two to three hours, and these guys would just go on and on about their stories, telling me, like, exact baseball games and memories that they had. Nowadays, I've attended four Negro League Reunions, three of which I've actually roomed with former Negro league ball player Russell "Crazy Legs" Patterson of the Indianapolis Clowns. He actually snores at night, in case you all were wondering. I've worked on about a dozen pensions and I've tracked down over a hundred Negro league ball players, constantly finding new ball players, getting them in touch with their former teammates, bringing baseball back into these players' lives and bringing these guys back into the game. (Music) Thank you! (Applause)

**P42 2014-01-31 How to track a tornado - Karen Kosiba**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=42)

So, I think all good tornado talks need to start with an awesome tornado shot. And this is not that awesome tornado shot. That was the first tornado I ever saw, it was really cool, really scary, and I'm showing it to you guys because that's why I got into the field in the first place. So even though it's a bad photograph, it was really cool to be out there the first time. But now I'm taking real tornado footage. Fast forward a few years. This is a few years ago, during a field project called VORTEX2, where myself and a bunch of other scientists were out there, surrounding tornadoes with different types of instrumentation and trying to figure out how tornadoes form. It's a big question we're trying to answer. It sounds like a very basic one, but it's something we're still trying to figure out. We're also still trying to figure out what the winds are like near the surface. We know what the winds are like above building level, but we really don't know what they're like at the surface and how that relates to what we're seeing above building level. Most tornadoes form from what we call supercell thunderstorms. Supercell thunderstorms are what you commonly think of as tornado-raising storms. They're big, rotating thunderstorms that happen a lot of times in the midsection of the United States. But the problem is that even though they're rotating up above, it doesn't mean they're rotating at the surface. And when we look at these storms and at these pictures and at the data we have, they all kind of look the same. And it's really problematic if we're trying to make tornado forecasts or warnings, because we only want to warn or forecast about the storms that are going to actually make a tornado. One of the big, critical distinguishing features, we think, between these storms, is something about the rear-flank downdraft. So these big rotating thunderstorms have this downdraft that wraps around the rear edge of it, hence the "rear-flank" downdraft. But we think how warm that is, how buoyant that air is, and then also how strong the updraft it's wrapping into, makes a big difference on whether or not it's going to make a tornado. There's a lot more that goes into it -- I'll tell you about that in a second. Once you actually get a tornado, again, the problem that we have is getting measurements near the surface. It's really hard to get measurements near the surface -- most people don't want to drive into tornadoes. There are a few exceptions; you might have seen them on TV shows. But most people don't want to do that. Even getting instrumentation in the path of the tornado is pretty tricky, too. Because, again, you don't want to be that close to a tornado because sometimes the winds around the tornado are strong as well. So getting information, that critical location, is key for us because, again, we don't know if the winds that we're seeing above ground level, way above building level, actually map to the surface, if they're stronger, weaker, or about the same as what we're seeing above buildings. The way we get at answering a lot of these questions -- and I'm an observationalist; I love to get out in the field, and collect data on tornadoes -- we compile a lot of observations. I work with this group who operates mobile radars, and they're exactly what they say -- basically, a radar on the back of a big blue truck, and we drive up really close to tornadoes to map out the winds. We map out the precipitation. We map out all these different things that are going on in order to better understand the processes in these storms. And that bottom there, that's what a tornado looks like when you're looking at it with a mobile radar, and really close. Also, what we do is a lot of modeling, so we do a lot of computer models and simulations, because the atmosphere is governed by the laws of physics. So we can model the laws of physics and see where the tornado might go, where the storm might go, how strong the winds are near the surface and not actually have to go out in the field. But of course, we want to have both observations and modeling to move forward with the science. So, I showed you that video earlier that went real quick, too. This is what it looks like, looking at it with a radar. So you saw it visually, but this is what I get really excited about when I see now in the field, stuff that looks like this. The really exciting thing about looking at stuff like this is that we caught this storm from when it didn't make a tornado to when it made a tornado and intensified and when it dissipated. This is the one of the rare data sets that we have out there that were able to study the entire life cycle of a tornado. I talked about how we think that rear-flank downdraft is important because it tilts, there's a lot of spin in the atmosphere, but the problem with all this spin in the atmosphere is it needs to be oriented vertically, because that's what tornadoes are doing, and it needs to orientated vertically near the ground. So we think this rear-flank downdraft just pulses. And these pulses in this rear-flank downdraft, we think, are very important for converging that rotation, but also getting that rotation into the right place. Other things we've learned is that we have gotten a bunch of fortuitous measurements in the path of the tornadoes and very near the surface. And we found out that the winds near the surface are actually pretty comparable to what we're seeing 30, 40 meters above ground level. So there's not a big reduction in what we're seeing above the surface to what we're seeing at house level. And that was a pretty surprising finding for us, because we kind of assumed that the winds decrease pretty substantially near the surface. I'm going to end with this real quick. And this is not my last tornado I ever saw, but I really like this image, because this was taken with one of those mobile radars I was talking about. This is a tornado, not a hurricane, and this is what it looks like when you're really close to it. And I find this amazing, that we can actually take technology this close to these types of storms and see these inner workings. And for those of you who look at tornado images often, you can see there's a lot going on -- there's rain spiraling, and you can actually see the debris cloud associated with this tornado. I look forward to the future and future technologies and being able to learn a lot more about these storms, as the world advances, as you guys contribute to the science and we're able to really learn more about how tornadoes form. Thank you. (Applause)

**P43 2014-01-31 Pixar - The math behind the movies - Tony DeRose**

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At Pixar, we're all about telling stories, but one story that hasn't been told very much is the huge degree to which math is used in the production of our films. The math that you're learning in middle school and high school is used all the time at Pixar. So, let's start with a very simple example. Anybody recognize this guy? (Cheers) Yeah, so this is Woody from Toy Story, and let's ask Woody to, say, walk across the stage from, say, left to right, just like that. So, believe it or not, you just saw a ton of mathematics. Where is it? Well, to explain that, it's important to understand that artists and designers think in terms of shape and images but computers think in terms of numbers and equations. So, to bridge those two worlds we use a mathematical concept called coordinate geometry, right? That is, we lay down a coordinate system with x describing how far something is to the right and y describing how high something is. So, with these coordinates we can describe where Woody is at any instant in time. For instance, if we know the coordinates of the lower left corner of that image, then we know where the rest of the image is. And in that little sliding animation we saw a second ago, that motion we call translation, the x coordinate started with a value of one, and it ended with a value of about five. So, if we want to write that in mathematics, we see that the x at the end is four bigger than x at the start. So, in other words, the mathematics of translation is addition. Alright? How about scaling? That is making something bigger or smaller. Any guesses as to what the mathematics of scaling might be? Dilation, multiplication, exactly. If you're going to make something twice as big, you need to mulitply the x and the y coordinates all by two. So, this shows us that the mathematics of scaling is mulitiplication. Okay? How about this one? How about rotation? Alright, spinning around. The mathematics of rotation is trigonometry. So, here's an equation that expresses that. It looks a little scary at first. You'll probably get this in eighth or ninth grade. If you find yourselves sitting in trigonometry class wondering when you're ever going to need this stuff, just remember that any time you see anything rotate in one of our films, there's trigonometry at work underneath. I first fell in love with mathematics in seventh grade. Any seventh graders? A few of you? Yeah. My seventh grade science teacher showed me how to use trigonometry to compute how high the rockets that I was building was going. I just thought that was amazing, and I've been enamored with math ever since. So, this is kind of old mathematics. Mathematics that's been known and, you know, developed by the old dead Greek guys. And there's a myth out there that all the interesting mathematics has already been figured out, in fact all of mathematics has been figured out. But the real story is that new mathematics is being created all the time. And some of it is being created at Pixar. So, I'd like to give you an example of that. So, here are some characters from some of our early films: Finding Nemo, Monsters Inc. and Toy Story 2. Anybody know who the blue character in the upper left is? It's Dory. Okay, that was easy. Here's a little harder one. Anybody know who's the character in the lower right? Al McWhiggin from Al's Toy Barn, exactly. The thing to notice about these characters is they're really complicated. Those shapes are really complicated. In fact, the toy cleaner, I have an example, the toy cleaner there in the middle, here's his hand. You can imagine how fun it was to bring this through airport security. His hand is a really complicated shape. It's not just a bunch of spheres and cylinders stuck together, right? And not only is it complicated, but it has to move in complicated ways. So, I'd like to tell you how we do that, and to do that I need to tell you about midpoints. So, here's a couple of points, A and B, and the line segment between them. We're going to start out first in two dimensions. The midpoint, M, is the point that splits that line segment in the middle, right? So, that's the geometry. To make equations and numbers, we again introduce a coordinate system, and if we know the coordinates of A and B, we can easily compute the coordinates of M just by averaging. You now know enough to work at Pixar. Let me show you. So, I'm going to do something slightly terrifying and move to a live demo here. So, what I have is a four-point polygon here, and it's going to be my job to make a smooth curve out of this thing. And I'm going to do it just using the idea of midpoints. So, the first thing I'm going to do is an operation I'll call split, which adds midpoints to all those edges. So, I went from four points to eight points, but it's no smoother. I'm going to make it a little bit smoother by moving all of these points from where they are now to the midpoint of their clockwise neighbor. So, let me animate that for you. I'm going to call that the averaging step. So, now I've got eight points, they're a little bit smoother, my job is to make a smooth curve, so what do I do? Do it again. Split and average. So, now I've got sixteen points. I'm going to put those two steps, split and average, together into something I'll call subdivide, which just means split and then average. So, now I've got 32 points. If that's not smooth enough, I'll do more. I'll get 64 points. Do you see a smooth curve appearing here from those original points? And that's how we create the shapes of our charcters. But remember, I said a moment ago it's not enough just to know the static shape, the fixed shape. We need to animate it. And to animate these curves, the cool thing about subdivision. Did you see the aliens in Toy Story? You know that sound they make, "Ooh"? Ready? So, the way we animate these curves is simply by animating the original four points. "Ooh." Alright, I think that's pretty cool, and if you don't, the door is there, it doesn't get any better than that, so. This idea of splitting and averaging also holds for surfaces. So, I'll split, and I'll average. I'll split, and I'll average. Put those together into subdivide, and this how we actually create the shapes of all of our surface characters in three dimensions. So, this idea of subdivision was first used in a short film in 1997 called Geri's Game. And Geri actually made a cameo apperance in Toy Story 2 as the toy cleaner. Each of his hands was the first time we ever used subdivision. So, each hand was a subdivision surface, his face was a subdivision surface, so was his jacket. Here's Geri's hand before subdivision, and here's Geri's hand after subdivision, so subdivision just goes in and smooths out all those facets, and creates the beautiful surfaces that you see on the screen and in the theaters. Since that time, we've built all of our characters this way. So, here's Merida, the lead character from Brave. Her dress was a subdivision surface, her hands, her face. The faces and hands of all the clansman were subdivision surfaces. Today we've seen how addition, multiplication, trigonometry and geometry play a roll in our films. Given a little more time, I could show you how linear algebra, differential calculus, integral calculus also play a roll. The main thing I want you to go away with today is to just remember that all the math that you're learning in high school and actually up through sophomore college we use all the time, everyday, at Pixar. Thanks.

**P44 2014-02-03 The Pangaea Pop-up - Michael Molina**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=44)

Once upon a time, South America lived harmoniously alongside Africa until a crack in the Earth drove the two continents apart. This breakup began about 200 million years ago during the separation of the supercontinent known as Pangaea. Their proximity back then explains why the same plant fossils and reptile fossils, like the Mesosaurus, can be found on the South American east coast and African west coast. However, this evidence does not account for how the continents moved apart. For that, we'll need to take a close look at the earth below our feet. Though you may not realize it, the ground below you is traveling across the Earth at a rate of about 10 cm/year, or the speed at which your fingernails grow. This is due to plate tectonics, or the large-scale movement of Earth's continents. The motion occurs within the top two layers of the Earth's mantle, the lithosphere and asthenosphere. The lithosphere, which includes the crust and uppermost mantle, comprises the land around you. Beneath the lithosphere is the asthenosphere the highly viscous but solid rock portion of the upper mantle. It's between 80 and 200 km below the Earth's surface. While the asthenosphere wraps around the Earth's core as one connected region, the lithosphere is separated on top into tectonic plates. There are seven primary tectonic plates that compose the shape of the planet we know today. Like the other smaller tectonic plates, the primary plates are about 100 km thick and are composed of one or two layers: continental crust and oceanic crust. Continental crust forms the continents and areas of shallow water close to their shores, whereas oceanic crust forms the ocean basins. The transition from the granitic continental crust to the basaltic oceanic crust occurs beyond the continentel shelf, in which the shore suddenly slopes down towards the ocean floor. The South American Plate is an example of a tectonic plate made of two crusts: the continent we know from today's map and a large region of the Atlantic Ocean around it. Collectively comprising the lithosphere, these plates are brittler and stiffer than the heated, malleable layer of the asthenosphere below. Because of this, the tectonic plates float on top of this layer, independently of one another. The speed and direction in which these tectonic plates move depends on the temperature and pressure of the asthenosphere below. Scientists are still trying to nail down the driving forces behind this movement, with some theories pointing towards mantle convection, while others are examining the influence of the Earth's rotation and gravitational pull. Though the mechanics have not been sorted out, the scientific community agrees that our tectonic plates are moving and have been for billions of years. Because these plates move independently, a fair amount of pushing and pulling between the plates occurs. The first type of interaction is a divergent boundary, in which two plates move away from one another. We see this in the Mid-Atlantic Ridge between South America and Africa. The next interaction is when two plates collide, known as a convergent boundary. In this instance, the land is pushed upward to form large mountain ranges, like the Himalayas. In fact, the Indian Plate is still colliding with the Eurasian Plate, which is why Mount Everest grows one cm/year. Finally, there's the transform boundaries, where two plates scrape past one another. The grinding of the transform boundary leads to many earthquakes, which is what happens in the 810 mile-long San Andreas Fault. The moving Earth is unstoppable, and, while a shift of 10 cm/year may not seem like a lot, over millions of years our planet will continue to dramatically change. Mountains will rise, shorelines will recede, islands will pop up. In fact, one projected map shows the cities of Los Angeles and San Francisco on top of each other. Maybe South America and Africa will come together again, too. Only time will tell.

**P45 2014-02-04 Why is glass transparent - Mark Miodownik**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=45)

Take a look out your window, put on your glasses if you wear them. You might want to grab a pair of binoculars, too, or a magnifying lens. Now, what do you see? Well, whatever it is, it's not the multiple layers of glass right in front of you. But have you ever wondered how something so solid can be so invisible? To understand that, we have to understand what glass actually is, and where it comes from. It all begins in the Earth's crust, where the two most common elements are silicon and oxygen. These react together to form silicon dioxide, whose molecules arrange themselves into a regular crystalline form known as quartz. Quartz is commonly found in sand, where it often makes up most of the grains and is the main ingredient in most type of glass. Of course, you probably noticed that glass isn't made of multiple tiny bits of quartz, and for good reason. For one thing, the edges of the rigidly formed grains and smaller defects within the crystal structure reflect and disperse light that hits them. But when the quartz is heated high enough the extra energy makes the molecules vibrate until they break the bonds holding them together and become a flowing liquid, the same way that ice melts into water. Unlike water, though, liquid silicon dioxide does not reform into a crystal solid when it cools. Instead, as the molecules lose energy, they are less and less able to move into an ordered position, and the result is what is called an amorphous solid. A solid material with the chaotic structure of a liquid, which allows the molecules to freely fill in any gaps. This makes the surface of glass uniform on a microscopic level, allowing light to strike it without being scattered in different directions. But this still doesn't explain why light is able to pass through glass rather than being absorbed as with most solids. For that, we need to go all the way down to the subatomic level. You may know that an atom consists of a nucleus with electrons orbiting around it, but you may be surprised to know that it's mostly empty space. In fact, if an atom were the size of a sports stadium, the nucleus would be like a single pea in the center, while the electrons would be like grains of sand in the outer seats. That should leave plenty of space for light to pass through without hitting any of these particles. So the real question is not why is glass transparent, but why aren't all materials transparent? The answer has to do with the different energy levels that electrons in an atom can have. Think of these as different rows of seats in the stadium stands. An electron is initially assigned to sit in a certain row, but it could jump to a better row, if it only had the energy. As luck would have it, absorbing one of those light photons passing through the atom can provide just the energy the electron needs. But there's a catch. The energy from the photon has to be the right amount to get an electron to the next row. Otherwise, it will just let the photon pass by, and it just so happens that in glass, the rows are so far apart that a photon of visible light can't provide enough energy for an electron to jump between them. Photons from ultraviolet light, on the other hand, give just the right amount of energy, and are absorbed, which is why you can't get a suntan through glass. This amazing property of being both solid and transparent has given glass many uses throughout the centuries. From windows that let in light while keeping out the elements, to lenses that allow us to see both the vast worlds beyond our planet, and the tiny ones right around us. It is hard to imagine modern civilization without glass. And yet for such an important material we rarely think about glass and its impact. It is precisely because the most important and useful quality of glass is being featureless and invisible that we often forget that it's even there.

**P46 2014-02-07 Eli the eel - A mysterious migration - James Prosek**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=46)

Transcriber: Jessica Ruby Reviewer: Caroline Cristal They're long and slithery, and they're not very colorful. But they do have a strange beauty of their own. Their sinuous, nocturnal movements through the water are mesmerizing to watch. And though they may resemble underwater snakes, eels are, in fact, a very interesting type of fish. There are several things about eels that make them unique besides their elongated shape and limbless bodies. For one thing, eels have the ability to breathe through their skin. Some can even leave the water and move over land for short periods. And, unlike most migratory fish, such as salmon, which spawn in fresh water but live their adult lives in salt water, eels of the genus Anguilla migrate in the opposite direction, spawning and breeding in oceans and seas, while spending most of their intervening time in fresh water. If we were to take one such fresh water eel and follow its life story, it would be born in the middle of the North Atlantic Ocean, about a thousand miles east of Bermuda. This area, called the Sargasso Sea, forms the western part of a subtropical gyre, a giant whirlpool in the middle of the ocean. Our eel, let's call it Eli, would begin as one of ten to twenty million tiny eggs, carried by a female eel, hatching into a transparent leaf-shaped thing that looks nothing like an adult eel. Eli starts to drift in ocean currents, predominantly the Gulf Stream towards either Europe or North America, depending on its particular species. Upon reaching the coast, Eli is about two inches long, looking more eely but still transparent, known at this stage as a glass eel. But within a couple of days in fresh water, Eli's skin becomes pigmented a brownish-black, now looking more like that of an adult eel. You might notice that we haven't mentioned anything about Eli's gender yet. That's because this is only determined once an eel enters fresh water, though nobody is sure exactly how that happens. Most of the eels that stay in the estuaries and brackish water become males, while those that go upstream become females, growing up to two to three times bigger than their future mates. In this case, it turns out that Eli was actually short for Elaine. As a female eel, Elaine will be quite solitary for most of her life in the stream, eating whatever falls in the water: grasshoppers, crickets, small fish, insect larvae, frogs, baby birds, almost anything she can get her mouth around. And she will grow quite big, up to four feet long and weighing as much as thirteen pounds. We don't know exactly how fresh water eels know when it's time to return to the ocean, but something calls to them. And their fall migration is one of the largest unseen migrations on the planet. As Elaine leaves fresh water for the ocean, she undergoes a shocking metamorphosis. Her eyes enlarge by about ten times, her skin gets thicker, and her fins get larger. These are most likely adaptations for their upcoming ocean travel, and Elaine seamlessly makes the transition from fresh to salt water, which would be toxic for most other fish. Once Elaine leaves the mouth of the fresh water streams, she will disappear completely from human view. No one has witnessed, or been able to follow, an adult eel on their migration, nor do we know how deep they spawn. But it's assumed that they can follow some signs that they can detect, such as a thermal barrier between ocean currents or a salinity front, in order to return to the same area of the ocean where they were born. Because we don't even know exactly what happens during an eel's migration, we can only imagine what the actual breeding looks like. But the common hypothesis is that Elaine and thousands, or hundreds of thousands, of other eels gather in large, intertwined masses and release their eggs and sperm in a giant orgy known as panmixia. A couple of days after the eggs are laid, they hatch, and the cycle begins again. And because we've never seen the adult eels returning up the fresh water rivers, we must assume that, having completed their long and roundabout journey, these amazing and mysterious creatures finally die there, in the same place where they were born. Goodbye, Elaine! It was a pleasure knowing you.

**P47 2014-02-07 How one piece of legislation divided a nation - Ben Labaree, Jr.**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=47)

Today when people complain about the state of American politics, they often mention the dominance of the Democratic and Republican Parties, or the sharp split between red and blue states. But while it may seem like both of these things have been around forever, the situation looked quite different in 1850, with the Republican Party not yet existing, and support for the dominant Democrats and Whigs cutting across geographic divides. The collapse of this Second Party System was at the center of increasing regional tensions that would lead to the birth of the Republican Party, the rise of Abraham Lincoln as its leader, and a civil war that would claim over half a million lives. And if this collapse could be blamed on a single event, it would be the Kansas-Nebraska Act of 1854. The story starts with the Missouri Compromise of 1820. To balance the number of slave states and free states in the Union, it allowed slavery in the newly admitted state of Missouri, while making it off limits in the remaining federally administered Louisiana Territory. But compromises tend to last only as long as they're convenient, and by the early 1850s, a tenacious Democratic Senator from Illionis named Stephen A. Douglas found its terms very inconvenient. As an advocate of western expansion, he promoted constructing a transcontinental railroad across the Northern Plains with an eastern terminus in Chicago, where he happened to own real estate. For his proposal to succeed, Douglas felt that the territories through which the railroad passed, would have to be formally organized, which required the support of Southern politicians. He was also a believer in popular sovereignty, arguing that the status of slavery in a territory should be decided by its residents rather than Congress. So Douglas introduced a bill designed to kill two birds with one stone. It would divide the large chunk of incorporated land into two new organized territories: Nebraska and Kansas, each of which would be open to slavery if the population voted to allow it. While Douglas and his Southern supporters tried to frame the bill as protecting the political rights of settlers, horrified Northerners recognized it as repealing the 34-year-old Missouri Compromise and feared that its supporters' ultimate goal was to extend slavery to the entire nation. Congress was able to pass the Kansas-Nebraska Act, but at the huge cost of bitterly dividing the nation, with 91% of the opposition coming from Northerners. In the House of Representatives, politicians traded insults and brandished weapons until a Sargent at Arms restored order. President Pierce signed the bill into law amidst a storm of protest, while Georgia's Alexander Stephens, future Confederate Vice President, hailed the Act's passage as, "Glory enough for one day." The New York Tribune reported, "The unanimous sentiment of the North is indignant resistance." Douglas even admitted that he could travel from Washington D.C. to Chicago by the light of his own burning effigies. The political consequences of the Kansas-Nebraska Act were stunning. Previously, both Whigs and Democrats had included Northern and Southern lawmakers united around various issues, but now slavery became a dividing factor that could not be ignored. Congressmen from both parties spoke out against the act, including an Illinois Whig named Abraham Lincoln, denouncing "the monstrous injustice of slavery" in an 1854 speech. By this time the Whigs had all but ceased to exist, irreparably split between their Northern and Southern factions. In the same year, the new Republican Party was founded by the anti-slavery elements from both existing parties. Although Lincoln still ran for Senate as a Whig in 1854, he was an early supporter of the new party, and helped to recruit others to its cause. Meanwhile the Democratic Party was shaken when events in the newly formed Kansas Territory revealed the violent consequences of popular sovereignty. Advertisements appeared across the North imploring people to emigrate to Kansas to stem the advance of slavery. The South answered with Border Ruffians, pro-slavery Missourians who crossed state lines to vote in fraudulent elections and raid anti-slavery settlements. One northern abolitionist, John Brown, became notorious following the Pottawatomie Massacre of 1856 when he and his sons hacked to death five pro-slavery farmers with broad swords. In the end, more than 50 people died in Bleeding Kansas. While nominally still a national party, Douglas's Democrats were increasingly divided along sectional lines, and many Northern members left to join the Republicans. Abraham Lincoln finally took up the Republican Party banner in 1856 and never looked back. That year, John C. Fremont, the first Republican presidential candidate, lost to Democrat, James Buchanan, but garnered 33% of the popular vote all from Northern states. Two years later, Lincoln challenged Douglas for his Illinois Senate seat, and although he lost that contest, it elevated his status among Republicans. Lincoln would finally be vindicated in 1860, when he was elected President of the United States, defeating in his own home state, a certain Northern Democrat, who was finally undone by the disastrous aftermath of the law he had masterminded. Americans today continue to debate whether the Civil War was inevitable, but there is no doubt that the Kansas-Nebraska Act made the ghastly conflict much more likely. And for that reason, it should be remembered as one of the most consequential pieces of legislation in American history.

**P48 2014-02-12 The history of marriage - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=48)

There have been many different things written and said about marriage. From the sweetly inspirational to the hilariously cynical. But what many of them have in common is that they sound like they express a universal and timeless truth, when in fact nearly everything about marriage, from its main purpose to the kinds of relationships it covers to the rights and responsibilities involved, has varied greatly between different eras, cultures and social classes. So, let's take a quick look at the evolution of marriage. Pair bonding and raising children is as old as humanity itself. With the rise of sedentary agricultural societies about 10,000 years ago, marriage was also a way of securing rights to land and property by designating children born under certain circumstances as rightful heirs. As these societies became larger and more complex, marriage became not just a matter between individuals and families, but also an official institution governed by religious and civil authorities. And it was already well established by 2100 B.C. when the earliest surviving written laws in the Mesopotamian Code of Ur-Nammu provided many specifics governing marriage, from punishments for adultery to the legal status of children born to slaves. Many ancient civilizations allowed some form of multiple simultaneous marriage. And even today, less than a quarter of the world's hundreds of different cultures prohibit it. But just because something was allowed doesn't mean it was always possible. Demographic realities, as well as the link between marriage and wealth, meant that even though rulers and elites in Ancient Mesopotamia, Egypt and Israel had multiple concubines or wives, most commoners could only afford one or two tending towards monogamy in practice. In other places, the tables were turned, and a woman could have multiple husbands as in the Himalayan Mountains where all brothers in a family marrying the same woman kept the small amount of fertile land from being constantly divided into new households. Marriages could vary not only in the number of people they involved but the types of people as well. Although the names and laws for such arrangements may have differed, publicly recognized same-sex unions have popped up in various civilizations throughout history. Mesopotamian prayers included blessings for such couples, while Native American Two-Spirit individuals had relationships with both sexes. The first instances of such arrangements actually being called "Marriage" come from Rome, where the Emperors Nero and Elagabalus both married men in public ceremonies with the practice being explictly banned in 342 A.D. But similar traditions survived well into the Christian era, such as Adelphopoiesis, or "brother-making" in Orthodox churches, and even an actual marriage between two men recorded in 1061 at a small chapel in Spain. Nor was marriage even necessarily between two living people. Ghost marriages, where either the bride or groom were deceased, were conducted in China to continue family lineages or appease restless spirits. And some tribes in Sudan maintain similar practices. Despite all these differences, a lot of marriages throughout history did have one thing in common. With crucial matters like property and reproduction at stake, they were way too important to depend on young love. Especially among the upperclasses, matches were often made by families or rulers. But even for commoners, who had some degree of choice, the main concern was practicality. The modern idea of marriage as being mainly about love and companionship only emerged in the last couple of centuries. With industrialization, urbanization and the growth of the middle class more people became independent from large extended families and were able to support a new household on their own. Encouraged by new ideas from the Enlightenment, people began to focus on individual happiness and pursuits, rather than familial duty or wealth and status, at least some of the time. And this focus on individual happiness soon led to other transformations, such as easing restrictions on divorce and more people marrying at a later age. So, as we continue to debate the role and definition of marriage in the modern world, it might help to keep in mind that marriage has always been shaped by society, and as a society's structure, values and goals change over time, its ideas of marriage will continue to change along with them.

**P49 2014-02-14 Poison vs. venom - What's the difference - Rose Eveleth**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=49)

Would you rather be bitten by a venomous snake or touch a poisonous frog? Wait, what's the difference between poison and venom, anyway? Let's say you have the misfortune to be bitten by a venomous rattlesnake. When it bites you, the snake will eject venom from little sacks behind its eyes, through its hollow fangs and into your flesh. That venom will then travel through your bloodstream and all over your body. In most cases, snake venom contains neurotoxins, proteins that can do all sorts of nasty stuff like make your muscles fire uncontrollably, burst your blood cells, and make you go completely numb. But you might get lucky! Snakes don't always decide you're worth wasting venom on. In fact, between 20 and 80% of snake bites are so-called "dry bites," where the snake is just trying to send a message without actually killing you. You see, venom takes energy and resources for the snake to make, and they don't want to waste it on a warning shot. When it comes to poison, on the other hand, there's no warning shot. If you pick up a poisonous dart frog to admire its beautiful colors, you've already gotten deadly poison all over your hands. As it seeps into your skin and travels through your blood, the poison starts to interfere with your nerves, preventing your muscles from contracting. If the frog's poison reaches your heart, it can cause it to stop. The distinction between venom and poison is purely in the method of delivery. Poison has to be inhaled, ingested, or absorbed. Venom has to be injected into a wound. Chemically, venoms and poisons are both considered toxins, so a snake bite is venomous. A poison dart frog is poisonous. Brown recluse spiders are venomous. Lionfish and pufferfish are poisonous. And some compounds can be poisons in one animal and venoms in another. Tetrodotoxin, a chemical 10,000 times more toxic than cyanide, is found in pufferfish, where it makes them poisonous. It's also found in the deadly blue-ringed octopus, where it's a venom delivered by bite. Some animals can even be both poisonous and venomous. Take the Asian tiger snake, for example. Not only does it have venom in its fangs but it also absorbs the toxins from the poisonous toads it eats, and then secretes those toxins from special glands on its neck, rendering it poisonous, too. Scientists are constantly finding new animals that employ toxins in weird, interesting ways. Recently, researchers discovered the very first venomous crustacean. Out of 70,000 species of crustaceans, only this one little remipede is venomous. Speleonectes tulumensis has figured out how to create a cocktail of toxins that it delivers through its tiny fangs. Scientists aren't totally sure how this venom works yet, but they think that it causes the unwitting victims' neurons to fire over and over and over again until it becomes paralyzed. Then, the little remipede closes in, dissolving away the exoskeleton of its prey and sucking out the juices. But poisons and venoms aren't always all bad. For thousands of years, humans have looked for ways to harness the power of these toxic compounds for good. Today, we have all sorts of medicines that come from toxins. The poison from cone snails is used as a painkiller. Many poisonous plants have been used to treat everything from malaria to irregular heartbeats. And scorpion venom might one day be used to treat heart disease. So, what should you do if something bites or poisons you? Don't try any of the things you've seen on the internet or in movies! Don't try to capture and kill the animal that bit you, and don't use a tourniquet or knife on your wound. Most importantly, don't panic! Stay calm, and seek medical attention. Treatment will mostly depend on what species you encountered. But if you forget the distinction between poison and venom, and tell the parademics that you were poisoned by a viper, they'll probably forgive you and treat you anyway.

**P50 2014-02-18 An athlete uses physics to shatter world records - Asaf Bar-Yosef**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=50)

In the early 1960s, Dick Fosbury tried his hand at almost every sport, but never excelled at anything, until, at the age of 16, he turned to the high jump. But when he couldn't compete against the strong athletes at his college using the standard high jump techniques of the time, Fosbury tried to jump a different way: backwards. Instead of jumping with his face towards the bar, bringing each leg over in the traditional straddle method, he jumped with his back towards the bar. Fosbury improved his record by over half a foot, and left his coaches amazed by this strange new style of high jumping. During the next few years, Fosbury perfected his high jump style, won the U.S. National trials, and assured his place in the 1968 Olympics in Mexico. In the Olympic Games, Fosbury amazed the world with his new technique, winning a gold metal with an Olympic record leap of 2.24 meters. By the next Olympic Games, almost all of the competing of high jumpers had adopted what came to be known as the Fosbury Flop. What's the secret behind the technique? It lies in a physics concept called the center of mass. For every object, we can locate the average position of all of its mass by taking into account how the mass is spread around the object. For instance, the center of mass of a flat, rectangular object of uniform density will be in the intersection of both diagonals, in equal distance from each corner. We can find the center of mass for other objects by similar calculations, or by finding the object's balancing point, which lies right underneath its center of mass. Try balancing a broom by holding it and slowly bringing your hands together until they meet. This balancing point lies right underneath the broom's center of mass. We humans also have a center of mass. When most people stand up, their center of mass is around the belly, but what happens to your center of mass when you lift your hands in the air? Your center of mass moves upwards. It moves all the time as you move through the day, based on how your body is positioned. It can even move outside of your body. When you bend forward, your center of mass is located below your bent belly in a place where there is no mass at all. Weird to think about, but that's the average position of all your mass. Many objects' center of mass are outside their bodies. Think of doughnuts or boomerangs. Now look at the Fosbury Flop, and follow the position of the center of mass of the jumper. The jumper runs very fast, so he can divert his horizontal velocity to vertical velocity, and jumps. Wait for it...there. Look at the jumper's center of mass as his body bends backward. It's below the bar. That is the secret behind the jump. With the old, pre-Fosbury techniques, the jumper had to apply enough force to lift his center of mass above the bar by a few inches in order to clear it. The Fosbury Flopper doesn't have to do that. The genius of the Fosbury Flop is that the jumper can apply the same amount of force, but raise his body much higher than before. That means he can raise the bar so high that even when his center of mass can't go any higher, his arching body can. Fosbury's technique brought the high jump to new heights by splitting the jumper's body away from his center of mass, giving it that much more room to clear higher and higher bars. So the Fosbury Flop may be sports history's only great leap forward, that is also a great leap backward.

**P51 2014-02-24 From the top of the food chain down - Rewilding our world - George Mo**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=51)

We all know about the dinosaurs that once roamed the planet, but long after they went extinct, great beasts we call the megafauna lived on every continent. In the Americas, ground sloths the size of elephants pulled down trees with their claws. Saber-toothed cats the size of brown bears hunted in packs, but they were no match for short-faced bears, which stood thirteen feet on their hind legs, and are likely to have driven these cats away from their prey. There were armadillos as big as small cars, an eight foot beaver, and a bird with a 26 foot wingspan. Almost everywhere, the world's megafauna were driven to extinction, often by human hunters. Some species still survive in parts of Africa and Asia. In other places, you can still see the legacy of these great beasts. Most trees are able to resprout where their trunk is broken to withstand the loss of much of their bark and to survive splitting, twisting and trampling, partly because they evolved to survive attacks by elephants. The American pronghorn can run so fast because it evolved to escape the American cheetah. The surviving animals live in ghost ecosystems adapted to threats from species that no longer exist. Today, it may be possible to resurrect those ghosts, to bring back lost species using genetic material. For instance, there's been research in to cloning woolly mammoths from frozen remains. But even if it's not possible, we can still restore many of the ecosystems the world has lost. How? By making use of abandoned farms. As the market for food is globalized, infertile land becomes uncompetitive. Farmers in barren places can't compete with people growing crops on better land elsewhere. As a result, farming has started to retreat from many regions, and trees have started to return. One estimate claims that two-thirds of land in the US that was once forested but was cleared for farming has become forested again. Another estimate suggests that by 2030, an area in Europe the size of Poland will be vaccated by farmers. So even if we can't use DNA to bring back ground sloths and giant armadillos, we can restore bears, wolves, pumas lynx, moose and bison to the places where they used to live. Some of these animals can reshape their surroundings, creating conditions that allow other species to thrive. When wolves were reintroduced to the Yellowstone National Park in 1995, they quickly transformed the ecosystem. Where they reduced the numbers of overpopulated deer, vegetation began to recover. The height of some trees quintupled in just six years. As forests returned, so did songbirds. Beavers, which eat trees, multiplied in the rivers, and their dams provided homes for otters, muskrats, ducks, frogs and fish. The wolves killed coyotes, allowing rabbits and mice to increase, providing more food for hawks, weasels, foxes and badgers. Bald eagles and ravens fed on the carrion that the wolves abandoned. So did bears, which also ate the berries on the returning shrubs. Bison numbers rose as they browsed the revitalized forests. The wolves changed almost everything. This is an example of a trophic cascade, a change at the top of the food chain that tumbles all the way to the bottom, affecting every level. The discovery of widespread trophic cascades may be one of the most exciting scientific findings of the past half century. They tell us that ecosystems that have lost just one or two species of large animals can behave in radically different ways from those that retain them. All over the world, new movements are trying to catalyze the restoration of nature in a process called rewilding. This means undoing some of the damage we've caused, reestablishing species which have been driven out, and then stepping back. There is no attempt to create an ideal ecosystem, to produce a heath, a rainforest or a coral reef. Rewilding is about bringing back the species that drive dynamic processes and then letting nature take its course. But it's essential that rewilding must never be used as an excuse to push people off the land. It should happen only with the consent and enthusiasm of the people who work there. Imagine standing on a cliff in England, watching sperm whales attacking shoals of herring as they did within sight of the shore until the 18th century. By creating marine reserves in which no commerical fishing takes place, that can happen again. Imagine a European Serengeti full of the animals that used to live there: hippos, rhinos, elephants, hyenas and lions. What rewilding reintroduces, alongside the missing animals and plants, is that rare species called hope. It tells us that ecological change need not always proceed in the same direction. The silent spring could be followed by a wild summer.

**P52 2014-02-24 What is the universe made of - Dennis Wildfogel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=52)

All the material objects around you are composed of submicroscopic units we call molecules. And molecules in turn are composed of individual atoms. Molecules frequently break apart and then form new molecules. On the other hand, virtually all the atoms you come in to contact with through the course of your life, the ones in the ground beneath you, the air you breath, the food you eat, those that make up every living thing, including you, have existed for billions of years and were created in places very unlike our planet. How those atoms came about is what I want to share with you. It all started 14 billion years ago with an event we call The Big Bang, which resulted in a universe consisting of gas alone. There were no stars and no planets. The gas was made up only of atoms belonging to the simplest elements. It was about 75 percent hydrogen and almost all the rest was helium. No elements like carbon, oxygen or nitrogen existed. No iron, silver or gold. In some places, the density of this gas was slightly higher than in others. Due to gravity, those places attracted even more gas, which further strengthened the pull of gravity, which then drew more gas in, and so on. Eventually, large dense gas balls formed, shrinking under their own gravity and consequently heating up on the inside. At some point, the core of such a ball gets hot enough that nuclear fusion occurs. Hydrogen atoms smash together to form helium, accompanied by a great release of energy, strong enough to counteract the shrinking force of the gravity. When the energy pushing out from the fusion reactions matches the gravity pulling all the gas inwards, an equilibrium occurs. From this a star is born. Over its lifetime, the fusion reactions in the core of a massive star will produce not only helium, but also carbon, oxygen, nitrogen and all the other elements in the periodic table up to iron. But eventually, the core's fuel runs out, leaving it to collapse completely. That causes an unbelievably powerful explosion we call a supernova. Now there are two things to note about how supernovas create elements. First, this explosion releases so much energy that fusion goes wild forming elements with atoms even heavier than iron like silver, gold and uranium. Second, all the elements that had been accumulating in the core of the star, like carbon, oxygen, nitrogen, iron, as well as all of those formed in the supernova explosion, are ejected in to interstellar space where they mix with the gas that's already there. History then repeats itself. Gas clouds, now containing many elements besides the original hydrogen and helium, have higher density areas that attract more matter, and so on. As before, new stars result. Our sun was born this way about 5 billion years ago. That means that the gas it arose from had itself been enriched with many elements from supernova explosions since the universe began. So that's how the sun wound up with all the elements. It's still mostly hydrogen at 71 percent, with most of the rest being helium at 27 percent. But bear in mind that while the first stars were made up of hydrogen and helium alone, the remaining elements in the periodic table make up two percent of the sun. And what about Earth? Planets form as an incidental process to star formation out of the same gas cloud as the star itself. Small planets like ours don't have enough gravity to hold on to much hydrogen or helium gas since both of those are very light. So, even though carbon, nitrogen, oxygen and so on made up only two percent of the gas cloud from which Earth was formed, these heavier elements form the bulk of our planet and everything on it. Think about this: with the exception of hydrogen and some helium, the ground you walk on, the air you breath, you, everything is made of atoms that were created inside stars. When scientists first worked this out over the first half of the 20th Century, the famous astronomer Harlow Shapley commented, "We are brothers of the boulders, cousins of the clouds."

**P53 2014-02-26 Why do we cry The three types of tears - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=53)

Our story is about a girl named Iris. Iris is very sensitive. (Bird cawing) So much that she is always in tears. She cries when she's sad, when she's happy, (Godzilla roars) and even tears up when things just get to her. She has special lacrimal glands to make new tears and special tubes, called lacrimal puncta, to drain old ones away. And she cries so much that she goes through ten ounces of tears per day, thirty gallons a year! In fact, if you look closely, you'll see that she's crying a little bit all the time. The basal tears that Iris constantly produces form a thin coating of three layers that cover her and keep dirt and debris away. Right next to Iris is the mucus layer, which keeps the whole thing fastened to her. On top of it is the aqueous layer, which keeps Iris hydrated, repels invasive bacteria, and protects her skin, or cornea, from damage. And, finally, there is the lipid layer, an oily outer film that keeps the surface smooth for Iris to see through, and prevents the other layers from evaporating. Normally, Iris goes about her day without really noticing the basal tears doing their thing. That's kind of their whole point. But one day, she meets a girl named Onion. Iris is immediately smitten. Onion looks gorgeous in her bright purple jacket, and she smells terrific. So, Iris invites Onion to her house for dinner. But when she comes in and takes off her jacket, something terrible happens. You see, when Onion's jacket is removed, a chemical reaction happens, converting the sulfoxides that make her smell so great into sulfenic acid, which then becomes a nasty substance with a long name: syn-Propanethial S-oxide. The gas stings Iris, and suddenly, she can't help it, she starts weeping uncontrollably. These reflex tears are different from the basal tears that Iris is used to. Because they're designed to wash away harmful substances, or particles, they're released in much larger amounts, and their aqueous layer contains more antibodies to stop any microorganisms that may be trying to get in, as well. Both Iris and Onion are devastated. They know they can't continue their relationship if Iris is going to hurt and cry every time Onion takes off her jacket. So, they decide to break up. As Onion walks out the door, Iris stops crying. And immediately starts again. Only now, she's not crying reflex tears but emotional tears. When someone is either too sad or too happy, it feels like a loss of control, which can be dangerous. So, emotional tears are sent in to stabilize the mood as quickly as possible, along with other physical reactions, such as an increased heart rate and slower breathing. But scientists still aren't sure exactly how or why the tears themselves are helpful. They may be a social mechanism to elicit sympathy or show submission. But some studies have also found that emotional tears contain higher levels of stress hormones, such as ACTH and enkephalin, an endorphin and natural pain killer. In this case, emotional tears are also directly calming Iris down, as well as signaling her emotional state to others. Sorry things didn't work out with Onion, Iris, but don't worry. As long as you have all three kinds of tears working to keep you balanced and healthy, it will get better. You'll see.

**P54 2014-02-27 What we can learn from galaxies far, far away - Henry Lin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=54)

Here are some images of clusters of galaxies. They're exactly what they sound like. They are these huge collections of galaxies, bound together by their mutual gravity. So most of the points that you see on the screen are not individual stars, but collections of stars, or galaxies. Now, by showing you some of these images, I hope that you will quickly see that galaxy clusters are these beautiful objects, but more than that, I think galaxy clusters are mysterious, they are surprising, and they're useful. Useful as the universe's most massive laboratories. And as laboratories, to describe galaxy clusters is to describe the experiments that you can do with them. And I think there are four major types, and the first type that I want to describe is probing the very big. So, how big? Well, here is an image of a particular galaxy cluster. It is so massive that the light passing through it is being bent, it's being distorted by the extreme gravity of this cluster. And, in fact, if you look very carefully you'll be able to see rings around this cluster. Now, to give you a number, this particular galaxy cluster has a mass of over one million billion suns. It's just mind-boggling how massive these systems can get. But more than their mass, they have this additional feature. They are essentially isolated systems, so if we like, we can think of them as a scaled-down version of the entire universe. And many of the questions that we might have about the universe at large scales, such as, how does gravity work? might be answered by studying these systems. So that was very big. The second things is very hot. Okay, if I take an image of a galaxy cluster, and I subtract away all of the starlight, what I'm left with is this big, blue blob. This is in false color. It's actually X-ray light that we're seeing. And the question is, if it's not galaxies, what is emitting this light? The answer is hot gas, million-degree gas -- in fact, it's plasma. And the reason why it's so hot goes back to the previous slide. The extreme gravity of these systems is accelerating particles of gas to great speeds, and great speeds means great temperatures. So this is the main idea, but science is a rough draft. There are many basic properties about this plasma that still confuse us, still puzzle us, and still push our understanding of the physics of the very hot. Third thing: probing the very small. Now, to explain this, I need to tell you a very disturbing fact. Most of the universe's matter is not made up of atoms. You were lied to. Most of it is made up of something very, very mysterious, which we call dark matter. Dark matter is something that doesn't like to interact very much, except through gravity, and of course we would like to learn more about it. If you're a particle physicist, you want to know what happens when we smash things together. And dark matter is no exception. Well, how do we do this? To answer that question, I'm going to have to ask another one, which is, what happens when galaxy clusters collide? Here is an image. Since galaxy clusters are representative slices of the universe, scaled-down versions. They are mostly made up of dark matter, and that's what you see in this bluish purple. The red represents the hot gas, and, of course, you can see many galaxies. What's happened is a particle accelerator at a huge, huge scale. And this is very important, because what it means is that very, very small effects that might be difficult to detect in the lab, might be compounded and compounded into something that we could possibly observe in nature. So, it's very funny. The reason why galaxy clusters can teach us about dark matter, the reason why galaxy clusters can teach us about the physics of the very small, is precisely because they are so very big. Fourth thing: the physics of the very strange. Certainly what I've said so far is crazy. Okay, if there's anything stranger I think it has to be dark energy. If I throw a ball into the air, I expect it to go up. What I don't expect is that it go up at an ever-increasing rate. Similarly, cosmologists understand why the universe is expanding. They don't understand why it's expanding at an ever-increasing rate. They give the cause of this accelerated expansion a name, and they call it dark energy. And, again, we want to learn more about it. So, one particular question that we have is, how does dark energy affect the universe at the largest scales? Depending on how strong it is, maybe structure forms faster or slower. Well, the problem with the large-scale structure of the universe is that it's horribly complicated. Here is a computer simulation. And we need a way to simplify it. Well, I like to think about this using an analogy. If I want to understand the sinking of the Titanic, the most important thing to do is not to model the little positions of every single little piece of the boat that broke off. The most important thing to do is to track the two biggest parts. Similarly, I can learn a lot about the universe at the largest scales by tracking its biggest pieces and those biggest pieces are clusters of galaxies. So, as I come to a close, you might feel slightly cheated. I mean, I began by talking about how galaxy clusters are useful, and I've given some reasons, but what is their use really? Well, to answer this, I want to give you a quote by Henry Ford when he was asked about cars. He had this to say: "If I had asked people what they wanted, they would have said faster horses." Today, we as a society are faced with many, many difficult problems. And the solutions to these problems are not obvious. They are not faster horses. They will require an enormous amount of scientific ingenuity. So, yes, we need to focus, yes, we need to concentrate, but we also need to remember that innovation, ingenuity, inspiration -- these things come when we broaden our field of vision when we step back when we zoom out. And I can't think of a better way to do this than by studying the universe around us. Thanks. (Applause)

**P55 2014-02-28 Getting started as a DJ - Mixing, mashups and digital turntables - Co**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=55)

(Music) Aw, thank you, thank you. As you can probably tell, I'm an astronaut. No, I'm a DJ/Producer, as it says on the screen. I am also a high school student, just like many of you guys. How many high school students do we have out here? (Cheers) Oh, okay! A good amount. I'm a proud member of my school's marching band, and I run track, as well, so if any of you guys are into that, it's one of my other passions. I have been DJing and producing for a little over three years now, and I've worked with artists that you may know, like Avicii, Skrillex, Major Lazer, Krewella, Porter Robinsion, Carnage, and many others. How many of you guys like dance music? Show off hands, dance music, oh okay. How many of you guys like rap or trap hip hop? Okay, good amount. Jazz? Classical? That's good, you guys have smart minds, that's good. What's great about DJing is that you can combine all these genres into one idea, and what I like to do is combine dance, hip hop, trap, dubstep, even movie samples, and kind of combine them into one set. DJing creates this, sort of, combined culture that really unites many fans. A good example of this is Skrillex and A$AP Rocky's collaboration "Wild for the Night" or, most recently, Avicii and Ella Black's "Wake Me Up." How many of you guys know that song? It's a great track. Now, what exactly does a DJ do? Well, as you just saw earlier, they mix tracks. What I just did was mix a Kanye West intro from "Black Skinheads" with a track called "LRAD." One of the main goals is to really trigger samples, tracks, or clips and kind of create this long journey. I'm going to do another little example for you guys right now of what DJs call a "mashup," which is taking two or more tracks and combining them into one. This mashup was made famous by a Hungarian duo Myon & Shane 54, and it takes the vocals from Krewella's "Alive." How many of you guys know that song? "Alive"? Yeah, okay. I'm going to take the vocals from that track and the song "Language" by Porter Robinson. So, let me just play you the vocals first. (Music) So, that's the vocals, and here's the actual track. (Music) So, what I'm going to do is I'm going to fill these vocals on top of the track and create a new song, a kind of combined song, with the two vocals. (Music) If you turn it down, you can just hear I'm playing it a capella or just the song by itself. (Music) Now, what I'm going to do after this drops is change it into another song. One of the most important things about dance music is really the drop, so I'm going to change it into another song and really catch you by surprise. (Music) And that's one example right there. (Applause) So, as you saw, I took three different songs and kind of combined them into one new idea, which is something plenty of DJs do out there on the professional circuit. There are plenty of ways to get started DJing. One of the main things I did was really take the time to study DJs that inspired me. Whether it was watching podcasts, watching live sets, or just really looking them up online. I really tried to take in what it meant to be a fantastic DJ. One of the best ways to really learn is to ask a friend, you know, a friend who knows how to DJ. Just go over there, ask him a few questions. If no that, thankfully we have a lot of great online resources. One of the things you can do is check out YouTube, check out some demonstrations. Now, many DJs, a high percentage of them, check out Beatport or Soundcloud to find a lot of the tracks. There are also many other blog sites, such as Billboard's CODE, EDMTunes, EDM Sauce, or Dancing Astronaut. Now, there are multiple ways to DJ, and what could originally only be done on turntables and vinyl, by legends such as Larry Levan, Grandmaster Flash, and Paul Oakenfold, can now be done with many more pieces of equipment, such as CDJs, which are, sort of, digital turntables and what I learned on and what I still use to this day. There are many other amazing programs now, such as Ableton, Traktor Pro, Serato, or even apps for tablets and touchscreens. There are many hardware systems just like my APC40 here that can launch samples, clips and tracks. You can also just use turntables, CDJs, an S4 controller, or an Novation Launchpad. And all of these really kind of do the same thing, and that's mix tracks. So, what I'm going to do now is show you guys another mix demonstration. I'm going to start with one of my own songs that I did with my friend Matt Dzyacky, and from there I'm going to go in a sort of medley of different tracks and show you the different styles of mixing that you can do. (Music) So I'll show you guys when I start mixing the new track, so you can hear it coming in. (Music) You can hear in the back, a new song is mixing in. (Music) Now, another thing that DJs use is what's called a mixer, and a mixer has many different effects, such as a beat roll, filter effects, and any other different ones. There's plenty of effects to use. (Music) So, now I'm going into a new song, and after this drops, I'm going to drop it in another song and kind of change it up. (Music) And that's a new song bite. (Music) So I'm just going to straight mash up another song right when this one breaks down. (Music) Now, if I want to change up the music, let's say, throw in some new beats, I can just choose a trap beat I want to throw over the breakdown. (Music) So, I get ready to throw in my new beats now. (Music) And that is the end of that demo. (Applause) Thank you, thank you! Now, the great thing about technologies now is whether it's a two dollar app or a couple hundred dollar equipment, which I'm sure most parents won't want to buy for their child, is that almost anyone who has a passion for DJing and a passion for the music and who might want to pursue a career in it really has the ability to, well, pursue it, such as myself. You can start with an app on a tablet or an app on your phone, even, an app on your iPad, and then move on to bigger equipment. The opportunities are endless, and, as you saw, you can mix many different styles of music. So, thank you!

**P56 2014-03-06 The science of spiciness - Rose Eveleth**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=56)

Why does your mouth feel like it's on fire when you eat a spicy pepper? And how do you soothe the burn? Why does wasabi make your eyes water? And how spicy is the spiciest spice? Let's back up a bit. First, what is spiciness? Even though we often say that something tastes spicy, it's not actually a taste, like sweet or salty or sour. Instead, what's really happening is that certain compounds in spicy foods activate the type of sensory neurons called polymodal nociceptors. You have these all over your body, including your mouth and nose, and they're the same receptors that are activated by extreme heat. So, when you eat a chili pepper, your mouth feels like it's burning because your brain actually thinks it's burning. The opposite happens when you eat something with menthol in it. The cool, minty compound is activating your cold receptors. When these heat-sensitive receptors are activated, your body thinks it's in contact with a dangerous heat source and reacts accordingly. This is why you start to sweat, and your heart starts beating faster. The peppers have elicited the same fight-or-flight response with which your body reacts to most threats. But you may have noticed that not all spicy foods are spicy in the same way. And the difference lies in the types of compounds involved. The capsaicin and piperine, found in black pepper and chili peppers, are made up of larger, heavier molecules called alkylamides, and those mostly stay in your mouth. Mustard, horseradish, and wasabi are made up of smaller molecules, called isothiocyanates, that easily float up into your sinuses. This is why chili peppers burn your mouth, and wasabi burns your nose. The standard measure of a food's spiciness is its rating on the Scoville scale, which measures how much its capsaicin content can be diluted before the heat is no longer detectable to humans. A sweet bell pepper gets 0 Scoville heat units, while Tabasco sauce clocks in between 1,200-2,400 units. The race to create the hottest pepper is a constant battle, but two peppers generally come out on top: The Trinidad Moruga Scorpion and the Carolina Reaper. These peppers measure between 1.5 and 2 million Scoville heat units, which is about half the units found in pepper spray. So, why would anyone want to eat something that causes such high levels of pain? Nobody really knows when or why humans started eating hot peppers. Archaeologists have found spices like mustard along with human artifacts dating as far back as 23,000 years ago. But they don't know whether the spices were used for food or medication or just decoration. More recently, a 6,000 year old crockpot, lined with charred fish and meat, also contained mustard. One theory says that humans starting adding spices to food to kill off bacteria. And some studies show that spice developed mostly in warmer climates where microbes also happen to be more prevalent. But why we continue to subject ourselves to spicy food today is still a bit of a mystery. For some people, eating spicy food is like riding rollercoasters; they enjoy the ensuing thrill, even if the immediate sensation is unpleasant. Some studies have even shown that those who like to eat hot stuff are more likely to enjoy other adrenaline-rich activities, like gambling. The taste for spicy food may even be genetic. And if you're thinking about training a bit, to up your tolerance for spice, know this: According to some studies, the pain doesn't get any better. You just get tougher. In fact, researchers have found that people who like to eat spicy foods don't rate the burn any less painful than those who don't. They just seem to like the pain more. So, torment your heat receptors all you want, but remember, when it comes to spicy food, you're going to get burned.

**P57 2014-03-13 Grammar's great divide - The Oxford comma - TED-Ed**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=57)

Say you're helping plan a friend's party, and he sends you a text asking you to "bring Bob, a DJ and a clown." You're pretty impressed. You had no idea Bob was so multitalented. But when the day arrives, it turns out that he's not, and you were supposed to bring three different people. As you and Bob sit at the silent, clownless party, it occurs to you that the confusion could've been avoided simply by using another comma after DJ. This final comma in a list, placed directly before the main conjunction, such as and, or, or nor, is called the serial comma, or Oxford comma. And it has long driven grammar nerds crazy because even major language institutions can't agree on whether it should be used. Ironically, the Oxford comma is more common in the United States, where it's recommended by the MLA, the Chicago Style Manual, and the US Government Printing Office, though not by the AP Style Book. In the UK and other English-speaking countries, most style guides do not support the comma's use, with the exception of its namesake, the Oxford University Press. Why not use the serial comma? One of the main arguments is that the conjunction is usually enough to denote a separate entity. And where it's not, like in your ill-fated invite list, changing the order of terms will usually do the job. Journalists also dislike the comma because it takes up precious space and can make text look cluttered. Sometimes, it can even create confusion of its own. For example, if your friend had asked for "Bob, a DJ and a puppy," you'd probably figure out that they're three separate beings. Puppies are cute, but they don't make great DJs. With the comma, you may think Bob is the DJ, and all you need is him and the puppy. The argument over the Oxford comma has raised such strong passions over the years that a sort of truce has been reached. The common wisdom is that its use is optional, and depends on whether it will help to avoid confusion. For one thing, you're supposed to keep your use or avoidance of the Oxford comma consistent throughout a whole piece of writing. So, using it only where necessary is not an option. And the very idea of a grammatical rule being optional is a bit odd. Imagine that you hadn't messed up the party planning, and read the next day that "everyone had a great time - ninjas, pirates, vikings, old and young." If the Oxford comma were standard, you would notice it missing and conclude that old and young must describe the awesome guests already listed. But as things stand, you will always wonder whether it means that a bunch of regular, boring kids and old people showed up as well. Ultimately, the serial comma may be useful or annoying, but your opinion on it, as for many optional things, probably has something to do with whichever style you were raised on. Your high school teachers favored it? It's likely you're still using it. Your first editor hated it? You probably do, too. And maybe so much hairsplitting over a tiny squiggle on a page is a bit silly. After all, there are so many bigger problems to worry about. But sometimes, little things can make a big difference.

**P58 2014-03-13 The case of the vanishing honeybees - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=58)

There is an environmental mystery afoot, and it begins with a seemingly trivial detail that reveals a disaster of global proportions. One day, you notice that the honey you slather on your morning toast is more expensive. Instead of switching to jam, you investigate the reason for the price hike. What you find is shocking. The number of domesticated honeybees in the US has been decreasing at an alarming rate. This decline appears too big to be explained by the usual causes of bee death alone: disease, parasites or starvation. A typical crime scene has almost no adult bees left in the hive, except, perhaps, a lonely queen and a few other survivors. It's full of untouched food stores and a brood of unborn larvae, suggesting that the adults vacated without waiting for them to hatch. But what's particularly eerie is that there's no tell-tale mass of dead or dying bees nearby. Either they have forgotten their way back to the hive, or they have simply disappeared. These mysterious disappearances aren't new. Humans have been collecting honey for centuries. But it wasn't until European settlers in the 1600's introduced the subspecies, Apis mellifera, that we domesticated bees. Since the 19th century, beekeepers have reported occasional mass disappearances, giving them enigmatic names like disappearing disease, spring dwindle disease and autumn collapse. But when in 2006 such losses were found to affect more than half of all hives in the US, the phenomenon got a new name: colony collapse disorder. The most frightening thing about this mystery isn't that we'll have to go back to using regular sugar in our tea. We farm bees for their honey, but they also pollinate our crops on an industrial scale, generating over 1/3 of America's food production this way. So, how can we find the culprit behind this calamity? Here are three of the possible offenders. Exhibit A: Pests and Disease. Most infamous is the varroa mite, a minuscule red pest that not only invades colonies and feeds on bees, but also transfers pathogens that stunt bee growth and shortens their life span. Exhibit B: Genetics. The queen is the core of a healthy hive. But nowadays, the millions of queen bees distributed in commercial hives are bred from just a few original queens, which raises the worry about a lack of genetic diversity which could weaken bees' defenses against pathogens and pests. Exhibit C: Chemicals. Pesticides used both on commercial beehives and agricultural crops to ward off parasites could be getting into the food and water that honeybees consume. Researchers have even found that some pesticides damage the honeybees' homing abilities. So we have a file full of clues but no clear leads. In reality, scientists, the actual detectives on this case, face disagreement over what causes colony collapse disorder. For now, we assume that several factors are the cause. Honeybees aren't necessarily in danger of extinction, but fewer bees overall means less pollination and higher food costs, so it's crucial that scientists solve the case of the vanishing bees. Because while having less honey might be a buzzkill, crop shortages are something that would truly sting.

**P59 2014-03-14 The fundamentals of space-time - Part 1 - Andrew Pontzen and Tom Whyn**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=59)

Space: it's where things happen. Time: it's when things happen. We can measure where things are and when things take place, but in modern physics, we realize when and where are actually part of the same question. Because when it comes to understanding the universe, we need to replace three-dimensional space plus time with a single concept: four-dimensional space-time. We'll explore and explain space-time in this series of animations. Animations? Yeah. Well, we're not very animated are we? Sure we are! Look, I can go from here to here. Whoa! How'd you get from here to there? How fast did you go? Did you run? Walk? Did you even go in a straight line? Ah! To answer that, you'll need to make our cartoon physics look more like physics physics. You'll need more panels. More panels, please! Okay, in each panel, Andrew's in a slightly different place. So I can see each one records where Andrew is at a different time. That's great. But it would be easier to see what's going on if we could cut out all the hundreds of panels and stack them up like a flip book. Right, now let's flip through the book so that we can see one panel after another getting through 24 in every second. See! I told you it was an animation. Now you can see me walking along. Drawing all those panels and putting them into a flip book is just one way of recording the way I'm moving. It's how animation, or even movies, work. As it turns out, at my walking speed, it takes two seconds to get past each fence post, and they're spaced four meters apart. So we can calculate my velocity -- how fast I'm moving through space - - is two meters per second. But I could've worked that out from the panels without flipping through them. From the edge of the flip book, you can see all of the copies of the fence posts and all of the copies of Andrew and he's in a slightly different place in each one. Now we can predict everything that will happen to Andrew when we flip through 24 pages every second, including his speed of motion, just by looking. No need to flip through at all. The edge of this flip book is known as a space-time diagram of Andrew's journey through, you guessed it, space and time. We call the line that represents Andrew's journey his world line. If i jog instead of walking, I might be able to get past a fence post every second. He's not very athletic. Anyway, when we look at this new flip book from the edge, we can do the same analysis as before. The world line for Andrew jogging is more tilted over than the world line for Andrew walking. We can tell he's going twice as fast as before without flipping the panels. But here's the clever bit. In physics, it's always good to view things from other perspectives. After all, the laws of physics should be the same for everyone or no one will obey them. So let's rethink our cartoon and have the camera follow Andrew jogging along as the fence posts approach and pass behind him. Still viewing it as a flip book of panels, we don't need to redraw anything. We simply move all of the cutout frames slightly until Andrew's tilted world line becomes completely vertical. To see why, let's flip it. Yes, now I'm stationery, just jogging on the spot, in the center of the panel. On the edge of the flip book, my world line was going straight upwards. The fence posts are coming past me. It's now their world lines that are tilted. This rearrangement of the panels is known as a Galilean transformation, and it lets us analyze physics from someeone else's perspective. In this case, mine. After all, it's always good to see things from other points of view, especially when the viewers are moving at different speeds. So long as the speeds aren't too high. If you're a cosmic ray moving at the speed of light, our flip book of your point of view falls apart. To stop that from happening, we'll have to glue panels together. Instead of a stack of separate panels, we'll need a solid block of space-time, which we'll come to in the next animation.

**P60 2014-03-19 Dead stuff - The secret ingredient in our food chain - John C. Moore**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=60)

If someone called you scum, you'd probably be offended, but scientifically, they might not be far off. Have you ever thought about where your food comes from? You might say it comes from plants, animals, or even fungi, but you'd probably rather not think about the rotting organisms and poop that feed those plants, animals, and fungi. So really, you and most of the matter in your body are just two or three degrees of separation from things like pond scum. All species in an ecosystem, from the creatures in a coral reef to the fish in a lake to the lions on the savannah, are directly or indirectly nourished by dead stuff. Most of the organic matter in our bodies, if we trace it back far enough, comes from CO2 and water through photosynthesis. Plants use the energy from sunlight to transform carbon dioxide and water from the environment into glucose and oxygen. That glucose is then transformed into more complex organic molecules to form leaves, stems, roots, fruit, and so on. The energy stored in these organic molecules supports the food chains with which we're familiar. You've probably seen illustrations like this or this. These green food chains start with living plants at their base. But in real-life terrestrial ecosystems, less than 10% of plant matter is eaten while it's still alive. What about the other 90? Well, just look at the ground on an autumn day. Living plants shed dead body parts: fallen leaves, broken branches, and even underground roots. Many plants are lucky enough to go their whole lives without being eaten, eventually dying and leaving remains. All of these uneaten, undigested, and dead plant parts, that 90% of terrestrial plant matter? That becomes detritus, the base of what we call the brown food chain, which looks more like this. What happens to plants also happens to all other organisms up the food chain: some are eaten alive, but most are eaten only when they're dead and rotting. And all along this food chain, living things shed organic matter and expel digestive waste before dying and leaving their remains to decay. All that death sounds grim, right? But it's not. All detritus is ultimately consumed by microbes and other scavengers, so it actually forms the base of the brown food chain that supports many other organisms, including us. Scientists are learning that this detritus is an unexpectedly huge energy source, fueling most natural ecosystems. But the interactions within an ecosystem are even more complex than that. What a food chain really represents is a single pathway of energy flow. And within any ecosystem, many of these flows are linked together to form a rich network of interactions, or food web, with dead matter supporting that network at every step. The resulting food web is so connected that almost every species is no more than two degrees from detritus, even us humans. You probably don't eat rotting things, poop, or pond scum directly, but your food sources probably do. Many animals we eat either feed directly on detritus themselves, like pork, poultry, mushrooms, shellfish, or catfish and other bottom feeders, or they are fed animal by-products. So, if you're thinking nature is full of waste, you're right. But one organism's garbage is another's gold, and all that rotting dead stuff ultimately provides the energy that nourishes us and most of life on Earth, as it passes through the food web. Now that's some food for thought.

**P61 2014-03-26 How many ways can you arrange a deck of cards - Yannay Khaikin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=61)

Pick a card, any card. Actually, just pick up all of them and take a look. This standard 52-card deck has been used for centuries. Everyday, thousands just like it are shuffled in casinos all over the world, the order rearranged each time. And yet, every time you pick up a well-shuffled deck like this one, you are almost certainly holding an arrangement of cards that has never before existed in all of history. How can this be? The answer lies in how many different arrangements of 52 cards, or any objects, are possible. Now, 52 may not seem like such a high number, but let's start with an even smaller one. Say we have four people trying to sit in four numbered chairs. How many ways can they be seated? To start off, any of the four people can sit in the first chair. One this choice is made, only three people remain standing. After the second person sits down, only two people are left as candidates for the third chair. And after the third person has sat down, the last person standing has no choice but to sit in the fourth chair. If we manually write out all the possible arrangements, or permutations, it turns out that there are 24 ways that four people can be seated into four chairs, but when dealing with larger numbers, this can take quite a while. So let's see if there's a quicker way. Going from the beginning again, you can see that each of the four initial choices for the first chair leads to three more possible choices for the second chair, and each of those choices leads to two more for the third chair. So instead of counting each final scenario individually, we can multiply the number of choices for each chair: four times three times two times one to achieve the same result of 24. An interesting pattern emerges. We start with the number of objects we're arranging, four in this case, and multiply it by consecutively smaller integers until we reach one. This is an exciting discovery. So exciting that mathematicians have chosen to symbolize this kind of calculation, known as a factorial, with an exclamation mark. As a general rule, the factorial of any positive integer is calculated as the product of that same integer and all smaller integers down to one. In our simple example, the number of ways four people can be arranged into chairs is written as four factorial, which equals 24. So let's go back to our deck. Just as there were four factorial ways of arranging four people, there are 52 factorial ways of arranging 52 cards. Fortunately, we don't have to calculate this by hand. Just enter the function into a calculator, and it will show you that the number of possible arrangements is 8.07 x 10^67, or roughly eight followed by 67 zeros. Just how big is this number? Well, if a new permutation of 52 cards were written out every second starting 13.8 billion years ago, when the Big Bang is thought to have occurred, the writing would still be continuing today and for millions of years to come. In fact, there are more possible ways to arrange this simple deck of cards than there are atoms on Earth. So the next time it's your turn to shuffle, take a moment to remember that you're holding something that may have never before existed and may never exist again.

**P62 2014-03-28 Sugar - Hiding in plain sight - Robert Lustig**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=62)

Sugar is playing hide and seek with you. You'd think it would be pretty easy for you to win, considering all the sugar in sodas, ice cream, candy, and big white bags labeled sugar. People get about half of their added sugars from those drinks and treats, so it might seem like sugar is hiding in plain sight, but like someone in the witness protection program, the other half is hidden in places you'd least suspect. Check the ingredients on ketchup, bologna, spaghetti sauce, soy milk, sports drinks, fish sticks, and peanut butter. You'll find sugar hiding in most of those products. In fact, you'll find added sugars in three-quarters of the more than 600,000 items available in grocery stores. But how is sugar hiding? Can't you just look on food labels? It's not that easy. Just like your friend Robert might go by Bob, Robby, Rob, Bobby, or Roberto, added sugar has a lot of aliases. And by a lot, we don't mean five or six, try fifty-six. There's brown rice syrup, barley malt, demerara, Florida Crystals, muscovado, and, of course, high fructose corn syrup, sometimes called HFCS, or corn sugar. Even sugar's tricky nicknames have nicknames. Grape or apple concentrate has the same effects on your body as its 55 sugary twins. And even though organic evaporated cane juice sounds healthy, when you evaporate it, you get sugar! Chemically speaking, it's all the same. And even trickier, when multiple added types of sugars are used in one type of product, they get buried down in a long list of ingredients, so the sugar content might appear to be okay, but when you add them all together, sugar can be the single biggest ingredient. Currently, the FDA doesn't suggest a recommended daily limit for sugar, so it's hard to tell if this 65 grams in a bottle of soda is a little or a lot. But the World Health Organization recommends limiting sugar to just 5% of your total calories, or about 25 grams per day. So, 65 grams is well over twice that amount. But just what is sugar? What's the difference between glucose and fructose? Well, both are carbohydrates with the same chemical composition of carbon, hydrogen, and oxygen. But they have very different structures and behave quite differently in our bodies. Glucose is the best source of energy for nearly all organisms on Earth. It can be metabolized by all organs in the body. Fructose, on the other hand, is metabolized primarily in the liver, and when your liver gets overloaded with sweet, sweet fructose, the excess is metabolized to fat. Fresh fruits actually contain fructose, but it's naturally occurring and doesn't cause an overload because the fiber in fruit slows its absorption. This gives your liver the time it needs to do its job. It's sugar that makes cookies chewy and candy crunchy. It even turns bread crust a beautiful, golden brown. It's also a great preservative; it doesn't spoil or evaporate, so the foods it's added to are easier to store and ship long distances and tend to be cheaper. That's why sugar is hiding everywhere. Actually, it might be easier to list the foods that added sugar isn't hiding in, things like: vegetables, eggs, meats, fish, fruit, raw nuts, even your kitchen sink. Simply choosing water over soda, juices, and sports drinks is a great way to avoid hidden added sugar. At the very least, try to pay attention to food labels, so you can keep your sugar intake at a healthy level. Because in this game of hide and seek, every time you don't find added sugar, you win!

**P63 2014-03-31 Nature's smallest factory - The Calvin cycle - Cathy Symington**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=63)

You're facing a giant bowl of energy packed Carbon Crunchies. One spoonful. Two. Three. Soon, you're powered up by the energy surge that comes from your meal. But how did that energy get into your bowl? Energy exists in the form of sugars made by the plant your cereal came from, like wheat or corn. As you can see, carbon is the chemical backbone, and plants get their fix of it in the form of carbon dioxide, CO2, from the air that we all breath. But how does a plant's energy factory, housed in the stroma of the chloroplast, turn a one carbon gas, like CO2, into a six carbon solid, like glucose? If you're thinking photosynthesis, you're right. But photosynthesis is divided into two steps. The first, which stores energy from the sun in the form of adenosine triphosphate, or ATP. And the second, the Calvin cycle, that captures carbon and turns it into sugar. This second phase represents one of nature's most sustainable production lines. And so with that, welcome to world's most miniscule factory. The starting materials? A mix of CO2 molecules from the air, and preassembled molecules called ribulose biphosphate, or RuBP, each containing five carbons. The initiator? An industrious enzyme named rubisco that welds one carbon atom from a CO2 molecule with the RuBP chain to build an initial six carbon sequence. That rapidly splits into two shorter chains containing three carbons each and called phosphoglycerates, or PGAs, for short. Enter ATP, and another chemical called nicotinamide adenine dinucleotide phosphate, or just NADPH. ATP, working like a lubricant, delivers energy, while NADPH affixes one hydrogen to each of the PGA chains, changing them into molecules called glyceraldehyde 3 phosphates, or G3Ps. Glucose needs six carbons to form, made from two molecules of G3P, which incidentally have six carbons between them. So, sugar has just been manufactured, right? Not quite. The Calvin cycle works like a sustainable production line, meaning that those original RuBPs that kicked things off at the start, need to be recreated by reusing materials within the cycle now. But each RuBP needs five carbons and manufacturing glucose takes a whole six. Something doesn't add up. The answer lies in one phenomenal fact. While we've been focusing on this single production line, five others have been happening at the same time. With six conveyor belts moving in unison, there isn't just one carbon that gets soldered to one RuBP chain, but six carbons soldered to six RuBPs. That creates 12 G3P chains instead of just two, meaning that all together, 36 carbons exist: the precise number needed to manufacture sugar, and rebuild those RuBPs. Of the 12 G3Ps pooled together, two are siphoned off to form that energy rich six carbon glucose chain. The one fueling you via your breakfast. Success! But back on the manufacturing line, the byproducts of this sugar production are swiftly assembled to recreate those six RuBPs. That requires 30 carbons, the exact number contained by the remaining 10 G3PS. Now a molecular mix and match occurs. Two of the G3Ps are welded together forming a six carbon sequence. By adding a third G3P, a nine carbon chain is built. The first RuBP, made up of five carbons, is cast from this, leaving four carbons behind. But there's no wastage here. Those are soldered to a fourth G3P molecule, making a seven carbon chain. Added to a fifth G3P molecule, a ten carbon chain is created, enough now to craft two more RuBPs. With three full RuBPs recreated from five of the ten G3Ps, simply duplicating this process will renew the six RuBP chains needed to restart the cycle again. So the Calvin cycle generates the precise number of elements and processes required to keep this biochemical production line turning endlessly. And it's just one of the 100s of cycles present in nature. Why so many? Because if biological production processes were linear, they wouldn't be nearly as efficient or successful at using energy to manufacture the materials that nature relies upon, like sugar. Cycles create vital feedback loops that repeatedly reuse and rebuild ingredients crafting as much as possible out of the planet's available resources. Such as that sugar, built using raw sunlight and carbon converted in plant factories to become the energy that powers you and keeps the cycles revolving in your own life.

**P64 2014-04-02 What is Alzheimer's disease - Ivan Seah Yu Jun**

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Every four seconds, someone is diagnosed with Alzheimer's disease. It's the most common cause of dementia, affecting over 40 million people worldwide, and yet finding a cure is something that still eludes researchers today. Dr. Alois Alzheimer, a German psychiatrist, first described the symptoms in 1901 when he noticed that a particular hospital patient had some peculiar problems, including difficulty sleeping, disturbed memory, drastic mood changes, and increasing confusion. When the patient passed away, Alzheimer was able to do an autopsy and test his idea that perhaps her symptoms were caused by irregularities in the brain's structure. What he found beneath the microscope were visible differences in brain tissue in the form of misfolded proteins called plaques, and neurofibrillary tangles. Those plaques and tangles work together to break down the brain's structure. Plaques arise when another protein in the fatty membrane surrounding nerve cells gets sliced up by a particular enzyme, resulting in beta-amyloid proteins, which are sticky and have a tendency to clump together. That clumping is what forms the things we know as plaques. These clumps block signaling and, therefore, communication between cells, and also seem to trigger immune reactions that cause the destruction of disabled nerve cells. In Alzheimer's disease, neurofibrillary tangles are built from a protein known as tau. The brain's nerve cells contain a network of tubes that act like a highway for food molecules among other things. Usually, the tau protein ensures that these tubes are straight, allowing molecules to pass through freely. But in Alzheimer's disease, the protein collapses into twisted strands or tangles, making the tubes disintegrate, obstructing nutrients from reaching the nerve cell and leading to cell death. The destructive pairing of plaques and tangles starts in a region called the hippocampus, which is responsible for forming memories. That's why short-term memory loss is usually the first symptom of Alzheimer's. The proteins then progressively invade other parts of the brain, creating unique changes that signal various stages of the disease. At the front of the brain, the proteins destroy the ability to process logical thoughts. Next, they shift to the region that controls emotions, resulting in erratic mood changes. At the top of the brain, they cause paranoia and hallucinations, and once they reach the brain's rear, the plaques and tangles work together to erase the mind's deepest memories. Eventually the control centers governing heart rate and breathing are overpowered as well resulting in death. The immensely destructive nature of this disease has inspired many researchers to look for a cure but currently they're focused on slowing its progression. One temporary treatment helps reduce the break down of acetylcholine, an important chemical messenger in the brain which is decreased in Alzheimer's patients due to the death of the nerve cells that make it. Another possible solution is a vaccine that trains the body's immune system to attack beta-amyloid plaques before they can form clumps. But we still need to find an actual cure. Alzheimer's disease was discovered more than a century ago, and yet still it is not well understood. Perhaps one day we'll grasp the exact mechanisms at work behind this threat and a solution will be unearthed.

**P65 2014-04-03 History vs. Vladimir Lenin - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=65)

He was one of the most influential figures of the 20th century, forever changing the course of one of the world's largest countries. But was he a hero who toppled an oppressive tyranny or a villain who replaced it with another? It's time to put Lenin on the stand in History vs. Lenin. "Order, order, hmm. Now, wasn't it your fault that the band broke up?" "Your honor, this is Vladimir Ilyich Ulyanov, AKA Lenin, the rabblerouser who helped overthrow the Russian tsar Nicholas II in 1917 and founded the Soviet Union, one of the worst dictatorships of the 20th century." "Ohh." "The tsar was a bloody tyrant under whom the masses toiled in slavery." "This is rubbish. Serfdom had already been abolished in 1861." "And replaced by something worse. The factory bosses treated the people far worse than their former feudal landlords. And unlike the landlords, they were always there. Russian workers toiled for eleven hours a day and were the lowest paid in all of Europe." "But Tsar Nicholas made laws to protect the workers." "He reluctantly did the bare minimum to avert revolution, and even there, he failed. Remember what happened in 1905 after his troops fired on peaceful petitioners?" "Yes, and the tsar ended the rebellion by introducing a constitution and an elected parliament, the Duma." "While retaining absolute power and dissolving them whenever he wanted." "Perhaps there would've been more reforms in due time if radicals, like Lenin, weren't always stirring up trouble." "Your Honor, Lenin had seen his older brother Aleksandr executed by the previous tsar for revolutionary activity, and even after the reforms, Nicholas continued the same mass repression and executions, as well as the unpopular involvement in World War I, that cost Russia so many lives and resources." "Hm, this tsar doesn't sound like such a capital fellow." "Your Honor, maybe Nicholas II did doom himself with bad decisions, but Lenin deserves no credit for this. When the February 1917 uprisings finally forced the tsar to abdicate, Lenin was still exiled in Switzerland." "Hm, so who came to power?" "The Duma formed a provisional government, led by Alexander Kerensky, an incompetent bourgeois failure. He even launched another failed offensive in the war, where Russia had already lost so much, instead of ending it like the people wanted." "It was a constitutional social democratic government, the most progressive of its time. And it could have succeeded eventually if Lenin hadn't returned in April, sent by the Germans to undermine the Russian war effort and instigate riots." "Such slander! The July Days were a spontaneous and justified reaction against the government's failures. And Kerensky showed his true colors when he blamed Lenin and arrested and outlawed his Bolshevik party, forcing him to flee into exile again. Some democracy! It's a good thing the government collapsed under their own incompetence and greed when they tried to stage a military coup then had to ask the Bolsheviks for help when it backfired. After that, all Lenin had to do was return in October and take charge. The government was peacefully overthrown overnight." "But what the Bolsheviks did after gaining power wasn't very peaceful. How many people did they execute without trial? And was it really necessary to murder the tsar's entire family, even the children?" "Russia was being attacked by foreign imperialists, trying to restore the tsar. Any royal heir that was rescued would be recognized as ruler by foreign governments. It would've been the end of everything the people had fought so hard to achieve. Besides, Lenin may not have given the order." "But it was not only imperialists that the Bolsheviks killed. What about the purges and executions of other socialist and anarchist parties, their old allies? What about the Tambov Rebellion, where peasants, resisting grain confiscation, were killed with poison gas? Or sending the army to crush the workers in Kronstadt, who were demanding democratic self-management? Was this still fighting for the people?" "Yes! The measures were difficult, but it was a difficult time. The new government needed to secure itself while being attacked from all sides, so that the socialist order could be established." "And what good came of this socialist order? Even after the civil war was won, there were famines, repression and millions executed or sent to die in camps, while Lenin's successor Stalin established a cult of personality and absolute power." "That wasn't the plan. Lenin never cared for personal gains, even his enemies admitted that he fully believed in his cause, living modestly and working tirelessly from his student days until his too early death. He saw how power-hungry Stalin was and tried to warn the party, but it was too late." "And the decades of totalitarianism that followed after?" "You could call it that, but it was Lenin's efforts that changed Russia in a few decades from a backward and undeveloped monarchy full of illiterate peasants to a modern, industrial superpower, with one of the world's best educated populations, unprecedented opportunities for women, and some of the most important scientific advancements of the century. Life may not have been luxurious, but nearly everyone had a roof over their head and food on their plate, which few countries have achieved." "But these advances could still have happened, even without Lenin and the repressive regime he established." "Yes, and I could've been a famous rock and roll singer. But how would I have sounded?" We can never be sure how things could've unfolded if different people were in power or different decisions were made, but to avoid the mistakes of the past, we must always be willing to put historical figures on trial.

**P66 2014-04-03 Why is ketchup so hard to pour - George Zaidan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=66)

French fries are delicious. French fries with ketchup are a little slice of heaven. The problem is it's basically impossible to pour the exactly right amount. We're so used to pouring ketchup that we don't realize how weird its behavior is. Imagine a ketchup bottle filled with a straight up solid like steel. No amount of shaking would ever get the steel out. Now imagine that same bottle full of a liquid like water. That would pour like a dream. Ketchup, though, can't seem to make up its mind. Is it is a solid? Or a liquid? The answer is, it depends. The world's most common fluids like water, oils and alcohols respond to force linearly. If you push on them twice as hard, they move twice as fast. Sir Isaac Newton, of apple fame, first proposed this relationship, and so those fluids are called Newtonian fluids. Ketchup, though, is part of a merry band of linear rule breakers called Non-Newtonian fluids. Mayonnaise, toothpaste, blood, paint, peanut butter and lots of other fluids respond to force non-linearly. That is, their apparent thickness changes depending on how hard you push, or how long, or how fast. And ketchup is actually Non-Newtonian in two different ways. Way number one: the harder you push, the thinner ketchup seems to get. Below a certain pushing force, ketchup basically behaves like a solid. But once you pass that breaking point, it switches gears and becomes a thousand times thinner than it was before. Sound familiar right? Way number two: if you push with a force below the threshold force eventually, the ketchup will start to flow. In this case, time, not force, is the key to releasing ketchup from its glassy prison. Alright, so, why does ketchup act all weird? Well, it's made from tomatoes, pulverized, smashed, thrashed, utterly destroyed tomatoes. See these tiny particles? This is what remains of tomatoes cells after they go through the ketchup treatment. And the liquid around those particles? That's mostly water and some vinegar, sugar, and spices. When ketchup is just sitting around, the tomato particles are evenly and randomly distributed. Now, let's say you apply a weak force very quickly. The particles bump into each other, but can't get out of each other's way, so the ketchup doesn't flow. Now, let's say you apply a strong force very quickly. That extra force is enough to squish the tomato particles, so maybe instead of little spheres, they get smushed into little ellipses, and boom! Now you have enough space for one group of particles to get passed others and the ketchup flows. Now let's say you apply a very weak force but for a very long time. Turns out, we're not exactly sure what happens in this scenario. One possibility is that the tomato particles near the walls of the container slowly get bumped towards the middle, leaving the soup they were dissolved in, which remember is basically water, near the edges. That water serves as a lubricant betwen the glass bottle and the center plug of ketchup, and so the ketchup flows. Another possibility is that the particles slowly rearrange themselves into lots of small groups, which then flow past each other. Scientists who study fluid flows are still actively researching how ketchup and its merry friends work. Ketchup basically gets thinner the harder you push, but other substances, like oobleck or some natural peanut butters, actually get thicker the harder you push. Others can climb up rotating rods, or continue to pour themselves out of a beeker, once you get them started. From a physics perspective, though, ketchup is one of the more complicated mixtures out there. And as if that weren't enough, the balance of ingredients and the presence of natural thickeners like xanthan gum, which is also found in many fruit drinks and milkshakes, can mean that two different ketchups can behave completely differently. But most will show two telltale properties: sudden thinning at a threshold force, and more gradual thinning after a small force is applied for a long time. And that means you could get ketchup out of the bottle in two ways: either give it a series of long, slow languid shakes making sure you don't ever stop applying force, or you could hit the bottle once very, very hard. What the real pros do is keep the lid on, give the bottle a few short, sharp shakes to wake up all those tomato particles, and then take the lid off and do a nice controlled pour onto their heavenly fries.

**P67 2014-04-10 A digital reimagining of Gettysburg - Anne Knowles**

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I'm a geographer at Middlebury College, and I use digital technologies to reimagine the past. I want to take you to Gettysburg, Pennsylvania, July 1, 1863, we're right in the middle of the Civil War. >From the northwest, the Confederate forces under Robert E. Lee, and from the southeast, the Union forces under George Meade, converge at this place more or less by chance. They didn't plan to fight here. But the Battle of Gettysburg turns out to be the turning point of the Civil War. Now, Robert E. Lee is probably the most famous American general, widely respected. But at Gettysburg, he made some crucial mistakes, probably the most important was in ordering Pickett's Charge. I'm going to show you how I took a new look at Pickett's Charge with historical maps and GIS. My key map was this extraordinary thing, 12 feet by 13 feet, in the vault of treasures at the National Archives. Here are some of my students at Middlebury to give you a sense of that scale. It was recompiled into a finished map the size of a large poster. You can see the layout of the town of Gettysburg, you see the undulating shape of the terrain. If you look at other details, you can see forests and orchards and streams and roads. I want you to look at those very fine black lines. Those are called contour lines, and they show the elevation at 4-foot intervals, the most detailed elevation I have ever seen. Now, before I explain this image, I need to tell you a little about GIS. It stands for Geographic Information Systems. It's a kind of software that allows you to map almost anything. You can also use it to do terrain analysis. For example, if you're building a ski resort, and you want people to get off the lift and have the most spectacular view possible, you use viewshed analysis that shows you what you can see from a certain point on the terrain. I used that to place myself digitally in the footsteps of Robert E. Lee, to ask, 'What could he see?' and 'What could he not see?' that might have influenced his command decisions. Now, back to these contour lines. This is the best elevation data that I could find. I traced all of the lines, you see in the black and white drawings, some of those lines, stitched them together, gave them elevation values, and then transformed it, within the GIS program, into a continuous terrain. This is a simulation of the ground of the battlefield. Now, I'm ready to place myself in Lee's boots and ask what he could see. The particular moment I want to look at is that battle I mentioned, Pickett's Charge. Lee makes a crucial decision on the morning of the third day, this is July 3rd, 1863, the fighting on the previous two days has been fierce. It's gone back and forth, neither side has a clear advantage. Lee goes down to the bottom of the field, we know this, here's my gorgeous source map again and watch the red circle appear. He goes to the southern end of the battlefield at about 8:00 in the morning with his binoculars and looks through them to figure out where to attack the Union line, where are they most vulnerable. Now, in this next image, I'm going to show you the GIS process called viewshed analysis, along with Lee's line of sight in that sort of reddish cone is the direction we think he was looking. Viewshed analysis, remember, tells me what I can see and what I can't see from a certain point, so in this map, the grey area is what Lee couldn't see. The clear area, where you see that historic map coming through, is what he could've definitely seen. Notice how much of the right side of the map is in grey. Now, we add another crucial piece of information. Someone named John Bachelder, a landscape painter from New Hampshire, went down to the battlefield as soon as he heard about the fight, in order to document where troops had been and to try to paint the battle. He ended up getting $10,000 from Congress in order to document troop positions down to the half hour. He produced 24 maps that we also digitized and brought into the GIS. And this next map shows that troop position information; it's crucial for understanding what Lee could and what he couldn't see. Now, if you look closely at this map, you might be able to see kind of the middle is a black oval around an area that's relatively clear. The blue markings in that black oval are Union troops that I'm definitely sure that Lee could see. But if you look to the right of that, you'll see an awful lot of blue markings. Those are Union troops in the shadows. Now, we know that on the night before Lee's reconnaissance so, the night of July 2nd, he sent out scouts. Of course, he wanted to know where the federal troops were. But quite astonishingly, we have no explanation for this. The scouts came back saying, 'Don't worry, General Lee. We didn't see any troops to the east,' in your map to the right, 'of the Roundtops, some really big hills.' We don't know if they got drunk or fell asleep, but they didn't see almost a third of the Union army. So Lee is blind from his scouts, and from his viewpoint, he's also blind. He decides to attack what he thinks is the weak middle of the Union line, not knowing about where the rest of the troops are. So if you look in the middle of this image, there's a gap in the Union line from where the blue soldiers are at the north of the battlefield and at the south. So let me now play out, using these troop positions, Pickett's Charge. The Confederate soldiers are lined up on the west side of the battlefield, standing under the trees. 18,000 men who first begin to walk and then trot and then run across open farm fields with their rifles leveled at the federal line. Now, the Union army has about 15-20 minutes to organize itself. They see that the Confederates are converging on the middle of their line, and what do they do? The blue arrow here, representing movement of the Union troops, they pull their troops toward that weak center, and let me show you how they were able to concentrate those men in a remarkably short period of time. Lee didn't know that the Union could've done this. You see now, they're standing like a wall, ready to receive the Confederate assault, which happens between 1:30 and about 2:00, 2:30 in the afternoon. There is tremendously fierce fighting, hand-to-hand combat. Now these blue lines, coming in between 2-2:30 in the afternoon, are pulling more reserves, more reinforcements, to that weak center of the Union line. What happens? The Union soliders drive the Confederates off. Lee rides out, among his men, at 3:00 in the afternoon, saying, 'I'm sorry. It's my fault. It's my fault.' This story of sight has been a missing part of the Battle of Gettysburg. Here's their retreat. Historians have not been previously able to figure out what he could and couldn't see. I think it helps explain his decision. Why? Because from his point of view, the federals were very weak. He was attacking at the logical place, but without full knowledge, he set his men out for a dreadful defeat. Now, there's one more piece to this story. Last summer was the 150th anniversary of the Battle of Gettysburg. And I was able to work with a 3D animator, so we were able to use the GIS information to render the terrain issue as you see it here. And my closing story is about how sight helped the other side. A federal general named GK Warren stood in the spot that this panoramic view is showing you, looking out over the battlefield. And at a key moment on day two, he was able to see on the far horizon Confederate soldiers emerging out of the trees who were about to attack Little Roundtop. He called in reinforcements just in time and saved the day for the Union, setting the stage for the Union almost-victory on day three. So, I hope that all of you who are so gifted with digital technologies will begin to think about how you can use them for history. It can be amazing. Thank you.

**P68 2014-04-10 How whales breathe, communicate ... and fart with their faces - Joy R**

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Hi, everybody! I am a comparative anatomist. A comparative anatomist is someone who studies the structure of the body of lots of different animals. And my favorite animals are whales. I like to study whales because they're so interesting. They've adapted to a unique environment of living in the water. And what I'm going to tell you about is how whales make sounds by basically farting with their face. You know that they do this farting thing with their blowhole; they blow out air like that, but they also use air in lots of other ways. They use it for sound production, which is what I'll focus on, but I also study other things they do with air, like keep it out of their bloodstream so they don't get bubbles, which is what happens to human scuba divers when they get decompression sickness. But I'd like to start with the story of how these animals make these farting noises, and that story begins with understanding how hard it is to look at whales, because they live underwater and they're really big, so they're hard animals to study. And in this picture -- you see that animal in the middle? That's a baby whale and it's already the size of a bus! When you look at whales, start with the top of their head because their nose is on the top of their head, kind of like a built-in snorkel. They breathe through that because they're mammals and mammals breathe air. Their nose can be opened and closed, as if you were to pinch it like this. You can see it's open in the bottom frame, where the red arrows are. But not all whales have two nostrils. Whales include the groups of dolphins and porpoises, and dolphins and porpoises, the small whales, have only one nostril on the top of their head, and they open and close that nostril by taking what is essentially an upper lip, like this, and turning it back over their nose, like this. That's how they open and close their nose. So when they make sounds, what they're basically doing is a raspberry, (Makes raspberry sound) which is kind of like a fart, right? Or up in New York, we call it a Bronx cheer. And the way they do that is by taking that big, fatty structure of a big fat lip, which, as you can see here in this picture, which is a cut through the middle of a dolphin's head, that big fat lip is that big yellow portion there, and they roll it back and forth over the top of their nose so that they vibrate it, kind of like when you let the air out of a balloon and it makes that weird vibration sound. So this is what it sounds like when they make their noise: (Vibration noise) Hear it? He'll do it again when he faces the camera. (Vibration noise) Sounds like it's farting underwater. What that dolphin is actually doing, though, is echolocation, which is making these series of pulses, and it uses it like a bat uses sonar. Well, a bat uses radar, but when it's underwater it's sonar, so this animal is using sonar to see its world in sound. Trying to understand how this works, you have to look at it as if you were looking at the amplifier speakers of a sound system. The small-toothed whales are basically the "tweeters," and the sound is coming from that little nose that's moving back and forth and coming out of their forehead. But the big whales are kind of like the "woofers," the big speakers that you have in an amplifier system. And what's happening is their sound is coming out of the throat. So if you tried to make sound like a whale -- make a sound right now, and go, "ahhhhhh." OK, now put your hand on your throat, on your Adam's apple. You feel that vibration right there? That is lost energy for you, because that's not how you communicate to everybody. You do it out of the mouth. But if you open your mouth underwater, no one will hear you. You have to be able to take this energy and amplify it through the water. That's what whales do. And when you hear their sound -- (Squeaking sound) it's kind of like when you squeak the air out of a balloon. So they get a lot of squeaky noises, but they also have this sound: (Vibrating sound) It sounds like it's farting, doesn't it? It's like it's got this giant whoopee cushion in its throat. So, how do you know that's what a whale is doing? Well, we study whales that come to us from strandings. These are animals that die on the beach. Small whales like dolphins and porpoises are easy; we can take them to the lab. But the big whales -- we've got to bring the lab to the whale. And this is what that looks like. I'm the one in the middle with the red hat. I'm not a very tall person, so you can see how big this whale was compared to me. The whale is 65 feet long. And my scalpel is this little tool on the side here. It basically looks like a hockey stick with a blade on the end of it. And doing a dissection of a whale is a very difficult process. You literally have to get into your work. It's kind of like a giant bloody construction zone. You're wearing a hard hat, you're working with heavy machinery. In this case, by the way, that's just the voice box of a blue whale. Just the voice box. I'm only five feet tall -- you can see it's like 12 feet long. How do we know what's going on? Well, we look at the voice box, or larynx, and we see -- this is from a baby whale so it's much smaller. You see this little u-shaped thing I've outlined in blue. That's the part that's vibrating. It's kind of like our vocal folds. When I put my hand in there, where that blue sleeve is, you can see there's a sack underneath it. That's the whoopee cushion. That's the air bubble or the balloon. So what these animals are doing -- and you can see, there's this big black balloon in the throat, where the digestive tract, which is in blue, meets the breathing tract, which is in light blue, and right in the middle is that black sack. These animals are using that sack to make these sounds. And so they vibrate that and send it out. Small-toothed whales also have air sacks; they're all over their heads, so it's like they're airheads. They use this to capture as much air as they can to take down with them when they're diving, because when you dive, pressures increase, and that decreases the volume of air you have available. But more importantly, having that sack allows them to recycle the air that they're using, because air is a precious commodity. You don't want to have to go back up to the surface to get more. So when you make a sound underwater, if you're a whale -- let's hear you start making a sound, go "ahhhh." But whales keep their mouths closed, so go "ahhhmm." (Audience makes noise) You're all humming, right? But whales keep their nose closed and go, "mmmm." (Makes noise) What happened? You can't make the sound anymore once you close your nose because you've pressurized the system. Whales, by having air sacks, keep themselves from pressurizing the system, which means the air continues to flow, and so if you had a bag on the end of your nose, you'd be able to make air continue to flow. So I hope you've enjoyed that. That's what a comparative anatomist does for a living. We study the structure of these animals. We try to mimic it; we apply it back to the human situation, maybe making new technologies for protective devices or maybe even making new treatments for medicines for people's diseases who mimic these weird environments. So I hope you enjoyed that. Thank you. (Applause)

**P69 2014-04-10 The family structure of elephants - Caitlin O'Connell-Rodwell**

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If I were to distill the 20 years of elephant research that I've done into one sentence, what would it be? What could I tell you? I would say that elephants are just like us! And what do I mean by that? It takes a lot of patience to be out there in the field and trying to figure out patterns of these very slow and intelligent animals. But over time, it is true they are very similar to us. And you think, "Well, how can I say that? Look, they have huge ears, they have really long noses. What do you mean they're like us?" Well, in fact, their families are very similar to ours. And family is extremely important to elephants. They grow up in very tight-knit families and they have extended families. And it's just like our family reunions where you have all the aunts gathering around with all the food they're going to bring and plan, and all the boys are thinking, "Are we going to play our video games together? Are we going to spar?" It's very, very similar, and it's jubilant, and screaming, yelling, it's really amazing to see. But, as soon as you get that family gathering, it's just like a wedding or anything else, all of the sudden the family politics come out, and the lower-ranking individuals in this scene, you see the arrow off to the back, the lower-ranking individuals already know their station, they're going to drink at the muddiest part of the pan because the whole family's here and we can't drink at the best water because that's reserved for the top-ranking family. What's also very similar is that you have elders in the group that everyone reveres. This is the matriarch, and the other female is reaching over and doing what's called a trunk to mouth placing her trunk in the mouth, and it's a sign of respect, it's kind of like a handshake, but it's also like a salute. And this salute is learned at a very young age. Now, ritual and bonding within the family also facilitates coordinated activities. So, here's a young female whose calf has fallen into the trough and she doesn't know what to do and she panics. Well, the older female, that's the matriarch, she says, "No problem here," she just scoops the baby out. Now, that's not true for a lot of different families, they can't coordinate very well, the younger females don't really know what to do, but the older ones will just get down, kneel down together and pick the baby out. Another thing that's very similar is the coming of age of teenage boys. Male elephants at the age of about 12 to 15. The biggest elephant in this photograph here is an elephant who's about the leave the family. He gets too big, he gets a little fresh, the adult females had enough of him, but he also is independent, he wants to go out and play with the guys. So what happens then is that you have this all male society, very ritual male society. Greg is our main dominant bull here, you can see him in the middle. He's got a huge posse, his following reveres him. And it's very interesting how very good leaders, very good dominant individuals know how to titrate the carrot and the stick. This guy's a master at it, and there's other bullies out there that want to kind of want to create their own little following, but they can't do it because they're too agressive. And so when he's not around they try and sweet talk the underlings to come into their fold, and they actually become less agressive. So it's very interesting to see how politics play out in these male and female societies. Now back to the ladies here. In a core family group you'll have a mother, maybe even a grandmother, her daughters and all of their offspring, the male and female calves. And what's very interesting here is that how character makes a difference. So each matriarch has a very different character. These two characters are kind of curious, they're uncertain, whereas these other two characters are really agressive. "We're going to charge first, ask questions later." But then there are also matriarchs that say, "Forget it! I'm going to run first and then figure it out when we're in the bush and it's safe." But the wisest matriarch, the matriarchs that succeed best in all of the studies that have been done, is the one that assesses the danger and decides is this worth running away from or is this not a big deal at all. Now being social is super important for elephants and of course right at the beginning, just like early childhood development, socialization is very important. Bathing together, eating together, playing together, rough housing, this is all very important for social development. And who hasn't tried to beat their sibling to the head of the line coming into the water hole? And these relationships from the beginning is just like best friends forever for real. These females are going to live together for life. Now if it's a male, female they might know each other for life, but it's really important to develop those bonds early on. Those are the relationships that are going to save you later. I'll show you a little schoolyard scenario here. Where, I think if you just focus on what's happening here you can see that we have the bully, he's pulling on the trunk of this baby calf, and then we have the diplomat who's reaching over and saying, "No, don't do that! Stop doing that!" And then, of course, we have the bystander. And how do you get these three different characters within the family? It's kind of fascinating to think that elephants really are just like us. And so I got curious about this and I thought, "Well, what if you measure the difference in character of a dominant female's calf versus a lower-ranking female's calf, and see what happens in their growing up." And so we started doing this. And you can see this little guy with his ears out, really charging at you. The difference between that character and the character who holds back, wants to touch mom, isn't so certain about what's going on here. But the other one's charging ahead all confident. Well, we started measuring how far away a calf will stray from mom, how often do they touch others, how often do they initiate play, and then look at the dominance of the females, of their mothers. And what we found is that socializing with the dominant calves actually socialize more significantly more than the lower-ranking calves. And what it looks like is it's not that the lower-ranking calves don't want to play, they're actually not allowed to interact with the higher-ranking calves. They get swatted away from the dominant females. and so this is kind of the downside of, okay we are very much like elephants, elephants are as much like us, but it's kind of for better or for worse because I can also see this happening in humans and maybe we should take a lesson from that. One last thing that we found is that the males will be the risk-takers, they're more independent and they're more likely to spend more time away from mom. And that's very true in human societies and with other social animals. So I hope I've convinced you that we have very similar lives to elephants and that elephants have very individual, durable characters that we've measured across years. The bully always tends to be the bully unless there's some kind of social upset, and he decides he better be a softy or else he's not going to gain favor at all. And then you have the gentle giants that are always going to be gentle. The young males really need mentoring from the elders, and those gentle giants are very good at doing that, soliciting them. Leaving family is a really hard things for the males, but they survive and they figure out who to hang out with. So, just to end here, I just wanted to say that since they are so similar to us, and have these characters, I hope when you see them on TV or you go out and you're lucky enough to see them in the wild, that maybe you'll think of them as individual characters deserving of our attention, and also deserving of our protection. Thank you.

**P70 2014-04-10 The networked beauty of forests - Suzanne Simard**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=70)

I was walking my mountain the other day, and I was feeling really at home with the forest. And I was so grateful to it for showing me that forests are built on relationships which form networks, like these beautiful river networks. And I thought, "Wow, forests are just like human families." And I was so taken by the beauty of this idea that I fell and I crashed down on the ground, and I hit my head on this new stump. And I was so angry! Then, I was so heartbroken because there was a whole family of trees cut down. Thing is, where I'm from in Western Canada, there's clearcuts like this hidden everywhere, and it wasn't until Google Earth starting sending images, like this, that we realized the whole world was wiping its noses on our old-growth forests. Did you know that deforestation like this around the world causes more greenhouse gas emissions than all the trains, planes and automobiles combined? Yeah, I'm really upset about this, but I'm also really hopeful because I've also discovered in my research that forest networks are organized in the same way as our own neural networks and our social networks. And I believe that if we can learn to integrate these into a whole that we can change this dangerous pathway of global warming because I believe we are wired for healing. So, here's the science: The most ancient of these networks is this below-ground fungal network, or mushroom network. And it evolved over a billion years ago to allow organisms to migrate from the ocean onto the land. And eventually, they got together with plants in this symbiosis. And this allowed plants to photosynthesize, pulling CO2, which is our biggest greenhouse gas, out of the atmosphere and giving off oxygen, which allows us to breathe and actually allowed humans to eventually evolve. Now, we call this symbiosis a mycorrhiza, myco for fungus, rrhiza for root. So, the fungus and root get together, and they trade for mutual benefit. Now, all trees in all forests all over the world depend on these mycorrhizas for their very survival. They can't live without them. And the way it works is that a seed falls on the forest floor, it germinates, it sends a root down into the soil, and it starts sending out chemical signals to the fungi to grow towards the root. And the fungus communicates back with its own signals, and it says to the root, 'You need to grow towards me and branch and soften.' And so by this communication, they grow together into this magical symbiosis. And the way that symbiosis works is the plant takes its hard-earned carbon from photosynthesis and brings it to the fungus because the fungus can't photosynthesize. And the fungus takes nutrients and water it gathers from the soil, where plant roots can't grow, and they give it to the plant. And so they're both benefiting in this cooperation. Now, as the fungus grows through the soil, it starts linking plant and plant and tree and tree together until the whole forest is linked together. Did you know that a single tree can be literally linked up to hundreds of other trees as far as the eye can see? And as you're walking through the forest, what you see, the trees, the roots, the mushrooms, are just the tip of the iceberg. Under a single footstep, there are 300 miles of fungal cells stacked end on end moving stuff around. And if you could look down into the ground, it would be like this super highway with cars going everywhere. Now, all networks are made of nodes and links. In forests, those nodes would be trees and the links fungi. It's kind of like in your Facebook network, where nodes would be friends and links would be your friendships. Now, we all know that some of those nodes, or friends, are busier than others, like that friend who is always sending out group messages. Well, it's the same in forests, and these nodes in forests, we call them hubs, they're the big trees in the forests with roots going everywhere. Now, we also have learned that the systems organized around these hubs, these big old trees, so in forests, that's where the regeneration occurs. In your Facebook network, that might be how parties are organized, around that hub that's always sending out the group messages. We call those hubs in forests mother trees; they're the big old trees in the forest. And they fix the carbon in their leaves, and they send it down through their massive trunks and into the networks all around them that are linked up to all the other trees and seedlings, the young ones, and they start sending that carbon everywhere. The more those seedlings are stressed out, maybe from drought or shade, the more the mother tree sends to them. It's kind of like in your families, where if you're kind of stressed out, mom and dad kick in and help you out a bit more, right? Well, it's the same in forests. The other thing that we've recently discovered is that mother trees will preferentially send more signals to her own kids, her own children. And then, this way she helps them do better, and then they survive more, and then they can pass their genes on to future generations. So, how natural selection works. Now, the way these forests are organized makes them both resilient and vulnerable. They're resilient because there's many mother trees, and there's many fungal species linking them together. And that network is really hard to break. It's pretty darn tough. But of course, we humans have figured out how to do that. And what we do is we take out the mother trees. And maybe taking one out won't make much difference but when you take more and more and more and clearcut and more and more and more that it can cause the system to collapse and fall down, like dominoes. And we can cross tipping points and cause more forest death and more global warming, and we're doing that. So what we do, our choices we make, can lead us towards global heatlh or global sickness. We do have choices. And I'm going to leave you with four ideas that I think are worth spreading. First one: To love the forest you have to go spend time in it. Go be in the forest, connect with it. And then you'll fight hard enough to protect them. Second: Learn how they work. Learn how those networks link things together in organized forests. And to do that, you gotta go out there take risks, make mistakes. Third: Protect forests. They need you to do that because they can't do it themselves. They're stuck in one spot. They can't run away from humans, and they can't run away from global warming. They need you. And finally, and most importantly, use your own very clever, brilliant, neural and social networks to create amazing messages, and spread the word that forests are worth saving because you're worth saving, and I believe that together we're all wired for healing.

**P71 2014-04-10 The sweaty teacher's lament - Justin Lamb**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=71)

I'd love to be the compassionate teacher; the tough, but fair teacher. But to my brilliant young minds, these scholars for whom I'd stand up at all costs, I'm the sweaty teacher. Not the compassionate teacher who, hey, by the way, happens to sweat, or even the teacher who sweats. No. The sweaty teacher. Adjective, sweaty purposefully coming before noun, teacher, as if to say, "This is Mr. Lamb. Do not define him by the profession he devotes his life to. Define him by the geysers he calls armpits." Every morning, I wake up in a cold... nevermind. The easy-going teacher says, "I shouldn't sweat it." The loud teacher says, "YEAH YOU SHOULDN'T SWEAT IT!" But even the empathetic teacher doesn't understand. I've got funny teacher potential. I used to pretend the notes I confiscated in class were thank you letters. Acknowledgements of my great teaching. "Oh ho ho, you shouldn't have!" Until I intercepted one about a Mr. Stank Pits. No, really. You shouldn't have. Ever since I've started developing quirky habits to deflect attention, to become someone new: the teacher who shrugs his shoulders really aggressively. The teacher who tucks his tie into his pants and pulls the end out his fly because he's so wacky. But it's no use. Because I had the sweaty teacher, too, for geography. And to this day I cannot remember the capital of Bulgaria, and the two bodies of water I know the most about sat below his shoulders. And now, I'm the one looking like I've got the Atlantic and Pacific in headlocks. The one being asked, "How was the dunk tank?" "There was no dunk tank! We live in New Orleans and it is humid!" is how I'd respond if I was the angry teacher. Instead, I look the kid in the eye as the sweat cascades down my nose, and splatters onto his blank paper below, and I say, "I sweat because I am working my tail off and I need you to do the same."

**P72 2014-04-17 Cell vs. virus - A battle for health - Shannon Stiles**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=72)

You're in line at the grocery store when, uh oh, someone sneezes on you. The cold virus is sucked inside your lungs and lands on a cell on your airway lining. Every living thing on Earth is made of cells, from the smallest one-celled bacteria to the giant blue whale to you. Each cell in your body is surrounded by a cell membrane, a thick flexible layer made of fats and proteins, that surrounds and protects the inner components. It's semipermeable, meaning that it lets some thing pass in and out but blocks others. The cell membrane is covered with tiny projections. They all have functions, like helping cells adhere to their neighbors or binding to nutrients the cell will need. Animal and plant cells have cell membranes. Only plant cells have a cell wall, which is made of rigid cellulose that gives the plant structure. The virus cell that was sneezed into your lungs is sneaky. Pretending to be a friend, it attaches to a projection on the cell membrane, and the cell brings it through the cell membrane and inside. When the virus gets through, the cell recognizes its mistake. An enemy is inside! Special enzymes arrive at the scene and chop the virus to pieces. They then send one of the pieces back through the cell membrane, where the cell displays it to warn neighboring cells about the invader. A nearby cell sees the warning and immediately goes into action. It needs to make antibodies, proteins that will attack and kill the invading virus. This process starts in the nucleus. The nucleus contains our DNA, the blueprint that tells our cells how to make everything our bodies need to function. A certain section of our DNA contains instructions that tell our cells how to make antibodies. Enzymes in the nucleus find the right section of DNA, then create a copy of these instructions, called messenger RNA. The messenger RNA leaves the nucleus to carry out its orders. The messenger RNA travels to a ribosome. There can be as many as 10 million ribosomes in a human cell, all studded along a ribbon-like structure called the endoplasmic reticulum. This ribosome reads the instructions from the nucleus. It takes amino acids and links them together one by one creating an antibody protein that will go fight the virus. But before it can do that, the antibody needs to leave the cell. The antibody heads to the golgi apparatus. Here, it's packed up for delivery outside the cell. Enclosed in a bubble made of the same material as the cell membrane, the golgi apparatus also gives the antibody directions, telling it how to get to the edge of the cell. When it gets there, the bubble surrounding the antibody fuses to the cell membrane. The cell ejects the antibody, and it heads out to track down the virus. The leftover bubble will be broken down by the cell's lysosomes and its pieces recycled over and over again. Where did the cell get the energy to do all this? That's the roll of the mitochondria. To make energy, the mitochondria takes oxygen, this is the only reason we breathe it, and adds electrons from the food we eat to make water molecules. That process also creates a high energy molecule, called ATP which the cell uses to power all of its parts. Plant cells make energy a different way. They have chloroplasts that combine carbon dioxide and water with light energy from the sun to create oxygen and sugar, a form of chemical energy. All the parts of a cell have to work together to keep things running smoothly, and all the cells of your body have to work together to keep you running smoothly. That's a whole lot of cells. Scientists think there are about 37 trillion of them.

**P73 2014-04-18 Climate change - Earth's giant game of Tetris - Joss Fong**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=73)

To understand climate change, think of the game "Tetris." For eons, Earth has played a version of this game with blocks of carbon. They enter the atmosphere as carbon dioxide gas from volcanoes, decaying plant matter, breathing creatures and the surface of the sea. And they leave the atmosphere when they're used by plants during photosynthesis, absorbed back into the ocean, or stored in soil and sediment. This game of Tetris is called the carbon cycle, and it's the engine of life on Earth. What's the connection to climate? Well, when that carbon dioxide is in the air, waiting to be reabsorbed, it traps a portion of the sun's heat, which would otherwise escape to space. That's why carbon dioxide is called a greenhouse gas. It creates a blanket of warmth, known as the greenhouse effect, that keeps our Earth from freezing like Mars. The more carbon dioxide blocks hang out in the atmosphere waiting to be cleared, the warmer Earth becomes. Though the amount of carbon in the atmosphere has varied through ice ages and astroid impacts, over the past 8,000 years the stable climate we know took shape, allowing human civilization to thrive. But about 200 years ago, we began digging up that old carbon that had been stored in the soil. These fossil fuels, coal, oil and natural gas are made from the buried remains of plants and animals that died long before humans evolved. The energy stored inside them was able to power our factories, cars and power plants. But burning these fuels also injected new carbon blocks into Earth's Tetris game. At the same time, we cleared forests for agriculture, reducing the Earth's ability to remove the blocks. And since 1750, the amount of carbon in the atmosophere has increased by 40%, and shows no sign of slowing. Just like in Tetris, the more blocks pile up, the harder it becomes to restore stability. The extra carbon dioxide in the atmosphere accelerates the greenhouse effect by trapping more heat near the surface and causing polar ice caps to melt. And the more they melt, the less sunlight they're able to reflect, making the oceans warm even faster. Sea levels rise, coastal populations are threatened with flooding, natural ecosystems are disrupted, and the weather becomes more extreme over time. Climate change may effect different people and places in different ways. But, ultimately, it's a game that we're all stuck playing. And unlike in Tetris, we won't get a chance to start over and try again.

**P74 2014-04-18 Not all scientific studies are created equal - David H. Schwartz**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=74)

Studies have shown that taking vitamins is good for your health and bad for your health. That newly discovered herb can improve your memory or destroy your liver. Headlines proclaim a promising new cancer treatment and never mention it again. On a daily basis, we are bombarded with attention-grabbing news, backed up by scientific studies, but what are these studies? How are they performed? And how do we know whether they're reliable? When it comes to dietary or medical information, the first thing to remember is that while studies on animals or individual cells can point the way towards further research, the only way to know how something will affect humans is through a study involving human subjects. And when it comes to human studies, the scientific gold standard is the randomized clinical trial, or RCT. The key to RCTs is that the subjects are randomly assigned to their study groups. They are often blinded to make them more rigorous. This process attempts to ensure that the only difference between the groups is the one the researchers are attempting to study. For example, when testing a new headache medication, a large pool of people with headaches would be randomly divided into two groups, one receiving the medication and another receiving a placebo. With proper randomization, the only significant overall difference between the two groups will be whether or not they received the medication, rather than other differences that could affect results. Randomized clinical trials are incredible tools, and, in fact, the US Food and Drug Administration often requires at least two to be conducted before a new drug can be marketed. But the problem is that an RCT is not possible in many cases, either because it's not practical or would require too many volunteers. In such cases, scientists use an epidemiological study, which simply observes people going about their usual behavior, rather than randomly assigning active participants to control invariable groups. Let's say we wanted to study whether an herbal ingredient on the market causes nausea. Rather than deliberately giving people something that might make them nauseated, we would find those who already take the ingredient in their everyday lives. This group is called the cohort. We would also need a comparison group of people who do not have exposure to the ingredient. And we would then compare statistics. If the rate of nausea is higher in the herbal cohort, it suggests an association between the herbal supplement and nausea. Epidemiological studies are great tools to study the health effects of almost anything, without directly interfering in people's lives or assigning them to potentially dangerous exposures. So, why can't we rely on these studies to establish causal relationships between substances and their effects on health? The problem is that even the best conducted epidemiological studies have inherent flaws. Precisely because the test subjects are not randomly assigned to their groups. For example, if the cohort in our herbal study consisted of people who took the supplement for health reasons, they may have already had higher rates of nausea than the other people in the sample. Or the cohort group could've been composed of people who shop at health food stores and have different diets or better access to healthcare. These factors that can affect results, in addition to the factor being studied, are known as confounding variables. These two major pitfalls, combined with more general dangers, such as conflicts of interest or selective use of data, can make the findings of any particular epidemiological study suspect, and a good study must go out of its way to prove that its authors have taken steps to eliminate these types of errors. But even when this has been done, the very nature of epidemiological studies, which examine differences between preexisting groups, rather than deliberately inducing changes within the same individuals, means that a single study can only demonstrate a correlation between a substance and a health outcome, rather than a true cause and effect relationship. At the end of the day, epidemiological studies have served as excellent guides to public health, alerting us to critical health hazards, such as smoking, asbestos, lead, and many more. But these were demonstrated through multiple, well-conducted epidemiological studies, all pointing in the same direction. So, the next time you see a headline about a new miracle cure or the terrible danger posed by an everyday substance, try to learn more about the original study and the limitations inherent in any epidemiological study or clinical trial before jumping to conclusions.

**P75 2014-04-21 The case of the missing fractals - Alex Rosenthal and George Zaidan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=75)

It was a night like any other night, except here I was climbing the platonic peaks like Romeo on a second date. (ugh) I was there for the dame. She had eyes like imaginary numbers and curves that went on forever. Said she wanted to go home. Said I could help. Said the pay was good. Didn't say anything about climbing a... Voice: "Who's there?" Manny Brot: "Manny Brot, private eye." Voice: "What are you doing here?" "A pretty number sent me to find a stolen dingus." Voice: "Well, to enter the cave, you must answer my riddles three." What was it with riddles, and why do they always come in threes? "Is it an egg?" "No. Why would it be an egg?" "It's usually an egg." "What can I hold in my hand, but has zero area?" "Is it a dodo egg?" "It's not an egg!" I took out the rock that had nearly brained me before and gave it a hard ponder. The size of the rising bump on my conk said to me that this thing had area, and a lot of it. But what if I carved out a triangle from this side here? As any mook could see, this triangle had a quarter of the area of the full triangle. I did the same thing again with each of the smaller triangles. Again, a quarter of the remaining area -- gone. And I just kept going. After an infinite number of cuts, I was satisfied that my triangle had zero area. A bounded shape with zero area. Now, it's not often that I surprise myself, but my own two mitts had created something crazy, and new. "Very good. (ahem) Now, show me a shape with finite area, but an infinitely long perimeter." "Let me get this straight. If I want to make a snip in the border of this shape, smooth it out, and lay it on the ground ... " "It would go on for ... " "Wait 'til I'm through, and then you can talk. It would go on forever." "Are you through?" "Yeah." "So show me that shape then." Mmm ... I hadn't been this stuck since the Rubik's Cube fiasco of '58. All the shapes I knew had perimeters. Circles: 2πr. Triangles: sum of their sides. What's this? An angle. An angle from heaven. What if I were to pinch each side, like so. A third of the way through, just so. And do it again, and again, and again. After each pinch, the perimeter got a third longer because where there had been three line segments, now there were four. As for the area, every pinch made more triangles, that's true. But those triangles were getting smaller and smaller. You could say that the area was converging, approaching a fixed number, while the perimeter was just getting bigger and bigger, uncontrollably ballooning like an overindulgent birthday clown. After infinity pinches, flimflam, there it was: Finite area, but infinite perimeter. Now that is a piece of work. "Oh, you're good. (ahem) Riddle three: Show me a picture that if I magnify it under my microscope, I'll keep seeing the original picture, no matter how much I zoom in." "You're a strange little man." "Thank you." I was out of ideas, so I looked at my muse, my complex Dora. Voice: "Who's the dame?" And then it hit me. "She's a heart breaker, my fractal femme fatale. Will she do?" "Yes, she'll do just fine." (lightning) It was dark, and at first I thought the cave was empty, but then I noticed: the box. The dame had played me like a triangle. She had told me she wanted to go home. (Lightning) What she really wanted was to bring her home here. The fractals spread everywhere. Most of them the same no matter how deep you looked at them, like Dora's mugshot. Some had infinitely long perimeters, others were objects with no area or volume, all of them created through infinite repetition. So, you wanted to know what fractals are? Well, kid, they're the stuff that dreams are made of. (Music)

**P76 2014-04-22 How tsunamis work - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=76)

In 479 BC, when Persian soldiers besieged the Greek city of Potidaea, the tide retreated much farther than usual, leaving a convenient invasion route. But this wasn't a stroke of luck. Before they had crossed halfway, the water returned in a wave higher than anyone had ever seen, drowning the attackers. The Potiidaeans believed they had been saved by the wrath of Poseidon. But what really saved them was likely the same phenomenon that has destroyed countless others: a tsunami. Although tsunamis are commonly known as tidal waves, they're actually unrelated to the tidal activity caused by the gravitational forces of the Sun and Moon. In many ways, tsunamis are just larger versions of regular waves. They have a trough and a crest, and consist not of moving water, but the movement of energy through water. The difference is in where this energy comes from. For normal ocean waves, it comes from wind. Because this only affects the surface, the waves are limited in size and speed. But tsunamis are caused by energy originating underwater, from a volcanic eruption, a submarine landslide, or most commonly, an earthquake on the ocean floor caused when the tectonic plates of the Earth's surface slip, releasing a massive amount of energy into the water. This energy travels up to the surface, displacing water and raising it above the normal sea level, but gravity pulls it back down, which makes the energy ripple outwards horizontally. Thus, the tsunami is born, moving at over 500 miles per hour. When it's far from shore, a tsunami can be barely detectable since it moves through the entire depth of the water. But when it reaches shallow water, something called wave shoaling occurs. Because there is less water to move through, this still massive amount of energy is compressed. The wave's speed slows down, while its height rises to as much as 100 feet. The word tsunami, Japanese for "harbor wave," comes from the fact that it only seems to appear near the coast. If the trough of a tsunami reaches shore first, the water will withdraw farther than normal before the wave hits, which can be misleadingly dangerous. A tsunami will not only drown people near the coast, but level buildings and trees for a mile inland or more, especially in low-lying areas. As if that weren't enough, the water then retreats, dragging with it the newly created debris, and anything, or anyone, unfortunate enough to be caught in its path. The 2004 Indian Ocean tsunami was one of the deadliest natural disasters in history, killing over 200,000 people throughout South Asia. So how can we protect ourselves against this destructive force of nature? People in some areas have attempted to stop tsunamis with sea walls, flood gates, and channels to divert the water. But these are not always effective. In 2011, a tsunami surpassed the flood wall protecting Japan's Fukushima Power Plant, causing a nuclear disaster in addition to claiming over 18,000 lives. Many scientists and policy makers are instead focusing on early detection, monitoring underwater pressure and seismic activity, and establishing global communication networks for quickly distributing alerts. When nature is too powerful to stop, the safest course is to get out of its way.

**P77 2014-04-22 The fundamentals of space-time - Part 2 - Andrew Pontzen and Tom Whyn**

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Light: it's the fastest thing in the universe, but we can still measure its speed if we slow down the animation, we can analyze light's motion using a space-time diagram, which takes a flipbook of animation panels, and turns them on their side. In this lesson, we'll add the single experimental fact that whenever anyone measures just how fast light moves, they get the same answer: 299,792,458 meters every second, which means that when we draw light on our space-time diagram, it's world line always has to appear at the same angle. But we saw previously that speed, or equivalently world line angles, change when we look at things from other people's perspective. To explore this contradiction, let's see what happens if I start moving while I stand still and shine the laser at Tom. First, we'll need to construct the space-time diagram. Yes, that means taking all of the different panels showing the different moments in time and stacking them up. From the side, we see the world line of the laser light at its correct fixed angle, just as before. So far, so good. But that space-time diagram represents Andrew's perspective. What does it look like to me? In the last lesson, we showed how to get Tom's perspective moving all the panels along a bit until his world line is completely vertical. But look carefully at the light world line. The rearrangement of the panels means it's now tilted over too far. I'd measure light traveling faster than Andrew would. But every experiment we've ever done, and we've tried very hard, says that everyone measures light to have a fixed speed. So let's start again. In the 1900s, a clever chap named Albert Einstein worked out how to see things properly, from Tom's point of view, while still getting the speed of light right. First, we need to glue together the separate panels into one solid block. This gives us our space-time, turning space and time into one smooth, continuous material. And now, here is the trick. What you do is stretch your block of space-time along the light world line, then squash it by the same amount, but at right angles to the light world line, and abracadabra! Tom's world line has gone vertical, so this does represent the world from his point of view, but most importantly, the light world line has never changed its angle, and so light will be measured by Tom going at the correct speed. This superb trick is known as a Lorentz transformation. Yeah, more than a trick. Slice up the space-time into new panels and you have the physically correct animation. I'm stationary in the car, everything else is coming past me and the speed of light works out to be that same fixed value that we know everyone measures. On the other hand, something strange has happened. The fence posts aren't spaced a meter apart anymore, and my mom will be worried that I look a bit thin. But that's not fair. Why don't I get to look thin? I thought physics was supposed to be the same for everyone. Yes, no, it is, and you do. All that stretching and squashing of space-time has just muddled together what we used to think of separately as space and time. This particular squashing effect is known as Lorentz contraction. Okay, but I still don't look thin. No, yes, you do. Now that we know better about space-time, we should redraw what the scene looked like to me. To you, I appear Lorentz contracted. Oh but to you, I appear Lorentz contracted. Yes. Uh, well, at least it's fair. And speaking of fairness, just as space gets muddled with time, time also gets muddled with space, in an effect known as time dilation. No, at everyday speeds, such as Tom's car reaches, actually all the effects are much, much smaller than we've illustrated them. Oh, yet, careful experiments, for instance watching the behavior of tiny particles whizzing around the Large Hadron Collider confirmed that the effects are real. And now that space-time is an experimentally confirmed part of reality, we can get a bit more ambitious. What if we were to start playing with the material of space-time itself? We'll find out all about that in the next animation.

**P78 2014-04-24 Lessons from Auschwitz - The power of our words - Benjamin Zander**

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It really makes a difference what we say. I learned this from a woman who survived Auschwitz. She went to Auschwitz when she was fifteen years old, and her brother was eight, and the parents were lost. And she told me this, "We were in the train going to Auschwitz, and I looked down, and I saw my brother's shoes were missing. And I said, 'Why are you so stupid? Can't you keep your things together? For goodness sake!' The way an elder sister might speak to a younger brother." Unfortunately, it was the last thing she ever said to him because she never saw him again. He did not survive. And so when she came out of Auschwitz, she made a vow. She said, "I walked out of Auschwitz into life. And the vow was, "I will never say anything that couldn't stand as the last thing I ever say." Now, can we do that? No. But it is a possibility to live in to. Thank you.

**P79 2014-04-30 The science of symmetry - Colm Kelleher**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=79)

When you hear the word symmetry, maybe you picture a simple geometric shape like a square or a triangle, or the complex pattern on a butterfly's wings. If you are artistically inclined, you might think of the subtle modulations of a Mozart concerto, or the effortless poise of a prima ballerina. When used in every day life, the word symmetry represents vague notions of beauty, harmony and balance. In math and science, symmetry has a different, and very specific, meaning. In this technical sense, a symmetry is the property of an object. Pretty much any type of object can have symmetry, from tangible things like butterflies, to abstract entities like geometric shapes. So, what does it mean for an object to be symmetric? Here's the definition: a symmetry is a transformation that leaves that object unchanged. Okay, that sounds a bit abstract, so let's unpack it. It will help to look at a particular example, like this equilateral triangle. If we rotate our triangle through 120 degrees, around an access through its center, we end up with a triangle that's identical to the original. In this case, the object is the triangle, and the transformation that leaves the object unchanged is rotation through 120 degrees. So we can say an equilateral triangle is symmetric with respect to rotations of 120 degrees around its center. If we rotated the triangle by, say, 90 degrees instead, the rotated triangle would look different to the original. In other words, an equilateral triangle is not symmetric with respect to rotations of 90 degrees around its center. But why do mathematicians and scientists care about symmetries? Turns out, they're essential in many fields of math and science. Let's take a close look at one example: symmetry in biology. You might have noticed that there's a very familiar kind of symmetry we haven't mentioned yet: the symmetry of the right and left sides of the human body. The transformation that gives this symmetry is reflection by an imaginary mirror that slices vertically through the body. Biologists call this bilateral symmetry. As with all symmetries found in living things, it's only approximate, but still a striking feature of the human body. We humans aren't the only bilaterally symmetric organisms. Many other animals, foxes, sharks, beetles, that butterfly we mentioned earlier, have this kind of symmetry, as do some plants like orchid flowers. Other organisms have different symmetries, ones that only become apparent when you rotate the organism around its center point. It's a lot like the rotational symmetry of the triangle we watched earlier. But when it occurs in animals, this kind of symmetry is known as radial symmetry. For instance, some sea urchins and starfish have pentaradial or five-fold symmetry, that is, symmetry with respect to rotations of 72 degrees around their center. This symmetry also appears in plants, as you can see for yourself by slicing through an apple horizontally. Some jellyfish are symmetric with respect to rotations of 90 degrees, while sea anemones are symmetric when you rotate them at any angle. Some corals, on the other hand, have no symmetry at all. They are completely asymmetric. But why do organisms exhibit these different symmetries? Does body symmetry tell us anything about an animal's lifestyle? Let's look at one particular group: bilaterally symmetric animals. In this camp, we have foxes, beetles, sharks, butterflies, and, of course, humans. The thing that unites bilaterally symmetric animals is that their bodies are designed around movement. If you want to pick one direction and move that way, it helps to have a front end where you can group your sensory organs-- your eyes, ears and nose. It helps to have your mouth there too since you're more likely to run into food or enemies from this end. You're probably familiar with a name for a group of organs, plus a mouth, mounted on the front of an animal's body. It's called a head. Having a head leads naturally to the development of bilateral symmetry. And it also helps you build streamlined fins if you're a fish, aerodynamic wings if you're a bird, or well coordinated legs for running if you're a fox. But, what does this all have to do with evolution? Turns out, biologists can use these various body symmetries to figure out which animals are related to which. For instance, we saw that starfish and sea urchins have five-fold symmetry. But really what we should have said was adult starfish and sea urchins. In their larval stage, they're bilateral, just like us humans. For biologists, this is strong evidence that we're more closely related to starfish than we are, to say, corals, or other animals that don't exhibit bilateral symmetry at any stage in their development. One of the most fascinating and important problems in biology is reconstructing the tree of life, discovering when and how the different branches diverged. Thinking about something as simple as body symmetry can help us dig far into our evolutionary past and understand where we, as a species, have come from.

**P80 2014-05-05 The science of attraction - Dawn Maslar**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=80)

We like to think of romantic feelings as spontaneous and indescribable things that come from the heart. But it's actually your brain running a complex series of calculations within a matter of seconds that's responsible for determining attraction. Doesn't sound quite as poetic, does it? But just because the calculations are happening in your brain doesn't mean those warm, fuzzy feelings are all in your head. In fact, all five of your senses play a role, each able to vote for, or veto, a budding attraction. The eyes are the first components in attraction. Many visual beauty standards vary between cultures and eras, and signs of youth, fertility and good health, such as long lustrous hair, or smooth, scar-free skin, are almost always in demand because they're associated with reproductive fitness. And when the eyes spot something they like, our instinct is to move closer so the other senses can investigate. The nose's contribution to romance is more than noticing perfume or cologne. It's able to pick up on natural chemical signals known as pheromones. These not only convey important physical or genetic information about their source but are able to activate a physiological or behavioral response in the recipient. In one study, a group of women at different points in their ovulation cycles wore the same T-shirts for three nights. After male volunteers were randomly assigned to smell either one of the worn shirts, or a new unworn one, saliva samples showed an increase in testosterone in those who had smelled a shirt worn by an ovulating woman. Such a testosterone boost may give a man the nudge to pursue a woman he might not have otherwise noticed. A woman's nose is particularly attuned to MHC molecules, which are used to fight disease. In this case, opposites attract. When a study asked women to smell T-shirts that had been worn by different men, they preferred the odors of those whose MHC molecules differed from theirs. This makes sense. Genes that result in a greater variety of immunities may give offspring a major survival advantage. Our ears also determine attraction. Men prefer females with high-pitched, breathy voices, and wide formant spacing, correlated with smaller body size. While women prefer low-pitched voices with a narrow formant spacing that suggest a larger body size. And not surprisingly, touch turns out to be crucial for romance. In this experiment, not realizing the study had begun, participants were asked to briefly hold the coffee, either hot or iced. Later, the participants read a story about a hypothetical person, and were asked to rate their personality. Those who had held the hot cup of coffee perceived the person in the story as happier, more social, more generous and better-natured than those who had held the cup of iced coffee, who rated the person as cold, stoic, and unaffectionate. If a potential mate has managed to pass all these tests, there's still one more: the infamous first kiss, a rich and complex exchange of tactile and chemical cues, such as the smell of one's breath, and the taste of their mouth. This magical moment is so critical that a majority of men and women have reported losing their attraction to someone after a bad first kiss. Once attraction is confirmed, your bloodstream is flooded with norepinephrine, activating your fight or flight system. Your heart beats faster, your pupils dilate, and your body releases glucose for additional energy, not because you're in danger but because your body is telling you that something important is happening. To help you focus, norepinephrine creates a sort of tunnel vision, blocking out surrounding distractions, possibly even warping your sense of time, and enhancing your memory. This might explain why people never forget their first kiss. The idea of so much of our attraction being influenced by chemicals and evolutionary biology may seem cold and scientific rather than romantic, but the next time you see someone you like, try to appreciate how your entire body is playing matchmaker to decide if that beautiful stranger is right for you.

**P81 2014-05-06 What is the world wide web - Twila Camp**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=81)

The World Wide Web, where you're likely watching this video, is used by millions of people every day for everything from checking the weather, ordering food, and chatting with friends to raising funds, sharing news, or starting revolutions. We use it from our computers, our phones, even our cars. It's just there, all around us, all the time. But what is it exactly? Well first of all, the World Wide Web is not the Internet, even though the terms are often used interchangeably. The Internet is simply the way computers connect to each other in order to share information. When the Internet first emerged, computers actually made direct calls to each other. Today, networks are all around us, so computers can communicate seamlessly. The communication enabled through the Internet has many uses, such as email, file transfer, and conferencing. But the most common use is accessing the World Wide Web. Think of the Web as a bunch of skyscrapers, each representing a web server, a computer always connected to the Internet, specifically designed to store information and share it. When someone starts a website, they are renting a room in this skyscraper, filling it with information and linking that information together in an organized way for others to access. The people who own these skyscrapers and rent space in them are called web hosts, but anyone can set up a web server with the right equipment a bit of know-how. There's another part to having a website, without which we would be lost in the city with no way of finding what we need. This is the website address, which consists of domain names. Just like with a real life address, a website address lets you get where you want to go. The information stored in the websites is in web languages, such as HTML and JavaScript. When we find the website we're looking for, our web browser is able to take all the code on the site and turn it into words, graphics, and videos. We don't need to know any special computer languages because the web browser creates a graphic interface for us. So, in a lot of ways, the World Wide Web is a big virtual city where we communicate with each other in web languages, with browsers acting as our translators. And just like no one owns a city, no one owns the Web; it belongs to all of us. Anyone can move in and set up shop. We might have to pay an Internet service provider to gain access, a hosting company to rent web space, or a registrar to reserve our web address. Like utility companies in a city, these companies provide crucial services, but in the end, not even they own the Web. But what really makes the Web so special lies in its very name. Prior to the Web, we used to consume most information in a linear fashion. In a book or newspaper article, each sentence was read from beginning to end, page by page, in a straight line until you reached the end. But that isn't how our brains actually work. Each of our thoughts is linked to other thoughts, memories, and emotions in a loose interconnected network, like a web. Tim Berners-Lee, the father of the World Wide Web, understood that we needed a way to organize information that mirrored this natural arrangement. And the Web accomplishes this through hyperlinks. By linking several pages within a website or even redirecting you to other websites to expand on information or ideas immediately as you encounter them, hyperlinks allow the Web to operate along the same lines as our thought patterns. The Web is so much a part of our lives because in content and structure, it reflects both the wider society and our individual minds. And it connects those minds across all boundaries, not only enthnicity, gender, and age but even time and space.

**P82 2014-05-12 The cancer gene we all have - Michael Windelspecht**

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Cancer is like a car crash. Your body typically regulates the speed at which your cells divide, but sometimes, cancer cuts the brake lines, and your cells divide too quickly, accumulating mutations that cause them to veer away from their original function, form dangerous tumors, and land you in the hospital. Cancer is basically an inability of the body to control the speed at which cells divide. When cells divide too quickly, they can often accumulate mutations that cause them to ignore their original function in the body, forming tumors. In turn, these tumors may interfere with the natural processes of the body, such as digestion and respiration, potentially leading to death. Typically, your body has a number of genetic mechanisms to control how fast your cells divide. One of these genes is BRCA1, which stands for breast cancer susceptibility gene 1. BRCA1 belongs to a class of genes called tumor suppressor genes. Tumor suppressor genes are involved in regulating how fast a cell divides. Normally, cell division follows an orderly process called the cell cycle, which is basically the life cycle of a cell. Within the cell cycle is a series of checkpoints, where proteins, such as the one produced by BRCA1, regulate how fast the cell may proceed. How does it do this? BRCA1 helps repair some forms of mutation in your DNA. If your DNA is damaged, BRCA1 keeps the cell from dividing until the mutation is repaired. You have two copies of the BRCA1 gene in every cell of your body. One copy you inherited from Mom, the other from Dad. This redundancy is a good a thing because you only need one functioning BRCA1 gene in a cell to regulate the cell cycle. But it's important to note that while these copies have a similar function they're not necessarily the same. In fact, there are hundreds of variations, or alleles, of BRCA1. Some regulate the cell cycle more effectively than others. In other words, some people are born with better regulating and repair mechanisms than others. And in some cases, mutations may render BRCA1 ineffective. When this happens, cells with damaged DNA are allowed to divide. As they divide, these cells may accumulate additional mutations. These mutations may cause the cell to become less specialized and stop performing its original function in the tissue. If this occurs, then there's a greater chance they'll develop into cancer cells. While we all have the gene, such as BRCA1, that can cause cancer, it's only when these genes fail at their function that problems develop. Having an ineffective or mutated version of BRCA1 can increase your susceptibility to cancer, much like driving with bad brakes increases the risk of an accident.

**P83 2014-05-13 From Aaliyah to Jay-Z - Captured moments in hip-hop history - Jonatha**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=83)

This is The Notorious B.I.G., 1995, the Palladium nightclub, New York City. What really I want to talk about is my dedication, my 100% focus, and finding something that I love, my passion point. I fought to be on this stage, to be able to stand next to Lil' Kim and take all these pictures to create one definitive photo. A photo that was the most important of anything that I took. And I really wanted it for future generations to be able to feel the energy that was in that room, and certaintly you can feel that right there. I'm a photographer, this is what I do for a living. I chase these moments, these fractions of seconds, that will never be the same again. You can't take this picture again because I took it, and he's no longer with us, sadly, rest in peace. The definitive portrait of that person, in that moment, is what I strive for every single time out, like when you close your eyes and think of a picture of Jay-Z, I want it to be my picture. So far, so good. Eight album covers for Jay-Z later, I'm not doing too bad. Aaliyah. Gorgeous and amazing, and I really spent proper time with her, conversing, having a conversation, connecting to her, which I find is a big part of my work. That connection, to be able to have a conversation, to say you're doing great, to say why I want a certain picture and a certain attitude. In this moment, we talked about shooting in the Caribbean, and it's sort of a passion point for me, Caribbean culture, Trinidad, Barbados, Jamaica, and I said, "We should do a photo shoot there because I think it would be incredible." And she said, "Yeah, you know, let's do it." You know, as we're taking these beautiful pictures, all this is happening, I'm continuing to converse with her and really connect. So, she believed in my vision at that moment, you know, even while all the work was happening there was a human connection that happened. At the end of the day, I have people sign Polaroids just as kind of a diary for myself. And she wrote, "I can't wait for the Caribbean. I'll see you then." (Exhales) You've got to take a breath. You've got to take a breath. She's missed incredibly. And I think what the reminder is that these moments are really precious, and you really have to take the time to connect to them, to be part of that process, to make a difference in people's lives in that moment. You never know how you're affected by somebody, clearly I am, you can see it, but you never know how you affect that person, how you make that moment a little more important for them. This is my good friend Drake. I had the opportunity to work with him for the FADER magazine. He is a beast and one of my favorites. He's my friend. I shot him for three different days, two in New York, and he had just signed his record deal. He said, "What's most important to me is going home to Toronto to celebrate with my family." So, we went home. We flew home. And he said, "I've got to do a pit stop. I've got to go see my grandmother in the afternoon, and so you probably don't want to bother with that." I said, "It would be an honor to meet your grandmother." I asked for what I wanted. I asked for access that nobody else had because this is what makes a photographer sort of greater, to have a picture that somebody else doesn't have. We want these unique moments. I asked for these moments, right? And I'm reminded of a story. He said, "Grandma, I just got millions of dollars. I just signed a record deal. I've got millions of dollars from Cash Money Universal and Young Money." And she said, "A million dollars?" He said, "No Grandma, millions of dollars. What do you want?" And she said, "I want a kiss, and I want a hug." Again, the reminder of, like, why we do this. It also revealed for me another layer of Drake as a character, and how important this guy is, you know, his message. He's not just about the limelight and self-serving. He's connected to these moments as much as I was connected to this moment as a photographer. I know everybody does this everyday, they ask DMX to get in a pool of blood. This was my challenge this day. I needed to get him to see my vision. I was very clear in what I wanted for "Flesh of My Flesh, Blood of My Blood," which was his album cover. You know, I envisioned photographs of him in this pool of blood, just making these things happen, you know? And what was difficult was he didn't see it the same way I saw it, right? He walked in, and he had these pants on. Brand new pants. Everybody feels fresh when they have brand new pants on, right? He said, "I'm not getting in that pool of blood." I said, "Oh yes, you're going to get in that pool of blood." You know? And he said, "No, my dogs, I'm not getting in that pool of blood." And I said, "My dude, you're going to get in that pool of blood." And in a bold statement, using all the psychology knowledge that I had from my schooling at Kenyon College, I dropped my pants in front of 40 people on a set that all were, like, stunned. DMX laughed. He said, "Alright, my dude, put your pants back on, and I'll get in the blood." One of the most epic photos that we've ever created in this hip-hop movement. I'm on home soil. I'm in New Orleans. We've got to give love to Lil Wayne. Lil Wayne is an incredible MC, and the biggest point that I want to drive home here is about the opportunity to create somebody's legacy with them, to take pictures, to see them grow. It was about trust in the moment and understanding that you could make a difference, have a communication, see somebody elevate and move forward, to take a variety of different pictures, you know? Him in a spacesuit. He's a Martian, you know, what can I say, you know? But it was about seeing his growth, and having an important role and communication with this guy in the moment. DJ Quick once said, "Isn't it incredible how you make people see your vision in hip-hop? The way that people look at hip-hop is through your eyes." I'm really, really proud of what I've created, what I've done, and passionately working to make quality work constantly. It's not about taking a photo. For me, it's about giving a photo to people that believe in it so much. Thank you.

**P84 2014-05-15 How the heart actually pumps blood - Edmond Hui**

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For most of history, humans had no idea what purpose the heart served. In fact, the organ so confused Leonardo da Vinci, that he gave up studying it. Although everyone could feel their own heart beating, it wasn't always clear what each thump was achieving. Now we know that the heart pumps blood. But that fact wasn't always obvious, because if a heart was exposed or taken out, the body would perish quickly. It's also impossible to see through the blood vessels, and even if that were possible, the blood itself is opaque, making it difficult to see the heart valves working. Even in the 21st century, only a few people in surgery teams have actually seen a working heart. Internet searches for heart function, point to crude models, diagrams or animations that don't really show how it works. It's as if there has been a centuries old conspiracy amongst teachers and students to accept that heart function cannot be demonstrated. Meaning that the next best thing is simply to cut it open and label the parts. That way students might not fully grasp the way it works, but can superficially understand it, learning such concepts as the heart is a four-chambered organ, or potentially misleading statements like, mammals have a dual-circulation: one with blood going to the lungs and back, and another to the body and back. In reality, mammals have a figure-eight circulation. Blood goes from one heart pump to the lungs, back to the second heart pump, which sends it to the body, and then back to the first pump. That's an important difference because it marks two completely different morphologies. This confusion makes many students wary of the heart in biology lessons, thinking it signals an intimidating subject full of complicated names and diagrams. Only those who end up studying medicine compeltely understand how it all actually works. That's when its functions become apparent as medics get to observe the motion of the heart's valves. So, let's imagine you're a medic for a day. What you'll need to get started is a whole fresh heart, like one from a sheep or pig. Immerse this heart in water and you'll see that it doesn't pump when squeezed by hand. That's because water doesn't enter the heart cleanly enough for the pumping mechanism to work. We can solve this problem in an extraordinarly simple way. Simply identify the two atria and cut them off, trimming them down to the tops of the ventricles. This makes the heart look less complicated because the atria have several incoming veins attached. So without them there, the only vessels remaining are the two major heart arteries: the aorta and pulmonary artery, which rise like white columns from between the ventricles. It looks -- and really is -- very simple. If you run water into the right ventricle from a tap (the left also works, but less spectacularly), you'll see that the ventricular valve tries to close against the incoming stream. And then ventricle inflates with water. Squeeze the ventricle and a stream of water squirts out of the pulmonary artery. The ventricular valves, called the tricuspid in the right ventricle and the mitral in the left, can be seen through the clear water opening and closing like parachutes as the ventricle is rhythmically squeezed. This flow of water mimics the flow of blood in life. The valves are completely efficient. You'll notice they don't leak at all when the ventricles are squeezed. Over time, they also close against each other with very little wear and tear, which explains how this mechanism continues to work seamlessly for more than 2 billion beats a heart gives in its lifetime. Now, anyone studying the heart can hold one in their hands, make it pump for real and watch the action unfold. So place your hand above your own and feel its rhymic beat. Understanding how this dependable inner pump works gives new resonance to the feeling you get when you run a race, drink too much caffeine or catch the eye of the one you love.

**P85 2014-05-21 The fundamentals of space-time - Part 3 - Andrew Pontzen and Tom Whyn**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=85)

Gravity. It controls the universe. Everything attracts everything else. Ouch! Including you. Ow! In this final lesson, we'll explore what gravity means for space-time, or rather what space-time means for gravity. Until now, we've been dealing with things moving at constant speeds, with straight world lines in space-time. But once you add gravity, if you measure a speed at one moment, then again a bit later, the speed may have changed. In other words, as I discovered, gravity causes acceleration, so we need the world line to look different from one moment to the next. As we saw in the last lesson, the correct way to tilt an object's world line is using a Lorentz transformation: Einstein's stretch and squash trick. So, to map out what gravity is doing to Tom's motion, we need to create a whole load of little patches of space-time, each transformed by different amounts. So that my world line is at a different angle in each one. And then, we're ready to stitch everything together. We assemble a cozy quilt of space-time where world lines look curved. Where the world lines join, the objects collide. By making these connections between the patches, a curvature gets built into space-time itself. But Einstein's true genius was to describe precisely how each patch is stretched and squashed according to nearby mass and energy. The mere presence of stuff curves the space-time, and curving space-time moves the stuff around. This is gravity, according to Einstein. Previously, Isaac Newton had explained gravity using the ideas of force and acceleration, without any wibbily wobbly space-time, and that did pretty well. But Einstein's theory does just slightly better at predicting, for example, the orbit of Mercury around the Sun, or the way that light rays are deflected by massive objects. More importantly, Einstein's theory predicts things that simply don't exist in older theories where space, time and gravity were separate. The stitching can leave wrinkles in the space-time material. These are called gravitational waves, which should be detectable as tiny, repetitive, subtle squashes and stretches in space. So we're building experiments to check if they are there. In the meantime, indirect evidence, most recently in the polarization patterns of light left over from the Big Bang, strongly suggest that they are. But despite Einstein's successes, when too much stuff gets concentrated in too small a space, like in a black hole, the curvature of space-time becomes so large, that his equations collapse. We need a new picture of space-time that incorporates quantum mechanics to unlock the secret at the heart of black holes. Which means there's plenty more to be discovered about space, time, and space-time in the future.

**P86 2014-05-23 How languages evolve - Alex Gendler**

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In the biblical story of the Tower of Babel, all of humanity once spoke a single language until they suddenly split into many groups unable to understand each other. We don't really know if such an original language ever existed, but we do know that the thousands of languages existing today can be traced back to a much smaller number. So how did we end up with so many? In the early days of human migration, the world was much less populated. Groups of people that shared a single language and culture often split into smaller tribes, going separate ways in search of fresh game and fertile land. As they migrated and settled in new places, they became isolated from one another and developed in different ways. Centuries of living in different conditions, eating different food and encountering different neighbors turned similar dialects with varied pronunciation and vocabulary into radically different languages, continuing to divide as populations grew and spread out further. Like genealogists, modern linguists try to map this process by tracing multiple languages back as far as they can to their common ancestor, or protolanguage. A group of all languages related in this way is called a language family, which can contain many branches and sub-families. So how do we determine whether languages are related in the first place? Similar sounding words don't tell us much. They could be false cognates or just directly borrowed terms rather than derived from a common root. Grammar and syntax are a more reliable guide, as well as basic vocabulary, such as pronouns, numbers or kinship terms, that's less likely to be borrowed. By systematically comparing these features and looking for regular patterns of sound changes and correspondences between languages, linguists can determine relationships, trace specific steps in their evolution and even reconstruct earlier languages with no written records. Linguistics can even reveal other important historical clues, such as determining the geographic origins and lifestyles of ancient peoples based on which of their words were native, and which were borrowed. There are two main problems linguists face when constructing these language family trees. One is that there is no clear way of deciding where the branches at the bottom should end, that is, which dialects should be considered separate languages or vice versa. Chinese is classified as a single language, but its dialects vary to the point of being mutually unintelligible, while speakers of Spanish and Portuguese can often understand each other. Languages actually spoken by living people do not exist in neatly divided categories, but tend to transition gradually, crossing borders and classifications. Often the difference between languages and dialects is a matter of changing political and national considerations, rather than any linguistic features. This is why the answer to, "How many languages are there?" can be anywhere between 3,000 and 8,000, depending on who's counting. The other problem is that the farther we move back in time towards the top of the tree, the less evidence we have about the languages there. The current division of major language families represents the limit at which relationships can be established with reasonable certainty, meaning that languages of different families are presumed not to be related on any level. But this may change. While many proposals for higher level relationships -- or super families -- are speculative, some have been widely accepted and others are being considered, especially for native languages with small speaker populations that have not been extensively studied. We may never be able to determine how language came about, or whether all human languages did in fact have a common ancestor scattered through the babel of migration. But the next time you hear a foreign language, pay attention. It may not be as foreign as you think.

**P87 2014-05-30 How does your brain respond to pain - Karen D. Davis**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=87)

Translator: Jessica Ruby Reviewer: Caroline Cristal Let's say that it would take you ten minutes to solve this puzzle. How long would it take if you received constant electric shocks to your hands? Longer, right? Because the pain would distract you from the task. Well, maybe not; it depends on how you handle pain. Some people are distracted by pain. It takes them longer to complete a task, and they do it less well. Other people use tasks to distract themselves from pain, and those people actually do the task faster and better when they're in pain than when they're not. Some people can just send their mind wandering to distract themselves from pain. How can different people be subjected to the exact same painful stimulus and yet experience the pain so differently? And why does this matter? First of all, what is pain? Pain is an unpleasant sensory and emotional experience, associated with actual or potential tissue damage. Pain is something we experience, so it's best measured by what you say it is. Pain has an intensity; you can describe it on a scale from zero, no pain, to ten, the most pain imaginable. But pain also has a character, like sharp, dull, burning, or aching. What exactly creates these perceptions of pain? Well, when you get hurt, special tissue damage-sensing nerve cells, called nociceptors, fire and send signals to the spinal cord and then up to the brain. Processing work gets done by cells called neurons and glia. This is your Grey matter. And brain superhighways carry information as electrical impulses from one area to another. This is your white matter. The superhighway that carries pain information from the spinal cord to the brain is our sensing pathway that ends in the cortex, a part of the brain that decides what to do with the pain signal. Another system of interconnected brain cells called the salience network decides what to pay attention to. Since pain can have serious consequences, the pain signal immediately activates the salience network. Now, you're paying attention. The brain also responds to the pain and has to cope with these pain signals. So, motor pathways are activated to take your hand off a hot stove, for example. But modulation networks are also activated that deliver endorphins and enkephalins, chemicals released when you're in pain or during extreme exercise, creating the runner's high. These chemical systems help regulate and reduce pain. All these networks and pathways work together to create your pain experience, to prevent further tissue damage, and help you to cope with pain. This system is similar for everyone, but the sensitivity and efficacy of these brain circuits determines how much you feel and cope with pain. This is why some people have greater pain than others and why some develop chronic pain that does not respond to treatment, while others respond well. Variability in pain sensitivities is not so different than all kinds of variability in responses to other stimuli. Like how some people love roller coasters, but other people suffer from terrible motion sickness. Why does it matter that there is variability in our pain brain circuits? Well, there are many treatments for pain, targeting different systems. For mild pain, non-prescription medications can act on cells where the pain signals start. Other stronger pain medicines and anesthetics work by reducing the activity in pain-sensing circuits or boosting our coping system, or endorphins. Some people can cope with pain using methods that involve distraction, relaxation, meditation, yoga, or strategies that can be taught, like cognitive behavioral therapy. For some people who suffer from severe chronic pain, that is pain that doesn't go away months after their injury should have healed, none of the regular treatments work. Traditionally, medical science has been about testing treatments on large groups to determine what would help a majority of patients. But this has usually left out some who didn't benefit from the treatment or experienced side effects. Now, new treatments that directly stimulate or block certain pain-sensing attention or modulation networks are being developed, along with ways to tailor them to individual patients, using tools like magnetic resonance imaging to map brain pathways. Figuring out how your brain responds to pain is the key to finding the best treatment for you. That's true personalized medicine.

**P88 2014-06-02 The Silk Road - Connecting the ancient world through trade - Shannon**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=88)

A banker in London sends the latest stock info to his colleagues in Hong Kong in less than a second. With a single click, a customer in New York orders electronics made in Beijing, transported across the ocean within days by cargo plane or container ship. The speed and volume at which goods and information move across the world today is unprecedented in history. But global exchange itself is older than we think, reaching back over 2,000 years along a 5,000 mile stretch known as the Silk Road. The Silk Road wasn't actually a single road, but a network of multiple routes that gradually emerged over centuries, connecting to various settlements and to each other thread by thread. The first agricultural civilizations were isolated places in fertile river valleys, their travel impeded by surrounding geography and fear of the unknown. But as they grew, they found that the arid deserts and steps on their borders were inhabited, not by the demons of folklore, but nomadic tribes on horseback. The Scythians, who ranged from Hungary to Mongolia, had come in contact with the civilizations of Greece, Egypt, India and China. These encounters were often less than peaceful. But even through raids and warfare, as well as trade and protection of traveling merchants in exchange for tariffs, the nomads began to spread goods, ideas and technologies between cultures with no direct contact. One of the most important strands of this growing web was the Persian Royal Road, completed by Darius the First in the 5th century BCE. Stretching nearly 2,000 miles from the Tigris River to the Aegean Sea, its regular relay points allowed goods and messages to travel at nearly 1/10 the time it would take a single traveler. With Alexander the Great's conquest of Persia, and expansion into Central Asia through capturing cities like Samarkand, and establishing new ones like Alexandria Eschate, the network of Greek, Egyptian, Persian and Indian culture and trade extended farther east than ever before, laying the foundations for a bridge between China and the West. This was realized in the 2nd century BCE, when an ambassador named Zhang Qian, sent to negotiate with nomads in the West, returned to the Han Emperor with tales of sophisticated civilizations, prosperous trade and exotic goods beyond the western borders. Ambassadors and merchants were sent towards Persia and India to trade silk and jade for horses and cotton, along with armies to secure their passage. Eastern and western routes gradually linked together into an integrated system spanning Eurasia, enabling cultural and commercial exhange farther than ever before. Chinese goods made their way to Rome, causing an outflow of gold that led to a ban on silk, while Roman glassware was highly prized in China. Military expeditions in Central Asia also saw encounters between Chinese and Roman soldiers. Possibly even transmitting crossbow technology to the Western world. Demand for exotic and foreign goods and the profits they brought, kept the strands of the Silk Road in tact, even as the Roman Empire disintegrated and Chinese dynasties rose and fell. Even Mongolian hoards, known for pillage and plunder, actively protected the trade routes, rather than disrupting them. But along with commodities, these routes also enabled the movement of traditions, innovations, ideologies and languages. Originating in India, Buddhism migrated to China and Japan to become the dominant religion there. Islam spread from the Arabian Penninsula into South Asia, blending with native beliefs and leading to new faiths, like Sikhism. And gunpowder made its way from China to the Middle East forging the futures of the Ottoman, Safavid and Mughul Empires. In a way, the Silk Road's success led to its own demise as new maritime technologies, like the magnetic compass, found their way to Europe, making long land routes obsolete. Meanwhile, the collapse of Mongol rule was followed by China's withdrawal from international trade. But even though the old routes and networks did not last, they had changed the world forever and there was no going back. Europeans seeking new maritime routes to the riches they knew awaited in East Asia led to the Age of Exploration and expansion into Africa and the Americas. Today, global interconnectedness shapes our lives like never before. Canadian shoppers buy t-shirts made in Bangladesh, Japanese audiences watch British television shows, and Tunisians use American software to launch a revolution. The impact of globalization on culture and economy is indisputable. But whatever its benefits and drawbacks, it is far from a new phenomenon. And though the mountains, deserts and oceans that once separated us are now circumvented through super sonic vehicles, cross-continental communication cables, and signals beamed through space rather than caravans traveling for months, none of it would have been possible without the pioneering cultures whose efforts created the Silk Road: history's first world wide web.

**P89 2014-06-03 How to choose your news - Damon Brown**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=89)

How do you know what's happening in your world? The amount of information just a click away may be limitless, but the time and energy we have to absorb and evaluate it is not. All the information in the world won't be very useful unless you know how to read the news. To your grandparents, parents, or even older siblings, this idea would have sounded strange. Only a few decades ago, news was broad-based. Your choices were limited to a couple of general interest magazines and newspaper of record, and three or four TV networks where trusted newscasters delivered the day's news at the same reliable time every evening. But the problems with this system soon became apparent as mass media spread. While it was known that authoritarian countries controlled and censored information, a series of scandals showed that democratic governments were also misleading the public, often with media cooperation. Revelations of covert wars, secret assassinations, and political corruption undermined public faith in official narratives presented by mainstream sources. This breakdown of trust in media gatekeepers lead to alternative newspapers, radio shows, and cable news competing with the major outlets and covering events from various perspectives. More recently, the Internet has multiplied the amount of information and viewpoints, with social media, blogs, and online video turning every citizen into a potential reporter. But if everyone is a reporter, nobody is, and different sources may disagree, not only opinions, but on the facts themselves. So how do you get the truth, or something close? One of the best ways is to get the original news unfiltered by middlemen. Instead of articles interpreting a scientific study or a politician's speech, you can often find the actual material and judge for yourself. For current events, follow reporters on social media. During major events, such as the Arab Spring or the Ukrainian protests, newscasters and bloggers have posted updates and recordings from the midst of the chaos. Though many of these later appear in articles or broadcasts, keep in mind that these polished versions often combine the voice of the person who was there with the input of editors who weren't. At the same time, the more chaotic the story, the less you should try to follow it in real time. In events like terrorist attacks and natural disasters, today's media attempts continuous coverage even when no reliable new information is available, sometimes leading to incorrect information or false accusations of innocent people. It's easy to be anxious in such events, but try checking for the latest information at several points in the day, rather than every few minutes, allowing time for complete details to emerge and false reports to be refuted. While good journalism aims for objectivity, media bias is often unavoidable. When you can't get the direct story, read coverage in multiple outlets which employ different reporters and interview different experts. Tuning in to various sources and noting the differences lets you put the pieces together for a more complete picture. It's also crucial to separate fact from opinion. Words like think, likely, or probably mean that the outlet is being careful or, worse, taking a guess. And watch out for reports that rely on anonymous sources. These could be people who have little connection to the story, or have an interest in influencing coverage, their anonymity making them unaccountable for the information they provide. Finally, and most importantly, try to verify news before spreading it. While social media has enabled the truth to reach us faster, it's also allowed rumors to spread before they can be verified and falsehoods to survive long after they've been refuted. So, before you share that unbelievable or outrageous news item, do a web search to find any additional information or context you might have missed and what others are saying about it. Today, we are more free than ever from the old media gatekeepers who used to control the flow of information. But with freedom comes responsibility: the responsibility to curate our own experience and ensure that this flow does not become a flood, leaving us less informed than before we took the plunge.

**P90 2014-06-06 The colossal consequences of supervolcanoes - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=90)

The year was 1816. Europe and North America had just been through a devastating series of wars, and a slow recovery seemed to be underway, but nature had other plans. After two years of poor harvests, the spring brought heavy rains and cold, flooding the rivers and causing crop failures from the British Isles to Switzerland. While odd-colored snow fell in Italy and Hungary, famine, food riots and disease epidemics ensued. Meanwhile, New England was blanketed by a strange fog that would not disperse as the ground remained frozen well into June. In what came to be known as "the Year Without a Summer," some thought the apocalypse had begun. A mood captured in Lord Byron's poem "Darkness": "I had a dream which was not all a dream. The bright sun was extinguish'd, and the stars did wander darkling in the eternal space, rayless, and pathless, and the icy Earth swung blind and blackening in the moonless air; morn came and went -- and came, and brought no day." They had no way of knowing that the real source of their misfortunes had occurred a year ago thousands of miles away. The 1815 eruption of Mount Tambora on the Indonesian island of Sumbawa was what is known as a supervolcano, characterized by a volume of erupted material, many times greater than that of ordinary volcanoes. And while the popular image of volcanic destruction is molten rock engulfing the surrounding land, far greater devastation is caused by what remains in the air. Volcanic ash, dispersed by wind, can blanket the sky for days, while toxic gases, such as sulfur dioxide, react in the stratosphere, blocking out solar radiation and drastically cooling the atmosphere below. The resulting volcanic winter, along with other effects such as acid rain, can effect multiple continents, disrupting natural cycles and annihilating the plant life on which other organisms, including humans, depend. Releasing nearly 160 cubic kilometers of rock, ash and gas, the Mount Tambora eruption was the largest in recorded history, causing as many as 90,000 deaths. But previous eruptions have been even more deadly. The 1600 eruption of Peru's Huaynaputina is likely to have triggered the Russian famine, that killed nearly two million, while more ancient eruptions have been blamed for major world events, such as the fall of the Chinese Xia Dynasty, the disappearance of the Minoan civilization, and even a genetic bottleneck in human evolution that may have resulted from all but a few thousand human beings being wiped out 70,000 years ago. One of the most dangerous types of supervolcano is an explosive caldera, formed when a volcanic mountain collapses after an eruption so large that the now-empty magma chamber can no longer support its weight. But though the above-ground volcano is gone, the underground volcanic activity continues. With no method of release, magma and volcanic gases continue to accumulate and expand underground, building up pressure until a massive and violent explosion becomes inevitable. And one of the largest active volcanic calderas lies right under Yellowstone National Park. The last time it erupted, 650,000 years ago, it covered much of North America in nearly two meters of ash and rock. Scientists are currently monitoring the world's active volcanoes, and procedures for predicting eruptions, conducting evacuations and diverting lava flows have improved over the years. But the massive scale and global reach of a supervolcano means that for many people there would be nowhere to run. Fortunately, the current data shows no evidence of such an eruption occurring in the next few thousand years. But the idea of a sudden and unavoidable civilization-destroying apocalypse caused by events half a globe away will remain a powerful and terrifying vision. Less fictional than we would like to believe. "The winds were withered in the stagnant air, and the clouds perish'd; darkness had no need of aid from them -- she was the universe." - Lord Byron

**P91 2014-06-10 Tycho Brahe, the scandalous astronomer - Dan Wenkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=91)

How do you imagine the life of a scientist? Boring and monotonous, spending endless hours in the lab with no social interaction? Maybe for some but not Tycho Brahe. The 16th century scholar who accurately predicted planetary motion and cataloged hundreds of stars before the telescope had been invented also had a cosmic-sized personal life. Tycho Brahe was born in 1546 to Danish nobles, but at age two was kidnapped to be raised by his uncle instead. His parents didn't seem to mind. Tycho was supposed to have a career in law, but after witnessing a solar eclipse at thirteen, he began spending more time with mathematics and science professors, who taught him the art of celestial observation. By the time Tycho's uncle sent him off to Germany a few years later, he had lost interest in his law studies, instead reading astronomy books, improving his instruments, and taking careful notes of the night skies. It wasn't long before his own measurements were more accurate than those in his books. While in Germany, Tycho got into a bit of an argument with another student at a party over a mathematical formula, resulting in a sword duel and Tycho losing a good-sized chunk of his nose. After that, he was said to have worn a realistic prosthetic of gold and silver that he would glue onto his face. Fortunately, Tycho didn't need his nose to continue his astronomical work. He kept studying the night sky and creating all sorts of instruments, including a building-sized quadrant for measuring the angles of stars. After months of careful observation, Tycho discovered a new star in the constellation Cassiopeia. The publication of this discovery granted him rock star status and offers of scientific positions all over Europe. Wanting to keep him at home, the King of Denmark offered to give Tycho his own personal island with a state of the art observatory. Called Uraniborg and costing about 1% of Denmark's entire budget, this observatory was more of a castle, containing formal gardens, rooms for family, staff and visiting royalty, and an underground section just for all the giant instruments. Tycho also built a papermill and printing press for publishing his papers, and a lab for studying alchemy. And since no castle would be complete without entertainment, Tycho employed a clairvoyant dwarf named Jep as court jester. Tycho lived on his island, studying and partying for about 20 years. But after falling out with the new Danish King, he took up an invitation from the Holy Roman Emperor to become the official imperial astronomer in Prague. There, he met another famous astronomer Johannes Kepler, who became his assistant. While Kepler's work interested him, Tycho was protective of his data, and the two often got into heated arguments. In 1601, Tycho attended a formal banquet where he drank quite a lot but was too polite to leave the table to relieve himself, deciding to tough it out instead. This proved to be a bad idea, as he quickly developed a bladder infection and died a few days later. But over 400 years after his death, Tycho still had a few surprises up his sleeve. When his body was exhumed and studied in 2010, the legendary gold and silver nose was nowhere to be found, with chemical traces suggesting that he wore a more casual brass nose instead. Tycho's mustache hair was also found to contain unusually high levels of toxic mercury. Was it from a medicine used to treat his bladder infection? A residue from his alchemy experiments? Or did his quarrelsome coworker Johannes Kepler poison him to acquire his data? We may never know, but the next time you think scientists lead boring lives, dig a little deeper. A fascinating story may be just beyond the tip of your nose.

**P92 2014-06-10 Why do honeybees love hexagons - Zack Patterson and Andy Peterson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=92)

Honeybees are fascinating creatures for a number of reasons: their incredible work ethic, the sugary sweet syrup they produce and their intricate social structure. But another reason is that honeybees are, in fact, excellent mathematicians. Scientists claim the tiny insects can calculate angles, and can even comprehend the roundness of the Earth. But there's particular mathematical bee genius behind the most important aspect of honeybee life: the hive. Just like humans, bees need food and shelter to stay alive. The hive is not only the bees' home, but doubles as a place to store their honey. Since it's so central to survival, honeybees have to perfect the hive's architectural design. If you examine any piece of honeycomb, you'll see that it's constructed from tightly packed hexagonal, or six-sided, cells. Of all the possible designs, why do honeybees choose this one? To understand, you need to think like a bee. Bees need a secure place for their entire colony to live. Similarly, there needs to be a place where their nectar can be stored and ripened suitably until it turns into honey. That means there's a need for some serious space efficiency. A good solution is to build little storage units, or cells, just big enough for a bee to fit into, which can also double as the containers in which nectar is stored: The bees' very own honey jars. The next thing, is to decide what the little cells should be made out of. Bees don't have beaks or arms to pick up things, but they are capable of producing wax. The thing is, producing it is a lot of hard work. Bees have to consume 8 ounces of honey to produce just 1 ounce of wax. So they don't want to waste it. So, they need a design that allows them to store the largest possible amount of honey using the least amount of wax. What shape does that? Imagining for a minute that all bees had to attend architecture academy and go to math class. Let's say they asked their geometry teacher, "What shape would give us the most space to store our honey, but require the least amount of wax?" And then geometry teacher replied, "The shape that you're seeking is the circle." Leaving the bees to return to their trial construction site and begin building their honeycomb using circular cells. After a while, some of them might have noticed a problem with their design: small gaps between the cells. "We can't even fit in there! That's wasted space!" they might have thought. So, ignoring the geometry lesson, and taking matters into their own hands, the bees went back to the drawing board to rethink their beehive design. One suggested triangles, "We can use triangles. Look! They fit together perfectly." Another bee suggested squares. Finally, a third bee piped up and said, "Pentagons don't seem to work, but hexagons do! We want the one that will use the least amount of wax and be able to store the most amount of honey. Yes, I think that's the hexagon." "Why?" "It looks more like the circle than the others." "But how do we know for sure?" To find out, the industrious insect architects calculated the areas of the triangle, the square and the hexagon and found that the hexagon was, in fact, the shape that gave them the most storage space. They agreed on an ideal size and returned to work. The space efficient comb that is a bee's trademark today, is probably the result of this trial and error, but over long periods of evolutionary history. However, it paid off. Peek into any hive -- with your protective goggles and netting on, of course -- and you'll see the end result: a beautiful compact honeycomb that any architect would have be proud to design.

**P93 2014-06-16 A brief history of religion in art - TED-Ed**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=93)

It's only been the last few hundreds years or so that Western civilization has been putting art in museums, at least museums resembling the public institutions we know today. Before this, for most, art served other purposes. What we call fine art today was, in fact, primarily how people experienced an aesthetic dimension of religion. Paintings, sculpture, textiles and illuminations were the media of their time, supplying vivid imagery to accompany the stories of the day. In this sense, Western art shared a utilitarian purpose with other cultures around the world, some of whose languages incidentally have no word for art. So how do we define what we call art? Generally speaking, what we're talking about here is work that visually communicates meaning beyond language, either through representation or the arrangement of visual elements in space. Evidence of this power of iconography, or ability of images to convey meaning, can be found in abundance if we look at art from the histories of our major world religions. Almost all have, at one time or another in their history, gone through some sort of aniconic phase. Aniconism prohibits any visual depiction of the divine. This is done in order to avoid idolatry, or confusion between the representation of divinity and divinity itself. Keeping it real, so to speak, in the relationship between the individual and the divine. However, this can be a challenge to maintain, given that the urge to visually represent and interpret the world around us is a compulsion difficult to suppress. For example, even today, where the depiction of Allah or the Prophet Muhammad is prohibited, an abstract celebration of the divine can still be found in arabesque patterns of Islamic textile design, with masterful flourishes of brushwork and Arabic calligraphy, where the words of the prophet assume a dual role as both literature and visual art. Likewise, in art from the early periods of Christianity and Buddhism, the divine presence of the Christ and the Buddha do not appear in human form but are represented by symbols. In each case, iconographic reference is employed as a form of reverence. Anthropomorphic representation, or depiction in human form, eventually became widespread in these religions only centuries later, under the influence of the cultural traditions surrounding them. Historically speaking, the public appreciation of visual art in terms other than traditional, religious or social function is a relatively new concept. Today, we fetishize the fetish, so to speak. We go to museums to see art from the ages, but our experience of it there is drastically removed from the context in which it was originally intended to be seen. It might be said that the modern viewer lacks the richness of engagement that she has with contemporary art, which has been created relevant to her time and speaks her cultural language. It might also be said that the history of what we call art is a conversation that continues on, as our contemporary present passes into what will be some future generation's classical past. It's a conversation that reflects the ideologies, mythologies, belief systems and taboos and so much more of the world in which it was made. But this is not to say that work from another age made to serve a particular function in that time is dead or has nothing to offer the modern viewer. Even though in a museum setting works of art from different places and times are presented alongside each other, isolated from their original settings, their juxtaposition has benefits. Exhibits are organized by curators, or people who've made a career out of their ability to recontextualize or remix cultural artifacts in a collective presentation. As viewers, we're then able to consider the art in terms of a common theme that might not be apparent in a particular work until you see it alongside another, and new meanings can be derived and reflected upon. If we're so inclined, we might even start to see every work of art as a complementary part of some undefined, unified whole of past human experience, a trail that leads right to our doorstep and continues on with us, open to anyone who wants to explore it.

**P94 2014-06-17 How bees help plants have sex - Fernanda S. Valdovinos**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=94)

Bees are very busy little matchmakers. Wingmen in every sense of the word. You see, the bees' side of the whole "birds and the bees" business is to help plants find mates and reproduce. In their work as pollinators, honeybees are integral to the production of nearly 1/3 of the food that we eat. And these bees, dutifully helping lonely plants have sex, aren't alone. But rather are part of a very complex network of matchmaking creatures, critical for the pollination of natural ecosystems and crops. Plants in many natural ecosystems need help to have sex. Like many of us, they're too busy to find a relationship. They have too much photosynthesis to do, and they can't find the time to evolve feet and walk to a singles bar. Those places are called meat markets for a reason, because plants can't walk. So they need matchmaker pollinators to transport their pollen grains to flowers of the same plant species, and they pay these pollinators with food. Today, around 170,000 plant species receive pollination services from more than 200,000 pollinator species. Pollinators include many species of bees, butterflies, moths, flies, wasps, beetles, even birds and bats, who together help pollinate many species of trees, shrubs and other flowering plants. In return, flowering plants are an abundant and diverse food source for pollinators. For instance, fossil records suggest bees may have evolved from wasps that gave up hunting after they acquired a taste for nectar. Plant pollinator networks are everywhere. Ecologists record these networks in the field by observing which pollinators visit which plants, or by analyzing the identity of pollen loads on their bodies. Networks, registered in these ways, contain from 20 to 800 species. These networks show a repeated structure, or architecture. Pollinators interact with plants in a very heterogenous way. Most plants are specialists, they have only one or a few matchmakers. Meanwhile, only a few generalist plants hire a diverse team of matchmakers, getting visits from almost all the pollinators of the network. The same occurs with pollinators. Most are specialists that feed on only a few plant species, while a few pollinators, including the honeybee usually, are generalists, busily feeding from and matchmaking for almost all the plant species in that ecosystem. What's interesting is that specialists and generalists across both plants and pollinators, sort themselves out in a particular pattern. Most pollinator networks, for which we have data, are nested. In a nested network, specialists tend to interact more with generalists than with other specialists. This is because if you're a specialist plant, and your only matchmaker also specializes on you as its only food source, you're each more vulnerable to extinction. So, you're better off specializing on a generalist pollinator that has other sources of food to ensure its persistence in bad years. The same goes if you're a specialist pollinator. You're better off in the long run specializing on a generalist plant that gets pollinated by other species in times when you're not around to help. Finally, in addition to nestedness, the networks are usually modular. This means that the species in a network are compartmentalized into modules of plants and animals that interact more with each other than with species in other modules. Think of them like social cliques. A plant or pollinator dying off will effect the species in its module, but those effects will be less severe on the rest of the network. Why's all that important? Because plant pollinator network structure effects the stability of ecosystems. Heterogeneous distribution, nestedness and modularity enable networks to better prevent and respond to extinctions. That's critical because nature is never static. Some species may not show up every year. Plants flower at different times. Pollinators mature on varying schedules. Generalist pollinators have to adapt their preferences depending on who's flowering when. So from one flowering season to the next, the participants and patterns of matchmaking can drastically change. With all those variables, you can understand the importance of generalist pollinators, like bees, to the stability of not only a crop harvest, but the entire network of plants and pollinators we see in nature, and rely on for life. Next time you see a bee fly by, remember that it belongs to a complex network of matchmakers critical to the love lives of plants all around you.

**P95 2014-06-17 Why aren't we only using solar power - Alexandros George Charalambide**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=95)

We have some good reasons to completely switch over to solar power. It's cheaper in many cases, and definitely more sustainable than our dependance on traditional power plants that use resources like coal, which will eventually run out. So why don't we replace these traditional plants with solar energy? Because there's one factor that makes solar power very unpredictable: cloud cover. As the sun's rays move towards Earth, some get absorbed by the Earth's atmosphere, some are reflected back into outer space, but the rest make it to the Earth's surface. The ones that aren't deviated are called direct irradiance. The ones that are deflected by clouds are called diffuse irradiance. And those rays that first get reflected by a surface, like a nearby building, before reaching the solar energy system are called reflected irradiance. But before we can examine how clouds affect the sun's rays and electricity production, let's see how these solar energy systems work. First up, we have solar towers. These are made up of a central tower surrounded by a huge field of mirrors that track the sun's path and focus only the direct rays onto a single point on the tower, kind of like an eager beachgoer. The heat generated by these rays is so immense that it can be used to boil water producing steam that drives a traditional turbine, which makes electricity. But when we say solar energy systems, we're usually talking about photovoltaics, or solar panels, which are the systems most commonly used to generate solar power. In solar panels, photons from the sun's rays hit the surface of a panel, and electrons are released to get an electric current going. Solar panels can use all types of irradiance, while solar towers can only use direct irradiance, and this is where clouds become important because depending on their type and location relative to the sun, they can either increase or decrease the amount of electricity produced. For instance, even a few cumulus clouds in front of the sun can reduce the electricity production in solar towers to almost zero because of this dependence on direct rays. In solar panels, those clouds would decrease energy output as well, though not as much because solar panels can use all types of irradiance. However, all this depends on the clouds exact positioning. Due to reflection, or a particular phenomeon called Mie scattering, the sun's rays can actually be focused forward by clouds to create a more than 50% increase in the solar irradiance reaching a solar panel. If this potential increase isn't accounted for, it could damage the solar panel. Why does this matter? Well, you wouldn't want this lesson to stop just because a cloud passed over the panel on your roof. In solar towers, huge tanks of molten salt or oil can be used to store any excess heat and use it when needed, so that's how they manage the problem of fluctuating solar irradiance to smooth out electricity production. But in the case of solar panels, there currently isn't any way to affordably store extra energy. That's where traditional power plants come in because to correct for any fluctuations in these solar powered plants, extra electricity from traditional sources always needs to be available. But then why aren't these tradtional power plants just used as a backup, instead of us humans depending on them as our main sources of energy? Because it's impossible for an employee at a coal fired or a nuclear plant to turn a knob to produce more or less electricity depending on how many clouds there are in the sky. The response time would simply be too slow. Instead, to accommodate these fluctuations, some extra electricity from traditional power plants is always being produced. On clear sky days, that extra electricity might be wasted, but when cloudy skies prevail, it's what fills the gap. This is what we currently depend on for a constant supply of energy. For this reason, a lot of researchers are interested in forcasting the motion and formation of clouds through satellite images or cameras that look up at the sky to maximize the energy from solar power plants and minimize energy waste. If we could accomplish that, you'd be able to enjoy this video powered solely by the sun's rays, no matter what the weather, although if the sun is shining, you may be tempted to venture outside to go and do a different kind of cloud gazing.

**P96 2014-06-19 What gives a dollar bill its value - Doug Levinson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=96)

If you tried to pay for something with a piece of paper, you might run into some trouble. Unless, of course, the piece of paper was a hundred dollar bill. But what is it that makes that bill so much more interesting and valuable than other pieces of paper? After all, there's not much you can do with it. You can't eat it. You can't build things with it. And burning it is actually illegal. So what's the big deal? Of course, you probably know the answer. A hundred dollar bill is printed by the government and designated as official currency, while other pieces of paper are not. But that's just what makes them legal. What makes a hundred dollar bill valuable, on the other hand, is how many or few of them are around. Throughout history, most currency, including the US dollar, was linked to valuable commodities and the amount of it in circulation depended on a government's gold or silver reserves. But after the US abolished this system in 1971, the dollar became what is known as fiat money, meaning not linked to any external resource but relying instead solely on government policy to decide how much currency to print. Which branch of our government sets this policy? The Executive, the Legislative, or the Judicial? The surprising answer is: none of the above! In fact, monetary policy is set by an independent Federal Reserve System, or the Fed, made up of 12 regional banks in major cities around the country. Its board of governors, which is appointed by the president and confirmed by the Senate, reports to Congress, and all the Fed's profit goes into the US Treasury. But to keep the Fed from being influenced by the day-to-day vicissitudes of politics, it is not under the direct control of any branch of government. Why doesn't the Fed just decide to print infinite hundred dollar bills to make everyone happy and rich? Well, because then the bills wouldn't be worth anything. Think about the purpose of currency, which is to be exchanged for goods and services. If the total amount of currency in circulation increases faster than the total value of goods and services in the economy, then each individual piece will be able to buy a smaller portion of those things than before. This is called inflation. On the other hand, if the money supply remains the same, while more goods and services are produced, each dollar's value would increase in a process known as deflation. So which is worse? Too much inflation means that the money in your wallet today will be worth less tomorrow, making you want to spend it right away. While this would stimulate business, it would also encourage overconsumption, or hoarding commodities, like food and fuel, raising their prices and leading to consumer shortages and even more inflation. But deflation would make people want to hold onto their money, and a decrease in consumer spending would reduce business profits, leading to more unemployment and a further decrease in spending, causing the economy to keep shrinking. So most economists believe that while too much of either is dangerous, a small, consistent amount of inflation is necessary to encourage economic growth. The Fed uses vast amounts of economic data to determine how much currency should be in circulation, including previous rates of inflation, international trends, and the unemployment rate. Like in the story of Goldilocks, they need to get the numbers just right in order to stimulate growth and keep people employed, without letting inflation reach disruptive levels. The Fed not only determines how much that paper in your wallet is worth but also your chances of getting or keeping the job where you earn it.

**P97 2014-06-24 Attack of the killer algae - Eric Noel Muñoz**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=97)

We've all seen the movies where a monster, created by a scientist in a laboratory, escapes to wreak havoc on the outside world. But what if the monster was not some giant rampaging beast, destroying a city, but just a tiny amount of seaweed with the potential to disrupt entire coastal ecosystems? This is the story of Caulerpa taxifolia, originally a naturally occurring seaweed native to tropical waters. In the 1980s, one strain was found to thrive in colder environments. This trait, combined with its beautiful, bright green color and ability to grow quickly without maintenance made it ideal for aquariums, which it helped keep clean by consuming nutrients and chemicals in the water. Further selective breeding made it even heartier, and soon it was used in aquariums around the world. But it was not long before a sample of this aquarium-developed super algae turned up in the Mediterranean Sea near the famed Oceanographic Museum of Monaco. The marine biologist who found it believed that the museum had accidentally realeased it into the ocean along with aquarium waters, while museum directors claimed it had be carried into the area by ocean currents. Regardless of how it ended up there, the non-native Caulerpa multiplied rapidly, having no natural predators due to releasing a toxin that keeps fish away. And like some mythical monster, even a tiny piece that broke off could grow into a whole new colony. Through water currents and contact with boat anchors and fishing lines, it fragmented and spread throughout Mediterranean coastal cities covering coral reefs. So what was the result of this invasion? Well, it depends on who you ask. Many scientists warned that the spread of Caulerpa reduces biodiversity by crowding out native species of seaweed that are eaten by fish, with the biologist who first discovered its presence dubbing it Killer Algae. Other studies instead claim that the algae actually had a beneficial effect by consuming chemical pollutants -- one reason the aquariums strain was developed. But the disruption of a natural ecosystem by an introduced foreign species can have unpredictable and uncontrollable effects that may not be immediately visible. So when Culerpa taxifolia was discovered at Carlsbad's Agua Hedionda Lagoon, near San Diego in the year 2000, having most likely come from the dumping of home aquarium water into a connecting storm drain, it was decided to stop it before it spread. Tarps were placed over the Culerpa colonies and chlorine injected inside. Although this method killed all other marine life trapped under the tarps, it did succeed in eradicating the algae and native eelgrass was able to emerge in its place. By responding quickly, authorities in California were able to prevent Culerpa from propagating. But another occurrence of the strain, in the coastal wetlands of southeast Australia, was left unchecked and allowed to spread. And unfortunately, a tarp cannot cover the Mediterranean Sea or the Australian coast. Invasive species are not a new problem, and can indeed occur naturally. But when such species are the results of human directed selective breeding or genetic modification and then released into the natural environment, their effect on ecosystems can be far more radical and irreversible. With the proliferation of new technologies and multiple threats to the environment, it is more important than ever for scientists to monitor and evaluate the risks and dangers, and for the rest of us to remember that what starts in our backyard can effect ecosystems half a world away.

**P98 2014-06-24 How to speak monkey - The language of cotton-top tamarins - Anne Sava**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=98)

Living with her family high above the ground in the northern tropical forests of Colombia, you will find Shakira, a cotton-top tamarin with a penchant for conversation. Say, "Hola!" Though you may not realize it, this one pound monkey communicates in a highly sophisticated language of 38 distinct calls based on variations of chirps and whistles. The response she just gave is known as a "B chirp", a call often directed at humans. To appreciate the complexities of Shakira's language, let's learn a few chirps and whistles, then examine how their combinations form grammatically structured sequences. The chirp Shakira used to greet us comes from a class of calls known as single frequency modulated syllables. This class is made up of short duration calls, or chirps, and long duration calls, like screams and squeals. Researchers have determined that there are eight different types of chirps categorized by stem upsweep, duration, peak frequency, and frequency change. In addition, each chirp has its own unique meaning. For example, Shakira's "C chirp" is used when she is approaching food, where as her "D chirp" is only used when she has the food in hand. Single whistles also exhibit a unique intention with each call and just as there are eight different chirps, there are five different whistles. Based on frequency modulation, single whistles are subdivided into four categories: squeaks, initially modulated whistles, terminally modulated whistles, and flat whistles. The language's quality of unique intention is wonderfully exemplified by the category of initially modulated whistles. These whistles change based on the proximity of Shakira to other members of her family. If Shakira is greater than .6 meters from her family, she'll sound a large initally modulated whistle. But if she's less than .6 meters from her family, she'll sound a small initially modulated whistle. Now that we've learned a few chirps and whistles, Shakira wants to show off by taking you through a quick day in her life with these calls. While heading towards a feeding tree for her first meal of the day, she says, (monkey noise), a call most often used in relaxed investigations. However, suddenly she spots the shadow of a hawk. "E chirp" for alarm. This call alerts her family to the presence of this predator, and Shakira jumps to the safety of an inner branch. The coast seems clear, so Shakira makes her way towards her dad. Wait, wait. Who is that? Ah, it's her younger brother, Carlos. Cotton-top tamarins often squeal during play wrestling. Uh-oh. He's playing a little too roughly, and Shakira screams, alerting her parents to help her. Her dad makes his way towards the ball of rolling fur and her brother stops. Shakira shakes herself and scratches herself to get the hair on her head back in place. Then Shakira spots another group of unfamiliar tamarins and hears their normal long call. She turns to her family. (Monkey noise) Did you catch that? First there was a chirp, then a whistle. This is what's known as a combination vocalization, a phrase that contains both a chirp and a whistle. These are two calls strung together to convey a message. The combination of these two elements alerts her family to the presence of another group, the "F chirp", and the distance they are away, the normal long call whistle. In other words, Shakira just said a sentence. Her simple demonstration is just the tip of the iceberg. She's got trills, chatters, multiple whistle calls, more combination vocalizations, even twitters. Yet sadly enough, we may not get to hear everything she has to say. Mixed in with chirping sonatas from high above is the constant thud of a machete chopping trees. Shakira's habitat in Colombia is being cut down, piece by piece, and if we don't work to protect the critically endangered cotton-top tamarin, it will become extinct in our lifetime. If the chirp from one tamarin to the next has proven to be more than just idle chit chat, imagine what else we have left to discover. Imagine what else Shakira can tell us.

**P99 2014-06-30 A guide to the energy of the Earth - Joshua M. Sneideman**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=99)

Energy is all around us, a physical quantity that follows precise natural laws. Our universe has a finite amount of it; it's neither created nor destroyed but can take different forms, such as kinetic or potential energy, with different properties and formulas to remember. For instance, an LED desk lamp's 6 Watt bulb transfers 6 Joules of light energy per second. But let's jump back up into space to look at our planet, its systems, and their energy flow. Earth's physical systems include the atmosphere, hydrosphere, lithosphere, and biosphere. Energy moves in and out of these systems, and during any energy transfer between them, some is lost to the surroundings, as heat, light, sound, vibration, or movement. Our planet's energy comes from internal and external sources. Geothermal energy from radioactive isotopes and rotational energy from the spinning of the Earth are internal sources of energy, while the Sun is the major external source, driving certain systems, like our weather and climate. Sunlight warms the surface and atmosphere in varying amounts, and this causes convection, producing winds and influencing ocean currents. Infrared radiation, radiating out from the warmed surface of the Earth, gets trapped by greenhouse gases and further affects the energy flow. The Sun is also the major source of energy for organisms. Plants, algae, and cyanobacteria use sunlight to produce organic matter from carbon dioxide and water, powering the biosphere's food chains. We release this food energy using chemical reactions, like combustion and respiration. At each level in a food chain, some energy is stored in newly made chemical structures, but most is lost to the surroundings, as heat, like your body heat, released by your digestion of food. Now, as plants are eaten by primary consumers, only about 10% of their total energy is passed on to the next level. Since energy can only flow in one direction in a food chain, from producers on to consumers and decomposers, an organism that eats lower on the food chain, is more efficient than one higher up. So eating producers is the most efficient level at which an animal can get its energy, but without continual input of energy to those producers, mostly from sunlight, life on Earth as we know it would cease to exist. We humans, of course, spend our energy doing a lot of things besides eating. We travel, we build, we power all sorts of technology. To do all this, we use sources like fossil fuels: coal, oil, and natural gas, which contain energy that plants captured from sunlight long ago and stored in the form of carbon. When we burn fossil fuels in power plants, we release this stored energy to generate electricity. To generate electricity, heat from burning fossil fuels is used to power turbines that rotate magnets, which, in turn, create magnetic field changes relative to a coil of wire, causing electrons to be induced to flow in the wire. Modern civilization depends on our ability to keep powering that flow of electrons. Fortunately, we aren't limited to burning non-renewable fossil fuels to generate electricity. Electrons can also be induced to flow by direct interaction with light particles, which is how a solar cell operates. Other renewable energy sources, such as wind, water, geothermal, and biofuels can also be used to generate electricity. Global demand for energy is increasing, but the planet has limited energy resources to access through a complex energy infrastructure. As populations rise, alongside rates of industrialization and development, our energy decisions grow more and more important. Access to energy impacts health, education, political power, and socioeconomic status. If we improve our energy efficiency, we can use our natural resources more responsibly and improve quality of life for everyone.

**P100 2014-06-30 What you might not know about the Declaration of Independence - Kenne**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=100)

"All men are created equal and they are endowed with the rights to life, liberty and the pursuit of happiness." Not so fast, Mr. Jefferson! These words from the Declaration of Independence, and the facts behind them, are well known. In June of 1776, a little more than a year after the war against England began with the shots fired at Lexington and Concord, the Continental Congress was meeting in Philadelphia to discuss American independence. After long debates, a resolution of independence was approved on July 2, 1776. America was free! And men like John Adams thought we would celebrate that date forever. But it was two days later that the gentlemen in Congress voted to adopt the Declaration of Independence, largely written by Thomas Jefferson, offering all the reasons why the country should be free. More than 235 years later, we celebrate that day as America's birthday. But there are some pieces of the story you may not know. First of all, Thomas Jefferson gets the credit for writing the Declaration, but five men had been given the job to come up with a document explaining why America should be independent: Robert Livingston, Roger Sherman, Benjamin Franklin and John Adams were all named first. And it was Adams who suggested that the young, and little known, Thomas Jefferson join them because they needed a man from the influential Virginia Delegation, and Adams thought Jefferson was a much better writer than he was. Second, though Jefferson never used footnotes, or credited his sources, some of his memorable words and phrases were borrowed from other writers and slightly tweaked. Then, Franklin and Adams offered a few suggestions. But the most important change came after the Declaration was turned over to the full Congress. For two days, a very unhappy Thomas Jefferson sat and fumed while his words were picked over. In the end, the Congress made a few, minor word changes, and one big deletion. In the long list of charges that Jefferson made against the King of England, the author of the Declaration had included the idea that George the Third was responsible for the slave trade, and was preventing America from ending slavery. That was not only untrue, but Congress wanted no mention of slavery in the nation's founding document. The reference was cut out before the Declaration was approved and sent to the printer. But it leaves open the hard question: How could the men, who were about to sign a document, celebrating liberty and equality, accept a system in which some people owned others? It is a question that would eventually bring the nation to civil war and one we can still ask today.

**P101 2014-07-02 The time value of money - German Nande**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=101)

They say, 'Time is money,' but what does one really have to do with the other? Meet Sheila! She just got her first big bonus. Sheila knows exactly what she wants to do with that money. She's had her eye on a nice convertible for a while now. Yes, Sheila, that's a nice car! Oh, looks like Sheila is a little short. But wait! She has an idea. Sheila is a smart cookie. She knows that if she deposits the money for a year instead of buying the car today, she will earn interest. Then she'll be able to afford the car. Sheila knows that the value of her deposit one year from now will equal the money deposited today plus the interest earned. We call Sheila's money deposited today the present value of money. And the value of Sheila's deposit next year is the future value of money. What connects one to the other? The interest rate, also known as the time value of money. Now, with a little bit of rearranging, we can figure out the future value of Sheila's money with this equation. So in a year, the future value will be $11,000. Well, it's been a year! And there's Sheila, with enough money to buy the car. Sheila really understands the future value of money. Now, I just hope she understands the speed limit! Now, meet Timmy. He's also gotten his bonus. The money seems to be burning a hole in his pocket. Yes, Timmy, that's a nice car that will surely impress people. Oh! Looks like you're a little short. Maybe you can follow Sheila's example. You see, Timmy, just like Sheila, after the first year, you'll have $11,000. But Timmy, that is still not enough to buy that fancy car. Why don't you leave the money deposited for another year? Let's see how your deposit will be doing in two years. With a little bit of rearranging, it becomes the value of your money next year, times one plus the interest rate. We can then convert the future value one year from now to the present value times one plus the interest rate. We can even simplify this further by just squaring the value of one plus the interest rate. Sorry, Timmy, you'll have more money after two years, but you still can't afford the car! I don't know how many more years you'll have to wait, but I can tell you one way we can figure it out. Do you see that little number two in the equation? Any number that you put in there is the number of years that you are waiting, also known as the period. Sure, Timmy, we can see how much you'll have in five years. Let's connect future value and present value across five years. Let's watch the period increase from two to five. After 5 years, you'll have $16,105.10. Sorry, Timmy, you have to wait a little longer. 10 years? Yeah! Let's see if you'll be able to buy the car then. Not quite. Well, Timmy, it looks like you'll need 26 years to afford this car. You should ask Sheila for a ride to the beach. Maybe a bicycle will suit you better? I hear the bus is pretty cheap!

**P102 2014-07-03 How heavy is air - Dan Quinn**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=102)

Transcriber: Jessica Ruby Reviewer: Caroline Cristal You may not realize it, but from the moment you got out of bed today to the point where you sat down to watch this video, you've essentially been swimming. Why? Because air is a fluid just like water. It has waves and eddies. It flows. And when you push air out of the way, it rushes around you into a wake. So why don't we notice it most of the time? We commonly think of air as empty space. But while one cubic centimeter of interstellar space, the volume in the tip of your pinky finger, contains roughly one atom, the same volume of air has about 10 quintillion molecules. If that sounds hard to wrap your head around, it happens to be about the same as the number of insects alive on the planet, all crawling, climbing, and flying over each other in an enormous, tightly packed swarm. When this swarm of molecules runs into things, it exerts a force, pressing against the boundaries of the fluid, like water pressing against the glass of a bottle. This is known as air pressure. And while air is lighter than water, all those molecules still get pretty heavy, with the total air filling a typical school gym, weighing about as much as an adult elephant. So when you walk into a gym, how come you're not immediately crushed by the elephant of air in the room? Well, first of all, because most of it is pressing on the floor and the walls, and the part that is pressing on you is pushed back by the pressure inside you! You see, the air, as well as the water and everything else, that fills our bodies exerts an amount of pressure equal to that of the air outside. Of course, this is no accident. It's precisely what allows us to survive in the normal atmosphere, and what makes it more difficult at high altitudes or deep water. And we normally don't feel the air pressing on us because it's generally uniform. So even though different amounts of air molecules are hitting you at different times, the swarm is so thick that all those little differences average out. What happens when air pressure isn't uniform? This means that the molecules are pushing harder in one region of air than another, driving the air flow from the higher pressure region to the lower. We feel this flow directly as wind, and the pressure systems that meteorologists are always going on about are responsible for other weather changes, from the mundane to the catastrophic. But differences in air pressure do more than just let us complain about the weather; they're the very reason we're alive. We breathe by lowering the pressure in our lungs, allowing air to rush in. So the next time you take a deep breath, think of the unfathomable number of air molecules you're commanding to move. We look up at the night sky to ponder the infinity of space, but unless you're watching this video from that deep space, there are more air molecules in and around your body than there are grains of sand in all the world's beaches and deserts, stars in the visible universe, or both of those numbers combined. The vastness of the universe is right in front of you and inside you.

**P103 2014-07-07 Inside the ant colony - Deborah M. Gordon**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=103)

Think about all the things that need to happen for a human settlement to thrive: obtaining food, building shelter, raising children and more. There needs to be a way to divide resources, organize major efforts and distribute labor efficiently. Now imagine having to do this without any sort of planning or higher level communication. Welcome to the ant colony. Ants have some of the most complex social organization in the animal kingdom, living in structured colonies containing different types of members who perform specific roles. But although this may sound similar to some human societies, this organization doesn't arise from any higher level decisions, but is part of a biologically programmed cycle. In many species, all the winged males and winged virgin queens from all the nearby colonies in the population each leave from their different nests and meet at a central place to mate, using pheromones to guide each other to a breeding ground. After mating, the males die off, while females try to establish a new colony. The few that are successful settle down in a suitable spot, lose their wings, and begin laying eggs, selectively fertilizing some using stored sperm they've saved up from mating. Fertilized eggs grow into female workers who care for the queen and her eggs. They will then defend the colony and forage for food, while unfertilized eggs grow into males whose only job is to wait until they are ready to leave the nest and reproduce, beginning the cycle again. So how do worker ants decide what to do and when? Well, they don't really. Although they have no methods of intentional communication, individual ants do interact with one another through touch, sound and chemical signals. These stimuli accomplish many things from serving as an alarm to other ants if one is killed, to signaling when a queen is nearing the end of her reproductive life. But one of the most impressive collective capabilities of an ant colony is to thoroughly and efficiently explore large areas without any predetermined plan. Most species of ants have little or no sense of sight and can only smell things in their vicinity. Combined with their lack of high level coordination, this would seem to make them terrible explorers, but there is an amazingly simple way that ants maximize their searching efficiency; by changing their movement patterns based on individual interactions. When two ants meet, they sense each other by touching antennae. If there are many ants in a small area this will happen more often causing them to respond by moving in more convoluted, random paths in order to search more thoroughly. But in a larger area, with less ants, where such meetings happen less often, they can walk in straight lines to cover more ground. While exploring their environment in this way, an ant may come across any number of things, from threats or enemies, to alternate nesting sites. And some species have another capability known as recruitment. When one of these ants happens to find food, it will return with it, marking its path with a chemical scent. Other ants will then follow this pheromone trail, renewing it each time they manage to find food and return. Once the food in that spot is depleted, the ants stop marking their return. The scent dissipates and ants are no longer attracted to that path. These seemingly crude methods of search and retrieval are, in fact, so useful that they are applied in computer models to obtain optimal solutions from decentralized elements, working randomly and exchanging simple information. This has many theoretical and practical applications, from solving the famous traveling salesman problem, to scheduling computing tasks and optimizing Internet searches, to enabling groups of robots to search a minefield or a burning building collectively, without any central control. But you can observe these fascinatingly simple, yet effective, processes directly through some simple experiments, by allowing ants to enter empty spaces of various sizes and paying attention to their behavior. Ants may not be able to vote, hold meetings or even make any plans, but we humans may still be able to learn something from the way that such simple creatures are able to function so effectively in such complex ways.

**P104 2014-07-10 What makes tattoos permanent - Claudia Aguirre**

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Tattoos have often been presented in popular media as either marks of the dangerous and deviant or trendy youth fads. But while tattoo styles come and go, and their meaning has differed greatly across cultures, the practice is as old as civilization itself. Decorative skin markings have been discovered in human remains all over the world, with the oldest found on a Peruvian mummy dating back to 6,000 BCE. But have you ever wondered how tattooing really works? You may know that we shed our skin, losing about 30-40,000 skin cells per hour. That's about 1,000,000 per day. So, how come the tattoo doesn't gradually flake off along with them? The simple answer is that tattooing involves getting pigment deeper into the skin than the outermost layer that gets shed. Throughout history, different cultures have used various methods to accomplish this. But the first modern tattooing machine was modeled after Thomas Edison's engraving machine and ran on electricity. Tattooing machines used today insert tiny needles, loaded with dye, into the skin at a frequency of 50 to 3,000 times per minute. The needles punch through the epidermis, allowing ink to seep deep into the dermis, which is composed of collagen fibers, nerves, glands, blood vessels and more. Every time a needle penetrates, it causes a wound that alerts the body to begin the inflammatory process, calling immune system cells to the wound site to begin repairing the skin. And it is this very process that makes tattoos permanent. First, specialized cells called macrophages eat the invading material in an attempt to clean up the inflammatory mess. As these cells travel through the lymphatic system, some of them are carried back with a belly full of dye into the lymph nodes while others remain in the dermis. With no way to dispose of the pigment, the dyes inside them remain visible through the skin. Some of the ink particles are also suspended in the gel-like matrix of the dermis, while others are engulfed by dermal cells called fibroblasts. Initially, ink is deposited into the epidermis as well, but as the skin heals, the damaged epidermal cells are shed and replaced by new, dye-free cells with the topmost layer peeling off like a heeling sunburn. Blistering or crusting is not typically seen with professional tattoos and complete epidermal regeneration requires 2-4 weeks, during which excess sun exposure and swimming should be avoided to prevent fading. Dermal cells, however, remain in place until they die. When they do, they are taken up, ink and all, by younger cells nearby, so the ink stays where it is. But with time, tattoos do fade naturally as the body reacts to the alien pigment particles, slowly breaking them down to be carried off by the immune system's macrophages. Ultraviolet radiation can also contribute to this pigment breakdown, though it can be mitigated by the use of sunblock. But since the dermal cells are relatively stable, much of the ink will remain deep in the skin for a person's whole life. But if tattoos are embedded in your skin for life, is there any way to erase them? Technically, yes. Today, a laser is used to penetrate the epidermis and blast apart underlying pigment colors of various wavelengths, black being the easiest to target. The laser beam breaks the ink globules into smaller particles that can then be cleared away by the macrophages. But some color inks are harder to remove than others, and there could be complications. For this reason, removing a tattoo is still more difficult than getting one, but not impossible. So a single tattoo may not truly last forever, but tattoos have been around longer than any existing culture. And their continuing popularity means that the art of tattooing is here to stay.

**P105 2014-07-11 It's a church. It's a mosque. It's Hagia Sophia. - Kelly Wall**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=105)

They say that if walls could talk, each building would have a story to tell, but few would tell so many fascinating stories in so many different voices as the Hagia Sophia, or holy wisdom. Perched at the crossroads of continents and cultures, it has seen massive changes from the name of the city where it stands, to its own structure and purpose. And today, the elements from each era stand ready to tell their tales to any visitor who will listen. Even before you arrive at the Hagia Sophia, the ancient fortifications hint at the strategic importance of the surrounding city, founded as Byzantium by Greek colonists in 657 BCE. And successfully renamed as Augusta Antonia, New Rome and Constantinople as it was conquered, reconquered, destroyed and rebuilt by various Greek, Persian and Roman rulers over the following centuries. And it was within these walls that the first Megale Ekklesia, or great church, was built in the fourth century. Though it was soon burned to the ground in riots, it established the location for the region's main religious structure for centuries to come. Near the entrance, the marble stones with reliefs are the last reminders of the second church. Built in 415 CE, it was destroyed during the Nika Riots of 532 when angry crowds at a chariot race nearly overthrew the emperor, Justinian the First. Having barely managed to retain power, he resolved to rebuild the church on a grander scale, and five years later, the edifice you see before you was completed. As you step inside, the stones of the foundation and walls murmur tales from their homelands of Egypt and Syria, while columns taken from the Temple of Artemis recall a more ancient past. Runic inscriptions carved by the Vikings of the emperor's elite guard carry the lore of distant northern lands. But your attention is caught by the grand dome, representing the heavens. Reaching over 50 meters high and over 30 meters in diameter and ringed by windows around its base, the golden dome appears suspended from heaven, light reflecting through its interior. Beneath its grandiose symbolism, the sturdy reinforcing Corinthian columns, brought from Lebanon after the original dome was partially destroyed by an earthquake in 558 CE, quietly remind you of its fragility and the engineering skills such a marvel requires. If a picture is worth a thousand words, the mosaics from the next several centuries have the most to say not only about their Biblical themes, but also the Byzantine emperors who commissioned them, often depicted along with Christ. But beneath their loud and clear voices, one hears the haunting echoes of the damaged and missing mosaics and icons, desecrated and looted during the Latin Occupation in the Fourth Crusade. Within the floor, the tomb inscription of Enrico Dandolo, the Venetian ruler who commanded the campaign, is a stark reminder of those 57 years that Hagia Sophia spent as a Roman Catholic church before returning to its orthodox roots upon the Byzantine Reconquest. But it would not remain a church for long. Weakened by the Crusades, Constantinople fell to the Ottomans in 1453 and would be known as Istanbul thereafter. After allowing his soldiers three days of pillage, Sultan Mehmed the Second entered the building. Though heavily damaged, its grandeur was not lost on the young sultan who immediately rededicated it to Allah, proclaiming that it would be the new imperial mosque. The four minarets built over the next century are the most obvious sign of this era, serving as architectural supports in addition to their religious purpose. But there are many others. Ornate candle holders relate Suleiman's conquest of Hungary, while giant caligraphy discs hung from the ceiling remind visitors for the first four caliphs who followed Muhammad. Though the building you see today still looks like a mosque, it is now a museum, a decision made in 1935 by Kemal Ataturk, the modernizing first president of Turkey following the Ottoman Empire's collapse. It was this secularization that allowed for removal of the carpets hiding the marble floor decorations and the plaster covering the Christian mosaics. Ongoing restoration work has allowed the multiplicity of voices in Hagia Sophia's long history to be heard again after centuries of silence. But conflict remains. Hidden mosaics cry out from beneath Islamic calligraphy, valuable pieces of history that cannot be uncovered without destroying others. Meanwhile, calls sound from both Muslim and Christian communities to return the building to its former religious purposes. The story of the divine wisdom may be far from over, but one can only hope that the many voices residing there will be able to tell their part for years to come.

**P106 2014-07-14 The many meanings of Michelangelo's Statue of David - James Earle**

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When we think of classic works of art, the most common setting we imagine them in is a museum. But what we often forget is that much of this art was not produced with a museum setting in mind. What happens to an artwork when it's taken out of its originally intended context? Take the example of Michelangelo's Statue of David, depicting the boy hero who slew the giant philistine, Goliath, armed with only his courage and his slingshot. When Michelangelo began carving a block of pure white marble to communicate this famous Biblical story, the city of Florence intended to place the finished product atop their grand cathedral. Not only would the 17 foot tall statue be easily visible at this height, but its placement alongside 11 other statues of Old Testament heroes towering over onlookers would have a powerful religious significance, forcing the viewer to stare in awe towards the heavens. But by the time Michelangelo had finished the work, in 1504, the plans for the other statues had fallen through, and the city realized that lifting such a large sculpture to the roof would be more difficult than they had thought. Furthermore, the statue was so detailed and lifelike, down to the bulging veins in David's arm and the determination on his face, that it seemed a shame to hide it so far from the viewer. A council of politicians and artists convened to decide on a new location for the statue. Ultimately voting to place it in front of the Palazzo della Signoria, the town hall and home of the new Republican government. This new location transformed the statue's meaning. The Medici family, who for generations had ruled the city through their control of banking, had recently been exiled, and Florence now saw itself as a free city, threatened on all sides by wealthy and powerful rivals. David, now the symbol of heroic resistance against overwhelming odds, was placed with his intense stare, now a look of stern warning, focused directly towards Rome, the home of Cardinal Giovanni de Medici. Though the statue itself had not been altered, its placement changed nearly every aspect of it from a religious to a political significance. Though a replica of David still appears at the Palazzo, the original statue was moved in 1873 to the Galleria dell'Accademia, where it remains today. In the orderly, quiet environment of the museum, alongside numerous half-finished Michelangelo sculptures, overt religious and political interpretations fall away, giving way to detached contemplation of Michelangelo's artistic and technical skill. But even here, the astute viewer may notice that David's head and hand appear disproportionately large, a reminder that they were made to be viewed from below. So, not only does context change the meaning and interpretation of an artwork throughout its history, sometimes it can make that history resurface in the most unexpected ways.

**P107 2014-07-15 How quantum mechanics explains global warming - Lieven Scheire**

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You've probably heard that carbon dioxide is warming the Earth, but how does it work? Is it like the glass of a greenhouse or like an insulating blanket? Well, not entirely. The answer involves a bit of quantum mechanics, but don't worry, we'll start with a rainbow. If you look closely at sunlight separated through a prism, you'll see dark gaps where bands of color went missing. Where did they go? Before reaching our eyes, different gases absorbed those specific parts of the spectrum. For example, oxygen gas snatched up some of the dark red light, and sodium grabbed two bands of yellow. But why do these gases absorb specific colors of light? This is where we enter the quantum realm. Every atom and molecule has a set number of possible energy levels for its electrons. To shift its electrons from the ground state to a higher level, a molecule needs to gain a certain amount of energy. No more, no less. It gets that energy from light, which comes in more energy levels than you could count. Light consists of tiny particles called photons and the amount of energy in each photon corresponds to its color. Red light has lower energy and longer wavelengths. Purple light has higher energy and shorter wavelengths. Sunlight offers all the photons of the rainbow, so a gas molecule can choose the photons that carry the exact amount of energy needed to shift the molecule to its next energy level. When this match is made, the photon disappers as the molecule gains its energy, and we get a small gap in our rainbow. If a photon carries too much or too little energy, the molecule has no choice but to let it fly past. This is why glass is transparent. The atoms in glass do not pair well with any of the energy levels in visible light, so the photons pass through. So, which photons does carbon dioxide prefer? Where is the black line in our rainbow that explains global warming? Well, it's not there. Carbon dioxide doesn't absorb light directly from the Sun. It absorbs light from a totally different celestial body. One that doesn't appear to be emitting light at all: Earth. If you're wondering why our planet doesn't seem to be glowing, it's because the Earth doesn't emit visible light. It emits infared light. The light that our eyes can see, including all of the colors of the rainbow, is just a small part of the larger spectrum of electromagnetic radiation, which includes radio waves, microwaves, infrared, ultraviolet, x-rays, and gamma rays. It may seem strange to think of these things as light, but there is no fundamental difference between visible light and other electromagnetic radiation. It's the same energy, but at a higher or lower level. In fact, it's a bit presumptuous to define the term visible light by our own limitations. After all, infrared light is visible to snakes, and ultraviolet light is visible to birds. If our eyes were adapted to see light of 1900 megahertz, then a mobile phone would be a flashlight, and a cell phone tower would look like a huge lantern. Earth emits infrared radiation because every object with a temperature above absolute zero will emit light. This is called thermal radiation. The hotter an object gets, the higher frequency the light it emits. When you heat a piece of iron, it will emit more and more frequencies of infrared light, and then, at a temperature of around 450 degrees Celsius, its light will reach the visible spectrum. At first, it will look red hot. And with even more heat, it will glow white with all of the frequencies of visible light. This is how traditional light bulbs were designed to work and why they're so wasteful. 95% of the light they emit is invisible to our eyes. It's wasted as heat. Earth's infrared radiation would escape to space if there weren't greenhouse gas molecules in our atmophere. Just as oxygen gas prefers the dark red photons, carbon dioxide and other greenhouse gases match with infrared photons. They provide the right amount of energy to shift the gas molecules into their higher energy level. Shortly after a carbon dioxide molecule absorbs an infrared photon, it will fall back to its previous energy level, and spit a photon back out in a random direction. Some of that energy then returns to Earth's surface, causing warming. The more carbon dioxide in the atmosphere, the more likely that infrared photons will land back on Earth and change our climate.

**P108 2014-07-16 What happens when you get heat stroke - Douglas J. Casa**

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In 1985, 16-year-old Douglas Casa, ran the championship 10,000 meter track race at the Empire State Games. Suddenly, with just 200 meters to go, he collapsed, got back up and then collapsed again on the final straightaway, with his body temperature at dangerous levels. He had suffered an exertional heat stroke. Fortunately, with immediate and proper treatment, he survived the potentially fatal episode and has since helped save 167 people in similar circumstances. From ancient soldiers on the battlefield to modern day warriors on the gridiron, exertional heat stroke, or sunstroke, has long been a serious concern. And unlike classical heat stroke, which affects vulnerable people such as infants and the elderly during heat waves, exertional heat stroke is caused by intense exercise in the heat, and is one of the top three killers of athletes and soldiers in training. When you exercise, nearly 80% of the energy you use is transformed into heat. In normal circumstances, this is what's known as compensable heat stress. And your body can dissipate the heat as quickly as it's generated through cooling methods like the evaporation of sweat. But with uncompensable heat stress, your body is unable to lose enough heat due to overexertion or high temperatures in humidity, which raises your core temperature beyond normal levels. This causes the proteins and cell membranes to denature, creating cells that no longer function properly and begin to leak their contents. If these leaky cells proliferate through the body, the results can be devastating. Including liver damage, blood clot formation in the kidneys, damage to the gastrointestinal tract and even the failure of vital organs. So how do you diagnose an exertional heat stroke? The main criterion is a core body temperature greater than 40 degrees Celsius observed along with physical symptoms such as increased heart rate, low blood pressure and rapid breathing or signs of central nervous system disfunction such as confused behavior, aggression or loss of consciousness. The most feasible and accurate way to assess core body temperature is with a rectal thermometer as other common temperature-taking methods are not accurate in these circumstances. As far as treatment goes, the most important thing to remember is cool first, transport second. Because the human body can withstand a core temperature above 40 degrees Celsius for about 30 minutes before cell damage sets in, it's essential to initiate rapid cooling on site in order to lower it as quickly as possible. After any athletic or protective gear has been removed from the victim, place them in an ice water tub while stirring the water and monitoring vitals continuously. If this is not possible, dousing in ice water and applying wet towels over the entire body can help. But before you start anything, emergency services should be called. As you wait, it's important to keep the victim calm while cooling as much surface area as possible until emergency personnel arrive. If medical staff are available on site, cooling should continue until a core temperature of 38.9 degrees Celsius is reached. The sun is known for giving life, but it can also take life away if we're not careful, even affecting the strongest among us. As Dr. JJ Levick wrote of exertional heat stroke in 1859, "It strikes down its victim with his full armor on. Youth, health and strength oppose no obstacle to its power." But although this condition is one of the top three leading causes of death in sports, it has been 100% survivable with proper care.

**P109 2014-07-17 Under the hood - The chemistry of cars - Cynthia Chubbuck**

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There are over one billion cars in the world today, getting people where they need to go, but cars aren't just a mode of transportation, they're also a chemistry lesson waiting to be taught. The process of starting your car begins in the engine cylinders, where a spritz of gasoline from the fuel injector and a gulp of air from the intake valve mix together before being ignited by a spark, forming gases that expand and push the piston. But combustion is an exothermic reaction, meaning it releases heat. Lots of it. And while much of this heat escapes through the tail pipe, the heat that remains in the engine block needs to be absorbed, transported, and dissipated to protect the metal components from deforming or even melting. This is where the cooling system comes in. A liquid gets circulated throughout the engine, but what kind of liquid can absorb all that heat? Water may seem like an obvious first choice. After all, its specific heat, the amount of energy required to raise the temperature of a given amount by one degree Celsius, is higher than that of any other common substance. And we have a lot of heat energy to absorb. But using water can get us into deep trouble. For one thing, its freezing point is zero degrees Celsius. Since water expands as it freezes, a cold winter night could mean a cracked radiator and a damaged engine block, a chilling prospect. And considering how hot car engines can get, the relatively low boiling point of 100 degrees Celsius can lead to a situation that would get anyone steamed. So, instead of water, we use a solution, a homogeneous mixture consisting of a solute and a solvent. Some of the solution's properties will differ depending on the proportion of solute present. These are called colligative properties, and as luck would have it, they include freezing point depression and boiling point elevation. So, solutions have both a lower freezing point and a higher boiling point than pure solvent, and the more solute is present, the bigger the difference. So, why do these properties change? First of all, we need to understand that temperature is a measure of the particle's average kinetic energy. The colder the liquid, the less of this energy there is, and the slower the molecules move. When a liquid freezes, the molecules slow down, enough for their attractive forces to act on each other, arranging themselves into a crystal structure. But the presence of solute particles gets in the way of these attractions, requiring a solution to be cooled down further before the arrangement can occur. As for the boiling point, when a liquid boils, it produces bubbles filled with its vapor, but for a bubble to form, the vapor pressure must become as strong as the atmosphere constantly pushing down on the surface of the liquid. As the liquid is heated, the vapor pressure increases, and when it becomes equal to the atmospheric pressure, the bubbles form and boiling occurs. A solution's vapor pressure is lower than that of pure solvent, so it must be heated to an even higher temperature before it can match the strength of the atmosphere. As an added bonus, the pressure in the radiator is kept above atmospheric pressure, raising the boiling point by another 25 degrees Celsius. The solution commonly used for a car's cooling system is a 50/50 mixture of ethylene glycol and water, which freezes at -37 degrees Celsius and boils at 106 degrees Celsius. At the highest recommended proportion of 70 to 30, the freezing point is even lower at -55 degrees Celsius, and the boiling point rises to 113 degrees Celsius. As you can see, the more ethylene glycol you add, the more protection you get, so why not go even higher? Well, it turns out you can have too much of a good thing because at higher proportions, the freezing point actually starts to go back up. The properties of the solution head towards the properties of ethylene glycol, which freezes at -12.9 degrees Celsius, a higher temperature than we attained with the solution. The solution flows through the engine, absorbing heat along the way. When it reaches the radiator, it's cooled by a fan, as well as air rushing through the front of the car before returning to the hot engine compartment. So, an effective and safe engine coolant must have a high specific heat, a low freezing point, and a high boiling point. But instead of searching all over the world for the perfect liquid to solve our problem, we can create our own solution.

**P110 2014-07-18 How playing an instrument benefits your brain - Anita Collins**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=110)

Did you know that every time musicians pick up their instruments, there are fireworks going off all over their brain? On the outside, they may look calm and focused, reading the music and making the precise and practiced movements required. But inside their brains, there's a party going on. How do we know this? Well, in the last few decades, neuroscientists have made enormous breakthroughs in understanding how our brains work by monitoring them in real time with instruments like fMRI and PET scanners. When people are hooked up to these machines, tasks, such as reading or doing math problems, each have corresponding areas of the brain where activity can be observed. But when researchers got the participants to listen to music, they saw fireworks. Multiple areas of their brains were lighting up at once, as they processed the sound, took it apart to understand elements like melody and rhythm, and then put it all back together into unified musical experience. And our brains do all this work in the split second between when we first hear the music and when our foot starts to tap along. But when scientists turned from observing the brains of music listeners to those of musicians, the little backyard fireworks became a jubilee. It turns out that while listening to music engages the brain in some pretty interesting activities, playing music is the brain's equivalent of a full-body workout. The neuroscientists saw multiple areas of the brain light up, simultaneously processing different information in intricate, interrelated, and astonishingly fast sequences. But what is it about making music that sets the brain alight? The research is still fairly new, but neuroscientists have a pretty good idea. Playing a musical instrument engages practically every area of the brain at once, especially the visual, auditory, and motor cortices. As with any other workout, disciplined, structured practice in playing music strengthens those brain functions, allowing us to apply that strength to other activities. The most obvious difference between listening to music and playing it is that the latter requires fine motor skills, which are controlled in both hemispheres of the brain. It also combines the linguistic and mathematical precision, in which the left hemisphere is more involved, with the novel and creative content that the right excels in. For these reasons, playing music has been found to increase the volume and activity in the brain's corpus callosum, the bridge between the two hemispheres, allowing messages to get across the brain faster and through more diverse routes. This may allow musicians to solve problems more effectively and creatively, in both academic and social settings. Because making music also involves crafting and understanding its emotional content and message, musicians often have higher levels of executive function, a category of interlinked tasks that includes planning, strategizing, and attention to detail and requires simultaneous analysis of both cognitive and emotional aspects. This ability also has an impact on how our memory systems work. And, indeed, musicians exhibit enhanced memory functions, creating, storing, and retrieving memories more quickly and efficiently. Studies have found that musicians appear to use their highly connected brains to give each memory multiple tags, such as a conceptual tag, an emotional tag, an audio tag, and a contextual tag, like a good Internet search engine. How do we know that all these benefits are unique to music, as opposed to, say, sports or painting? Or could it be that people who go into music were already smarter to begin with? Neuroscientists have explored these issues, but so far, they have found that the artistic and aesthetic aspects of learning to play a musical instrument are different from any other activity studied, including other arts. And several randomized studies of participants, who showed the same levels of cognitive function and neural processing at the start, found that those who were exposed to a period of music learning showed enhancement in multiple brain areas, compared to the others. This recent research about the mental benefits of playing music has advanced our understanding of mental function, revealing the inner rhythms and complex interplay that make up the amazing orchestra of our brain.

**P111 2014-07-18 What light can teach us about the universe - Pete Edwards**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=111)

How and when did our universe begin? How did it get to look like this? How will it end? Humans have been discussing these questions for as long as they've been around without ever reaching much agreement. Today, cosmologists are working hard to find the answers. But how can anyone hope to find concrete answers to such profound questions? And how is it possible to explore and study something as huge as the universe, most of which we'll never be able to reach? The answer is light. And although light from distant parts of the universe can take billions of years to reach us, it carries six unique messages that, when put together, can disclose an amazing amount of information to astronomers who know how to look for it. Just as sunlight can be split up into the familiar rainbow, splitting the light from distant objects exposes different patterns of colors depending on its source. This distinctive light barcode can reveal not only an object's composition, but also the temperature and pressure of its constituent parts. There's even more we can discover from light. If you've ever stood on a train platform, you might have noticed that the train sounds different depending on its direction with the pitch ascending when it approaches you and descending when it speeds away. But this isn't because the train conductor is practicing for a second career. Rather, it's because of something called the Doppler effect where sound waves generated by an approaching object are compressed, while those from a receding object are stretched. But what has this to do with astronomy? Sound does not travel through a vacuum. In space, no one can you hear you scream! But the same Doppler effect applies to light whose source is moving at exceptional speed. If it's moving towards us, the shorter wavelength will make the light appear to be bluer. While light from a source that's moving away will have a longer wavelength, shifting towards red. So by analyzing the color pattern in the Doppler shift of the light from any object observed with a telescope, we can learn what it's made of, how hot it is and how much pressure it's under, as well as whether it's moving, in what direction and how fast. And these six measurements, like six points of light, reveal the history of the universe. The first person to study the light from distant galaxies was Edwin Hubble, and the light he observed was redshifted. The distant galaxies were all moving away from us, and the further away the were, the faster they were receding. Hubble had discovered our universe is expanding, providing the first evidence for the Big Bang theory. Along with the idea that the visible universe has been constantly expanding from a densely packed single point, one of this theory's most important predictions is that the early universe consisted of just two gases: hydrogen and helium, in a ratio of three to one. And this prediction can also be tested with light. If we observe the light from a remote, quiet region of the universe and split it, we do indeed find the signatures of the two gases in just those proportions. Another triumph for the Big Bang. However, many puzzles remain. Although we know the visible universe is expanding, gravity should be applying the brakes. But recent measurements of light from distant dying stars show us that they're farther away than predicted. So the expansion of the universe is actually accelerating. Something appears to be pushing it, and many scientists believe that something is dark energy, making up over 2/3 of the universe and slowly tearing it apart. Our knowledge of the behavior of matter and the precision of our instruments means that simply observing distant stars can tell us more about the universe than we ever thought possible. But there are other mysteries, like the nature of dark energy upon which we have yet to shed light.

**P112 2014-07-18 What's hidden among the tallest trees on Earth - Wendell Oshiro**

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Some people can't see the forest for the trees, but before Stephen Sillett, no one could see or even imagine the forest in the trees. Stephen was an explorer of new worlds from the start. He spent his boyhood in Harrisburg, Pennsylvania reading Tolkien and playing Dungeons and Dragons with his brother Scott. But when the Sillett family visited their grandparent's cabin near Gettysburg, their grandmother Helen Poe Sillett, would take the boys into the nearby mountains and forests to bird-watch. They called Grandma Sillett Poe, and she taught the boys to identify songbirds, plants and even lichens, creatures that often look like splotches of carpet glued to the shady sides of rocks and tree trunks. Looking upwards, both boys found their callings. Scott became a research scientist specializing in migratory birds. Stephen was more interested in the trees. The tangle of branches and leaves attracted his curiosity. What could be hidden up there? By the time Stephen was in college, that curiosity pulled him skyward to the tallest trees on Earth: the ancient coast redwoods of Northern California. Rising from trunks up to 20 feet in diameter, redwoods can grow up to 380 feet, or 38 stories, over a 2,000 year lifetime. But no one had thought to investigate the crowns of these natural skyscrapers. Were there more than just branches up there? Stephen decided to find out firsthand. In 1987, Stephen, his brother Scott and his friend Marwood drove from Reed College in Oregon to Prairie Creek Redwoods State Park in Northern California. Deep inside the park, Stephen picked the tallest redwood he could find. Its lowest branches were almost 100 feet up, far beyond his reach. But he saw a younger, shorter redwood growing next to the target tree. With a running start, he leapt and grabbed the lowest branch, pulled himself up and scurried upwards. He was free climbing without ropes or a harness, one misstep meant death. But up he went, and when he reached the peak, he swayed and leapt across the gap of space onto a branch of the target tree and into a world never seen before. His buddy Marwood followed him up, and the two young men free climbed high into the redwood's crown. Stephen came across lichens like Grandma Poe had shown him as a boy. He noticed that the higher he went, the thicker the branches were, not the case with most trees. He found moist mats of soil many inches thick, made from fallen needles, bark, other plant debris and dust from the sky piled on the tops of the large branches. He even found reiterations: new redwood tree trunks growing out from the main trunk. The redwood had cloned itself. When Stephen reached the pinnacle, he rested on a platform of crisscrossing branches and needles. Growing in the soil mat was a huckleberry bush with ripe berries! He ate some and waited for his friend. Stephen had discovered a new world hundreds of feet above the ground. His climb led to more excursions, with safety equipment, thank goodness, up other ancient redwoods as he mapped and measured the architecture of branches and additional trunks in the canopy of an entire grove. Stephen became an expert in the ecology of the tallest trees on Earth and the rich diversity of life in their crowns, aerial ecosystems no one had imagined. There are ferns, fungi and epiphytic trees normally found at ground level like Douglas firs, hemlocks and tan oaks whose roots had taken hold in the rich wet soil mats. Invertebrates such as ants, bumblebees, mites, beetles, earthworms and aquatic crustacean copepods make their homes alongside flowering plants like rhododendrons, currant and elderberry bushes. Ospreys, spotted owls, and jays search the canopy for food. Even the marbled murrelet, a Pacific seabird, flies many miles from the ocean to nest there. Squirrels and voles peek out of penthouse burrows. And the top predator? The mighty wandering salamander! Sillett's research has changed how we think about tall trees, and bolstered the case for their conservation, not just as impressive individual organisms but as homes to countless other species. So when you look up into the branches and leaves of a tree, ask, "What else is up there?" A new world might be just out of reach. So leap for it.

**P113 2014-07-23 The history of the barometer (and how it works) - Asaf Bar-Yosef**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=113)

Aristotle famously said, "Nature fears of empty space" when he claimed that a true vacuum, a space devoid of matter, could not exist because the surrounding matter would immediately fill it. Fortunately, he turned out to be wrong. A vacuum is a key component of the barometer, an instrument for measuring air pressure. And because air pressure correlates to temperature and rapid shifts in it can contribute to hurricanes, tornadoes and other extreme weather events, a barometer is one of the most essential tools for weather forecasters and scientists alike. How does a barometer work, and how was it invented? Well, it took awhile. Because the theory of Aristotle and other ancient philosophers regarding the impossibility of a vacuum seemed to hold true in everyday life, few seriously thought to question it for nearly 2,000 years -- until necessity raised the issue. In the early 17th century, Italian miners faced a serious problem when they found that their pumps could not raise water more than 10.3 meters high. Some scientists at the time, including one Galileo Galilei, proposed that sucking air out of the pipe was what made water rise to replace the void. But that its force was limited and could lift no more than 10.3 meters of water. However, the idea of a vacuum existing at all was still considered controversial. And the excitement over Galileo's unorthodox theory, led Gasparo Berti to conduct a simple but brilliant experiment to demonstrate that it was possible. A long tube was filled with water and placed standing in a shallow pool with both ends plugged. The bottom end of the tube was then opened and water poured out into the basin until the level of the water remaining in the tube was 10.3 meters. With a gap remaining at the top, and no air having entered the tube, Berti had succeeded in directly creating a stable vacuum. But even though the possibility of a vacuum had been demonstrated, not everyone was satisfied with Galileo's idea that this empty void was exerting some mysterious yet finite force on the water. Evangelista Torricelli, Galileo's young pupil and friend, decided to look at the problem from a different angle. Instead of focusing on the empty space inside the tube, he asked himself, "What else could be influencing the water?" Because the only thing in contact with the water was the air surrounding the pool, he believed the pressure from this air could be the only thing preventing the water level in the tube from dropping further. He realized that the experiment was not only a tool to create a vacuum, but operated as a balance between the atmospheric pressure on the water outside the tube and the pressure from the water column inside the tube. The water level in the tube decreases until the two pressures are equal, which just happens to be when the water is at 10.3 meters. This idea was not easily accepted, as Galileo and others had traditionally thought that atmospheric air has no weight and exerts no pressure. Torricelli decided to repeat Berti's experiment with mercury instead of water. Because mercury was denser, it fell farther than the water and the mercury column stood only about 76 centimeters tall. Not only did this allow Torricelli to make the instrument much more compact, it supported his idea that weight was the deciding factor. A variation on the experiment used two tubes with one having a large bubble at the top. If Galileo's interpretation had been correct, the bigger vacuum in the second tube should have exerted more suction and lifted the mercury higher. But the level in both tubes was the same. The ultimate support for Torricelli's theory came via Blaise Pascal who had such a mercury tube taken up a mountain and showed that the mercury level dropped as the atmospheric pressure decreased with altitude. Mercury barometers based on Torricelli's original model remained one of the most common ways to measure atmospheric pressure until 2007 when restrictions on the use of mercury due to its toxicity led to them no longer being produced in Europe. Nevertheless, Torricelli's invention, born of the willingness to question long accepted dogmas about vacuums and the weight of air, is an outstanding example of how thinking outside of the box -- or the tube -- can have a heavy impact.

**P114 2014-07-24 The coelacanth - A living fossil of a fish - Erin Eastwood**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=114)

The dead coming back to life sounds scary. But for scientists, it can be a wonderful opportunity. Of course, we're not talking about zombies. Rather, this particular opportunity came in the unlikely form of large, slow-moving fish called the coelacanth. This oddity dates back 360 million years, and was believed to have died out during the same mass extinction event that wiped out the dinosaurs 65 million years ago. To biologists and paleontologists, this creature was a very old and fascinating but entirely extinct fish, forever fossilized. That is, until 1938 when Marjorie Courtenay-Latimer, a curator at a South African museum, came across a prehistoric looking, gleaming blue fish hauled up at the nearby docks. She had a hunch that this strange, 1.5 meter long specimen was important but couldn't preserve it in time to be studied and had it taxidermied. When she finally was able to reach J.L.B. Smith, a local fish expert, he was able to confirm, at first site, that the creature was indeed a coelacanth. But it was another 14 years before a live specimen was found in the Comoros Islands, allowing scientists to closely study a creature that had barely evolved in 300 million years. A living fossil. Decades later, a second species was found near Indonesia. The survival of creatures thought extinct for so long proved to be one of the biggest discoveries of the century. But the fact that the coelacanth came back from the dead isn't all that makes this fish so astounding. Even more intriguing is the fact that genetically and morphologically, the coelacanth has more in common with four-limbed vertebrates than almost any other fish, and its smaller genome is ideal for study. This makes the coelacanth a powerful link between aquatic and land vertebrates, a living record of their transition from water to land millions of years ago. The secret to this transition is in the fins. While the majority of ocean fish fall into the category of ray-finned fishes, coelacanths are part of a much smaller, evolutionarily distinct group with thicker fins known as lobe-finned fish. Six of the coelacanth's fins contain bones organized much like our limbs, with one bone connecting the fin to the body, another two connecting the bone to the tip of the fin, and several small, finger-like bones at the tip. Not only are those fins structured in pairs to move in a synchronized way, the coelacanth even shares the same genetic sequence that promotes limb development in land vertebrates. So although the coelacanth itself isn't a land-walker, its fins do resemble those of its close relatives who first hauled their bodies onto land with the help of these sturdy, flexible appendages, acting as an evolutionary bridge to the land lovers that followed. So that's how this prehistoric fish helps explain the evolutionary movement of vertebrates from water to land. Over millions of years, that transition led to the spread of all four-limbed animals, called tetrapods, like amphibians, birds, and even the mammals that are our ancestors. There's even another powerful clue in that unlike most fish, coelacanths don't lay eggs, instead giving birth to live, young pups, just like mammals. And this prehistoric fish will continue to provide us with fascinating information about the migration of vertebrates out of the ocean over 300 million years ago. A journey that ultimately drove our own evolution, survival and existence. Today the coelacanth remains the symbol of the wondrous mysteries that remain to be uncovered by science. With so much left to learn about this fish, the ocean depths and evolution itself, who knows what other well-kept secrets our future discoveries may bring to life!

**P115 2014-07-24 The nurdles' quest for ocean domination - Kim Preshoff**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=115)

Meet the nurdles. They may be tiny, look harmless, and sound like a bunch of cartoon characters, but don't be fooled. These little guys are plotting ocean domination. Nurdles are some of the planet's most pervasive pollutants, found in lakes, rivers, and oceans across the globe. The tiny factory-made pellets form the raw material for every plastic product we use. And each year, billions of pounds of nurdles are produced, melted, and molded into toys, bottles, buttons, bags, pens, shoes, toothbrushes, and beads. They are everywhere. And they come in many guises, multi-colored and many-shaped, they range in size from just a few millimeters to mere specks that are only visible through a microscope. But their real advantage in the quest for ocean domination is their incredible endurance, which allows them to persist in an environment for generations because their artificial makeup makes them unable to biodegrade. So, just as long as they don't get into the environment, we have nothing to worry about, right? The problem is nurdles have a crafty way of doing exactly this. Produced in several countries and shipped to plastic manufacturing plants the world over, nurdles often escape during the production process, carried by runoff to the coast or during shipping when they're mistakenly tipped into the waves. Once in the water, nurdles are swiftly carried by currents, ultimately winding up in huge circulating ocean systems called gyres, where they convene to plan their tactics. The Earth has five gyres that act as gathering points, but the headquarters of nurdle ocean domination are in the Pacific Ocean, where the comparative enormity of the gyre and the resulting concentration of pollution is so huge that it's known as The Great Pacific Garbage Patch. Here, nurdles have good company. This gyre draws in all kinds of pollution, but because they don't biodegrade, plastics dominate, and they come from other sources besides nurdles, too. You know those tiny beads you see in your face wash or your toothpaste? They're often made of plastic, and after you flush them down the drain, some also end up in this giant garbage patch, much to the delight of the nurdles, building up their plastic army there. And then there are the large pieces of unrecycled plastic litter, like bottles and carrier bags, transported by runoff from land to sea. Over time, these plastic chunks turn into a kind of nurdle, too, but one that's been worn down by the elements, not made in a factory. And as if they weren't threatening enough, the rough, pitted surfaces of these microplastics, the name we give to all those collective plastic bits, water-born chemicals stick, or adhere, to them, making them toxic. This gathering has grown so immense that the oceanic garbage patch can shift from around the size of Texas to something the size of the United States. But while this toxic tornado is circulating, the birds, fish, filter feeders, whales, and crustaceans around it are just going about their daily business, which means they're looking for food. Unfortunately for them, tiny bits of floating plastic look a lot like fish eggs and other enticing bits of food. But once ingested, microplastics have a very different and terrible habit of sticking around. Inside an animal's stomach, they not only damage its health with a cocktail of toxins they carry but can also lead to starvation because although nurdles may be ingested, they're never digested, tricking an animal into feeling like it's continually full and leading to its eventual death. When one organism consumes another, microplastics and their toxins are then passed up through the food chain. And that's how, bit by bit, nurdles accomplish their goal, growing ever more pervasive as they wipe out marine life and reshape the ocean's ecosystems. So, how to break this cycle? The best solution would be to take plastics out of the equation altogether. That'll take a lot of time but requires only small collective changes, like more recycling, replacing plastics with paper and glass, and ditching that toothpaste with the microbeads. If we accomplish these things, perhaps over time fewer and fewer nurdles will turn up at that giant garbage patch, their army of plastics will grow weaker, and they'll surrender the ocean to its true keepers once more.

**P116 2014-07-25 How do tornadoes form - James Spann**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=116)

They call me the tornado chaser. When the wind is up and conditions are right, I get in my car and follow violent storms. "Crazy," you say? Perhaps, but really I chase these sky beasts to learn about them. I want to share with you what I know. Tornadoes are rapidly rotating columns of air that form inside storms that connect with the ground via a funnel of cloud. When that happens, they tear across the Earth, posing a huge threat to life and property. Because of this, there's a great deal of research into these phenomena, but the truth is, there's still a lot we don't know about how tornadoes form. The conditions that may give rise to one tornado won't necessarily cause another. But we have learned a lot since people first started recording tornadoes, like how to recognize the signs when one is brewing in the sky. Are you coming along for the ride? Tornadoes begin with a thunderstorm but not just any thunderstorm. These are especially powerful, towering thunderstorms called supercells. Reaching up to over 50,000 feet, they bring high force winds, giant hailstones, sometimes flooding and great flashes of lightning, too. These are the kinds of storms that breed tornadoes, but only if there are also very specific conditions in place, clues that we can measure and look out for when we're trying to forecast a storm. Rising air is the first ingredient needed for a tornado to develop. Any storm is formed when condensation occurs, the byproducts of the clouds. Condensation releases heat, and heat becomes the energy that drives huge upward drafts of air. The more condensation and the bigger the storm clouds grow, the more powerful those updrafts become. In supercells, this rising airmass is particularly strong. As the air climbs, it can change direction and start to move more quickly. Finally, at the storm's base, if there is a lot of moisture, a huge cloud base develops, giving the tornado something to feed off later, if it gets that far. When all these things are in place, a vortex can develop enclosed by the storm, and forming a wide, tall tube of spinning air that then gets pulled upwards. We call this a mesocyclone. Outside, cool, dry, sinking air starts to wrap around the back of this mesocyclone, forming what's known as a rear flank downdraft. This unusual scenario creates a stark temperature difference between the air inside the mesocyclone, and the air outside, building up a level of instability that allows a tornado to thrive. Then, the mesocyclone's lower part becomes tighter, increasing the speed of the wind. If, and that's a big if, this funnel of air moves down into that large, moist cloud base at the bottom of the parent storm, it sucks it in and turns it into a rotating wall of cloud, forming a link between the storm that created it and the Earth. The second that tube of spinning cloud touches the ground, it becomes a tornado. Most are small and short-lived, producing winds of 65-110 miles per hour, but others can last for over an hour, producing 200 mile per hour winds. They are beautiful but terrifying, especially if you or your town is in its path. In that case, no one, not even tornado chasers like me, enjoy watching thing unfold. Just like everything, however, tornadoes do come to an end. When the temperature difference disappears and conditions grow more stable, or the moisture in the air dries up, the once fierce parent storm loses momentum and draws its tornado back inside. Even so, meteorologists and storm chasers like me will remain on the lookout, watching, always watching to see if the storm releases its long rope again.

**P117 2014-07-28 How do you know you exist - James Zucker**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=117)

How do you know you're real? It's an obvious question until you try to answer it, but let's take it seriously. How do you really know you exist? In his "Meditations on First Philosophy," René Descartes tried to answer that very question, demolishing all his preconceived notions and opinions to begin again from the foundations. All his knowledge had come from his sensory perceptions of the world. Same as you, right? You know you're watching this video with your eyes, hearing it with your ears. Your senses show you the world as it is. They aren't deceiving you, but sometimes they do. You might mistake a person far away for someone else, or you're sure you're about to catch a flyball, and it hits the ground in front of you. But come on, right here and now, you know what's right in front of you is real. Your eyes, your hands, your body: that's you. Only crazy people would deny that, and you know you're not crazy. Anyone who'd doubt that must be dreaming. Oh no, what if you're dreaming? Dreams feel real. You can believe you're swimming, flying or fighting off monsters with your bare hands, when your real body is lying in bed. No, no, no. When you're awake, you know you're awake. Ah! But when you aren't, you don't know you aren't, so you can't prove you aren't dreaming. Maybe the body you perceive yourself to have isn't really there. Maybe all of reality, even its abstract concepts, like time, shape, color and number are false, all just deceptions concocted by an evil genius! No, seriously. Descartes asks if you can disprove the idea that an evil genius demon has tricked you into believing reality is real. Perhaps this diabolical deceiver has duped you. The world, your perceptions of it, your very body. You can't disprove that they're all just made up, and how could you exist without them? You couldn't! So, you don't. Life is but a dream, and I bet you aren't row, row, rowing the boat merrily at all, are you? No, you're rowing it wearily like the duped, nonexistent doof you are/aren't. Do you find that convincing? Are you persuaded? If you aren't, good; if you are, even better, because by being persuaded, you would prove that you're a persuaded being. You can't be nothing if you think you're something, even if you think that something is nothing because no matter what you think, you're a thinking thing, or as Descartes put it, "I think, therefore I am," and so are you, really. (Airplane engine)

**P118 2014-07-31 What causes antibiotic resistance - Kevin Wu**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=118)

What if I told you there were trillions of tiny bacteria all around you? It's true. Microorganisms called bacteria were some of the first life forms to appear on Earth. Though they consist of only a single cell, their total biomass is greater than that of all plants and animals combined. And they live virtually everywhere: on the ground, in the water, on your kitchen table, on your skin, even inside you. Don't reach for the panic button just yet. Although you have 10 times more bacterial cells inside you than your body has human cells, many of these bacteria are harmless or even beneficial, helping digestion and immunity. But there are a few bad apples that can cause harmful infections, from minor inconveniences to deadly epidemics. Fortunately, there are amazing medicines designed to fight bacterial infections. Synthesized from chemicals or occurring naturally in things like mold, these antibiotics kill or neutralize bacteria by interrupting cell wall synthesis or interfering with vital processes like protein synthesis, all while leaving human cells unharmed. The deployment of antibiotics over the course of the 20th century has rendered many previously dangerous diseases easily treatable. But today, more and more of our antibiotics are becoming less effective. Did something go wrong to make them stop working? The problem is not with the antibiotics but the bacteria they were made to fight, and the reason lies in Darwin's theory of natural selection. Just like any other organisms, individual bacteria can undergo random mutations. Many of these mutations are harmful or useless, but every now and then, one comes along that gives its organism an edge in survival. And for a bacterium, a mutation making it resistant to a certain antibiotic gives quite the edge. As the non-resistant bacteria are killed off, which happens especially quickly in antibiotic-rich environments, like hospitals, there is more room and resources for the resistant ones to thrive, passing along only the mutated genes that help them do so. Reproduction isn't the only way to do this. Some can release their DNA upon death to be picked up by other bacteria, while others use a method called conjugation, connecting through pili to share their genes. Over time, the resistant genes proliferate, creating entire strains of resistant super bacteria. So how much time do we have before these superbugs take over? Well, in some bacteria, it's already happened. For instance, some strands of staphylococcus aureus, which causes everything from skin infections to pneumonia and sepsis, have developed into MRSA, becoming resistant to beta-lactam antibiotics, like penicillin, methicillin, and oxacillin. Thanks to a gene that replaces the protein beta-lactams normally target and bind to, MRSA can keep making its cell walls unimpeded. Other super bacteria, like salmonella, even sometimes produce enzymes like beta-lactams that break down antibiotic attackers before they can do any damage, and E. coli, a diverse group of bacteria that contains strains that cause diarrhea and kidney failure, can prevent the function of antibiotics, like quinolones, by actively booting any invaders that manage to enter the cell. But there is good news. Scientists are working to stay one step ahead of the bacteria, and although development of new antibiotics has slowed in recent years, the World Health Organization has made it a priority to develop novel treatments. Other scientists are investigating alternate solutions, such as phage therapy or using vaccines to prevent infections. Most importantly, curbing the excessive and unnecessary use of antibiotics, such as for minor infections that can resolve on their own, as well as changing medical practice to prevent hospital infections, can have a major impact by keeping more non-resistant bacteria alive as competition for resistant strains. In the war against super bacteria, deescalation may sometimes work better than an evolutionary arms race.

**P119 2014-08-04 The secret lives of baby fish - Amy McDermott**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=119)

What you're looking at isn't some weird x-ray. It's actually a baby yellow tang surgeonfish at two months old. And you thought your childhood was awkward. But here is the same fish as an adult, a beautiful inhabitant of the Indian and Pacific Oceans' coral reefs and one of the most popular captive fish for salt water aquariums. Of the 27,000 known fish species, over a quarter live on coral reefs that make up less than 1% of the Earth's surface. But prior to settling down in this diverse tropical environment, baby coral reef fish face the difficult process of growing up on their own, undergoing drastic changes, and the journey of a lifetime before they find that reef to call home. The life cycle for most of these fish begins when their parents spew sperm and eggs into the water column. This can happen daily, seasonally, or yearly depending on the species, generally following lunar or seasonal tidal patterns. Left to their fate, the fertilized eggs drift with the currents, and millions of baby larvae hatch into the world. When they first emerge, the larvae are tiny and vulnerable. Some don't even have gills yet and must absorb oxygen directly from the water through their tissue-thin skin. They may float in the water column anywhere from minutes to months, sometimes drifting thousands of miles across vast oceans, far from the reefs where they were born. Along the way, they must successfully avoid predators, obtain food, and ride the right currents to find their way to a suitable adult habitat, which might as well be a needle in vast haystack of ocean. So, how did they accomplish this feat? Until recently, marine biologists thought of larval fish as largely passive drifters, dispersed by ocean currents to distant locales. But in the last 20 years, new research has suggested that larvae may not be as helpless as they seem, and are capable of taking their fate in their own fins to maximize their chances of survival. The larvae of many species are unexpectedly strong swimmers, and can move vertically in the water column to place themselves in different water masses and preferentially ride certain currents. These fish may be choosing the best routes to their eventual homes. When searching for these homes, evidence suggests that larvae navigate via a complex suite of sensory systems, detecting both sound and smell. Odor, in particular, allows larvae to distinguish between different environments, even adjacent reefs, helping guide them toward their preferred adult habitats. Many will head for far-flung locales miles away from their birth place. But some will use smell and other sensory cues to navigate back to the reefs where they were born, even if they remain in the larval stage for months. So, what happens when larvae do find a suitable coral reef? Do they risk it all in one jump from the water column, hoping to land in exactly the right spot to settle down and metamorphose into adults? Not exactly. Instead, larvae appear to have more of a bungee system. Larvae will drop down in the water column to check out a reef below. If conditions aren't right, they can jump back up into higher water masses and ride on, chancing that the next reef they find will be a better fit. But this is the point where our knowledge ends. We don't know the geographic movements of individual larva for most species. Nor do we know which exact environmental cues and behaviors they use to navigate to the reefs they will call home. But we do know that these tiny trekkers are more than the fragile and helpless creatures science once believed them to be. The secret lives of baby fish remain largely mysterious to us, unknown adventures waiting to be told.

**P120 2014-08-05 What happens when you remove the hippocampus - Sam Kean**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=120)

On September 1st, 1953, William Scoville used a hand crank and a cheap drill saw to bore into a young man's skull, cutting away vital pieces of his brain and sucking them out through a metal tube. But this wasn't a scene from a horror film or a gruesome police report. Dr. Scoville was one of the most renowned neurosurgeons of his time, and the young man was Henry Molaison, the famous patient known as "H.M.", whose case provided amazing insights into how our brains work. As a boy, Henry had cracked his skull in an accident and soon began having seizures, blacking out and losing control of bodily functions. After enduring years of frequent episodes, and even dropping out of high school, the desperate young man had turned to Dr. Scoville, a daredevil known for risky surgeries. Partial lobotomies had been used for decades to treat mental patients based on the notion that mental functions were strictly localized to corresponding brain areas. Having successfully used them to reduce seizures in psychotics, Scoville decided to remove H.M.'s hippocampus, a part of the limbic system that was associated with emotion but whose function was unknown. At first glance, the operation had succeeded. H.M.'s seizures virtually disappeared, with no change in personality, and his IQ even improved. But there was one problem: His memory was shot. Besides losing most of his memories from the previous decade, H.M. was unable to form new ones, forgetting what day it was, repeating comments, and even eating multiple meals in a row. When Scoville informed another expert, Wilder Penfield, of the results, he sent a Ph.D student named Brenda Milner to study H.M. at his parents' home, where he now spent his days doing odd chores, and watching classic movies for the first time, over and over. What she discovered through a series of tests and interviews didn't just contribute greatly to the study of memory. It redefined what memory even meant. One of Milner's findings shed light on the obvious fact that although H.M. couldn't form new memories, he still retained information long enough from moment to moment to finish a sentence or find the bathroom. When Milner gave him a random number, he managed to remember it for fifteen minutes by repeating it to himself constantly. But only five minutes later, he forgot the test had even taken place. Neuroscientists had though of memory as monolithic, all of it essentially the same and stored throughout the brain. Milner's results were not only the first clue for the now familiar distinction between short-term and long-term memory, but show that each uses different brain regions. We now know that memory formation involves several steps. After immediate sensory data is temporarily transcribed by neurons in the cortex, it travels to the hippocampus, where special proteins work to strengthen the cortical synaptic connections. If the experience was strong enough, or we recall it periodically in the first few days, the hippocampus then transfers the memory back to the cortex for permanent storage. H.M.'s mind could form the initial impressions, but without a hippocampus to perform this memory consolidation, they eroded, like messages scrawled in sand. But this was not the only memory distinction Milner found. In a now famous experiment, she asked H.M. to trace a third star in the narrow space between the outlines of two concentric ones while he could only see his paper and pencil through a mirror. Like anyone else performing such an awkward task for the first time, he did horribly. But surprisingly, he improved over repeated trials, even though he had no memory of previous attempts. His unconscious motor centers remembered what the conscious mind had forgotten. What Milner had discovered was that the declarative memory of names, dates and facts is different from the procedural memory of riding a bicycle or signing your name. And we now know that procedural memory relies more on the basal ganglia and cerebellum, structures that were intact in H.M.'s brain. This distinction between "knowing that" and "knowing how" has underpinned all memory research since. H.M. died at the age of 82 after a mostly peaceful life in a nursing home. Over the years, he had been examined by more than 100 neuroscientists, making his the most studied mind in history. Upon his death, his brain was preserved and scanned before being cut into over 2000 individual slices and photographed to form a digital map down to the level of individual neurons, all in a live broadcast watched by 400,000 people. Though H.M. spent most of his life forgetting things, he and his contributions to our understanding of memory will be remembered for generations to come.

**P121 2014-08-06 What can Schrödinger's cat teach us about quantum mechanics - Josh Sa**

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Consider throwing a ball straight into the air. Can you predict the motion of the ball after it leaves your hand? Sure, that's easy. The ball will move upward until it gets to some highest point, then it will come back down and land in your hand again. Of course, that's what happens, and you know this because you have witnessed events like this countless times. You've been observing the physics of everyday phenomena your entire life. But suppose we explore a question about the physics of atoms, like what does the motion of an electron around the nucleus of a hydrogen atom look like? Could we answer that question based on our experience with everyday physics? Definietly not. Why? Because the physics that governs the behavior of systems at such small scales is much different than the physics of the macroscopic objects you see around you all the time. The everyday world you know and love behaves according to the laws of classical mechanics. But systems on the scale of atoms behave according to the laws of quantum mechanics. This quantum world turns out to be a very strange place. An illustration of quantum strangeness is given by a famous thought experiment: Schrödinger's cat. A physicist, who doesn't particularly like cats, puts a cat in a box, along with a bomb that has a 50% chance of blowing up after the lid is closed. Until we reopen the lid, there is no way of knowing whether the bomb exploded or not, and thus, no way of knowing if the cat is alive or dead. In quantum physics, we could say that before our observation the cat was in a superposition state. It was neither alive nor dead but rather in a mixture of both possibilities, with a 50% chance for each. The same sort of thing happens to physical systems at quantum scales, like an electron orbiting in a hydrogen atom. The electron isn't really orbiting at all. It's sort of everywhere in space, all at once, with more of a probability of being at some places than others, and it's only after we measure its position that we can pinpoint where it is at that moment. A lot like how we didn't know whether the cat was alive or dead until we opened the box. This brings us to the strange and beautiful phenomenon of quantum entanglement. Suppose that instead of one cat in a box, we have two cats in two different boxes. If we repeat the Schrödinger's cat experiment with this pair of cats, the outcome of the experiment can be one of four possibilities. Either both cats will be alive, or both will be dead, or one will be alive and the other dead, or vice versa. The system of both cats is again in a superposition state, with each outcome having a 25% chance rather than 50%. But here's the cool thing: quantum mechanics tells us it's possible to erase the both cats alive and both cats dead outcomes from the superposition state. In other words, there can be a two cat system, such that the outcome will always be one cat alive and the other cat dead. The technical term for this is that the states of the cats are entangled. But there's something truly mindblowing about quantum entanglement. If you prepare the system of two cats in boxes in this entangled state, then move the boxes to opposite ends of the universe, the outcome of the experiment will still always be the same. One cat will always come out alive, and the other cat will always end up dead, even though which particular cat lives or dies is completely undetermined before we measure the outcome. How is this possible? How is it that the states of cats on opposite sides of the universe can be entangled in this way? They're too far away to communicate with each other in time, so how do the two bombs always conspire such that one blows up and the other doesn't? You might be thinking, "This is just some theoretical mumbo jumbo. This sort of thing can't happen in the real world." But it turns out that quantum entanglement has been confirmed in real world lab experiments. Two subatomic particles entangled in a superposition state, where if one spins one way then the other must spin the other way, will do just that, even when there's no way for information to pass from one particle to the other indicating which way to spin to obey the rules of entanglement. It's not surprising then that entanglement is at the core of quantum information science, a growing field studying how to use the laws of the strange quantum world in our macroscopic world, like in quantum cryptography, so spies can send secure messages to each other, or quantum computing, for cracking secret codes. Everyday physics may start to look a bit more like the strange quantum world. Quantum teleportation may even progress so far, that one day your cat will escape to a safer galaxy, where there are no physicists and no boxes.

**P122 2014-08-08 How optical illusions trick your brain - Nathan S. Jacobs**

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Check this out: Here's a grid, nothing special, just a basic grid, very grid-y. But look closer, into this white spot at the center where the two central vertical and horizontal lines intersect. Look very closely. Notice anything funny about this spot? Yeah, nothing. But keep looking. Get weird and stare at it. Now, keeping your gaze fixed on this white spot, check what's happening in your peripheral vision. The other spots, are they still white? Or do they show weird flashes of grey? Now look at this pan for baking muffins. Oh, sorry, one of the cups is inverted. It pops up instead of dipping down. Wait, no spin the pan. The other five are domed now? Whichever it is, this pan's defective. Here's a photo of Abraham Lincoln, and here's one upside down. Nothing weird going on here. Wait, turn that upside down one right side up. What have they done to Abe? Those are just three optical illusions, images that seem to trick us. How do they work? Are magical things happening in the images themselves? While we could certainly be sneaking flashes of grey into the peripheral white spots of our animated grid, first off, we promise we aren't. You'll see the same effect with a grid printed on a plain old piece of paper. In reality, this grid really is just a grid. But not to your brain's visual system. Here's how it interprets the light information you call this grid. The white intersections are surrounded by relatively more white on all four sides than any white point along a line segment. Your retinal ganglion cells notice that there is more white around the intersections because they are organized to increase contrast with lateral inhibition. Better contrast means it's easier to see the edge of something. And things are what your eyes and brain have evolved to see. Your retinal ganglion cells don't respond as much at the crossings because there is more lateral inhibition for more white spots nearby compared to the lines, which are surrounded by black. This isn't just a defect in your eyes; if you can see, then optical illusions can trick you with your glasses on or with this paper or computer screen right up in your face. What optical illusions show us is the way your photo receptors and brain assemble visual information into the three-dimensional world you see around you, where edges should get extra attention because things with edges can help you or kill you. Look at that muffin pan again. You know what causes confusion here? Your brain's visual cortex operates on assumptions about the lighting of this image. It expects light to come from a single source, shining down from above. And so these shading patterns could only have been caused by light shining down on the sloping sides of a dome, or the bottom of a hole. If we carefully recreate these clues by drawing shading patterns, even on a flat piece of paper, our brain reflexively creates the 3D concave or convex shape. Now for that creepy Lincoln upside down face. Faces trigger activity in areas of the brain that have specifically evolved to help us recognize faces. Like the fusiform face area and others in the occipital and temporal lobes. It makes sense, too, we're very social animals with highly complex ways of interacting with each other. When we see faces, we have to recognize they are faces and figure out what they're expressing very quickly. And what we focus on most are the eyes and mouth. That's how we figure out if someone is mad at us or wants to be our friend. In the upside down Lincoln face, the eyes and mouth were actually right side up, so you didn't notice anything was off. But when we flipped the whole image over, the most important parts of the face, the eyes and mouth, were now upside down, and you realized something fishy was up. You realized your brain had taken a short cut and missed something. But your brain wasn't really being lazy, it's just very busy. So it spends cognitive energy as efficiently as possible, using assumptions about visual information to create a tailored, edited vision of the world. Imagine your brain calling out these edits on the fly: "Okay, those squares could be objects. Let's enhance that black-white contrast on the sides with lateral inhibition. Darken those corners! Dark grey fading into light grey? Assume overhead sunlight falling on a sloping curve. Next! Those eyes look like most eyes I've seen before, nothing weird going on here." See? Our visual tricks have revealed your brain's job as a busy director of 3D animation in a studio inside your skull, allocating cognitive energy and constructing a world on the fly with tried and mostly -- but not always -- true tricks of its own.

**P123 2014-08-15 Feedback loops - How nature gets its rhythms - Anje-Margriet Neutel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=123)

Testing, testing, one, two, three. When your band is trying to perform, feedback is an annoying obstacle, but in the grand orchestra of nature, feedback is not only beneficial, it's what makes everything work. What exactly is feedback? The key element, whether in sound, the environment or social science, is a phenomenon called mutual causal interaction, where x affects y, y affects x, and so on, creating an ongoing process called a feedback loop. And the natural world is full of these mechanisms formed by the links between living and nonliving things that build resilience by governing the way populations and food webs respond to events. When plants die, the dead material enriches the soil with humus, a stable mass of organic matter, providing moisture and nutrients for other plants to grow. The more plants grow and die, the more humus is produced, allowing even more plants to grow, and so on. This is an example of positive feedback, an essential force in the buildup of ecosystems. But it's not called positive feedback because it's beneficial. Rather, it is positive because it amplifies a particular effect or change from previous conditions. These positive, or amplifying, loops can also be harmful, like when removing a forest makes it vulnerable to erosion, which removes organic matter and nutrients from the earth, leaving less plants to anchor the soil, and leading to more erosion. In contrast, negative feedback diminishes or counteracts changes in an ecosystem to maintain a more stable balance. Consider predators and their prey. When lynx eat snowshoe hares, they reduce their population, but this drop in the lynx's food source will soon cause their own population to decline, reducing the predation rate and allowing the hare population to increase again. The ongoing cycle creates an up and down wavelike pattern, maintaining a long-term equilibrium and allowing a food chain to persist over time. Feedback processes might seem counterintuitive because many of us are used to more predictable linear scenarios of cause and effect. For instance, it seems simple enough that spraying pesticides would help plants grow by killing pest insects, but it may trigger a host of other unexpected reactions. For example, if spraying pushes down the insect population, its predators will have less food. As their population dips, the reduced predation would allow the insect population to rise, counteracting the effects of our pesticides. Note that each feedback is the product of the links in the loop. Add one negative link and it will reverse the feedback force entirely, and one weak link will reduce the effect of the entire feedback considerably. Lose a link, and the whole loop is broken. But this is only a simple example, since natural communities consist not of separate food chains, but networks of interactions. Feedback loops will often be indirect, occurring through longer chains. A food web containing twenty populations can generate thousands of loops of up to twenty links in length. But instead of forming a disordered cacophany, feedback loops in ecological systems play together, creating regular patterns just like multiple instruments, coming together to create a complex but harmonious piece of music. Wide-ranging negative feedbacks keep the positive feedbacks in check, like drums maintaining a rhythm. You can look at the way a particular ecosystem functions within its unique habitat as representing its trademark sound. Ocean environments dominated by predator-prey interactions, and strong negative and positive loops stabilized by self-damping feedback, are powerful and loud, with many oscillations. Desert ecosystems, where the turn over of biomass is slow, and the weak feedbacks loops through dead matter are more like a constant drone. And the tropical rainforest, with its great diversity of species, high nutrient turnover, and strong feedbacks among both living and dead matter, is like a lush panoply of sounds. Despite their stabilizing effects, many of these habitats and their ecosystems develop and change over time, as do the harmonies they create. Deforestation may turn lush tropics into a barren patch, like a successful ensemble breaking up after losing its star performers. But an abandoned patch of farmland may also become a forest over time, like a garage band growing into a magnificent orchestra.

**P124 2014-08-15 The past, present and future of the bubonic plague - Sharon N. DeWitt**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=124)

Imagine if half the people in your neighborhood, your city, or even your whole country were wiped out. It might sound like something out of an apocalyptic horror film, but it actually happened in the 14th century during a disease outbreak known as the Black Death. Spreading from China through Asia, the Middle East, Africa and Europe, the devastating epidemic destroyed as much as 1/5 of the world's population, killing nearly 50% of Europeans in just four years. One of the most fascinating and puzzling things abut the Black Death is that the illness itself was not a new phenomenon but one that has affected humans for centuries. DNA analysis of bone and tooth samples from this period, as well as an earlier epidemic known as the Plague of Justinian in 541 CE, has revealed that both were caused by Yersinia pestis, the same bacterium that causes bubonic plague today. What this means is that the same disease caused by the same pathogen can behave and spread very differently throughout history. Even before the use of antibiotics, the deadliest oubreaks in modern times, such as the ones that occurred in early 20th century India, killed no more than 3% of the population. Modern instances of plague also tend to remain localized, or travel slowly, as they are spread by rodent fleas. But the medieval Black Death, which spread like wildfire, was most likely communicated directly from one person to another. And because genetic comparisons of ancient to modern strains of Yersinia pestis have not revealed any significantly functional genetic differences, the key to why the earlier outbreak was so much deadlier must lie not in the parasite but the host. For about 300 years during the High Middle Ages, a warmer climate and agricultural improvements had led to explosive population growth throughout Europe. But with so many new mouths to feed, the end of this warm period spelled disaster. High fertility rates combined with reduced harvest, meant the land could no longer support its population, while the abundant supply of labor kept wages low. As a result, most Europeans in the early 14th century experienced a steady decline in living standards, marked by famine, poverty and poor health, leaving them vulnerable to infection. And indeed, the skeletal remains of Black Death victims found in London show telltale signs of malnutrition and prior illness. The destruction caused by the Black Death changed humanity in two important ways. On a societal level, the rapid loss of population led to important changes in Europe's economic conditions. With more food to go around, as well as more land and better pay for the surviving farmers and workers, people began to eat better and live longer as studies of London cemeteries have shown. Higher living standards also brought an increase in social mobility, weakening feudalism, and eventually leading to political reforms. But the plague also had an important biological impact. The sudden death of so many of the most frail and vulnerable people left behind a population with a significantly different gene pool, including genes that may have helped survivors resist the disease. And because such mutations often confer immunities to multiple pathogens that work in similar ways, research to discover the genetic consequences of the Black Death has the potential to be hugely beneficial. Today, the threat of an epidemic on the scale of the Black Death has been largely eliminated thanks to antibiotics. But the bubonic plague continues to kill a few thousand people worldwide every year, and the recent emergence of a drug-resistant strain threatens the return of darker times. Learning more about the causes and effects of the Black Death is important, not just for understanding how our world has been shaped by the past. It may also help save us from a similar nightmare in the future.

**P125 2014-08-15 Why we love repetition in music - Elizabeth Hellmuth Margulis**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=125)

How many times does the chorus repeat in your favorite song? And, take a moment to think, how many times have you listened to it? Chances are you've heard that chorus repeated dozens, if not hundreds, of times, and it's not just popular songs in the West that repeat a lot. Repetition is a feature that music from cultures around the world tends to share. So, why does music rely so heavily on repetition? One part of the answer come from what psychologists call the mere-exposure effect. In short, people tend to prefer things they've been exposed to before. For example, a song comes on the radio that we don't particularly like, but then we hear the song at the grocery store, at the movie theater and again on the street corner. Soon, we are tapping to the beat, singing the words, even downloading the track. This mere-exposure effect doesn't just work for songs. It also works for everything from shapes to Super Bowl ads. So, what makes repetition so uniquely prevalent in music? To investigate, psychologists asked people to listen to musical compositions that avoided exact repetition. They heard excerpts from these pieces in either their original form, or in a version that had been digitally altered to include repetition. Although the original versions had been composed by some of the most respected 20th century composers, and the repetitive versions had been assembled by brute force audio editing, people rated the repetitive versions as more enjoyable, more interesting and more likely to have been composed by a human artist. Musical repetition is deeply compelling. Think about the Muppets classic, "Mahna Mahna." If you've heard it before, it's almost impossible after I sing, "Mahna mahna," not to respond, "Do doo do do do." Repetition connects each bit of music irresistibly to the next bit of music that follows it. So when you hear a few notes, you're already imagining what's coming next. Your mind is unconsciously singing along, and without noticing, you might start humming out loud. Recent studies have shown that when people hear a segment of music repeated, they are more likely to move or tap along to it. Repetition invites us into music as imagined participants, rather than as passive listeners. Research has also shown that listeners shift their attention across musical repetitions, focusing on different aspects of the sound on each new listen. You might notice the melody of a phrase the first time, but when it's repeated, your attention shifts to how the guitarist bends a pitch. This also occurs in language, with something called semantic satiation. Repeating a word like atlas ad nauseam can make you stop thinking about what the word means, and instead focus on the sounds: the odd way the "L" follows the "T." In this way, repetition can open up new worlds of sound not accessible on first hearing. The "L" following the "T" might not be aesthetically relevant to "atlas," but the guitarist pitch bending might be of critical expressive importance. The speech to song illusion captures how simply repeating a sentence a number of times shifts listeners attention to the pitch and temporal aspects of the sound, so that the repeated spoken language actually begins to sound like it is being sung. A similar effect happens with random sequences of sound. People will rate random sequences they've heard on repeated loop as more musical than a random sequence they've only heard once. Repetition gives rise to a kind of orientation to sound that we think of as distinctively musical, where we're listening along with the sound, engaging imaginatively with the note about to happen. This mode of listening ties in with our susceptibility to musical ear worms, where segments of music burrow into our head, and play again and again, as if stuck on repeat. Critics are often embarrassed by music's repetitiveness, finding it childish or regressive, but repetition, far from an embarrassment, is actually a key feature that gives rise to the kind of experience we think about as musical.

**P126 2014-08-25 Why do we pass gas - Purna Kashyap**

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Flatulence, or passing gas, is a normal daily phenomenon. Most individuals, yes, that includes you, will make anywhere from 500-1500 milliliters of gas and can pass gas ten to twenty times a day. But where does this bodily gas come from? A small proportion may come from ingesting air during sleep, or at other times, but the majority of gas is produced by bacteria in our intestines as they digest parts of food which we cannot. Our intestine is home to trillions of bacteria living in a symbiotic relationship with us. We provide them with a safe place to stay and food to eat. In exchange, they help us extract energy from our food, make vitamins for us, like vitamin B and K, boost our immune system, and play an important role in gastrointestinal barrier function, motility and the development of various organ systems. Clearly, it's in our best interest to keep these bacteria happy. Gut bacteria get their nutrition primarily from undigested food, such as carbohydrates and proteins, which come to the large intestine. They ferment this undigested food to produce a wide range of compounds, such as short-chain fatty acids and, of course, gases. Hydrogen and carbon dioxide are the most common gaseous products of bacterial fermentation, and are odorless. Some people also produce methane due to specific microbes present in their gut. But methane is actually odorless, too. Well then, what stinks? The foul smell is usually due to volatile sulfur compounds, such as hydrogen sulfide and methanethiol, or methyl mercaptan. These gases, however, constitute less than 1% of volume, and are often seen with ingestion of amino acids containing sulfur, which may explain the foul smell of gas from certain high protein diets. Increased passage of gas is commonly noticed after eating foods with high amounts of indigestible carbohydrates, like beans, lentils, dairy products, onions, garlic, leeks, radishes, potatoes, oats, wheat, cauliflower, broccoli, cabbage, and brussel sprouts. Humans lack the enzymes, so the bacteria able to ferment complex carbohydrates take over, and this naturally leads to more gas than usual. But if you feel uncomfortable, bloated or visibly distended, this may indicate impaired movement of gas along the gastrointestinal track. It's important not to just blame certain foods for gas and bloating and then avoid them. You don't want to starve the bacteria that digest these complex carbohydrates, or they'll have to start eating the sugars in the mucus lining of your intestines. Your personal gas will vary based on what you eat, and what bacteria are in your gut. For example, from the same starting sugar, the bacteria clostridium produces carbon dioxide, butyrate and hydrogen, while propionibacterium can produce carbon dioxide, propionate and acetate. At the same time, methanogens can use hydrogen and carbon dioxide produced by other bacteria to generate methane, which can reduce the total volume of gas by using up hydrogen and carbon dioxide. So there's a complex web among intestinal bacteria allowing them to flourish by either directly consuming undigested food, or using what other bacteria produce. This interaction largely determines the amount and type of gas produced, so gas production is a sign that your gut bacteria are at work. But in some instances, people may develop abnormal increased flatulence. A common example is lactose intolerance. Most individuals have the enzyme for breaking down lactose, a sugar present in milk and milk-derived products. But some people either lack it entirely, or have a reduced amount, such as after a gastrointestinal infection, so they're unable to digest lactose products and may experience cramping, along with increased flatulence due to bacterial fermentation. But remember, most gas is produced as a natural result of bacterial fermentation in the intestine, and indicates healthy functioning of the gut. The amount and type can vary based on your diet and the bacteria in your intestine. Exercise social courtesy while passing gas, and do try to forgive your bacteria. They're only trying to be helpful.

**P127 2014-08-27 What did dogs teach humans about diabetes - Duncan C. Ferguson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=127)

Diabetes mellitus has been a scourge of the developed world with an estimated 400,000,000 people worldwide suffering from this disease, and 50% more predicted within twenty years. Its early symptoms, which include increased thirst and large volumes of urine, were recognized as far back as 1500 BCE in Egypt. While the term diabetes, meaning "to pass through," was first used in 250 BCE by the Greek physician Apollonius of Memphis, Type 1 and Type 2 diabetes, associated respectively with youth and obesity, were identified as separate conditions by Indian physicians somewhere in the 5th century CE. But despite the disease being known, a diagnosis of diabetes in a human patient would remain tantamount to a death sentence until the early 20th century, its causes unknown. What changed this dire situation was the help of humanity's longtime animal partner: Canis lupus familiaris, domesticated from Grey wolves thousands of years ago. In 1890, the German scientists Von Mering and Minkowski demonstrated that removing a dog's pancreas caused it to develop all the signs of diabetes, thus establishing the organ's central role in the disease. But the exact mechanism by which this occurred remained a mystery until 1920, when a young Canadian surgeon named Frederick Banting and his student, Charles Best, advanced the findings of their German colleagues. Working under Professor Macleod at the University of Toronto, they confirmed that the pancreas was responsible for regulating blood glucose, successfully treating diabetic dogs by injecting them with an extract they had prepared from pancreas tissue. By 1922, the researchers working with biochemist James Collip were able to develop a similar extract from beef pancreas to first treat a 14-year-old diabetic boy, followed by six additional patients. The manufacturing process for this extract, now known as insulin, was eventually turned over to a pharmaceutical company that makes different types of injectable insulin to this day. Banting and Macleod received the Nobel Prize for Medicine in 1923 for their discovery. But Banting chose to share his portion with Charles Best, for his help in the initial studies involving dogs. But while medical experimentation on animals remains controversial, in this case at least, it was not just a matter of exploiting dogs for human needs. Dogs develop diabetes at the rate of two cases per 1,000 dogs, almost the same as that of humans under 20. Most canine cases are of Type 1 diabetes, similar to the type that young children develop following immune system destruction of the pancreas, and genetic studies have shown that the dog disease has many similar hallmarks of the human disease. This has allowed veterinarians to turn the tables, successfully using insulin to treat diabetes in man's best friend for over 60 years. Many dog owners commit to managing their dogs' diabetes with insulin injected twice daily, regimented feedings, and periodic blood measurements using the same home-testing glucose monitors used by human patients. And if the purified pig insulin commonly used for dogs fails to work for a particular dog, the vet may even turn to a formulation of human insulin, bringing the process full circle. After all that dogs have done for us throughout the ages, including their role in a medical discovery that has saved countless human lives, using that same knowledge to help them is the least we could do.

**P128 2014-08-28 The chemistry of cold packs - John Pollard**

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So you just strained a muscle and the inflammation is unbearable. You wish you had something ice-cold to dull the pain, but to use an ice pack, you would have had to put it in the freezer hours ago. Fortunately, there's another option. A cold pack can be left at room temperature until the moment you need it, then just snap it as instructed and within seconds you'll feel the chill. But how can something go from room temperature to near freezing in such a short time? The answer lies in chemistry. Your cold pack contains water and a solid compound, usually ammonium nitrate, in different compartments separated by a barrier. When the barrier is broken, the solid dissolves causing what's known as an endothermic reaction, one that absorbs heat from its surroundings. To understand how this works, we need to look at the two driving forces behind chemical processes: energetics and entropy. These determine whether a change occurs in a system and how energy flows if it does. In chemistry, energetics deals with the attractive and repulsive forces between particles at the molecular level. This scale is so small that there are more water molecules in a single glass than there are known stars in the universe. And all of these trillions of molecules are constantly moving, vibrating and rotating at different rates. We can think of temperature as a measurement of the average motion, or kinetic energy, of all these particles, with an increase in movement meaning an increase in temperature, and vice versa. The flow of heat in any chemical transformation depends on the relative strength of particle interactions in each of a substance's chemical states. When particles have a strong mutual attractive force, they move rapidly towards one another, until they get so close, that repulsive forces push them away. If the initial attraction was strong enough, the particles will keep vibrating back and forth in this way. The stronger the attraction, the faster their movement, and since heat is essentially motion, when a substance changes to a state in which these interactions are stronger, the system heats up. But our cold packs do the opposite, which means that when the solid dissolves in the water, the new interactions of solid particles and water molecules with each other are weaker than the separate interactions that existed before. This makes both types of particles slow down on average, cooling the whole solution. But why would a substance change to a state where the interactions were weaker? Wouldn't the stronger preexisting interactions keep the solid from dissolving? This is where entropy comes in. Entropy basically describes how objects and energy are distributed based on random motion. If you think of the air in a room, there are many different possible arrangements for the trillions of particles that compose it. Some of these will have all the oxygen molecules in one area, and all the nitrogen molecules in another. But far more will have them mixed together, which is why air is always found in this state. Now, if there are strong attractive forces between particles, the probability of some configurations can change even to the point where the odds don't favor certain substances mixing. Oil and water not mixing is an example. But in the case of the ammonium nitrate, or other substance in your cold pack, the attractive forces are not strong enough to change the odds, and random motion makes the particles composing the solid separate by dissolving into the water and never returning to their solid state. To put it simply, your cold pack gets cold because random motion creates more configurations where the solid and water mix together and all of these have even weaker particle interaction, less overall particle movement, and less heat than there was inside the unused pack. So while the disorder that can result from entropy may have caused your injury in the first place, its also responsible for that comforting cold that soothes your pain.

**P129 2014-08-29 Corruption, wealth and beauty - The history of the Venetian gondola -**

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If I say, "Venice," do you imagine yourself gliding down the Grand Canal, serenaded by a gondolier? There's no doubt that the gondola is a symbol of Venice, Italy, but how did this curious banana-shaped black boat get its distinctive look? The origins of the Venetian gondola are lost to history, but by the 1500s, some 10,000 gondolas transported dignitaries, merchants and goods through the city's canals. In fact, Venice teemed with many types of handmade boats, from utilitarian rafts to the Doge's own ostentatious gilded barge. Like a modern day taxi system, gondolas were leased to boatmen who made the rounds of the city's ferry stations. Passengers paid a fare to be carried from one side of the Grand Canal to the other, as well as to other points around the city. But gondoliers soon developed a bad rap. Historical documents describe numerous infractions involving boatmen, including cursing, gambling, extorting passengers -- even occasional acts of violence. To minimize the unpredictability of canal travel, Venetian citizens who could afford it purchased their own gondolas, just as a celebirty might use a private car and driver today. These wealthy Venetians hired two private gondoliers to ferry them around the city and maintain their boats. The gondolas soon became a status symbol, much like an expensive car, with custom fittings, carved and gilded ornamentation, and seasonal fabrics, like silk and velvet. However, the majority of gondolas seen today are black because in 1562, Venetian authorities decreed that all but ceremonial gondolas be painted black in order to avoid sinfully extravagant displays. Apparently, Venetian authorities did not believe in "pimping their rides." Still, some wealthy Venetians chose to pay the fines in order to maintain their ornamental gondolas, a small price to keep up appearances. The distinctive look of the gondola developed over many centuries. Each gondola was constructed in a family boatyard called a squero. From their fathers and grandfathers, sons learned how to select and season pieces of beech, cherry, elm, fir, larch, lime, mahogany, oak and walnut. The gondola makers began with a wooden template that may have been hammered into the workshop floor generations earlier. From this basic form, they attached fore and aft sterns, then formed the longitudinal planks and ribs that made up the frame of a boat designed to glide through shallow, narrow canals. A gondola has no straight lines or edges. Its familiar profile was achieved through an impressive fire and water process that involved warping the boards with torches made of marsh reeds set ablaze. However, the majority of the 500 hours that went into building a gondola involved the final stages: preparing surfaces and applying successive coats of waterproof varnish. The varnish was a family recipe, as closely guarded as one for risotto or a homemade sauce. Yet even with the woodwork finished, the gondola was still not complete. Specialized artisans supplied their gondola-making colleagues with elaborate covered passenger compartments, upholstery and ornaments of steel and brass. Oar makers became integral partners to the gondola makers. The Venetian oarlock, or fórcola, began as a simple wooden fork, but evolved into a high-precision tool that allowed a gondolier to guide the oar into many positions. By the late 1800s, gondola makers began to make the left side of the gondola wider than the right as a counter balance to the force created by a single gondolier. This modification allowed rowers to steer from the right side only, and without lifting the oar from the water. While these modifications improved gondola travel, they were not enough to keep pace with motorized boats. Today, only about 400 gondolas glide through the waterways of Venice, and each year, fewer authentic gondolas are turned out by hand. But along the alleys, street signs contain words in Venetian dialect for the locations of old boatyards, oar makers and ferry stations, imprinting the memory of the boat-building trades that once kept life in the most serene republic gliding along at a steady clip.

**P130 2014-09-05 If matter falls down, does antimatter fall up - Chloé Malbrunot**

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"Hey, another atom. I'm hydrogen, nice to meet you. How are you feeling about the jump?" "Hi there, I'm antihydrogen, your antiatom, and to be honest, I'm feeling kind of neutral. My positron and antiproton balance out, just like your electron and proton, right?" "Hey, yeah! You look just like me, but different somehow." "Whoa, be careful! If we get too close, we'll disappear in a spark of energy. I'd like to stay in one piece." "Oh wow, sorry." "It's okay. I was just thinking, it's kind of weird for us to be chatting like this before our jump above CERN." "Why's that?" "Well, for starters, how do we know we'll both fall?" "Of course we'll fall. It's gravity, you know, the force of attraction between masses. I even know how fast we should fall. Galileo showed in that tower experiment that all falling objects accelerate at the same rate, regardless of mass." "That's for bigger objects. It's a different story for small particles like us. Our mass is so tiny that the gravitational force we experience is miniscule, and if the particles are charged, like my antiproton or your proton, then it becomes impossible to detect compared to the much greater electromagnetic force acting on them." "But that's only for charged particles. You and I are both neutral. Our charges balance out, so the electromagnetic force is small and the gravitational force should be detectable. I know mine's been measured." "Because you're everywhere, but I'm kind of hard to find." "Why is that, anyway? Shouldn't there have been an equal amount of matter and antimatter created in the Big Bang?" "You'd think so, but then all of those particles would have annihilated each other into energy, remember? And the Universe is obviously full of matter. No one knows why there is more matter than antimatter, which is why scientists are so interested in studying me." "So where do they find you anyway?" "Actually, I was made in that lab down there. They needed an accelerator to make my antiproton because it's so heavy, just as heavy as your proton. Getting my positron was easier. It's much lighter, like your electron, and there are materials that naturally decay by emitting one. Then they just had to put the two together and they got me. But it's only recently that they've been able to keep me around long enough to study my properties." "And now they've sent you on this jump with me. Hey, wait a minute." "That's right. We're reenacting Galileo's experiment, but with matter and antimatter instead of two objects made of matter." "So what's going to happen? Are you going to fall upwards or something?" "Only one way to find out!"

**P131 2014-09-06 How cosmic rays help us understand the universe - Veronica Bindi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=131)

How much can we really know about the universe beyond our galaxy? The Hubble Telescope has enabled us to see objects in space as far 13,000,000,000 light years away. But this still doesn't give us the answers to all our questions, questions like, "What is the universe made of?" "Which elements are the most abundant?" "Does space contain undiscovered forms of matter?" "Could there be antimatter stars or galaxies?" Some of these questions cannot be answered solely from visual images, but what if we had messengers bringing us physical data from distant parts of the cosmos, beyond the reach of explorers or satellites? In a way, we do, and these "space messengers" are called cosmic rays. Cosmic rays were first discovered in 1912 by Victor Hess when he set out to explore variations in the atmosphere's level of radiation, which had been thought to emanate from the Earth's crust. By taking measurements on board a flying balloon during an eclipse, Hess demonstrated both that the radiation actually increased at greater altitudes and that the sun could not be its source. The startling conclusion was that it wasn't coming from anywhere within the Earth's atmosphere but from outer space. Our universe is composed of many astronomical objects. BIllions of stars of all sizes, black holes, active galactic nuclei, astroids, planets and more. During violent disturbances, such as a large star exploding into a supernova, billions of particles are emitted into space. Although they are called rays, cosmic rays consist of these high energy particles rather than the photons that make up light rays. While the light from an explosion travels in a straight line at its famous constant speed, the particles are trapped in extraordinary loops by magnetic shockwaves generated by the explosion. Crossing back and forth through these magnetic field lines accelerates them to almost the speed of light before they escape. There are lots of cosmic rays in space, and some of these particles have traveled for billions of years before reaching Earth. When they enter our atmosphere, they collide with the molecules there, generating secondary cosmic rays, lighter particles with less energy than the original. Most of these are absorbed into the atmosphere, but some are able to reach the ground, even passing through our bodies. At sea level, this radiation is fairly low. But people who spend a lot of time at higher altitudes, such as airline crews, are exposed to much more. What makes cosmic rays useful as messengers is that they carry the traces of their origins. By studying the frequency with which different particles occur, scientists are able to determine the relative abundance of elements, such as hydrogen and helium, within the universe. But cosmic rays may provide even more fascinating information about the fabric of the universe itself. An experiment called the Alpha Magnetic Spectrometer, A.M.S., has recently been installed on board the International Space Station, containing several detectors that can separately measure a cosmic ray particle's velocity, trajectory, radiation, mass and energy, as well as whether the particle is matter or antimatter. While the two are normally indistinguishable, their opposite charges enable them to be detected with the help of a magnet. The Alpha Magnetic Spectrometer is currently measuring 50 million particles per day with information about each particle being sent in real time from the space station to the A.M.S. control room at CERN. Over the upcoming months and years, it's expected to yield both amazing and useful information about antimatter, the possible existence of dark matter, and even possible ways to mitigate the effects of cosmic radiation on space travel. As we stay tuned for new discoveries, look to the sky on a clear night, and you may see the International Space Station, where the Alpha Magnetic Spectrometer receives the tiny messengers that carry cosmic secrets.

**P132 2014-09-08 Making a TED-Ed Lesson - Bringing a pop-up book to life**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=132)

In this short video, we're going to show you how we constructed and animated a pop-up book to explain Earth's tectonic plates. The supercontinent Pangaea broke apart 200,000,000 years ago, but the pieces haven't stopped shifting. Although with animation we can show this movement easily with drawings, we thought it'd be more interesting to depict gigantic sliding slabs of rock using a tangible object that also moves and shifts. and the pop-up book idea was born. (music) To make your own pop-up book, you'll need some basic paper tools, such as scissors, an X-Acto knife, glue, double-sided Scotch tape, a ruler, a bone folder or other creasing tool, and, of course, some paper. For this lesson, we first determined the visual style by making illustrations and deciding on the overall design, colors, shapes and elements we wanted on each page, or spread. You can have more detailed illustrations, but we wanted to illustrate this lesson simply by playing with shapes and colors. When you visualize your pop-up and choose a visual style, you will want to make a bunch of good old pencil sketches on paper and plan each movement for each spread. Plan as much as you can: all the basic shapes and how they connect and how you want them to move, which parts you want to pop-up first. Challenge yourself, and explore multiple possibilities of how your main element on the spread can pop up. For the next step, make a mock-up spread and see if your masterful paper engineering ideas translate from a sketch to the actual prototype. Instead of using fancy paper, start with the cheap stuff and allow yourself to make mistakes and adjustments. This prototype lets you see how your preliminary sketches will come to life. You will want to first draw all individual parts on a single sheet, including all your main pieces, all the supporting pieces and the folds. You may be surprised that there are only two types of folds that can make your elements pop up the way you want: a step fold and a V-fold. Here, you can see how we used a step fold to make each layer of the Earth step out. Then, cut all your individual elements and assemble using glue or double-sided Scotch tape. (Music) Through trial and error, make sure that all the elements, shapes and placements are moving the way you imagined, and that they fold properly when closed and opened. (Music) Once your prototype is tested and complete, you can proceed to making the final product in color. Draw or paint on your main pop-up elements as you see fit. For this lesson, we decided to just play with simple shapes in different colors to create the world of shifting continents we imagined. (Music) When we were planning each spread, we knew we wanted some elements to move independently of the typical pop-up book using slight manipulations and animations. We had to plan well, but also use a few tricks. As always, when you're making stop-motion, you may have to be creative and use all sorts of unusual tools and props to achieve the effect that you want. In this shot, the birds had to fly across and off the edge of the book, so we used Fun-Tak to move the clouds across the page. Once they left the page, they had to be trimmed to get the illusion they flew off. When the pages of the book close at the end, we had to flip each page, supporting it in each position long enough to be photographed as an individual frame. We used binder clips, wedges, Fun-Tak, and almost every handy little thing you can think of. Once all the individual frames were photographed, we put them all together and composited to make our pop-up book look like it's moving on its own. So now, think of a special occasion where you can surprise someone with your own unique pop-up card, or an entire story that you want to tell, and start plotting the ins and outs of your pop-up book.

**P133 2014-09-09 Could comets be the source of life on Earth - Justin Dowd**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=133)

Humans have observed comets for thousands of years as their orbits have brought them within visible distance of Earth. Appearing throughout historical records, these mysterious lights that came out of nowhere and disappeared after a short while were thought to be ill omens of war and famine, or the wrath of gods. But recent research has revealed that comets may be even more deeply connected to humanity and our presence on Earth than any of these mythical explanations suggested. When you think of our Solar System, you probably imagine the nine, sorry eight, planets orbiting the Sun. But beyond Neptune, far from the heat of the Sun, there is a sparse ring found formed by icy chunks ranging from the size of marbles to that of small planets. And thousands of times farther at the outer reaches of the Solar System lies a spherical cloud of small fragments and gases. Many of these ancient clumps of stardust are leftovers from the formation of the Solar System 4.6 billion years ago, while some of the most distant may even come from a neighboring system. But sometimes the gravity from passing planets or stars pulls them toward our sun, beginning a journey that can take up to millions of years. As the frozen object travels further into the Solar System, the sun grows from a distant spark to an inferno, melting the ice for the first time in billions of years. Gas and steam eject dust into space, forming a bright surrounding cloud, called a coma, that can grow even larger than the sun itself. Meanwhile, the intense stream of high-energy particles constantly emitted by the Sun, known as the solar wind, blows particles away from the comet's core, forming a trail of debris up to millions of miles long. The ice, gas and dust reflect light glowing brightly. A comet is born, now orbiting the sun along with the rest of the objects in our Solar System. But as the comet travels through the Solar System, the solar wind tears apart and recombines molecules into various compounds. In some of the compounds that scientists found, first in the rubble left by a meteorite that disintegrated above northern Canada, and then in samples collected by a space craft from a passing comet's tail, were nothing less important than amino acids. Coming together to form proteins according to the instructs encoded in DNA, these are the main active components in all living cells, from bacteria to blue whales. If comets are where these building blocks of life were first formed, then they are the ultimate source of life on Earth, and, perhaps, some of the other places they visited as well. We know that planets orbit nearly every star in the night sky, with one in five having a planet similar to Earth in size and temperature. If Earth-like planets and the molecules found in DNA are not anomalies, we may be only one example of what's possible when a planet under the right conditions is seeded with organic molecules by a passing comet. So, rather than an omen of death, the comet that first brought amino acids to Earth could have been a portent of life, a prediction of a distant future, where creatures of stardust would return to space to find the mysteries of where they came from.

**P134 2014-09-11 The history of tattoos - Addison Anderson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=134)

Thinking of getting a tattoo? Decorating your birthday suit would add another personal story to a history of tattoos stretching back at least 8000 years. Tattooed mummies from around the world attest to the universality of body modification across the millennia, and to the fact that you really were stuck with it forever if your civilization never got around to inventing laser removal. A mummy from the Chinchorro culture in pre-Incan Peru has a mustache tattooed on his upper lip. Ötzi, mummified iceman of the Alps, has patterned charcoal tats along his spine, behind his knee and around his ankles, which might be from an early sort of acupuncture. The mummy of Amunet, a priestess in Middle Kingdom Egypt, features tattoos thought to symbolize sexuality and fertility. Even older than the mummies, figurines of seemingly tattooed people, and tools possibly used for tattooing date back tens of thousands of years. Tattoos don't have one historical origin point that we know of, but why do we English speakers call them all tattoos? The word is an anglophonic modification of "tatao," a Polynesian word used in Tahiti, where English captain James Cook landed in 1769 and encountered heavily tattooed men and women. Stories of Cook's findings and the tattoos his crew acquired cemented our usage of "tattoo" over previous words like "scarring," "painting," and "staining," and sparked a craze in Victorian English high society. We might think of Victorians having Victorian attitudes about such a risque thing, and you can find such sentiments, and even bans, on tattooing throughout history. But while publicly some Brits looked down their noses at tattoos, behind closed doors and away from their noses, lots of people had them. Reputedly, Queen Victoria had a tiger fighting a python, and tattoos became very popular among Cook's fellow soldiers, who used them to note their travels. You crossed the Atlantic? Get an anchor. Been south of the Equator? Time for your turtle tat. But Westerners sported tattoos long before meeting the Samoans and Maori of the South Pacific. Crusaders got the Jerusalem Cross so if they died in battle, they'd get a Christian burial. Roman soldiers on Hadrian's Wall had military tattoos and called the Picts beyond it "Picts," for the pictures painted on them. There's also a long tradition of people being tattooed unwillingly. Greeks and Romans tattooed slaves and mercenaries to discourage escape and desertion. Criminals in Japan were tattooed as such as far back as the 7th century. Most infamously, the Nazis tattooed numbers on the chest or arms of Jews and other prisoners at the Auschwitz concentration camp in order to identify stripped corpses. But tattoos forced on prisoners and outcasts can be redefined as people take ownership of that status or history. Primo Levi survived Auschwitz and wore short sleeves to Germany after the war to remind people of the crime his number represented. Today, some Holocaust survivors' descendants have their relatives numbers' tattooed on their arms. The Torah has rules against tattoos, but what if you want to make indelible what you feel should never be forgotten? And those criminals and outcasts of Japan, where tattooing was eventually outlawed from the mid-19th century to just after World War II, added decoration to their penal tattoos, with designs borrowed from woodblock prints, popular literature and mythical spirtual iconography. Yakuza gangs viewed their outsider tattoos as signs of lifelong loyalty and courage. After all, they lasted forever and it really hurt to get them. For the Maori, those tattoos were an accepted mainstream tradition. If you shied away from the excruciating chiseling in of your moko design, your unfinished tattoo marked your cowardice. Today, unless you go the traditional route, your tattoo artist will probably use a tattoo machine based on the one patented by Samuel O'Reilly in 1891, itself based on Thomas Edison's stencil machine from 1876. But with the incredibly broad history of tattoos giving you so many options, what are you going to get? This is a bold-lined expression of who you are, or you want to appear to be. As the naturalist aboard Cook's ship said of the tataoed Tahitians, "Everyone is marked, thus in different parts of his body, according maybe to his humor or different circumstances of his life." Maybe your particular humor and circumstances suggest getting a symbol of cultural heritage, a sign of spirituality, sexual energy, or good old-fashioned avant-garde defiance. A reminder of a great accomplishment, or of how you think it would look cool if Hulk Hogan rode a Rhino. It's your expression, your body, so it's your call. Just two rules: you have to find a tattooist who won't be ashamed to draw your idea, and when in doubt, you can never go wrong with "Mom."

**P135 2014-09-11 What is the Heisenberg Uncertainty Principle - Chad Orzel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=135)

The Heisenberg Uncertainty Principle is one of a handful of ideas from quantum physics to expand into general pop culture. It says that you can never simultaneously know the exact position and the exact speed of an object and shows up as a metaphor in everything from literary criticism to sports commentary. Uncertainty is often explained as a result of measurement, that the act of measuring an object's position changes its speed, or vice versa. The real origin is much deeper and more amazing. The Uncertainty Principle exists because everything in the universe behaves like both a particle and a wave at the same time. In quantum mechanics, the exact position and exact speed of an object have no meaning. To understand this, we need to think about what it means to behave like a particle or a wave. Particles, by definition, exist in a single place at any instant in time. We can represent this by a graph showing the probability of finding the object at a particular place, which looks like a spike, 100% at one specific position, and zero everywhere else. Waves, on the other hand, are disturbances spread out in space, like ripples covering the surface of a pond. We can clearly identify features of the wave pattern as a whole, most importantly, its wavelength, which is the distance between two neighboring peaks, or two neighboring valleys. But we can't assign it a single position. It has a good probability of being in lots of different places. Wavelength is essential for quantum physics because an object's wavelength is related to its momentum, mass times velocity. A fast-moving object has lots of momentum, which corresponds to a very short wavelength. A heavy object has lots of momentum even if it's not moving very fast, which again means a very short wavelength. This is why we don't notice the wave nature of everyday objects. If you toss a baseball up in the air, its wavelength is a billionth of a trillionth of a trillionth of a meter, far too tiny to ever detect. Small things, like atoms or electrons though, can have wavelengths big enough to measure in physics experiments. So, if we have a pure wave, we can measure its wavelength, and thus its momentum, but it has no position. We can know a particles position very well, but it doesn't have a wavelength, so we don't know its momentum. To get a particle with both position and momentum, we need to mix the two pictures to make a graph that has waves, but only in a small area. How can we do this? By combining waves with different wavelengths, which means giving our quantum object some possibility of having different momenta. When we add two waves, we find that there are places where the peaks line up, making a bigger wave, and other places where the peaks of one fill in the valleys of the other. The result has regions where we see waves separated by regions of nothing at all. If we add a third wave, the regions where the waves cancel out get bigger, a fourth and they get bigger still, with the wavier regions becoming narrower. If we keep adding waves, we can make a wave packet with a clear wavelength in one small region. That's a quantum object with both wave and particle nature, but to accomplish this, we had to lose certainty about both position and momentum. The positions isn't restricted to a single point. There's a good probability of finding it within some range of the center of the wave packet, and we made the wave packet by adding lots of waves, which means there's some probability of finding it with the momentum corresponding to any one of those. Both position and momentum are now uncertain, and the uncertainties are connected. If you want to reduce the position uncertainty by making a smaller wave packet, you need to add more waves, which means a bigger momentum uncertainty. If you want to know the momentum better, you need a bigger wave packet, which means a bigger position uncertainty. That's the Heisenberg Uncertainty Principle, first stated by German physicist Werner Heisenberg back in 1927. This uncertainty isn't a matter of measuring well or badly, but an inevitable result of combining particle and wave nature. The Uncertainty Principle isn't just a practical limit on measurment. It's a limit on what properties an object can have, built into the fundamental structure of the universe itself.

**P136 2014-09-11 Where do genes come from - Carl Zimmer**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=136)

You have about 20,000 genes in your DNA. They encode the molecules that make up your body, from the keratin in your toenails, to the collagen at the tip of your nose, to the dopamine surging around inside your brain. Other species have genes of their own. A spider has genes for spider silk. An oak tree has genes for chlorophyll, which turns sunlight into wood. So where did all those genes come from? It depends on the gene. Scientists suspect that life started on Earth about 4 billion years ago. The early life forms were primitive microbes with a basic set of genes for the basic tasks required to stay alive. They passed down those basic genes to their offspring through billions of generations. Some of them still do the same jobs in our cells today, like copying DNA. But none of those microbes had genes for spider silk or dopamine. There are a lot more genes on Earth today than there were back then. It turns out that a lot of those extra genes were born from mistakes. Each time a cell divides, it makes new copies of its DNA. Sometimes it accidentally copies the same stretch of DNA twice. In the process, it may make an extra copy of one of its genes. At first, the extra gene works the same as the original one. But over the generations, it may pick up new mutations. Those mutations may change how the new gene works, and that new gene may duplicate again. A surprising number of our mutated genes emerged more recently; many in just the past few million years. The youngest evolved after our own species broke off from our cousins, the apes. While it may take over a million years for a single gene to give rise to a whole family of genes, scientists are finding that once the new genes evolve, they can quickly take on essential functions. For example, we have hundreds of genes for the proteins in our noses that grab odor molecules. The mutations let them grab different molecules, giving us the power to perceive trillions of different smells. Sometimes mutations have a bigger effect on new copies of genes. They may cause a gene to make its protein in a different organ, or at a different time of life, or the protein may start doing a different job altogether. In snakes, for example, there's a gene that makes a protein for killing bacteria. Long ago, the gene duplicated and the new copy mutated. That mutation changed the signal in the gene about where it should make its protein. Instead of becoming active in the snake's pacreas, it started making this bacteria-killing protein in the snake's mouth. So when the snake bit its prey, this enzyme got into the animal's wound. And when this protein proved to have a harmful effect, and helped the snake catch more prey, it became favored. So now what was a gene in the pancreas makes a venom in the mouth that kills the snake's prey. And there are even more incredible ways to make a new gene. The DNA of animals and plants and other species contain huge stretches without any protein coding genes. As far as scientists can tell, its mostly random sequences of genetic gibberish that serve no function. These stretches of DNA sometimes mutate, just like genes do. Sometimes those mutations turn the DNA into a place where a cell can start reading it. Suddenly the cell is making a new protein. At first, the protein may be useless, or even harmful, but more mutations can change the shape of the protein. The protein may start doing something useful, something that makes an organism healthier, stronger, better able to reproduce. Scientists have found these new genes at work in many parts of animal bodies. So our 20,000 genes have many origins, from the origin of life, to new genes still coming into existence from scratch. As long as life is here on Earth, it will be making new genes.

**P137 2014-09-12 Cloudy climate change - How clouds affect Earth's temperature - Jaspe**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=137)

Cloudy climate change: How clouds affect Earth's temperature. Earth's average surface temperature has warmed by .8 Celsius since 1750. When carbon dioxide concentrations in the atmosphere have doubled, which is expected before the end of the 21st century, researchers project global temperatures will have risen by 1.5 to 4.5 degrees Celsius. If the increase is near the low end, 1.5 Celsius, then we're already halfway there, and we should be more able to adapt with some regions becoming drier and less productive, but others becoming warmer, wetter and more productive. On the other hand, a rise of 4.5 degrees Celsius would be similar in magnitude to the warming that's occurred since the last glacial maximum 22,000 years ago, when most of North America was under an ice sheet two kilometers thick. So that would represent a dramatic change of climate. So it's vitally important for scientists to predict the change in temperature with as much precision as possible so that society can plan for the future. The present range of uncertainty is simply too large to be confident of how best to respond to climate change. But this estimate of 1.5 to 4.5 Celsius for a doubling of carbon dioxide hasn't changed in 35 years. Why haven't we been able to narrow it down? The answer is that we don't yet understand aerosols and clouds well enough. But a new experiment at CERN is tackling the problem. In order to predict how the temperature will change, scientists need to know something called Earth's climate sensitivity, the temperature change in response to a radiative forcing. A radiative forcing is a temporary imbalance between the energy received from the Sun and the energy radiated back out to space, like the imbalance caused by an increase of greenhouse gases. To correct the imbalance, Earth warms up or cools down. We can determine Earth's climate sensitivity from the experiment that we've already performed in the industrial age since 1750 and then use this number to determine how much more it will warm for various projected radiative forcings in the 21st century. To do this, we need to know two things: First, the global temperature rise since 1750, and second, the radiative forcing of the present day climate relative to the pre-industrial climate. For the radiative forcings, we know that human activities have increased greenhouse gases in the atmosphere, which have warmed the planet. But our activities have at the same time increased the amount of aerosol particles in clouds, which have cooled the planet. Pre-industrial greenhouse gas concentrations are well measured from bubbles trapped in ice cores obtained in Greenland and Antarctica. So the greenhouse gas forcings are precisely known. But we have no way of directly measuring how cloudy it was in 1750. And that's the main source of uncertainty in Earth's climate sensitivity. To understand pre-industrial cloudiness, we must use computer models that reliably simulate the processes responsible for forming aerosols in clouds. Now to most people, aerosols are the thing that make your hair stick, but that's only one type of aerosol. Atmospheric aerosols are tiny liquid or solid particles suspended in the air. They are either primary, from dust, sea spray salt or burning biomass, or secondary, formed by gas to particle conversion in the atmosphere, also known as particle nucleation. Aerosols are everywhere in the atmosphere, and they can block out the sun in polluted urban environments, or bathe distant mountains in a blue haze. More importantly, a cloud droplet cannot form without an aerosol particle seed. So without aerosol particles, there'd be no clouds, and without clouds, there'd be no fresh water. The climate would be much hotter, and there would be no life. So we owe our existence to aerosol particles. However, despite their importance, how aerosol particles form in the atmosphere and their effect on clouds are poorly understood. Even the vapors responsible for aerosol particle formation are not well established because they're present in only minute amounts, near one molecule per million million molecules of air. This lack of understanding is the main reason for the large uncertainty in climate sensitivity, and the corresponding wide range of future climate projections. However, an experiment underway at CERN, named, perhaps unsurprisingly, "Cloud" has managed to build a steel vessel that's large enough and has a low enough contamination, that aerosol formation can, for the first time, be measured under tightly controlled atmospheric conditions in the laboratory. In its first five years of operation, Cloud has identified the vapors responsible for aerosol particle formation in the atmosphere, which include sulfuric acid, ammonia, amines, and biogenic vapors from trees. Using an ionizing particle beam from the CERN proton synchrotron, Cloud is also investigating if galactic cosmic rays enhance the formation of aerosols in clouds. This has been suggested as a possible unaccounted natural climate forcing agent since the flux of cosmic rays raining down on the atmosphere varies with solar activity. So Cloud is addressing two big questions: Firstly, how cloudy was the pre-industrial climate? And, hence, how much have clouds changed due to human activities? That knowledge will help sharpen climate projections in the 21st century. And secondly, could the puzzling observations of solar climate variability in the pre-industrial climate be explained by an influence of galactic cosmic rays on clouds? Ambitious but realistic goals when your head's in the clouds.

**P138 2014-09-12 Particles and waves - The central mystery of quantum mechanics - Chad**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=138)

One of the most amazing facts in physics is this: everything in the universe, from light to electrons to atoms, behaves like both a particle and a wave at the same time. All of the other weird stuff you might have heard about quantum physics, Schrodinger's Cat, God playing dice, spooky action at a distance, all of it follows directly from the fact that everything has both particle and wave nature. This might sound crazy. If you look around, you'll see waves in water and particles of rock, and they're nothing alike. So why would you think to combine them? Physicists didn't just decide to mash these things together out of no where. Rather, they were led to the dual nature of the universe through a process of small steps, fitting together lots of bits of evidence, like pieces in a puzzle. The first person to seriously suggest the dual nature of light was Albert Einstein in 1905, but he was picking up an earlier idea from Max Planck. Planck explained the colors of light emitted by hot objects, like the filament in a light bulb, but to do it, he needed a desperate trick: he said the object was made up of oscillators that could only emit light in discrete chunks, units of energy that depend on the frequency of the light. Planck was never really happy with this, but Einstein picked it up and ran with it. He applied Planck's idea to light itself, saying that light, which everybody knew was a wave, is really a stream of photons, each with a discrete amount of energy. Einstein himself called this the only truly revolutionary thing he did, but it explains the way light shining on a metal surface knocks loose electrons. Even people who hated the idea had to agree that it works brilliantly. The next puzzle piece came from Ernest Rutherford in England. In 1909, Ernest Marsden and Hans Geiger, working for Rutherford, shot alpha particles at gold atoms and were stunned to find that some bounced straight backwards. This showed that most of the mass of the atom is concentrated in a tiny nucleus. The cartoon atom you learn in grade school, with electrons orbiting like a miniature solar system, that's Rutherford's. There's one little problem with Rutherford's atom: it can't work. Classical physics tells us that an electron whipping around in a circle emits light, and we use this all the time to generate radio waves and X-rays. Rutherford's atoms should spray X-rays in all directions for a brief instant before the electron spirals in to crash into the nucleus. But Niels Bohr, a Danish theoretical physicist working with Rutherford, pointed out that atoms obviously exist, so maybe the rules of physics needed to change. Bohr proposed that an electron in certain special orbits doesn't emit any light at all. Atoms absorb and emit light only when electrons change orbits, and the frequency of the light depends on the energy difference in just the way Planck and Einstein introduced. Bohr's atom fixes Rutherford's problem and explains why atoms emit only very specific colors of light. Each element has its own special orbits, and thus its own unique set of frequencies. The Bohr model has one tiny problem: there's no reason for those orbits to be special. But Louis de Broglie, a French PhD student, brought everything full circle. He pointed out that if light, which everyone knew is a wave, behaves like a particle, maybe the electron, which everyone knew is a particle, behaves like a wave. And if electrons are waves, it's easy to explain Bohr's rule for picking out the special orbits. Once you have the idea that electrons behave like waves, you can go look for it. And within a few years, scientists in the US and UK had observed wave behavior from electrons. These days we have a wonderfully clear demonstration of this: shooting single electrons at a barrier with slits cut in it. Each electron is detected at a specific place at a specific time, like a particle. But when you repeat the experiment many times, all the individual electrons trace out a pattern of stripes, characteristic of wave behavior. The idea that particles behave like waves, and vice versa, is one of the strangest and most powerful in physics. Richard Feynman famously said that this illustrates the central mystery of quantum mechanics. Everything else follows from this, like pieces of a puzzle falling into place.

**P139 2014-09-15 Schrödinger's cat - A thought experiment in quantum mechanics - Chad**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=139)

Austrian physicist Erwin Schrödinger is one of the founders of quantum mechanics, but he's most famous for something he never actually did: a thought experiment involving a cat. He imagined taking a cat and placing it in a sealed box with a device that had a 50% chance of killing the cat in the next hour. At the end of that hour, he asked, "What is the state of the cat?" Common sense suggests that the cat is either alive or dead, but Schrödinger pointed out that according to quantum physics, at the instant before the box is opened, the cat is equal parts alive and dead, at the same time. It's only when the box is opened that we see a single definite state. Until then, the cat is a blur of probability, half one thing and half the other. This seems absurd, which was Schrödinger's point. He found quantum physics so philosophically disturbing, that he abandoned the theory he had helped make and turned to writing about biology. As absurd as it may seem, though, Schrödinger's cat is very real. In fact, it's essential. If it weren't possible for quantum objects to be in two states at once, the computer you're using to watch this couldn't exist. The quantum phenomenon of superposition is a consequence of the dual particle and wave nature of everything. In order for an object to have a wavelength, it must extend over some region of space, which means it occupies many positions at the same time. The wavelength of an object limited to a small region of space can't be perfectly defined, though. So it exists in many different wavelengths at the same time. We don't see these wave properties for everyday objects because the wavelength decreases as the momentum increases. And a cat is relatively big and heavy. If we took a single atom and blew it up to the size of the Solar System, the wavelength of a cat running from a physicist would be as small as an atom within that Solar System. That's far too small to detect, so we'll never see wave behavior from a cat. A tiny particle, like an electron, though, can show dramatic evidence of its dual nature. If we shoot electrons one at a time at a set of two narrow slits cut in a barrier, each electron on the far side is detected at a single place at a specific instant, like a particle. But if you repeat this experiment many times, keeping track of all the individual detections, you'll see them trace out a pattern that's characteristic of wave behavior: a set of stripes - regions with many electrons separated by regions where there are none at all. Block one of the slits and the stripes go away. This shows that the pattern is a result of each electron going through both slits at the same time. A single electron isn't choosing to go left or right but left and right simultaneously. This superposition of states also leads to modern technology. An electron near the nucleus of an atom exists in a spread out, wave-like orbit. Bring two atoms close together, and the electrons don't need to choose just one atom but are shared between them. This is how some chemical bonds form. An electron in a molecule isn't on just atom A or atom B, but A+ B. As you add more atoms, the electrons spread out more, shared between vast numbers of atoms at the same time. The electrons in a solid aren't bound to a particular atom but shared among all of them, extending over a large range of space. This gigantic superposition of states determines the ways electrons move through the material, whether it's a conductor or an insulator or a semiconductor. Understanding how electrons are shared among atoms allows us to precisely control the properties of semiconductor materials, like silicon. Combining different semiconductors in the right way allows us to make transistors on a tiny scale, millions on a single computer chip. Those chips and their spread out electrons power the computer you're using to watch this video. An old joke says that the Internet exists to allow the sharing of cat videos. At a very deep level, though, the Internet owes its existance to an Austrian physicist and his imaginary cat.

**P140 2014-09-18 Is telekinesis real - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=140)

When the infamous fictional character, Carrie White, left her high school prom hall ablaze, and brought terror upon her town, she relied on her powers of telekinesis, the ability to manipulate physical objects using the power of the mind alone. But while Carrie is just a fictional film based upon a fictional book, belief in telekinesis isn't fictional at all. For centuries, humans have claimed they really do have the power to control the motion of objects using only their minds. Levitation, opening doors at will and spoon bending are all intriguing examples. It happens in the Matrix when Neo freezes bullets midair, and it's a skill that Yoda has honed to a T. But is telekinesis real, or just as fictional as Carrie, Yoda and Neo combined? To investigate, we need to evaluate telekinetic claims through a scientific lens using the scientific method. Telekinesis is part of the discipline called parapsychology, in which researchers study psychic phenomena. Parapsychologists regard what they do as a science, but other scientists disagree. Let's start with a few basic observations. Observation #1: While there are loads of anecdotes out there about telekinesis, there's no scientific proof that it exists; no studies conducted according to the scientific method and repeated under lab conditions can show that its real. In the 1930s, the so-called father of parapsychology, Joseph Banks Rhine, tested in the lab whether people could use telekinesis to make a dice roll the way they wanted it to. But afterwards, scientists couldn't replicate his results, and since replication is key to proving an idea, that was a problem. Aside from scientists, there are also countless self-proclaimed telekinetics, but all have been exposed as tricksters, or can't perform under conditions where they're not totally in control, suggesting that they manipulate the situation to get the results they want. Today, there's even a huge stash of prize money available from lots of organizations for anyone who can prove that psychic abilities, like telekinesis, are real. But these riches remain unclaimed. Observation #2: When we investigate telekinesis, there's no consensus about what exactly is being measured. Are powerful, Yoda-like brainwaves at work perhaps? Since nobody agrees, it's difficult to apply a research standard, something required in all other types of science to test the validity of ideas. Observation #3: The point of science is to discover the unknown, and in the history of scientific investigation, it's definitely happened that new discoveries have gone against established science, and even overturned whole branches of science. Such discoveries must be proven extra carefully to withstand skepticism. In the case of telekinesis, the idea goes against established science, but lacks the powerful evidence in favor of it. Our universe is controlled and explained by the laws of physics, and one of these laws tells us that brain waves can't control objects because they're neither strong nor far-reaching enough to influence anything outside of our skulls. Physics also tells us that the only forces that can influence objects from afar are magnetic and gravitational. Probably the closest thing to telekinesis that science can explain is the use of thoughts to control a robotic arm. In the brains of stroke patients who can't move, researchers can implant tiny wires into the region that controls movement, and then train the patient to concentrate on moving a robotic arm, which acts like an extension of their minds, and it works. It's amazing, but it isn't telekinesis. The patients thoughts aren't just vague, undetectable things. They're measurable brain signals, translated through wires into a robot. Science can measure, test and explain the motion, and that's how we've shown that this kind of mind control is real. Science is a slow process of accumulating the evidence that either stands for or against an idea. When we stack up evidence, we can see which tower grows tallest, and in the case of telekinesis, it's not the tower showing that it exists. Some say this mystical phenomenon can't fit within the confines of science, and that's okay. But then telekinesis becomes purely a matter of personal conviction. If something can't be assessed scientifically, then it can't be described as scientific either. So the results of our investigation reveal that however much we may want to believe that the force really is within us, the case for telekinesis remains weak. Sorry Neo, Carrie and Yoda. Your skills are mind-blowing, but for now, they belong in the movies.

**P141 2014-09-18 The great brain debate - Ted Altschuler**

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In 1861, two scientists got into a very brainy argument. Specifically, they had opposing ideas of how speech and memory operated within the human brain. Ernest Aubertin, with his localistic model, argued that a particular region or the brain was devoted to each separate process. Pierre Gratiolet, on the other hand, argued for the distributed model, where different regions work together to accomplish all of these various functions. The debate they began reverberated throughout the rest of the century, involving some of the greatest scientific minds of the time. Aubertin and his localistic model had some big names on his side. In the 17th century, René Descartes had assigned the quality of free will and the human soul to the pineal gland. And in the late 18th century, a young student named Franz Joseph Gall had observed that the best memorizers in his class had the most prominent eyes and decided that this was due to higher development in the adjacent part of the brain. As a physician, Gall went on to establish the study of phrenology, which held that strong mental faculties corresponded to highly developed brain regions, observable as bumps in the skull. The widespread popularity of phrenology throughout the early 19th century tipped the scales towards Aubertin's localism. But the problem was that Gall had never bothered to scientifically test whether the individual brain maps he had constructed applied to all people. And in the 1840's, Pierre Flourens challenged phrenology by selectively destroying parts of animal brains and observing which functions were lost. Flourens found that damaging the cortex interfered with judgement or movement in general, but failed to identify any region associated with one specific function, concluding that the cortex carried out brain functions as an entire unit. Flourens had scored a victory for Gratiolet, but it was not to last. Gall's former student, Jean-Baptiste Bouillaud, challenged Flourens' conclusion, observing that patients with speech disorders all had damage to the frontal lobe. And after Paul Broca's 1861 autopsy of a patient who had lost the power to produce speech, but not the power to understand it, revealed highly localized frontal lobe damage, the distributed model seemed doomed. Localism took off. In the 1870's, Karl Wernicke associated part of the left temporal lobe with speech comprehension. Soon after, Eduard Hitzig and Gustav Fritsch stimulated a dog's cortex and discovered a frontal lobe region responsible for muscular movements. Building on their work, David Ferrier mapped each piece of cortex associated with moving a part of the body. And in 1909, Korbinian Brodmann built his own cortex map with 52 separate areas. It appeared that the victory of Aubertin's localistic model was sealed. But neurologist Karl Wernicke had come up with an interesting idea. He reasoned that since the regions for speech production and comprehension were not adjacent, then injuring the area connecting them might result in a special type of language loss, now known as receptive aphasia. Wernicke's connectionist model helped explain disorders that didn't result from the dysfunction of just one area. Modern neuroscience tools reveal a brain more complex than Gratiolet, Aubertin, or even Wernicke imagined. Today, the hippocampus is associated with two distinct brain functions: creating memories and processing location in space. We also now measure two kinds of connectivity: anatomical connectivity between two adjoining regions of cortex working together, and functional connectivity between separated regions working together to accomplish one process. A seemingly basic function like vision is actually composed of many smaller functions, with different parts of the cortex representing shape, color and location in space. When certain areas stop functioning, we may recognize an object, but not see it, or vice versa. There are even different kinds of memory for facts and for routines. And remembering something like your first bicycle involves a network of different regions each representing the concept of vehicles, the bicycle's shape, the sound of the bell, and the emotions associated with that memory. In the end, both Gratiolet and Aubertin turned out to be right. And we still use both of their models to understand how cognition happens. For example, we can now measure brain activity on such a fine time scale that we can see the individual localized processes that comprise a single act of remembering. But it is the integration of these different processes and regions that creates the coherent memory we experience. The supposedly competing theories prove to be two aspects of a more comprehensive model, which will in turn be revised and refined as our scientific techologies and methods for understanding the brain improve.

**P142 2014-09-19 A brief history of melancholy - Courtney Stephens**

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Sadness is part of the human experience, but for centuries there has been vast disagreement over what exactly it is and what, if anything, to do about it. In its simplest terms, sadness is often thought of as the natural reaction to a difficult situation. You feel sad when a friend moves away or when a pet dies. When a friend says, "I'm sad," you often respond by asking, "What happened?" But your assumption that sadness has an external cause outside the self is a relatively new idea. Ancient Greek doctors didn't view sadness that way. They believed it was a dark fluid inside the body. According to their humoral system, the human body and soul were controlled by four fluids, known as humors, and their balance directly influenced a person's health and temperament. Melancholia comes from melaina kole, the word for black bile, the humor believed to cause sadness. By changing your diet and through medical practices, you could bring your humors into balance. Even though we now know much more about the systems that govern the human body, these Greek ideas about sadness resonate with current views, not on the sadness we all occasionally feel, but on clinical depression. Doctors believe that certain kinds of long-term, unexplained emotional states are at least partially related to brain chemistry, the balance of various chemicals present inside the brain. Like the Greek system, changing the balance of these chemicals can deeply alter how we respond to even extremely difficult circumstances. There's also a long tradition of attempting to discern the value of sadness, and in that discussion, you'll find a strong argument that sadness is not only an inevitable part of life but an essential one. If you've never felt melancholy, you've missed out on part of what it means to be human. Many thinkers contend that melancholy is necessary in gaining wisdom. Robert Burton, born in 1577, spent his life studying the causes and experience of sadness. In his masterpiece "The Anatomy of Melancholy," Burton wrote, "He that increaseth wisdom increaseth sorrow." The Romantic poets of the early 19th century believed melancholy allows us to more deeply understand other profound emotions, like beauty and joy. To understand the sadness of the trees losing their leaves in the fall is to more fully understand the cycle of life that brings flowers in the spring. But wisdom and emotional intelligence seem pretty high on the hierarchy of needs. Does sadness have value on a more basic, tangible, maybe even evolutionary level? Scientists think that crying and feeling withdrawn is what originally helped our ancestors secure social bonds and helped them get the support they needed. Sadness, as opposed to anger or violence, was an expression of suffering that could immediately bring people closer to the suffering person, and this helped both the person and the larger community to thrive. Perhaps sadness helped generate the unity we needed to survive, but many have wondered whether the suffering felt by others is anything like the suffering we experience ourselves. The poet Emily Dickinson wrote, "I measure every Grief I meet With narrow, probing Eyes - I wonder if it weighs like MIne - Or has an Easier size." And in the 20th century, medical anthropologists, like Arthur Kleinman, gathered evidence from the way people talk about pain to suggest that emotions aren't universal at all, and that culture, particularly the way we use language, can influence how we feel. When we talk about heartbreak, the feeling of brokenness becomes part of our experience, where as in a culture that talks about a bruised heart, there actually seems to be a different subjective experience. Some contemporary thinkers aren't interested in sadness' subjectivity versus universality, and would rather use technology to eliminate suffering in all its forms. David Pearce has suggested that genetic engineering and other contemporary processes cannot only alter the way humans experience emotional and physical pain, but that world ecosystems ought to be redesigned so that animals don't suffer in the wild. He calls his project "paradise engineering." But is there something sad about a world without sadness? Our cavemen ancestors and favorite poets might not want any part of such a paradise. In fact, the only things about sadness that seem universally agreed upon are that it has been felt by most people throughout time, and that for thousands of years, one of the best ways we have to deal with this difficult emotion is to articulate it, to try to express what feels inexpressable. In the words of Emily Dickinson, "'Hope' is the thing with feathers - That perches in the soul - "And sings the tune without the words - And never stops - at all -"

**P143 2014-09-22 Einstein's brilliant mistake - Entangled states - Chad Orzel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=143)

Albert Einstein played a key role in launching quantum mechanics through his theory of the photoelectric effect but remained deeply bothered by its philosophical implications. And though most of us still remember him for deriving E=MC^2, his last great contribution to physics was actually a 1935 paper, coauthored with his young colleagues Boris Podolsky and Nathan Rosen. Regarded as an odd philosophical footnote well into the 1980s, this EPR paper has recently become central to a new understanding of quantum physics, with its description of a strange phenomenon now known as entangled states. The paper begins by considering a source that spits out pairs of particles, each with two measurable properties. Each of these measurements has two possible results of equal probability. Let's say zero or one for the first property, and A or B for the second. Once a measurement is performed, subsequent measurements of the same property in the same particle will yield the same result. The strange implication of this scenario is not only that the state of a single particle is indeterminate until it's measured, but that the measurement then determines the state. What's more, the measurements affect each other. If you measure a particle as being in state 1, and follow it up with the second type of measurement, you'll have a 50% chance of getting either A or B, but if you then repeat the first measurement, you'll have a a 50% chance of getting zero even though the particle had already been measured at one. So switching the property being measured scrambles the original result, allowing for a new, random value. Things get even stranger when you look at both particles. Each of the particles will produce random results, but if you compare the two, you will find that they are always perfectly correlated. For example, if both particles are measured at zero, the relationship will always hold. The states of the two are entangled. Measuring one will tell you the other with absolute certainty. But this entanglement seems to defy Einstein's famous theory of relativity because there is nothing to limit the distance between particles. If you measure one in New York at noon, and the other in San Francisco a nanosecond later, they still give exactly the same result. But if the measurement does determine the value, then this would require one particle sending some sort of signal to the other at 13,000,000 times the speed of light, which according to relativity, is impossible. For this reason, Einstein dismissed entanglement as "spuckafte ferwirklung," or spooky action at a distance. He decided that quantum mechanics must be incomplete, a mere approximation of a deeper reality in which both particles have predetermined states that are hidden from us. Supporters of orthodox quantum theory lead by Niels Bohr maintained that quantum states really are fundamentally indeterminate, and entanglement allows the state of one particle to depend on that of its distant partner. For 30 years, physics remained at an impasse, until John Bell figured out that the key to testing the EPR argument was to look at cases involving different measurements on the two particles. The local hidden variable theories favored by Einstein, Podolsky and Rosen, strictly limited how often you could get results like 1A or B0 because the outcomes would have to be defined in advanced. Bell showed that the purely quantum approach, where the state is truly indeterminate until measured, has different limits and predicts mixed measurement results that are impossible in the predetermined scenario. Once Bell had worked out how to test the EPR argument, physicists went out and did it. Beginning with John Clauster in the 70s and Alain Aspect in the early 80s, dozens of experiments have tested the EPR prediction, and all have found the same thing: quantum mechanics is correct. The correlations between the indeterminate states of entangled particles are real and cannot be explained by any deeper variable. The EPR paper turned out to be wrong but brilliantly so. By leading physicists to think deeply about the foundations of quantum physics, it led to further elaboration of the theory and helped launch research into subjects like quantum information, now a thriving field with the potential to develop computers of unparalleled power. Unfortunately, the randomness of the measured results prevents science fiction scenarios, like using entangled particles to send messages faster than light. So relativity is safe, for now. But the quantum universe is far stranger than Einstein wanted to believe.

**P144 2014-09-26 Is math discovered or invented - Jeff Dekofsky**

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Would mathematics exist if people didn't? Since ancient times, mankind has hotly debated whether mathematics was discovered or invented. Did we create mathematical concepts to help us understand the universe around us, or is math the native language of the universe itself, existing whether we find its truths or not? Are numbers, polygons and equations truly real, or merely ethereal representations of some theoretical ideal? The independent reality of math has some ancient advocates. The Pythagoreans of 5th Century Greece believed numbers were both living entities and universal principles. They called the number one, "the monad," the generator of all other numbers and source of all creation. Numbers were active agents in nature. Plato argued mathematical concepts were concrete and as real as the universe itself, regardless of our knowledge of them. Euclid, the father of geometry, believed nature itself was the physical manifestation of mathematical laws. Others argue that while numbers may or may not exist physically, mathematical statements definitely don't. Their truth values are based on rules that humans created. Mathematics is thus an invented logic exercise, with no existence outside mankind's conscious thought, a language of abstract relationships based on patterns discerned by brains, built to use those patterns to invent useful but artificial order from chaos. One proponent of this sort of idea was Leopold Kronecker, a professor of mathematics in 19th century Germany. His belief is summed up in his famous statement: "God created the natural numbers, all else is the work of man." During mathematician David Hilbert's lifetime, there was a push to establish mathematics as a logical construct. Hilbert attempted to axiomatize all of mathematics, as Euclid had done with geometry. He and others who attempted this saw mathematics as a deeply philosophical game but a game nonetheless. Henri Poincaré, one of the father's of non-Euclidean geometry, believed that the existence of non-Euclidean geometry, dealing with the non-flat surfaces of hyperbolic and elliptical curvatures, proved that Euclidean geometry, the long standing geometry of flat surfaces, was not a universal truth, but rather one outcome of using one particular set of game rules. But in 1960, Nobel Physics laureate Eugene Wigner coined the phrase, "the unreasonable effectiveness of mathematics," pushing strongly for the idea that mathematics is real and discovered by people. Wigner pointed out that many purely mathematical theories developed in a vacuum, often with no view towards describing any physical phenomena, have proven decades or even centuries later, to be the framework necessary to explain how the universe has been working all along. For instance, the number theory of British mathematician Gottfried Hardy, who had boasted that none of his work would ever be found useful in describing any phenomena in the real world, helped establish cryptography. Another piece of his purely theoretical work became known as the Hardy-Weinberg law in genetics, and won a Nobel prize. And Fibonacci stumbled upon his famous sequence while looking at the growth of an idealized rabbit population. Mankind later found the sequence everywhere in nature, from sunflower seeds and flower petal arrangements, to the structure of a pineapple, even the branching of bronchi in the lungs. Or there's the non-Euclidean work of Bernhard Riemann in the 1850s, which Einstein used in the model for general relativity a century later. Here's an even bigger jump: mathematical knot theory, first developed around 1771 to describe the geometry of position, was used in the late 20th century to explain how DNA unravels itself during the replication process. It may even provide key explanations for string theory. Some of the most influential mathematicians and scientists of all of human history have chimed in on the issue as well, often in surprising ways. So, is mathematics an invention or a discovery? Artificial construct or universal truth? Human product or natural, possibly divine, creation? These questions are so deep the debate often becomes spiritual in nature. The answer might depend on the specific concept being looked at, but it can all feel like a distorted zen koan. If there's a number of trees in a forest, but no one's there to count them, does that number exist?

**P145 2014-09-26 The language of lying — Noah Zandan**

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"Sorry, my phone died." "It's nothing. I'm fine." "These allegations are completely unfounded." "The company was not aware of any wrongdoing." "I love you." We hear anywhere from 10 to 200 lies a day, and we spent much of our history coming up with ways to detect them, from medieval torture devices to polygraphs, blood-pressure and breathing monitors, voice-stress analyzers, eye trackers, infrared brain scanners, and even the 400-pound electroencephalogram. But although such tools have worked under certain circumstances, most can be fooled with enough preparation, and none are considered reliable enough to even be admissible in court. But, what if the problem is not with the techniques, but the underlying assumption that lying spurs physiological changes? What if we took a more direct approach, using communication science to analyze the lies themselves? On a psychological level, we lie partly to paint a better picture of ourselves, connecting our fantasies to the person we wish we were rather than the person we are. But while our brain is busy dreaming, it's letting plenty of signals slip by. Our conscious mind only controls about 5% of our cognitive function, including communication, while the other 95% occurs beyond our awareness, and according to the literature on reality monitoring, stories based on imagined experiences are qualitatively different from those based on real experiences. This suggests that creating a false story about a personal topic takes work and results in a different pattern of language use. A technology known as linguistic text analysis has helped to identify four such common patterns in the subconscious language of deception. First, liars reference themselves less, when making deceptive statements. They write or talk more about others, often using the third person to distance and disassociate themselves from their lie, which sounds more false: "Absolutely no party took place at this house," or "I didn't host a party here." Second, liars tend to be more negative, because on a subconscious level, they feel guilty about lying. For example, a liar might say something like, "Sorry, my stupid phone battery died. I hate that thing." Third, liars typically explain events in simple terms since our brains struggle to build a complex lie. Judgment and evaluation are complex things for our brains to compute. As a U.S. President once famously insisted: "I did not have sexual relations with that woman." And finally, even though liars keep descriptions simple, they tend to use longer and more convoluted sentence structure, inserting unnecessary words and irrelevant but factual sounding details in order to pad the lie. Another President confronted with a scandal proclaimed: "I can say, categorically, that this investigation indicates that no one on the White House staff, no one in this administration presently employed was involved in this very bizarre incident." Let's apply linguistic analysis to some famous examples. Take seven-time Tour de France winner Lance Armstrong. When comparing a 2005 interview, in which he had denied taking performance-enhancing drugs to a 2013 interview, in which he admitted it, his use of personal pronouns increased by nearly 3/4. Note the contrast between the following two quotes. First: "Okay, you know, a guy in a French, in a Parisian laboratory opens up your sample, you know, Jean-Francis so-and-so, and he tests it. And then you get a phone call from a newspaper that says: 'We found you to be positive six times for EPO." Second: "I lost myself in all of that. I'm sure there would be other people that couldn't handle it, but I certainly couldn't handle it, and I was used to controlling everything in my life. I controlled every outcome in my life." In his denial, Armstrong described a hypothetical situation focused on someone else, removing himself from the situation entirely. In his admission, he owns his statements, delving into his personal emotions and motivations. But the use of personal pronouns is just one indicator of deception. Let's look at another example from former Senator and U.S. Presidential candidate John Edwards: "I only know that the apparent father has said publicly that he is the father of the baby. I also have not been engaged in any activity of any description that requested, agreed to, or supported payments of any kind to the woman or to the apparent father of the baby." Not only is that a pretty long-winded way to say, "The baby isn't mine," but Edwards never calls the other parties by name, instead saying "that baby," "the woman," and "the apparent father." Now let's see what he had to say when later admitting paternity: "I am Quinn's father. I will do everything in my power to provide her with the love and support she deserves." The statement is short and direct, calling the child by name and addressing his role in her life. So how can you apply these lie-spotting techniques to your life? First, remember that many of the lies we encounter on a daily basis are far less serious that these examples, and may even be harmless. But it's still worthwhile to be aware of telltale clues, like minimal self-references, negative language, simple explanations and convoluted phrasing. It just might help you avoid an overvalued stock, an ineffective product, or even a terrible relationship.

**P146 2014-09-26 The unexpected math behind Van Gogh's 'Starry Night' - Natalya St. Cl**

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One of the most remarkable aspects of the human brain is its ability to recognize patterns and describe them. Among the hardest patterns we've tried to understand is the concept of turbulent flow in fluid dynamics. The German physicist Werner Heisenberg said, "When I meet God, I'm going to ask him two questions: why relativity and why turbulence? I really believe he will have an answer for the first." As difficult as turbulence is to understand mathematically, we can use art to depict the way it looks. In June 1889, Vincent van Gogh painted the view just before sunrise from the window of his room at the Saint-Paul-de-Mausole asylum in Saint-Rémy-de-Provence, where he'd admitted himself after mutilating his own ear in a psychotic episode. In "The Starry Night," his circular brushstrokes create a night sky filled with swirling clouds and eddies of stars. Van Gogh and other Impressionists represented light in a different way than their predecessors, seeming to capture its motion, for instance, across sun-dappled waters, or here in star light that twinkles and melts through milky waves of blue night sky. The effect is caused by luminance, the intensity of the light in the colors on the canvas. The more primitive part of our visual cortex, which sees light contrast and motion, but not color, will blend two differently colored areas together if they have the same luminance. But our brains' primate subdivision will see the contrasting colors without blending. With these two interpretations happening at once, the light in many Impressionist works seems to pulse, flicker and radiate oddly. That's how this and other Impressionist works use quickly executed prominent brushstrokes to capture something strikingly real about how light moves. Sixty years later, Russian mathematician Andrey Kolmogorov furthered our mathematical understanding of turbulence when he proposed that energy in a turbulent fluid at length R varies in proportion to the 5/3rds power of R. Experimental measurements show Kolmogorov was remarkably close to the way turbulent flow works, although a complete description of turbulence remains one of the unsolved problems in physics. A turbulent flow is self-similar if there is an energy cascade. In other words, big eddies transfer their energy to smaller eddies, which do likewise at other scales. Examples of this include Jupiter's Great Red Spot, cloud formations and interstellar dust particles. In 2004, using the Hubble Space Telescope, scientists saw the eddies of a distant cloud of dust and gas around a star, and it reminded them of Van Gogh's "Starry Night." This motivated scientists from Mexico, Spain and England to study the luminance in Van Gogh's paintings in detail. They discovered that there is a distinct pattern of turbulent fluid structures close to Kolmogorov's equation hidden in many of Van Gogh's paintings. The researchers digitized the paintings, and measured how brightness varies between any two pixels. From the curves measured for pixel separations, they concluded that paintings from Van Gogh's period of psychotic agitation behave remarkably similar to fluid turbulence. His self-portrait with a pipe, from a calmer period in Van Gogh's life, showed no sign of this correspondence. And neither did other artists' work that seemed equally turbulent at first glance, like Munch's "The Scream." While it's too easy to say Van Gogh's turbulent genius enabled him to depict turbulence, it's also far too difficult to accurately express the rousing beauty of the fact that in a period of intense suffering, Van Gogh was somehow able to perceive and represent one of the most supremely difficult concepts nature has ever brought before mankind, and to unite his unique mind's eye with the deepest mysteries of movement, fluid and light.

**P147 2014-10-01 Light seconds, light years, light centuries - How to measure extreme**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=147)

Light is the fastest thing we know. It's so fast that we measure enormous distances by how long it takes for light to travel them. In one year, light travels about 6,000,000,000,000 miles, a distance we call one light year. To give you an idea of just how far this is, the Moon, which took the Apollo astronauts four days to reach, is only one light-second from Earth. Meanwhile, the nearest star beyond our own Sun is Proxima Centauri, 4.24 light years away. Our Milky Way is on the order of 100,000 light years across. The nearest galaxy to our own, Andromeda, is about 2.5 million light years away Space is mind-blowingly vast. But wait, how do we know how far away stars and galaxies are? After all, when we look at the sky, we have a flat, two-dimensional view. If you point you finger to one star, you can't tell how far the star is, so how do astrophysicists figure that out? For objects that are very close by, we can use a concept called trigonometric parallax. The idea is pretty simple. Let's do an experiment. Stick out your thumb and close your left eye. Now, open your left eye and close your right eye. It will look like your thumb has moved, while more distant background objects have remained in place. The same concept applies when we look at the stars, but distant stars are much, much farther away than the length of your arm, and the Earth isn't very large, so even if you had different telescopes across the equator, you'd not see much of a shift in position. Instead, we look at the change in the star's apparent location over six months, the halfway point of the Earth's yearlong orbit around the Sun. When we measure the relative positions of the stars in summer, and then again in winter, it's like looking with your other eye. Nearby stars seem to have moved against the background of the more distant stars and galaxies. But this method only works for objects no more than a few thousand light years away. Beyond our own galaxy, the distances are so great that the parallax is too small to detect with even our most sensitive instruments. So at this point we have to rely on a different method using indicators we call standard candles. Standard candles are objects whose intrinsic brightness, or luminosity, we know really well. For example, if you know how bright your light bulb is, and you ask your friend to hold the light bulb and walk away from you, you know that the amount of light you receive from your friend will decrease by the distance squared. So by comparing the amount of light you receive to the intrinsic brightness of the light bulb, you can then tell how far away your friend is. In astronomy, our light bulb turns out to be a special type of star called a cepheid variable. These stars are internally unstable, like a constantly inflating and deflating balloon. And because the expansion and contraction causes their brightness to vary, we can calculate their luminosity by measuring the period of this cycle, with more luminous stars changing more slowly. By comparing the light we observe from these stars to the intrinsic brightness we've calculated this way, we can tell how far away they are. Unfortunately, this is still not the end of the story. We can only observe individual stars up to about 40,000,000 light years away, after which they become too blurry to resolve. But luckily we have another type of standard candle: the famous type 1a supernova. Supernovae, giant stellar explosions are one of the ways that stars die. These explosions are so bright, that they outshine the galaxies where they occur. So even when we can't see individual stars in a galaxy, we can still see supernovae when they happen. And type 1a supernovae turn out to be usable as standard candles because intrinsically bright ones fade slower than fainter ones. Through our understanding of this relationship between brightness and decline rate, we can use these supernovae to probe distances up to several billions of light years away. But why is it important to see such distant objects anyway? Well, remember how fast light travels. For example, the light emitted by the Sun will take eight minutes to reach us, which means that the light we see now is a picture of the Sun eight minutes ago. When you look at the Big Dipper, you're seeing what it looked like 80 years ago. And those smudgy galaxies? They're millions of light years away. It has taken millions of years for that light to reach us. So the universe itself is in some sense an inbuilt time machine. The further we can look back, the younger the universe we are probing. Astrophysicists try to read the history of the universe, and understand how and where we come from. The universe is constantly sending us information in the form of light. All that remains if for us to decode it.

**P148 2014-10-02 A different way to visualize rhythm - John Varney**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=148)

We usually think of rhythm as an element of music, but it's actually found everywhere in the world around us, from the ocean tides to our own heartbeats, rhythm is essentially an event repeating regularly over time. Even the ticking of a clock itself is a sort of rhythm. But for musical rhythm, a steady string of repeating single beats is not enough. For that, we need at least one opposing beat with a different sound, which can be the unstressed off beat or the accented back beat. There are several ways to make these beats distinct, whether by using high and low drums, or long and short beats. Which ends up being heard as the main beat is not a precise rule, but like the famous Rubin's vase, can be reversed depending on cultural perception. In standard notation, rhythm is indicated on a musical bar line, but there are other ways. Remember that ticking clock? Just as its round face can trace the linear passage of time, the flow of rhythm can be traced in a circle. The continuity of a wheel can be a more intuitive way to visualize rhythm than a linear score that requires moving back and forth along the page. We can mark the beats at different positions around the circle using blue dots for main beats, orange ones for off beats, and white dots for secondary beats. Here is a basic two beat rhythm with a main beat and an opposing off beat. Or a three beat rhythm with a main beat, an off beat, and a secondary beat. And the spaces between each beat can be divided into further sub-beats using multiples of either two or three. Layering multiple patterns using concentric wheels lets us create more complex rhythms. For example, we can combine a basic two beat rhythm with off beats to get a four beat system. This is the recognizable backbone of many genres popular around the world, from rock, country, and jazz, to reggae and cumbia. Or we can combine a two beat rhythm with a three beat one. Eliminating the extra main beat and rotating the inner wheel leaves us with a rhythm whose underlying feel is three-four. This is the basis of the music of Whirling Dervishes, as well as a broad range of Latin American rhythms, such as Joropo, and even Bach's famous Chaconne. Now if we remember Rubin's vase and hear the off beats as the main beats, this will give us a six-eight feel, as found in genres such as Chacarera, and Quechua, Persian music and more. In an eight beat system, we have three layered circles, each rhythm played by a different instrument. We can then add an outermost layer consisting of an additive rhythmic component, reinforcing the main beat and increasing accuracy. Now let's remove everything except for this combined rhythm and the basic two beat on top. This rhythmic configuration is found as the Cuban cinquillo, in the Puerto Rican bomba, and in Northern Romanian music. And rotating the outer circle 90 degrees counterclockwise gives us a pattern often found in Middle Eastern music, as well as Brazilian choro, and Argentinian tango. In all of these examples, the underlying rhythm reinforces the basic one-two, but in different ways depending on arrangement and cultural context. So it turns out that the wheel method is more than just a nifty way of visualizing complex rhythms. By freeing us from the tyranny of the bar line, we can visualize rhythm in terms of time, and a simple turn of the wheel can take us on a musical journey around the world.

**P149 2014-10-02 How do we study the stars - Yuan-Sen Ting**

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The city sky is, frankly, rather boring. If you look up at the patches of murk between buildings, you might be able to pick out The Big Dipper, or perhaps, Orion's Belt. But hold on. Look at that murky patch again and hold our your thumb. How many stars do you think are behind it? Ten, twenty? Guess again. If you looked at that thumbnail-sized patch of sky with the Hubble Space Telescope, instead of points of light, you'd see smudges. These aren't stars. They're galaxies, just like our Milky Way. Cities of billions of stars, and more than 1,000 of them are hidden behind your thumb. The universe is bigger than you can see from the city, and even bigger than the starry sky you can see from the countryside. This is the universe as astrophysicists see it, with more stars than all the grains of sand on Earth. By staring up at the stars at night, you've taken part in the oldest science in human history. The study of the heavens is older than navigation, agriculture, perhaps even language itself. Yet unlike other sciences, astronomy is purely observational. We cannot control the parameters of our experiments from lab benches. Our best technology can send man to the moon, and probes to the edge of the solar system. But these distances are vanishingly small compared to the yawning gulfs between stars. So how can we know so much about other galaxies, what they're made of, how many there are, or that they're even there at all? Well, we can start with the first thing we see when we look up at night: the stars. What we are trying to learn is their properties. What are they made of? How hot are they? How massive? How old? How far are they from Earth? And believe it or not, we can learn all of these things simply from the light shining in the sky. We can decipher one kind of stellar message by turning starlight into rainbows. When you look at a rainbow on Earth, you're really looking at light from our Sun being scattered through water droplets in the atmosphere into all the different wavelengths that make it up. And we study the light from other stars, we can create rainbows on demand using not water droplets, but other specific instruments that disperse light. When we look at the scattered light from our sun, we see something strange: dark lines in our rainbow. These lines are the characteristic fingerprints of atoms. Each type of atom in the solar atmosphere soaks up light at specific wavelengths, and the amount of absorption depends on how many of these atoms there are. So by observing how much light is missing at these characteristic wavelengths, we can tell not only what elements are in the Sun's atmosphere, but even their concentrations. And the same idea can be applied to study other stars. Make a spectral rainbow, see what's missing, and figure out which elements are present. Bingo. Now you know what stars are made of. But we aren't restricted to just the wavelengths that our eyes perceive. Consider radio waves. Yes, they can bring the Billboard Top 100 to your car, but they can also travel almost unimpeded through space. Because they've come so far, radio waves can tell us the very early history of the universe, from just a few thousand years after The Big Bang. We can also study the infrared light, emitted by colder objects, like the gas and dust clouds in space, and the ultraviolet light from the hot stars recently born from those clouds. Studying different wavelengths not only gives us a more complete picture of any single object but also different views of the universe. For this reason, astrophysicists use several different kinds of telescopes covering the spectrum from the infrared to the ultraviolet to the X-ray, from giant radio dishes to giant silver mirrors to space satellites, detecting light that would be otherwise blocked by the Earth's atmosphere. Astrophysicists don't just see the billions of stars among the billions of galaxies in the universe. They hear, feel and sense them through many channels, each revealing a different story. But it all begins with light, the kind we can see and the kind we can't. Want to know the secrets of the Universe? Just follow the light.

**P150 2014-10-03 How do vitamins work - Ginnie Trinh Nguyen**

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A, C, E, D, B, K. No, this isn't some random, out of order alphabet. These are vitamins, and just like letters build words, they're the building blocks that keep the body running. Vitamins are organic compounds we need to ingest in small amounts to keep functioning. They're the body's builders, defenders and maintenance workers, helping it to build muscle and bone, make use of nutrients, capture and use energy and heal wounds. If you need convincing about vitamin value, just consider the plight of olden day sailors, who had no access to vitamin-rich fresh produce. They got scurvy. But vitamin C, abundant in fruits and vegetables, was the simple antidote to this disease. While bacteria, fungi and plants produce their own vitamins, our bodies can't, so we have to get them from other sources. So how does the body get vitamins from out there into here? That's dependent on the form these compounds take. Vitamins come in two types: lipid-soluble and water-soluble, and the difference between them determines how the body transports and stores vitamins, and gets rid of the excess. The water-solubles are vitamin C and B Complex vitamins that are made up of eight different types that each do something unique. These are dissolved in the watery parts of fruits, vegetables and grains, meaning their passage through the body is relatively straightforward. Once inside the system, these foods are digested and the vitamins within them are taken up directly by the bloodstream. Because blood plasma is water-based, water-soluble vitamins C and B have their transport cut out for them and can move around freely within the body. For lipid-soluble vitamins, dissolved in fat and found in foods like diary, butter and oils, this trip into the blood is a little more adventurous. These vitamins make it through the stomach and the intestine, where an acidic substance called bile flows in from the liver, breaking up the fat and preparing it for absorption through the intestinal wall. Because fat-soluble vitamins can't make use of the blood's watery nature, they need something else to move them around, and that comes from proteins that attach to the vitamins and act like couriers, transporting fat-solubles into the blood and around the body. So, this difference between water- or fat-soluble vitamins determines how they get into the blood, but also how they're stored or rejected from the body. The system's ability to circulate water-soluble vitamins in the bloodstream so easily means that most of them can be passed out equally easily via the kidneys. Because of that, most water-soluble vitamins need to be replenished on a daily basis through the food we eat. But fat-soluble vitamins have staying power because they can be packed into the liver and in fat cells. The body treats these parts like a pantry, storing the vitamins there and rationing them out when needed, meaning we shouldn't overload on this type of vitamin because the body is generally well stocked. Once we figured the logistics of transport and storage, the vitamins are left to do the work they came here to do in the first place. Some, like many of the B Complex vitamins, make up coenzymes, whose job it is to help enzymes release the energy from food. Other B vitamins then help the body to use that energy. From vitamin C, you get the ability to fight infection and make collagen, a kind of tissue that forms bones and teeth and heals wounds. Vitamin A helps make white blood cells, key in the body's defense, helps shape bones and improves vision by keeping the cells of the eye in check. Vitamin D gathers calcium and phosphorus so we can make bones, and vitamin E works as an antioxidant, getting rid of elements in the body that can damage cells. Finally, from Vitamin K, we score the ability to clot blood, since it helps make the proteins that do this job. Without this vitamin variety, humans face deficiencies that cause a range of problems, like fatigue, nerve damage, heart disorders, or diseases like rickets and scurvy. On the other hand, too much of any vitamin can cause toxicity in the body, so there goes the myth that loading yourself with supplements is a great idea. In reality, it's all about getting the balance right, and hitting that vitamin jackpot.

**P151 2014-10-09 History vs. Christopher Columbus - Alex Gendler**

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Many people in the United States and Latin America have grown up celebrating the anniversary of Christopher Columbus's voyage, but was he an intrepid explorer who brought two worlds together or a ruthless exploiter who brought colonialism and slavery? And did he even discover America at all? It's time to put Columbus on the stand in History vs. Christopher Columbus. "Order, order in the court. Wait, am I even supposed to be at work today?" <i>Cough</i> "Yes, your Honor. From 1792, Columbus Day was celebrated in many parts of the United States on October 12th, the actual anniversary date. But although it was declared an official holiday in 1934, individual states aren't required to observe it. Only 23 states close public services, and more states are moving away from it completely." <i>Cough</i> "What a pity. In the 70s, we even moved it to the second Monday in October so people could get a nice three-day weekend, but I guess you folks just hate celebrations." "Uh, what are we celebrating again?" "Come on, Your Honor, we all learned it in school. Christopher Columbus convinced the King of Spain to send him on a mission to find a better trade route to India, not by going East over land but sailing West around the globe. Everyone said it was crazy because they still thought the world was flat, but he knew better. And when in 1492 he sailed the ocean blue, he found something better than India: a whole new continent." "What rubbish. First of all, educated people knew the world was round since Aristotle. Secondly, Columbus didn't discover anything. There were already people living here for millennia. And he wasn't even the first European to visit. The Norse had settled Newfoundland almost 500 years before." "You don't say, so how come we're not all wearing those cow helmets?" "Actually, they didn't really wear those either." <i>Cough</i> "Who cares what some Vikings did way back when? Those settlements didn't last, but Columbus's did. And the news he brought back to Europe spread far and wide, inspiring all the explorers and settlers who came after. Without him, none of us would be here today." "And because of him, millions of Native Americans aren't here today. Do you know what Columbus did in the colonies he founded? He took the very first natives he met prisoner and wrote in his journal about how easily he could conquer and enslave all of them." "Oh, come on. Everyone was fighting each other back then. Didn't the natives even tell Columbus about other tribes raiding and taking captives?" "Yes, but tribal warfare was sporadic and limited. It certainly didn't wipe out 90% of the population." "Hmm. Why is celebrating this Columbus so important to you, anyway?" "Your Honor, Columbus's voyage was an inspiration to struggling people all across Europe, symbolizing freedom and new beginnings. And his discovery gave our grandparents and great-grandparents the chance to come here and build better lives for their children. Don't we deserve a hero to remind everyone that our country was build on the struggles of immigrants?" "And what about the struggles of Native Americans who were nearly wiped out and forced into reservations and whose descendants still suffer from poverty and discrimination? How can you make a hero out of a man who caused so much suffering?" "That's history. You can't judge a guy in the 15th century by modern standards. People back then even thought spreading Christianity and civilization across the world was a moral duty." "Actually, he was pretty bad, even by old standards. While governing Hispaniola, he tortured and mutilated natives who didn't bring him enough gold and sold girls as young as nine into sexual slavery, and he was brutal even to the other colonists he ruled, to the point that he was removed from power and thrown in jail. When the missionary, Bartolomé de las Casas, visited the island, he wrote, 'From 1494 to 1508, over 3,000,000 people had perished from war, slavery and the mines. Who in future generations will believe this?'" "Well, I'm not sure I believe those numbers." "Say, aren't there other ways the holiday is celebrated?" "In some Latin American countries, they celebrate the same date under different names, such as Día de la Raza. In these places, it's more a celebration of the native and mixed cultures that survived through the colonial period. Some places in the U.S. have also renamed the holiday, as Native American Day or Indigenous People's Day and changed the celebrations accordingly." "So, why not just change the name if it's such a problem?" "Because it's tradition. Ordinary people need their heroes and their founding myths. Can't we just keep celebrating the way we've been doing for a century, without having to delve into all this serious research? It's not like anyone is actually celebrating genocide." "Traditions change, and the way we choose to keep them alive says a lot about our values." "Well, it looks like giving tired judges a day off isn't one of those values, anyway." Traditions and holidays are important to all cultures, but a hero in one era may become a villain in the next as our historical knowledge expands and our values evolve. And deciding what these traditions should mean today is a major part of putting history on trial.

**P152 2014-10-17 How do germs spread (and why do they make us sick) - Yannay Khaikin a**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=152)

The sun is shining. The birds are singing. It looks like the start of another lovely day. You're walking happily in the park, when, "Ah-choo!" A passing stranger has expelled mucus and saliva from their mouth and nose. You can feel the droplets of moisture land on your skin, but what you can't feel are the thousands, or even millions, of microscopic germs that have covertly traveled through the air and onto your clothing, hands and face. As gross as this scenario sounds, it's actually very common for our bodies to be exposed to disease-causing germs, and most of the time, it's not nearly as obvious. Germs are found on almost every surface we come into contact with. When we talk about germs, we're actually referring to many different kinds of microscopic organisms, including bacteria, fungi, protozoa and viruses. But what our germs all have in common is the ability to interact with our bodies and change how we feel and function. Scientists who study infectious diseases have wondered for decades why it is that some of these germs are relatively harmless, while others cause devastating effects and can sometimes be fatal. We still haven't solved the entire puzzle, but what we do know is that the harmfulness, or virulence, of a germ is a result of evolution. How can it be that the same evolutionary process can produce germs that cause very different levels of harm? The answer starts to become clear if we think about a germ's mode of transmission, which is the strategy it uses to get from one host to the next. A common mode of transmission occurs through the air, like the sneeze you just witnessed, and one germ that uses this method is the rhinovirus, which replicates in our upper airways, and is responsible for up to half of all common colds. Now, imagine that after the sneeze, one of three hypothetical varieties of rhinovirus, let's call them "too much," "too little," and "just right," has been lucky enough to land on you. These viruses are hardwired to replicate, but because of genetic differences, they will do so at different rates. "Too much" multiplies very often, making it very successful in the short run. However, this success comes at a cost to you, the host. A quickly replicating virus can cause more damage to your body, making cold symptoms more severe. If you're too sick to leave your home, you don't give the virus any opportunities to jump to a new host. And if the disease should kill you, the virus' own life cycle will end along with yours. "Too little," on the other hand, multiplies rarely and causes you little harm in the process. Although this leaves you healthy enough to interact with other potential hosts, the lack of symptoms means you may not sneeze at all, or if you do, there may be too few viruses in your mucus to infect anyone else. Meanwhile, "just right" has been replicating quickly enough to ensure that you're carrying sufficient amounts of the virus to spread but not so often that you're too sick to get out of bed. And in the end, it's the one that will be most successful at transmitting itself to new hosts and giving rise to the next generation. This describes what scientists call trade-off hypothesis. First developed in the early 1980s, it predicts that germs will evolve to maximize their overall success by achieving a balance between replicating within a host, which causes virulence, and transmission to a new host. In the case of the rhinovirus, the hypothesis predicts that its evolution will favor less virulent forms because it relies on close contact to get to its next victim. For the rhinovirus, a mobile host is a good host, and indeed, that is what we see. While most people experience a runny nose, coughing and sneezing, the common cold is generally mild and only lasts about a week. It would be great if the story ended there, but germs use many other modes of transmission. For example, the malaria parasite, plasmodium, is transmitted by mosquitoes. Unlike the rhinovirus, it doesn't need us to be up and about, and may even benefit from harming us since a sick and immobile person is easier for mosquitoes to bite. We would expect germs that depend less on host mobility, like those transmitted by insects, water or food, to cause more severe symptoms. So, what can we do to reduce the harmfulness of infectious diseases? Evolutionary biologist Dr. Paul Ewald has suggested that we can actually direct their evolution through simple disease-control methods. By mosquito-proofing houses, establishing clean water systems, or staying home when we get a cold, we can obstruct the transmission strategies of harmful germs while creating a greater dependence on host mobility. So, while traditional methods of trying to eradicate germs may only breed stronger ones in the long run, this innovative approach of encouraging them to evolve milder forms could be a win-win situation. (Cough) Well, for the most part.

**P153 2014-10-22 Is our climate headed for a mathematical tipping point - Victor J. Do**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=153)

For most of us, two degrees Celsius is a tiny difference in temperature, not even enough to make you crack a window. But scientists have warned that as CO2 levels in the atmosphere rise, an increase in the Earth's temperature by even this amount can lead to catastrophic effects all over the world. How can such a small measurable change in one factor lead to massive and unpredictable changes in other factors? The answer lies in the concept of a mathematical tipping point, which we can understand through the familiar game of billiards. The basic rule of billiard motion is that a ball will go straight until it hits a wall, then bounce off at an angle equal to its incoming angle. For simplicity's sake, we'll assume that there is no friction, so balls can keep moving indefinitely. And to simplify the situation further, let's look at what happens with only one ball on a perfectly circular table. As the ball is struck and begins to move according to the rules, it follows a neat star-shaped pattern. If we start the ball at different locations, or strike it at different angles, some details of the pattern change, but its overall form remains the same. With a few test runs, and some basic mathematical modeling, we can even predict a ball's path before it starts moving, simply based on its starting conditions. But what would happen if we made a minor change in the table's shape by pulling it apart a bit, and inserting two small straight edges along the top and bottom? We can see that as the ball bounces off the flat sides, it begins to move all over the table. The ball is still obeying the same rules of billiard motion, but the resulting movement no longer follows any recognizable pattern. With only a small change to the constraints under which the system operates, we have shifted the billiard motion from behaving in a stable and predictable fashion, to fluctuating wildly, thus creating what mathematicians call chaotic motion. Inserting the straight edges into the table acts as a tipping point, switching the systems behavior from one type of behavior (regular), to another type of behavior (chaotic). So what implications does this simple example have for the much more complicated reality of the Earth's climate? We can think of the shape of the table as being analogous to the CO2 level and Earth's average temperature: Constraints that impact the system's performance in the form of the ball's motion or the climate's behavior. During the past 10,000 years, the fairly constant CO2 atmospheric concentration of 270 parts per million kept the climate within a self-stabilizing pattern, fairly regular and hospitable to human life. But with CO2 levels now at 400 parts per million, and predicted to rise to between 500 and 800 parts per million over the coming century, we may reach a tipping point where even a small additional change in the global average temperature would have the same effect as changing the shape of the table, leading to a dangerous shift in the climate's behavior, with more extreme and intense weather events, less predictability, and most importantly, less hospitably to human life. The hypothetical models that mathematicians study in detail may not always look like actual situations, but they can provide a framework and a way of thinking that can be applied to help understand the more complex problems of the real world. In this case, understanding how slight changes in the constraints impacting a system can have massive impacts gives us a greater appreciation for predicting the dangers that we cannot immediately percieve with our own senses. Because once the results do become visible, it may already be too late.

**P154 2014-10-27 How a wound heals itself - Sarthak Sinha**

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The largest organ in your body isn't your liver or your brain. It's your skin, with a surface area of about 20 square feet in adults. Though different areas of the skin have different characteristics, much of this surface performs similar functions, such as sweating, feeling heat and cold, and growing hair. But after a deep cut or wound, the newly healed skin will look different from the surrounding area, and may not fully regain all its abilities for a while, or at all. To understand why this happens, we need to look at the structure of the human skin. The top layer, called the epidermis, consists mostly of hardened cells, called keratinocytes, and provides protection. Since its outer layer is constantly being shed and renewed, it's pretty easy to repair. But sometimes a wound penetrates into the dermis, which contains blood vessels and the various glands and nerve endings that enable the skin's many functions. And when that happens, it triggers the four overlapping stages of the regenerative process. The first stage, hemostasis, is the skin's response to two immediate threats: that you're now losing blood and that the physical barrier of the epidermis has been compromised. As the blood vessels tighten to minimize the bleeding, in a process known as vasoconstriction, both threats are averted by forming a blood clot. A special protein known as fibrin forms cross-links on the top of the skin, preventing blood from flowing out and bacteria or pathogens from getting in. After about three hours of this, the skin begins to turn red, signaling the next stage, inflammation. With bleeding under control and the barrier secured, the body sends special cells to fight any pathogens that may have gotten through. Among the most important of these are white blood cells, known as macrophages, which devour bacteria and damage tissue through a process known as phagocytosis, in addition to producing growth factors to spur healing. And because these tiny soldiers need to travel through the blood to get to the wound site, the previously constricted blood vessels now expand in a process called vasodilation. About two to three days after the wound, the proliferative stage occurs, when fibroblast cells begin to enter the wound. In the process of collagen deposition, they produce a fibrous protein called collagen in the wound site, forming connective skin tissue to replace the fibrin from before. As epidermal cells divide to reform the outer layer of skin, the dermis contracts to close the wound. Finally, in the fourth stage of remodeling, the wound matures as the newly deposited collagen is rearranged and converted into specific types. Through this process, which can take over a year, the tensile strength of the new skin is improved, and blood vessels and other connections are strengthened. With time, the new tissue can reach from 50-80% of some of its original healthy function, depending on the severity of the initial wound and on the function itself. But because the skin does not fully recover, scarring continues to be a major clinical issue for doctors around the world. And even though researchers have made significant strides in understanding the healing process, many fundamental mysteries remain unresolved. For instance, do fibroblast cells arrive from the blood vessels or from skin tissue adjacent to the wound? And why do some other mammals, such as deer, heal their wounds much more efficiently and completely than humans? By finding the answers to these questions and others, we may one day be able to heal ourselves so well that scars will be just a memory.

**P155 2014-10-27 Ideasthesia - How do ideas feel - Danko Nikolić**

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Long before Descartes famously declared, "I think, therefore I am," and long after that, scientists and philosophers alike have puzzled over what they call the mind-body problem. Is the mind some separate, non-material entity piloting a machine of flesh? Or if it's just a particularly elusive part of our physical body, how can it translate the input of our animal senses into the seemingly non-physical experiences that we call thoughts? But though the answers have been debated endlessly, new research suggests that part of the problem lies in how we pose the question in the first place, assuming a distinction between our sensory perception and our ideas that may not really be there. The traditional model of our mental function has been that the senses provide separate data to our brain which are then translated into the appropriate mental phenomena: visual images into trees, auditory experiences into bird songs, and so on. But occasionally, we have come across people whose senses seem to mingle together, allowing them to hear colors, or taste sounds. Until recently, the common understanding was that this phenomenon, called synesthesia, was a direct connection between the parts of the brain responsible for sensory stimuli such as seeing the color yellow immediately upon hearing the tone of b flat. But newer studies have shown that synesthesia is actually mediated through our understanding of the shapes, colors and sounds that our senses apprehend. In order for the cross-sensory experiences to occur, the higher level ideas and concepts that our minds associate with the sensory input must be activated. For example, this shape can be seen as either the letter "s" or the number "5," and synesthetes associate each with different colors or sounds based on how they interpret it despite the purely visual stimulus remaining identical. In another study, synesthetes created novel color associations for unfamiliar letters after learning what the letters were. So because it relies on a connection between ideas and senses, this mental phenomenon underlying synesthesia is known as ideasthesia. Synesthesia only occurs in some people, although it may be more common than previously thought. But ideasthesia itself is a fundamental part of our lives. Virtually all of us recognize the color red as warm and blue as cold. Many would agree that bright colors, italic letters and thin lines are high-pitched, while earth tones are low-pitched. And while many of these associations are acquired through cultural exposure, others have been demonstrated even in infants and apes, suggesting that at least some associations are inborn. When asked to choose between two possible names for these shapes, people from entirely different cultural and language backgrounds overwhelmingly agree that "kiki" is the spiky star, while "bouba" is the rounded blob, both because of the sounds themselves and the shapes our mouths make to produce them. And this leads to even more associations within a rich semantic network. Kiki is described as nervous and clever, while bouba is perceived as lazy and slow. What all of this suggests is that our everyday experiences of colors, sounds and other stimuli do not live on separate sensory islands but are organized in a network of associations similar to our language network. This is what enables us to understand metaphors even though they make no logical sense, such as the comparison of snow to a white blanket, based on the shared sensations of softness and lightness. Ideasthesia may even be crucial to art, which relies on a synthesis of the conceptual and the emotional. In great art, idea and aesthesia enhance each other, whether it's song lyrics combining perfectly with a melody, the thematic content of a painting heightened by its use of colors and brushstrokes, or the well constructed plot of a novel conveyed through perfectly crafted sentences. Most importantly, the network of associations formed by ideasethesia may not only be similar to our linguistic network but may, in fact, be an integral part of it. Rather than the traditional view, where our senses first capture a collection of colors and shapes, or some vibrations in the air, and our mind then classifies them as a tree or a siren, ideasthesia suggests that the two processes occur simultaneously. Our sensory perceptions are shaped by our conceptual understanding of the world. and the two are so connected that one cannot exist without the other. If this model suggested by ideasthesia is accurate, it may have major implications for some of the biggest scientific and philosophical issues surrounding the study of mind. Without a preexisting concept of self, Descartes would not have had an "I" to attribute the thinking to. And without a preexisting network of interrelated and distinct concepts, our sensory experience of the world would be an undifferentiated mass rather than the discrete objects we actually apprehend. For science, the task is to find where this network lies, how it is formed, and how it interacts with external stimuli. For philosophy, the challenge is to rethink what this new model of consciousness means for our understanding of our selves and our relation to the world around us.

**P156 2014-10-28 How do scars form - Sarthak Sinha**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=156)

Remember the time you fell off your bike or bumped your head on a sharp corner? Childhood injuries are things we'd often like to forget, but our bodies often carry the memories in the form of scars. So what are these unwanted souvenirs and why do we keep them for so long after that unintended vacation to the emergency room? The most common place we see scars are on our skin, a patch that looks slightly different from the normal skin around it. Often, this is considered an unfortunate disfigurement, while other times, deliberate scarification has been used in both traditional and modern cultures, to mark a rite of passage or simply for aesthetic decoration. But the difference isn't only cosmetic. When we look at healthy skin tissue under a microscope, we see the cells that perform various functions connected by an extracellular matrix, or ECM. This is composed of structural proteins, like collagen, secreted by specialized fibroblast cells. Well-arranged ECM allows for transportation of nutrients, cell-to-cell communication, and cell adhesion. But when a deep wound occurs, this arrangement is disrupted. During the process of wound healing, collagen is redeposited at the wound site, but instead of the basket-weave formation found in healthy tissue, the new ECM is aligned in a single direction, impeding inter-cell processes, and reducing durability and elasticity. To make matters worse, the healed tissue contains a higher proportion of ECM than before, reducing its overall function. In the skin, the overabundance of collagen interferes with its original functions, like producing sweat, controlling body temperature and even growing hair. The scar tissue is fragile, sensitive to changes in temperature and sensation, and should be kept in moist environments to maximize healing. This presence of excessive fibrous connective tissue in an organ is known as fibrosis, and if that term sounds familiar, it's because our skin is not the only organ vulnerable to scarring. Cystic fibrosis is a genetic disorder that causes scarring of the pancreas, while pulmonary fibrosis is a scarring of the lungs, resulting in shortness of breath. Scarring of the heart and the buildup of ECM following a heart attack can inhibit its beating, leading to further heart problems. What's common to all these conditions is that although it retains some of the original functions, the scar tissue formed after a wound is inferior to the native tissue it replaces. However, there is hope. Medical researchers are now studying what causes fibroblast cells to secrete excessive amounts of collagen and how we can recruit the body's other cells in regenerating and repopulating the damaged tissue. By learning how to better control wound healing and the formation of scar tissue, we can utilize the multi-billion-dollar budgets currently used to address the aftermath of wounding in a much more efficient manner, and help millions of people live better and healthier lives. But until then, at least some of our scars can help us remember to avoid the sorts of things that cause them.

**P157 2014-10-28 What does the liver do - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=157)

There's a factory inside you that weighs about 1.4 kilograms and runs for 24 hours a day. This is your liver, the heaviest organ in your body, and one of the most crucial. This industrious structure simultaneously acts as a storehouse, a manufacturing hub, and a processing plant. And each of these functions involve so many important subtasks that without the liver, our bodies would simply stop working. One of the liver's main functions is to filter the body's blood, which it receives in regular shipments from two sources: the hepatic artery delivers blood from the heart, while the hepatic portal vein brings it from the intestine. This double delivery fills the liver with nutrients, that it then sorts, processes and stores with the help of thousands of tiny internal processing plants, known as lobules. Both blood flows also deliver the oxygen that the liver needs to function. The blood that is received from the intestine contains carbohydrates, fats, and vitamins and other nutrients dissolved in it from the food you've consumed. These must be processed in different ways. In the case of carbohydrates, the liver breaks them down and converts them into sugars for the body to use as energy when the filtered blood is sent back out. Sometimes the body has leftovers of nutrients that it doesn't immediately require. When that happens, the liver holds some back, and stacks them in its storage facility. This facility works like a pantry for future cases when the body might be in need of nutrients. But the blood flowing into the liver isn't always full of good things. It also contains toxins and byproducts that the body can't use. And the liver monitors these strictly. When it spots a useless or toxic substance, it either converts it into a product that can't hurt the body or isolates it and whisks it away, channeling it through the kidneys and intestine to be excreted. Of course, we wouldn't consider the liver a factory if it didn't also manufacture things. This organ makes everything from various blood plasma proteins that transport fatty acids and help form blood clots, to the cholesterol that helps the body create hormones. It also makes vitamin D and substances that help digestion. But one of its most vital products is bile. Like an eco-friendly treatment plant, the liver uses cells called hepatocytes to convert toxic waste products into this bitter greenish liquid. As it's produced, bile is funneled into a small container below the liver, called the gallbladder, before being trickled into the intestine to help break down fats, destroy microbes, and neutralize extra stomach acid. Bile also helps carry other toxins and byproducts from the liver out of the body. So as you can see, the liver is an extremely efficient industrial site, performing multiple tasks that support each other. But such a complex system needs to be kept running smoothly by keeping it healthy and not overloading it with more toxins than it can handle. This is one factory we simply can't afford to shut down.

**P158 2014-11-03 How to understand power - Eric Liu**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=158)

Every day of your life, you move through systems of power that other people made. Do you sense them? Do you understand power? Do you realize why it matters? Power is something we are often uncomfortable talking about. That's especially true in civic life, how we live together in community. In a democracy, power is supposed to reside with the people, period. Any further talk about power and who really has it seems a little dirty, maybe even evil. But power is no more inherently good or evil than fire or physics. It just is. It governs how any form of government works. It determines who gets to determine the rules of the game. So learning how power operates is key to being effective, being taken seriously, and not being taken advantage of. In this lesson, we'll look at where power comes from, how it's exercised and what you can do to become more powerful in public life. Let's start with a basic definition. Power is the ability to make others do what you would have them do. Of course, this plays out in all arenas of life, from family to the workplace to our relationships. Our focus is on the civic arena, where power means getting a community to make the choices and to take the actions that you want. There are six main sources of civic power. First, there's physical force and a capacity for violence. Control of the means of force, whether in the police or a militia, is power at its most primal. A second core source of power is wealth. Money creates the ability to buy results and to buy almost any other kind of power. The third form of power is state action, government. This is the use of law and bureaucracy to compel people to do or not do certain things. In a democracy, for example, we the people, theoretically, give government its power through elections. In a dictatorship, state power emerges from the threat of force, not the consent of the governed. The fourth type of power is social norms or what other people think is okay. Norms don't have the centralized machinery of government. They operate in a softer way, peer to peer. They can certainly make people change behavior and even change laws. Think about how norms around marriage equality today are evolving. The fifth form of power is ideas. An idea, individual liberties, say, or racial equality, can generate boundless amounts of power if it motivates enough people to change their thinking and actions. And so the sixth source of power is numbers, lots of humans. A vocal mass of people creates power by expressing collective intensity of interest and by asserting legitimacy. Think of the Arab Spring or the rise of the Tea Party. Crowds count. These are the six main sources of power, what power is. So now, let's think about how power operates. There are three laws of power worth examining. Law number one: power is never static. It's always either accumulating or decaying in a civic arena. So if you aren't taking action, you're being acted upon. Law number two: power is like water. It flows like a current through everyday life. Politics is the work of harnessing that flow in a direction you prefer. Policymaking is an effort to freeze and perpetuate a particular flow of power. Policy is power frozen. Law number three: power compounds. Power begets more power, and so does powerlessness. The only thing that keeps law number three from leading to a situation where only one person has all the power is how we apply laws one and two. What rules do we set up so that a few people don't accumulate too much power, and so that they can't enshrine their privilege in policy? That's the question of democracy, and you can see each of these laws at work in any news story. Low wage workers organize to get higher pay. Oil companies push to get a big pipeline approved. Gay and lesbian couples seek the legal right to marry. Urban parents demand school vouchers. You may support these efforts or not. Whether you get what you want depends on how adept you are with power, which brings us finally to what you can do to become more powerful in public life. Here, it's useful to think in terms of literacy. Your challenge is to learn how to read power and write power. To read power means to pay attention to as many texts of power as you can. I don't mean books only. I mean seeing society as a set of texts. Don't like how things are in your campus or city or country? Map out who has what kind of power, arrayed in what systems. Understand why it turned out this way, who's made it so, and who wants to keep it so. Study the strategies others in such situations used: frontal attack or indirection, coalitions or charismatic authority. Read so you may write. To write power requires first that you believe you have the right to write, to be an author of change. You do. As with any kind of writing, you learn to express yourself, speak up in a voice that's authentic. Organize your ideas, then organize other people. Practice consensus building. Practice conflict. As with writing, it's all about practice. Every day you have a chance to practice, in your neighborhood and beyond. Set objectives, then bigger ones. Watch the patterns, see what works. Adapt, repeat. This is citizenship. In this short lesson, we've explored where civic power comes from, how it works and what you can do to exercise it. One big question remaining is the "why" of power. Do you want power to benefit everyone or only you? Are your purposes pro-social or anti-social? This question isn't about strategy. It's about character, and that's another set of lessons. But remember this: Power plus character equals a great citizen, and you have the power to be one.

**P159 2014-11-05 Why elephants never forget - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=159)

It's a common saying that elephants never forget, but these magnificent animals are more than giant walking hard drives. The more we learn about elephants, the more it appears that their impressive memory is only one aspect of an incredible intelligence that makes them some of the most social, creative, and benevolent creatures on Earth. Unlike many proverbs, the one about elephant memory is scientifically accurate. Elephants know every member in their herd, able to recognize as many as 30 companions by sight or smell. This is a great help when migrating or encountering other potentially hostile elephants. They also remember and distinguish particular cues that signal danger and can recall important locations long after their last visit. But it's the memories unrelated to survival that are the most fascinating. Elephants remember not only their herd companions but other creatures who have made a strong impression on them. In one case, two circus elephants that had briefly performed together rejoiced when crossing paths 23 years later. This recognition isn't limited to others of their species. Elephants have also recognized humans they've bonded with after decades apart. All of this shows that elephant memory goes beyond responses to stimuli. Looking inside their heads, we can see why. The elephant boasts the largest brain of any land mammal, as well as an impressive encephalization quotient. This is the size of the brain relative to what we'd expect for an animal's body size, and the elephant's EQ is nearly as high as a chimpanzee's. And despite the distant relation, convergent evolution has made it remarkably similar to the human brain, with as many neurons and synapses and a highly developed hippocampus and cerebral cortex. It is the hippocampus, strongly associated with emotion, that aids recollection by encoding important experiences into long-term memories. The ability to distinguish this importance makes elephant memory a complex and adaptable faculty beyond rote memorization. It's what allows elephants who survived a drought in their youth to recognize its warning signs in adulthood, which is why clans with older matriarchs have higher survival rates. Unfortunately, it's also what makes elephants one of the few non-human animals to suffer from post-traumatic stress disorder. The cerebral cortex, on the other hand, enables problem solving, which elephants display in many creative ways. They also tackle problems cooperatively, sometimes even outwitting the researchers and manipulating their partners. And they've grasped basic arithmetic, keeping track of the relative amounts of fruit in two baskets after multiple changes. The rare combination of memory and problem solving can explain some of elephants' most clever behaviors, but it doesn't explain some of the things we're just beginning to learn about their mental lives. Elephants communicate using everything from body signals and vocalizations, to infrasound rumbles that can be heard kilometers away. And their understanding of syntax suggests that they have their own language and grammar. This sense of language may even go beyond simple communication. Elephants create art by carefully choosing and combining different colors and elements. They can also recognize twelve distinct tones of music and recreate melodies. And yes, there is an elephant band. But perhaps the most amazing thing about elephants is a capacity even more important than cleverness: their sense of empathy, altruism, and justice. Elephants are the only non-human animals to mourn their dead, performing burial rituals and returning to visit graves. They have shown concern for other species, as well. One working elephant refused to set a log down into a hole where a dog was sleeping, while elephants encountering injured humans have sometimes stood guard and gently comforted them with their trunk. On the other hand, elephant attacks on human villages have usually occurred right after massive poachings or cullings, suggesting deliberate revenge. When we consider all this evidence, along with the fact that elephants are one of the few species who can recognize themselves in a mirror, it's hard to escape the conclusion that they are conscious, intelligent, and emotional beings. Unfortunately, humanity's treatment of elephants does not reflect this, as they continue to suffer from habitat destruction in Asia, ivory poaching in Africa, and mistreatment in captivity worldwide. Given what we now know about elephants and what they continue to teach us about animal intelligence, it is more important than ever to ensure that what the English poet John Donne described as "nature's great masterpiece" does not vanish from the world's canvas.

**P160 2014-11-10 How do lungs work - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=160)

Many of us have hundreds of things on our minds at any moment, often struggling to keep track of everything we need to do. But fortunately, there's one important thing we don't have to worry about remembering: breathing. When you breathe, you transport oxygen to the body's cells to keep them working and clear your system of the carbon dioxide that this work generates. Breathing, in other words, keeps the body alive. So, how do we accomplish this crucial and complex task without even thinking about it? The answer lies in our body's respiratory system. Like any machinery, it consists of specialized components, and requires a trigger to start functioning. Here, the components are the structures and tissues making up the lungs, as well as the various other respiratory organs connected to them. And to get this machine moving, we need the autonomic nervous system, our brain's unconscious control center for the vital functions. As the body prepares to take in oxygen-rich air, this system sends a signal to the muscles around your lungs, flattening the diaphragm and contracting the intercostal muscles between your ribs to create more space for the lungs to expand. Air then wooshes into your nose and mouth, through your trachea, and into the bronchi that split at the trachea's base, with one entering each lung. Like tree branches, these small tubes divide into thousands of tinier passages called bronchioles. It's tempting to think of the lungs as huge balloons, but instead of being hollow, they're actually spongy inside, with the bronchioles running throughout the parenchyma tissue. At the end of each bronchiole is a little air sack called an alveolus, wrapped in capillaries full of red blood cells containing special proteins called hemoglobin. The air you've breathed in fills these sacks, causing the lungs to inflate. Here is where the vital exchange occurs. At this point, the capillaries are packed with carbon dioxide, and the air sacks are full of oxygen. But due to the basic process of diffusion, the molecules of each gas want to move to a place where there's a lower concentration of their kind. So as oxygen crosses over to the capillaries, the hemoglobin grabs it up, while the carbon dioxide is unloaded into the lungs. The oxygen-rich hemoglobin is then transported throughout the body via the bloodstream. But what do our lungs do with all that carbon dioxide? Exhale it, of course. The autonomic nervous system kicks in again, causing the diaphragm to ball up, and the intercostal muscles to relax, making the chest cavities smaller and forcing the lungs to compress. The carbon dioxide-rich air is expelled, and the cycle begins again. So that's how these spongy organs keep our bodies efficiently supplied with air. Lungs inhale and exhale between 15 and 25 times a minute, which amounts to an incredible 10,000 liters of air each day. That's a lot of work, but don't sweat it. Your lungs and your autonomic nervous system have got it covered.

**P161 2014-11-10 How to create cleaner coal - Emma Bryce**

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What lights up the screen that you're looking at right now? Trace back the battery chargers and power cords and you'll end up at an electrical outlet, providing easy, safe access to reliable electricity. But beyond that outlet, the picture gets messier. It takes a lot of fuel to heat our homes, preserve our food, and our power our gadgets around the clock. And for 40% of the world, that fuel is cheap, plentiful, and it's called coal. But coal also releases pollutants into the air, like sulfur dioxide, nitrogen oxides, soot, and toxic metals, like mercury. These cause environmental damage, like acid rain, and serious health problems. In fact, in 1952, coal burning caused such heavy smog in London that pedestrians couldn't even see their feet, and thousands of people died from ill health. Since then, many countries have deployed technology to remove most of these pollutants before they reach the air. But now we have a new air pollution problem on our hands, one that doesn't show up in a cloud of dark smog, but in rising seas, floods, and heat waves. It's global climate change, and again, the main culprit is coal. It's responsible for 44% of global carbon dioxide emissions, which trap the sun's heat in the Earth's atmosphere, instead of letting it escape. So now the question is how do we remove that bad stuff as well? That's the idea behind cleaner coal. Creating cleaner coal is really about trying to contain its ill effects with the help of special technologies that make the end product more acceptable. Just like the most intriguing superheroes often have their own dark powers to overcome, so we can try and keep coal's negative forces in check. But why don't we just exterminate coal if it takes that much effort to clean it up? Simply, coal is extremely valuable to us, and it's easy to come by. Compressed underground for ages, coal holds chemical energy from plants that were fed from by the sun hundreds of millions of years ago, long before humans evolved. That makes coal energy dense, meaning it can be burned 'round the clock. It's also cheap, if you ignore the pollution costs, and should last us through the end of the 21st century. We've already got all the infrastructure in place for harnessing its power, and globally, although countries are making a move towards energy from cleaner and more renewable sources, there's no sign yet that coal use is slowing down. In fact, as of 2012, over 1000 new coal plants have been proposed, mostly in China and India. Since for the time being coal is here to stay, experts say that if we want to reduce its emissions' impact on the atmosphere, and slow down climate change, we'll have to think of creative ways of reducing coal's destructive power. To do that, we need to strip it of its foul forces, all that toxic carbon dioxide that causes havoc in the atmosphere. Then, we need to store the CO2 somewhere else. This mission is called carbon capture and sequestration, or CCS. And as if carbon dioxide were some evil genie we didn't want to escape, once it has been separated from coal, we've devised ways to banish it underground. We can do this by injecting it deep into the Earth, or by placing it deep under the ocean's surface. Stripping away coal's negative elements can happen in three ways. First, and most commonly, as coal burns, the exhaust gas can be mixed with a compound called monoethanolamine. Like a forceful power-stripping magnet, this compound bonds to the CO2, yanking it out of the gas stream so it can be stored separately underground. Another method is to relieve coal of its CO2 before it even has a chance to be released as exhaust. In this process, steam and oxygen swoop in to the rescue to convert coal into a special product called syngas, made up of carbon monoxide and hydrogen and some CO2. Zap that with some water vapor, and the carbon monoxide gets converted into carbon dioxide, which can be isolated. The leftover hydrogen gas is then used as energy to generate electricity, so there's an added bonus. A third technique exposes coal to pure oxygen, instead of burning it in air. This creates exhaust gas with higher concentrations of carbon dioxide, which makes it easy to isolate and to banish to the chasms below. All this can reduce emissions at a power plant by up to 90%, but as with any superhero struggling with their destructive powers, it takes a lot of effort to switch over from the dark side. So these positive pollution-busting forces, although they're available, have barely been used in commercial power plants because they cost a lot. But ultimately, the bigger problem is that in most parts of the world, it's still too easy and much cheaper to keep emitting carbon dioxide, and that makes it tempting to completely ignore coal's dark side. In this case, the most powerful force for good is regulation, the rules that can restrict the amount of carbon dioxide emitted from power plants, and make energy companies around the world wary of what they put into the air. Until then, every time you turn on a screen or flick a light switch, coal is lurking in the background, carrying its dark powers with it wherever it goes.

**P162 2014-11-10 What are those floaty things in your eye - Michael Mauser**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=162)

Have you ever noticed something swimming in your field of vision? It may look like a tiny worm or a transparent blob, and whenever you try to get a closer look, it disappears, only to reappear as soon as you shift your glance. But don't go rinsing out your eyes! What you are seeing is a common phenomenon known as a floater. The scientific name for these objects is Muscae volitantes, Latin for "flying flies," and true to their name, they can be somewhat annoying. But they're not actually bugs or any kind of external objects at all. Rather, they exist inside your eyeball. Floaters may seem to be alive, since they move and change shape, but they are not alive. Floaters are tiny objects that cast shadows on the retina, the light-sensitive tissue at the back of your eye. They might be bits of tissue, red blood cells, or clumps of protein. And because they're suspended within the vitreous humor, the gel-like liquid that fills the inside of your eye, floaters drift along with your eye movements, and seem to bounce a little when your eye stops. Floaters may be only barely distinguishable most of the time. They become more visible the closer they are to the retina, just as holding your hand closer to a table with an overhead light will result in a more sharply defined shadow. And floaters are particularly noticeable when you are looking at a uniform bright surface, like a blank computer screen, snow, or a clear sky, where the consistency of the background makes them easier to distinguish. The brighter the light is, the more your pupil contracts. This has an effect similar to replacing a large diffuse light fixture with a single overhead light bulb, which also makes the shadow appear clearer. There is another visual phenomenon that looks similar to floaters but is in fact unrelated. If you've seen tiny dots of light darting about when looking at a bright blue sky, you've experienced what is known as the blue field entoptic phenomenon. In some ways, this is the opposite of seeing floaters. Here, you are not seeing shadows but little moving windows letting light through to your retina. The windows are actually caused by white blood cells moving through the capillaries along your retina's surface. These leukocytes can be so large that they nearly fill a capillary causing a plasma space to open up in front of them. Because the space and the white blood cells are both more transparent to blue light than the red blood cells normally present in capillaries, we see a moving dot of light wherever this happens, following the paths of your capillaries and moving in time with your pulse. Under ideal viewing conditions, you might even see what looks like a dark tail following the dot. This is the red blood cells that have bunched up behind the leukocyte. Some science museums have an exhibit which consists of a screen of blue light, allowing you to see these blue sky sprites much more clearly than you normally would. While everybody's eyes experience these sort of effects, the number and type vary greatly. In the case of floaters, they often go unnoticed, as our brain learns to ignore them. However, abnormally numerous or large floaters that interfere with vision may be a sign of a more serious condition, requiring immediate medical treatment. But the majority of the time entoptic phenomena, such as floaters and blue sky sprites, are just a gentle reminder that what we think we see depends just as much on our biology and minds as it does on the external world.

**P163 2014-11-12 The mighty mathematics of the lever - Andy Peterson and Zack Patterso**

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A famous Ancient Greek once said, "Give me a place to stand, and I shall move the Earth." But this wasn't some wizard claiming to perform impossible feats. It was the mathematician Archimedes describing the fundamental principle behind the lever. The idea of a person moving such a huge mass on their own might sound like magic, but chances are you've seen it in your everyday life. One of the best examples is something you might recognize from a childhood playground: a teeter-totter, or seesaw. Let's say you and a friend decide to hop on. If you both weigh about the same, you can totter back and forth pretty easily. But what happens if your friend weighs more? Suddenly, you're stuck up in the air. Fortunately, you probably know what to do. Just move back on the seesaw, and down you go. This may seem simple and intuitive, but what you're actually doing is using a lever to lift a weight that would otherwise be too heavy. This lever is one type of what we call simple machines, basic devices that reduce the amount of energy required for a task by cleverly applying the basic laws of physics. Let's take a look at how it works. Every lever consists of three main components: the effort arm, the resistance arm, and the fulcrum. In this case, your weight is the effort force, while your friend's weight provides the resistance force. What Archimedes learned was that there is an important relationship between the magnitudes of these forces and their distances from the fulcrum. The lever is balanced when the product of the effort force and the length of the effort arm equals the product of the resistance force and the length of the resistance arm. This relies on one of the basic laws of physics, which states that work measured in joules is equal to force applied over a distance. A lever can't reduce the amount of work needed to lift something, but it does give you a trade-off. Increase the distance and you can apply less force. Rather than trying to lift an object directly, the lever makes the job easier by dispersing its weight across the entire length of the effort and resistance arms. So if your friend weighs twice as much as you, you'd need to sit twice as far from the center as him in order to lift him. By the same token, his little sister, whose weight is only a quarter of yours, could lift you by sitting four times as far as you. Seesaws may be fun, but the implications and possible uses of levers get much more impressive than that. With a big enough lever, you can lift some pretty heavy things. A person weighing 150 pounds, or 68 kilograms, could use a lever just 3.7 meters long to balance a smart car, or a ten meter lever to lift a 2.5 ton stone block, like the ones used to build the Pyramids. If you wanted to lift the Eiffel Tower, your lever would have to be a bit longer, about 40.6 kilometers. And what about Archimedes' famous boast? Sure, it's hypothetically possible. The Earth weighs 6 x 10^24 kilograms, and the Moon that's about 384,400 kilometers away would make a great fulcrum. So all you'd need to lift the Earth is a lever with a length of about a quadrillion light years, 1.5 billion times the distance to the Andromeda Galaxy. And of course a place to stand so you can use it. So for such a simple machine, the lever is capable of some pretty amazing things. And the basic elements of levers and other simple machines are found all around us in the various instruments and tools that we, and even some other animals, use to increase our chances of survival, or just make our lives easier. After all, it's the mathematical principles behind these devices that make the world go round.

**P164 2014-11-17 How does cancer spread through the body - Ivan Seah Yu Jun**

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The onset of cancer usually begins as a solitary tumor in a specific area of the body. If the tumor is not removed, cancer has the ability to spread to nearby organs, as well as places far away from the origin, such as the brain. So how does cancer move to new areas, and why are some organs more likely to get infected than others? The process of cancer spreading across the body is known as metastasis. It begins when cancer cells from an initial tumor invade nearby normal tissue. As the cells proliferate, they spread via one of the three common routes of metastasis: transcoelomic, lymphatic, or hematogenous spread. In transcoelomic spread, malignant cells penetrate the covering surfaces of cavities in our body. These surfaces are known as peritoneum and serve as walls to segment the body cavity. Malignant cells in ovarian cancer, for example, spread through peritoneum, which connects the ovary to the liver, resulting in metastasis on the liver surface. Next, cancerous cells invade blood vessels when they undergo hematogenous spread. As there are blood vessels almost everywhere in the body, malignant cells utilize this to reach more distant parts of the body. Finally, lymphatic spread occurs when the cancer invades the lymph nodes, and travels to other parts of the body via the lymphatic system. As this system drains many parts of the body, it also provides a large network for the cancer. In addition, the lymphatic vessels empty into the blood circulation, allowing the malignant cells to undergo hematogenous spread. Once at a new site, the cells once again undergo proliferation, and form small tumors known as micrometastases. These small tumors then grow into full-fledged tumors, and complete the metastatic process. Different cancers have been known to have specific sites of metastasis. For example, prostate cancer commonly metastasizes to the bone, while colon cancer metastasizes to the liver. Various theories have been proposed to explain the migration pattern of malignant cells. Of particular interest are two conflicting theories. Stephen Paget, an English surgeon, came up with the seed and soil theory of metastasis. The seed and soil theory stated that cancer cells die easily in the wrong microenvironment, hence they only metastasize to a location with similar characteristics. However, James Ewing, the first professor of pathology at Cornell University, challenged the seed and soil theory, and proposed that the site of metastasis was determined by the location of the vascular and lymphatic channels which drain the primary tumor. Patients with primary tumors that were drained by vessels leading to the lung would eventually develop lung metastases. Today, we know that both theories contain valuable truths. Yet the full stories of metastasis is much more complicated than either of the two proposed theories. Factors like the cancer cell's properties, and the effectiveness of the immune system in eliminating the cancer cells, also play a role in determining the success of metastasis. Unfortunately, many questions about metastasis remain unanswered until today. Understanding the exact mechanism holds an important key to finding a cure for advanced stage cancers. By studying both the genetic and environmental factors, which contribute to successful metastasis, we can pinpoint ways to shut down the process. The war against cancer is a constant struggle, and scientists are hard at work developing new methods against metastasis. Of recent interest is immunotherapy, a modality which involves harnessing the power of the immune system to destroy the migrating cells. This can be done in different ways, such as training immune cells to recognize cancerous cells via vaccines. The growth and activity of the immune cells can also be stimulated by injecting man-made interleukins, chemicals which are usually secreted by the immune cells of the body. These two treatments are only the tip of the iceberg. With the collaborated research efforts of governments, companies and scientists, perhaps the process of metastasis will be stopped for good.

**P165 2014-11-24 The hidden worlds within natural history museums - Joshua Drew**

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When you think of natural history museums, you probably picture exhibits filled with ancient lifeless things, like dinosaurs meteroites, and gemstones. But behind that educational exterior, which only includes about 1% of a museum's collection, there are hidden laboratories where scientific breakthroughs are made. Beyond the unmarked doors, and on the floors the elevators won't take you to, you'd find windows into amazing worlds. This maze of halls and laboratories is a scientific sanctuary that houses a seemingly endless variety of specimens. Here, researchers work to unravel mysteries of evolution, cosmic origins, and the history of our planet. One museum alone may have millions of specimens. The American Museum of Natural History in New York City has over 32,000,000 in its collection. Let's take a look at just one of them. Scientists have logged exactly where and when it was found and used various dating techniques to pinpoint when it originated. Repeat that a million times over, and these plants, animals, minerals, fossils, and artifacts present windows into times and places around the world and across billions of years of history. When a research problem emerges, scientists peer through these windows and test hypotheses about the past. For example, in the 1950s, populations of predatory birds, like peregrine falcons, owls, and eagles started to mysteriously crash, to the point where a number of species, including the bald eagle, were declared endangered. Fortunately, scientists in The Field Museum in Chicago had been collecting the eggs of these predatory birds for decades. They discovered that the egg shells used to be thicker and had started to thin around the time when an insecticide called DDT started being sprayed on crops. DDT worked very well to kill insects, but when birds came and ate those heaps of dead bugs, the DDT accumulated in their bodies. It worked its way up the food chain and was absorbed by apex predator birds in such high concentrations that it thinned their eggs so that they couldn't support the nesting bird's weight. There were omelettes everywhere until scientists from The Field Museum in Chicago, and other institutions, helped solve the mystery and save the day. America thanks you, Field Museum. Natural history museums windows into the past have solved many other scientific mysteries. Museum scientists have used their collections to sequence the Neanderthal genome, discover genes that gave mammoths red fur, and even pinpoint where ancient giant sharks gave birth. There are about 900 natural history museums in the world, and every year they make new discoveries and insights into the Earth's past, present and future. Museum collections even help us understand how modern threats, such as global climate change, are impacting our world. For instance, naturalists have been collecting samples for over 100 years from Walden Pond, famously immortalized by Henry David Thoreau. Thanks to those naturalists, who count Thoreau among their number, we know that the plants around Walden Pond are blooming over three weeks earlier than they did 150 years ago. Because these changes have taken place gradually, one person may not have noticed them over the span of a few decades, but thanks to museum collections, we have an uninterrupted record showing how our world is changing. So the next time you're exploring a natural history museum, remember that what you're seeing is just one gem of a colossal scientific treasure trove. Behind those walls and under your feet are windows into forgotten worlds. And who knows? One day some future scientist may peer through one and see you.

**P166 2014-11-24 The pharaoh that wouldn't be forgotten - Kate Green**

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Three and a half thousand years ago in Egypt, a noble pharaoh was the victim of a violent attack. But the attack was not physical. This royal had been dead for 20 years. The attack was historical, an act of damnatio memoriae, the damnation of memory. Somebody smashed the pharaoh's statues, took a chisel and attempted to erase the pharaoh's name and image from history. Who was this pharaoh, and what was behind the attack? Here's the key: the pharaoh Hatshepsut was a woman. In the normal course of things, she should never have been pharaoh. Although it was legal for a woman to be a monarch, it disturbed some essential Egyptian beliefs. Firstly, the pharaoh was known as the living embodiment of the male god Horus. Secondly, disturbance to the tradition of rule by men was a serious challenge to Maat, a word for "truth," expressing a belief in order and justice, vital to the Egyptians. Hatshepsut had perhaps tried to adapt to this belief in the link between order and patriarchy through her titles. She took the name Maatkare, and sometimes referred to herself as Hatshepsu, with a masculine word ending. But apparently, these efforts didn't convince everyone, and perhaps someone erased Hatshepsut's image so that the world would forget the disturbance to Maat, and Egypt could be balanced again. Hatshepsut, moreover, was not the legitimate heir to the thrown, but a regent, a kind of stand-in co-monarch. The Egyptian kingship traditionally passed from father to son. It passed from Thutmose I to his son Thutmose II, Hatshepsut's husband. It should have passed from Thutmose II directly to his son Thutmose III, but Thutmose III was a little boy when his father died. Hatshepsut, the dead pharaoh's chief wife and widow, stepped in to help as her stepson's regent but ended up ruling beside him as a fully fledged pharaoh. Perhaps Thutmose III was angry about this. Perhaps he was the one who erased her images. It's also possible that someone wanted to dishonor Hatshepsut because she was a bad pharaoh. But the evidence suggests she was actually pretty good. She competently fulfilled the traditional roles of the office. She was a great builder. Her mortuary temple, Djeser-Djeseru, was an architectural phenomenon at the time and is still admired today. She enhanced the economy of Egypt, conducting a very successful trade mission to the distant land of Punt. She had strong religious connections. She even claimed to be the daughter of the state god, Amun. And she had a successful military career, with a Nubian campaign, and claims she fought alongside her soldiers in battle. Of course, we have to be careful when we assess the success of Hatshepsut's career, since most of the evidence was written by Hatshepsut herself. She tells her own story in pictures and writing on the walls of her mortuary temple and the red chapel she built for Amun. So who committed the crimes against Hatshepsut's memory? The most popular suspect is her stepson, nephew and co-ruler, Thutmose III. Did he do it out of anger because she stole his throne? This is unlikely since the damage wasn't done until 20 years after Hatshepsut died. That's a long time to hang onto anger and then act in a rage. Maybe Thutmose III did it to make his own reign look stronger. But it is most likely that he or someone else erased the images so that people would forget that a woman ever sat on Egypt's throne. This gender anomaly was simply too much of a threat to Maat and had to be obliterated from history. Happily, the ancient censors were not quite thorough enough. Enough evidence survived for us to piece together what happened, so the story of this unique powerful woman can now be told.

**P167 2014-12-01 What we know (and don't know) about Ebola - Alex Gendler**

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In the summer of 1976, a mysterious epidemic suddenly struck two central African towns, killing the majority of its victims. Medical researchers suspected the deadly Marburg virus to be the culprit. But what they saw in microscope images was an entirely new pathogen, which would be named after the nearby Ebola river. Like yellow fever or dengue, the disease caused by the Ebola virus is a severe type of hemorrhagic fever. It begins by attacking the immune system's cells and neutralizing its responses, allowing the virus to proliferate. Starting anywhere from two to twenty days after contraction, initial symptoms like high temperature, aching, and sore throat resemble those of a typical flu, but quickly escalate to vomiting, rashes, and diarrhea. And as the virus spreads, it invades the lymph nodes and vital organs, such as kidneys and liver, causing them to lose function. But the virus itself is not what kills Ebola victims. Instead, the mounting cell deaths trigger an immune system overload, known as a cytokine storm, an explosion of immune responses that damages blood vessels, causing both internal and external bleeding. The excessive fluid loss and resulting complications can be fatal within six to sixteen days of the first symptoms, though proper care and rehydration therapy can significantly reduce mortality rates in patients. Fortunately, while Ebola is highly virulent, several factors limit its contagiousness. Unlike viruses that proliferate through small, airborne particles, Ebola only exists in bodily fluids, such as saliva, blood, mucus, vomit, or feces. In order to spread, these must be transmitted from an infected person into another's body through passageways such as the eyes, mouth, or nose. And because the disease's severity increases directly along with the viral load, even an infected person is unlikely to be contagious until they have begun to show symptoms. While Ebola has been shown to survive on surfaces for several hours, and transmission through sneezing or coughing is theoretically possible, virtually all known cases of contraction have been through direct contact with the severely ill, with the greatest risk posed to medical workers and friends or relatives of the victims. This is why, despite its horrifying effects, Ebola has been far less deadly overall than more common infections, such as measles, malaria, or even influenza. Once an outbreak has been contained, the virus does not exist in the human population until the next outbreak begins. But while this is undoubtedly a good thing, it also makes Ebola difficult to study. Scientists believe fruit bats to be its natural carriers, but just how it is transmitted to humans remains unknown. Furthermore, many of the countries where Ebola outbreaks occur suffer from poor infrastructure and sanitation, which enables the disease to spread. And the poverty of these regions, combined with the relatively low amount of overall cases means there is little economic incentive for drug companies to invest in research. Though some experimental medicines have shown promise, and governments are funding development of a vaccine, as of 2014, the only widespread and effective solutions to an Ebola outbreak remain isolation, sanitation, and information.

**P168 2014-12-03 The 2,400-year search for the atom - Theresa Doud**

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What do an ancient Greek philosopher and a 19th century Quaker have in common with Nobel Prize-winning scientists? Although they are separated over 2,400 years of history, each of them contributed to answering the eternal question: what is stuff made of? It was around 440 BCE that Democritus first proposed that everything in the world was made up of tiny particles surrounded by empty space. And he even speculated that they vary in size and shape depending on the substance they compose. He called these particles "atomos," Greek for indivisible. His ideas were opposed by the more popular philosophers of his day. Aristotle, for instance, disagreed completely, stating instead that matter was made of four elements: earth, wind, water and fire, and most later scientists followed suit. Atoms would remain all but forgotten until 1808, when a Quaker teacher named John Dalton sought to challenge Aristotelian theory. Whereas Democritus's atomism had been purely theoretical, Dalton showed that common substances always broke down into the same elements in the same proportions. He concluded that the various compounds were combinations of atoms of different elements, each of a particular size and mass that could neither be created nor destroyed. Though he received many honors for his work, as a Quaker, Dalton lived modestly until the end of his days. Atomic theory was now accepted by the scientific community, but the next major advancement would not come until nearly a century later with the physicist J.J. Thompson's 1897 discovery of the electron. In what we might call the chocolate chip cookie model of the atom, he showed atoms as uniformly packed spheres of positive matter filled with negatively charged electrons. Thompson won a Nobel Prize in 1906 for his electron discovery, but his model of the atom didn't stick around long. This was because he happened to have some pretty smart students, including a certain Ernest Rutherford, who would become known as the father of the nuclear age. While studying the effects of X-rays on gases, Rutherford decided to investigate atoms more closely by shooting small, positively charged alpha particles at a sheet of gold foil. Under Thompson's model, the atom's thinly dispersed positive charge would not be enough to deflect the particles in any one place. The effect would have been like a bunch of tennis balls punching through a thin paper screen. But while most of the particles did pass through, some bounced right back, suggesting that the foil was more like a thick net with a very large mesh. Rutherford concluded that atoms consisted largely of empty space with just a few electrons, while most of the mass was concentrated in the center, which he termed the nucleus. The alpha particles passed through the gaps but bounced back from the dense, positively charged nucleus. But the atomic theory wasn't complete just yet. In 1913, another of Thompson's students by the name of Niels Bohr expanded on Rutherford's nuclear model. Drawing on earlier work by Max Planck and Albert Einstein he stipulated that electrons orbit the nucleus at fixed energies and distances, able to jump from one level to another, but not to exist in the space between. Bohr's planetary model took center stage, but soon, it too encountered some complications. Experiments had shown that rather than simply being discrete particles, electrons simultaneously behaved like waves, not being confined to a particular point in space. And in formulating his famous uncertainty principle, Werner Heisenberg showed it was impossible to determine both the exact position and speed of electrons as they moved around an atom. The idea that electrons cannot be pinpointed but exist within a range of possible locations gave rise to the current quantum model of the atom, a fascinating theory with a whole new set of complexities whose implications have yet to be fully grasped. Even though our understanding of atoms keeps changing, the basic fact of atoms remains, so let's celebrate the triumph of atomic theory with some fireworks. As electrons circling an atom shift between energy levels, they absorb or release energy in the form of specific wavelengths of light, resulting in all the marvelous colors we see. And we can imagine Democritus watching from somewhere, satisfied that over two millennia later, he turned out to have been right all along.

**P169 2014-12-05 At what moment are you dead - Randall Hayes**

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For as far back as we can trace our existence, humans have been fascinated with death and resurrection. Nearly every religion in the world has some interpretation of them, and from our earliest myths to the latest cinematic blockbusters, the dead keep coming back. But is resurrection really possible? And what is the actual difference between a living creature and a dead body, anyway? To understand what death is, we need to understand what life is. One ancient theory was an idea called vitalism, which claimed that living things were unique because they were filled with a special substance, or energy, that was the essence of life. Whether it was called qi, lifeblood, or humors, the belief in such an essence was common throughout the world, and still persists in the stories of creatures who can somehow drain life from others, or some form of magical sources that can replenish it. Vitalism began to fade in the Western world following the Scientific Revolution in the 17th century. René Descartes advanced the notion that the human body was essentially no different from any other machine, brought to life by a divinely created soul located in the brain's pineal gland. And in 1907, Dr. Duncan McDougall even claimed that the soul had mass, weighing patients immediately before and after death in an attempt to prove it. Though his experiments were discredited, much like the rest of vitalism, traces of his theory still come up in popular culture. But where do all these discredited theories leave us? What we now know is that life is not contained in some magical substance or spark, but within the ongoing biological processes themselves. And to understand these processes, we need to zoom down to the level of our individual cells. Inside each of these cells, chemical reactions are constantly occurring, powered by the glucose and oxygen that our bodies convert into the energy-carrying molecule known as ATP. Cells use this energy for everything from repair to growth to reproduction. Not only does it take a lot of energy to make the necessary molecules, but it takes even more to get them where they need to be. The universal phenomenon of entropy means that molecules will tend towards diffusing randomly, moving from areas of high concentration to low concentration, or even breaking apart into smaller molecules and atoms. So cells must constantly keep entropy in check by using energy to maintain their molecules in the very complicated formations necessary for biological functions to occur. The breaking down of these arrangements when the entire cell succumbs to entropy is what eventually results in death. This is the reason organisms can't be simply sparked back to life once they've already died. We can pump air into someone's lungs, but it won't do much good if the many other processes involved in the respiratory cycle are no longer functioning. Similarly, the electric shock from a defibrillator doesn't jump-start an inanimate heart, but resynchronizes the muscle cells in an abnormally beating heart so they regain their normal rhythm. This can prevent a person from dying, but it won't raise a dead body, or a monster sewn together from dead bodies. So it would seem that all our various medical miracles can delay or prevent death but not reverse it. But that's not as simple as it sounds because constant advancements in technology and medicine have resulted in diagnoses such as coma, describing potentially reversible conditions, under which people would have previously been considered dead. In the future, the point of no return may be pushed even further. Some animals are known to extend their lifespans or survive extreme conditions by slowing down their biological processes to the point where they are virtually paused. And research into cryonics hopes to achieve the same by freezing dying people and reviving them later when newer technology is able to help them. See, if the cells are frozen, there's very little molecular movement, and diffusion practically stops. Even if all of a person's cellular processes had already broken down, this could still conceivably be reversed by a swarm of nanobots, moving all the molecules back to their proper positions, and injecting all of the cells with ATP at the same time, presumably causing the body to simply pick up where it left off. So if we think of life not as some magical spark, but a state of incredibly complex, self-perpetuating organization, death is just the process of increasing entropy that destroys this fragile balance. And the point at which someone is completely dead turns out not to be a fixed constant, but simply a matter of how much of this entropy we're currently capable of reversing.

**P170 2014-12-09 The benefits of a good night's sleep - Shai Marcu**

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It's 4 a.m., and the big test is in eight hours, followed by a piano recital. You've been studying and playing for days, but you still don't feel ready for either. So, what can you do? Well, you can drink another cup of coffee and spend the next few hours cramming and practicing, but believe it or not, you might be better off closing the books, putting away the music, and going to sleep. Sleep occupies nearly a third of our lives, but many of us give surprisingly little attention and care to it. This neglect is often the result of a major misunderstanding. Sleep isn't lost time, or just a way to rest when all our important work is done. Instead, it's a critical function, during which your body balances and regulates its vital systems, affecting respiration and regulating everything from circulation to growth and immune response. That's great, but you can worry about all those things after this test, right? Well, not so fast. It turns out that sleep is also crucial for your brain, with a fifth of your body's circulatory blood being channeled to it as you drift off. And what goes on in your brain while you sleep is an intensely active period of restructuring that's crucial for how our memory works. At first glance, our ability to remember things doesn't seem very impressive at all. 19th century psychologist Herman Ebbinghaus demonstrated that we normally forget 40% of new material within the first twenty minutes, a phenomenon known as the forgetting curve. But this loss can be prevented through memory consolidation, the process by which information is moved from our fleeting short-term memory to our more durable long-term memory. This consolidation occurs with the help of a major part of the brain, known as the hippocampus. Its role in long-term memory formation was demonstrated in the 1950s by Brenda Milner in her research with a patient known as H.M. After having his hippocampus removed, H.M.'s ability to form new short-term memories was damaged, but he was able to learn physical tasks through repetition. Due to the removal of his hippocampus, H.M.'s ability to form long-term memories was also damaged. What this case revealed, among other things, was that the hippocampus was specifically involved in the consolidation of long-term declarative memory, such as the facts and concepts you need to remember for that test, rather than procedural memory, such as the finger movements you need to master for that recital. Milner's findings, along with work by Eric Kandel in the 90's, have given us our current model of how this consolidation process works. Sensory data is initially transcribed and temporarily recorded in the neurons as short-term memory. From there, it travels to the hippocampus, which strengthens and enhances the neurons in that cortical area. Thanks to the phenomenon of neuroplasticity, new synaptic buds are formed, allowing new connections between neurons, and strengthening the neural network where the information will be returned as long-term memory. So why do we remember some things and not others? Well, there are a few ways to influence the extent and effectiveness of memory retention. For example, memories that are formed in times of heightened feeling, or even stress, will be better recorded due to the hippocampus' link with emotion. But one of the major factors contributing to memory consolidation is, you guessed it, a good night's sleep. Sleep is composed of four stages, the deepest of which are known as slow-wave sleep and rapid eye movement. EEG machines monitoring people during these stages have shown electrical impulses moving between the brainstem, hippocampus, thalamus, and cortex, which serve as relay stations of memory formation. And the different stages of sleep have been shown to help consolidate different types of memories. During the non-REM slow-wave sleep, declarative memory is encoded into a temporary store in the anterior part of the hippocampus. Through a continuing dialogue between the cortex and hippocampus, it is then repeatedly reactivated, driving its gradual redistribution to long-term storage in the cortex. REM sleep, on the other hand, with its similarity to waking brain activity, is associated with the consolidation of procedural memory. So based on the studies, going to sleep three hours after memorizing your formulas and one hour after practicing your scales would be the most ideal. So hopefully you can see now that skimping on sleep not only harms your long-term health, but actually makes it less likely that you'll retain all that knowledge and practice from the previous night, all of which just goes to affirm the wisdom of the phrase, "Sleep on it." When you think about all the internal restructuring and forming of new connections that occurs while you slumber, you could even say that proper sleep will have you waking up every morning with a new and improved brain, ready to face the challenges ahead.

**P171 2014-12-15 The great conspiracy against Julius Caesar - Kathryn Tempest**

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What would you do if you thought your country was on the path to tyranny? If you saw one man gaining too much power, would you try to stop him? Even if that man was one of your closest friends and allies? These were the questions haunting Roman Senator Marcus Junius Brutus in 44 BCE, the year Julius Caesar would be assassinated. Opposing unchecked power wasn't just a political matter for Brutus; it was a personal one. He claimed descent from Lucius Junius Brutus, who had helped overthrow the tyrannical king known as Tarquin the Proud. Instead of seizing power himself, the elder Brutus led the people in a rousing oath to never again allow a king to rule. Rome became a republic based on the principle that no one man should hold too much power. Now, four and a half centuries later, this principle was threatened. Julius Ceasar's rise to the powerful position of consul had been dramatic. Years of military triumphs had made him the wealthiest man in Rome. And after defeating his rival Pompey the Great in a bitter civil war, his power was at its peak. His victories and initiatives, such as distributing lands to the poor, had made him popular with the public, and many senators vied for his favor by showering him with honors. Statues were built, temples were dedicated, and a whole month was renamed, still called July today. More importantly, the title of dictator, meant to grant temporary emergency powers in wartime, had been bestowed upon Caesar several times in succession. And in 44 BCE, he was made dictator perpetuo, dictator for a potentially unlimited term. All of this was too much for the senators who feared a return to the monarchy their ancestors had fought to abolish, as well as those whose own power and ambition were impeded by Caesar's rule. A group of conspirators calling themselves the liberators began to secretly discuss plans for assassination. Leading them were the senator Gaius Cassius Longinus and his friend and brother-in-law, Brutus. Joining the conspiracy was not an easy choice for Brutus. Even though Brutus had sided with Pompey in the ill-fated civil war, Caesar had personally intervened to save his life, not only pardoning him but even accepting him as a close advisor and elevating him to important posts. Brutus was hesitant to conspire against the man who had treated him like a son, but in the end, Cassius's insistence and Brutus's own fear of Caesar's ambitions won out. The moment they had been waiting for came on March 15. At a senate meeting held shortly before Caesar was to depart on his next military campaign, as many as 60 conspirators surrounded him, unsheathing daggers from their togas and stabbing at him from all sides. As the story goes, Caesar struggled fiercely until he saw Brutus. Despite the famous line, "Et tu, Brute?" written by Shakespeare, we don't know Caesar's actual dying words. Some ancient sources claim he said nothing, while others record the phrase, "And you, child?", fueling speculation that Brutus may have actually been Caesar's illegitimate son. But all agree that when Caesar saw Brutus among his attackers, he covered his face and gave up the fight, falling to the ground after being stabbed 23 times. Unfortunately for Brutus, he and the other conspirators had underestimated Caesar's popularity among the Roman public, many of whom saw him as an effective leader, and the senate as a corrupt aristocracy. Within moments of Caesar's assassination, Rome was in a state of panic. Most of the other senators had fled, while the assassins barricaded themselves on the Capitoline Hill. Mark Antony, Caesar's friend and co-consul, was swift to seize the upper hand, delivering a passionate speech at Caesar's funeral days later that whipped the crowd into a frenzy of grief and anger. As a result, the liberators were forced out of Rome. The ensuing power vacuum led to a series of civil wars, during which Brutus, facing certain defeat, took his own life. Ironically, the ultimate result would be the opposite of what the conspirators had hoped to accomplish: the end of the Republic and the concentration of power under the office of Emperor. Opinions over the assassination of Caesar were divided from the start and have remained so. As for Brutus himself, few historical figures have inspired such a conflicting legacy. In Dante's "Inferno," he was placed in the very center of Hell and eternally chewed by Satan himself for his crime of betrayal. But Swift's "Gulliver's Travels" described him as one of the most virtuous and benevolent people to have lived. The interpretation of Brutus as either a selfless fighter against dictatorship or an opportunistic traitor has shifted with the tides of history and politics. But even today, over 2000 years later, questions about the price of liberty, the conflict between personal loyalties and universal ideals, and unintended consequences remain more relevant than ever.

**P172 2014-12-15 The truth about bats - Amy Wray**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=172)

Flying through the night, I watch over this world, a silent guardian, a watchful protector, a dark knight, I'm... Okay, fine. So, I'm not Batman. I'm just a bat. But like Batman, I'm often misunderstood. People think I'm scary, strange and dangerous. If they only knew my story, though, I'd be cheered as a hero. When people think of bats, many think of vampires who want to suck their blood. But the truth is that out of over 1200 bat species, only three are vampire bats. Out of these three, only one prefers the blood of mammals, and even these bats mostly feed on cattle. Maybe that still doesn't seem so great, but vampire bats can be a great help to humans. A chemical known as desmoteplase found in vampire bat saliva helps break down blood clots, and is being tested by recovering stroke victims. Of the remaining 1000+ species of bats, about 70% feed on insects. These bats help control the real vampires: mosquitos, whose nasty bites are not just annoying but spread diseases, like West Nile virus. A single little brown bat can eat 1000 insects every hour, and a colony of Mexican free-tailed bats can eat several tons of moths in just one night. In the United States alone, bats provide an estimated 3.7 billion dollars worth of free pest control for farmers, which benefits everyone who eats the foods that they grow. Fruit bats, also called megabats because of their large size, are important for the role they play in plant pollination. By traveling between flowers while feeding on nectar and fruits, these bats transport the pollen and seeds that help plants reproduce. In Southeast Asia, for example, the cave nectar bat is the only pollinator of the durian fruit. Other bats pollinate peaches, bananas, and the agave plants that tequila is made from. Without them, many of our food plants would be unable to produce the tasty fruits we enjoy. As heroes of the ecosystem, bats have their own unique utility belts. Bats have been a source of inspiration for the design of flying robots and even an energy-efficient spy plane, as they are the only mammal capable of true powered flight. Echolocation, a type of biological sonar, is also used by bats as a way to navigate and find prey in the dark. Although there's a common misconception that bats are blind, in truth, all species of bats have sight. And some have even adapted large eyes to see better in dim lighting. Many people worry about getting infected by bats, and like any other animals, bats can carry diseases, like rabies. In reality, though, less than .5% of all bats carry this virus. That's about the same odds as getting the same result on a coin flip eight times in a row. The perception that bats are often diseased may come from the fact that sick bats, who may show unusual behavior, emerge during the daytime, or be unable to fly, are more likely to be encountered by people. So a good way to protect yourself is to protect bats as well, keeping them healthy, protecting their habitats, and reducing their risk of transmitting disease. In North America, bats are threatened by a devastating sickness called white-nose syndrome. This fungal infection causes bats to wake up while hibernating during a winter. Unable to find food, they expend large amounts of energy, and eventually starve to death. White-nose syndrome has wiped out entire caves full of bats, with a mortality rate that can exceed 90%. Climate change and habitat destruction also pose serious threats to bat populations. For example, in January 2014, a record heat wave in Australia caused over 100,000 bats to die from heat exhaustion. Some people just want to watch the world burn, and bats all over the world are threatened by damage to the places that we call home, including mangrove swamps, old-growth forests, and, of course, bat caves. So even though I'm the hero of the story, I do need to be saved. And now that you know the true story about us bats, you can learn how to protect such heroic animals. Install a properly designed bat box, one of the easiest ways to provide shelter for bats. Discourage the use of pesticides, which can harm bats when we try to feed on the insects you want to get rid of in the first place. Avoid going into caves where you might disturb hibernating bats, and always decontaminate your gear after visiting a cave. If you have unwanted bats living in an attic or barn, contact your local government to safely and humanely relocate us. And if you come across a bat, do not attempt to handle it, but instead, call Animal Control. Batman might want to keep his identity secret, but a great way to help real bats is by continuing to learn about them and spreading the truth that they are real heroes, even if their good deeds are often unseen.

**P173 2014-12-18 What is a gift economy - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=173)

This holiday season, people around the world will give and receive presents. You might even get a knitted sweater from an aunt. But what if instead of saying "thanks" before consigning it to the closet, the polite response expected from you was to show up to her house in a week with a better gift? Or to vote for her in the town election? Or let her adopt your firstborn child? All of these things might not sound so strange if you are involved in a gift economy. This phrase might seem contradictory. After all, isn't a gift given for free? But in a gift economy, gifts given without explicit conditions are used to foster a system of social ties and obligations. While the market economies we know are formed by relationships between the things being traded, a gift economy consists of the relationships between the people doing the trading. Gift economies have existed throughout human history. The first studies of the concept came from anthropologists Bronislaw Malinowski and Marcel Mauss who describe the natives of the Trobriand islands making dangerous canoe journeys across miles of ocean to exchange shell necklaces and arm bands. The items traded through this process, known as the kula ring, have no practical use, but derive importance from their original owners and carry an obligation to continue the exchange. Other gift economies may involve useful items, such as the potlatch feast of the Pacific Northwest, where chiefs compete for prestige by giving away livestock and blankets. We might say that instead of accumulating material wealth, participants in a gift economy use it to accumulate social wealth. Though some instances of gift economies may resemble barter, the difference is that the original gift is given without any preconditions or haggling. Instead, the social norm of reciprocity obligates recipients to voluntarily return the favor. But the rules for how and when to do so vary between cultures, and the return on a gift can take many forms. A powerful chief giving livestock to a poor man may not expect goods in return, but gains social prestige at the debtor's expense. And among the Toraja people of Indonesia, the status gained from gift ceremonies even determines land ownership. The key is to keep the gift cycle going, with someone always indebted to someone else. Repaying a gift immediately, or with something of exactly equal value, may be read as ending the social relationship. So, are gift economies exclusive to small-scale societies outside the industrialized world? Not quite. For one thing, even in these cultures, gift economies function alongside a market system for other exchanges. And when we think about it, parts of our own societies work in similar ways. Communal spaces, such as Burning Man, operate as a mix of barter and a gift economy, where selling things for money is strictly taboo. In art and technology, gift economies are emerging as an alternative to intellectual property where artists, musicians, and open-source developers distribute their creative works, not for financial profit, but to raise their social profile or establish their community role. And even potluck dinners and holiday gift traditions involve some degree of reciprocity and social norms. We might wonder if a gift is truly a gift if it comes with obligations or involves some social pay off. But this is missing the point. Our idea of a free gift without social obligations prevails only if we already think of everything in market terms. And in a commericalized world, the idea of strengthening bonds through giving and reciprocity may not be such a bad thing, wherever you may live.

**P174 2014-12-19 How spontaneous brain activity keeps you alive - Nathan S. Jacobs**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=174)

You probably don't need to be told how important your brain is. After all, every single thing you experience, your thoughts and your actions, your perceptions and your memories are processed here in your body's control center. But if this already seems like a lot for a single organ to handle, it's actually only a small part of what the brain does. Most of its activities are ones you'd never be aware of, unless they suddenly stopped. The brain is made up of billions of neurons, and trillions of connections. Neurons can be activated by specific stimuli or thoughts, but they are also often spontaneously active. Some fire cyclically in a set pattern. Others fire rapidly in short bursts before switching off, or remain quiet for long periods until thousands of inputs from other neurons line up in just the right way. On a large scale, this results in elaborate rhythms of internally generated brain activity, humming quietly in the background whether we're awake, asleep, or trying not to think about anything at all. And these spontaneously occurring brain functions form the foundation upon which all other brain functions rely. The most crucial of these automatically occurring activities are the ones that keep us alive. For example, while you've been paying attention to this video spontaneous activity in your brain has been maintaining your breathing at 12 to 16 breaths a minute, making sure that you don't suffocate. Without any conscious effort, signals from parts of your brainstem are sent through the spinal cord to the muscles that inflate your lungs, making them expand and contract, whether or not you're paying attention. The neuronal circuits underlying such rhythmic spontaneous activity are called central pattern generators, and control many simple repetitive behaviors, like breathing, walking, and swallowing. Ongoing neural activity also underlies our sensory perception. It may seem that the neurons in your retina that translate light into neural signals would remain quiet in the dark, but in fact, the retinal ganglion cells that communicate with the brain are always active. And the signals they send are increases and decreases in the rate of activity, rather than separate bursts. So at every level, our nervous system is teeming with spontaneous activity that helps it interpret and respond to any signals it might receive. And our brain's autopilot isn't just limited to our basic biological functions. Have you ever been on the way home, started thinking about what's for dinner, and then realized you don't remember walking for the past five minutes? While we don't understand all the details, we do know that the ongoing activity in multiple parts of your brain is somehow able to coordinate what is actually a complex task involving both cognitive and motor functions, guiding you down the right path and moving your legs while you're getting dinner figured out. But perhaps the most interesting thing about spontaneous brain function is its involvement in one of the most mysterious and poorly understood phenomena of our bodies: sleep. You may shut down and become inactive at night, but your brain doesn't. While you sleep, ongoing spontaneous activity gradually becomes more and more synchronized, eventually developing into large, rhythmic neural oscillations that envelop your brain. This transition to the more organized rhythms of sleep starts with small clusters of neurons tucked in the hypothalamus. Despite their small number, these neurons have a huge effect in turning off brainstem regions that normally keep you awake and alert, letting other parts, like the cortex and thalamus, slowly slip into their own default rhythms. The deeper we fall into sleep, the slower and more synchronized this rhythm becomes, with the deepest stages dominated by large amplitude, low frequency delta waves. But surprisingly, in the middle of this slow wave sleep, the brain's synchronized spontaneous activity repeatedly transitions into the sort of varied bursts that occur when we're wide awake. This is the sleep stage known as REM sleep, where our eyes move rapidly back and forth as we dream. Neuroscientists are still trying to answer many fundamental questions about sleep, such as its role in rejuvenating cognitive capacity, cellular homeostasis, and strengthening memory. And more broadly, they are exploring how it is that brain can accomplish such important and complex tasks, such as driving, or even breathing, without our awareness. But for now, until we are better able to understand the inner workings of their spontaneous functioning, we need to give our brains credit for being much smarter than we ourselves are.

**P175 2014-12-19 The Atlantic slave trade - What too few textbooks told you - Anthony**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=175)

Slavery, the treatment of human beings as property, deprived of personal rights, has occurred in many forms throughout the world. But one institution stands out for both its global scale and its lasting legacy. The Atlantic slave trade, occurring from the late 15th to the mid 19th century and spanning three continents, forcibly brought more than 10 million Africans to the Americas. The impact it would leave affected not only these slaves and their descendants, but the economies and histories of large parts of the world. There had been centuries of contact between Europe and Africa via the Mediterranean. But the Atlantic slave trade began in the late 1400s with Portuguese colonies in West Africa, and Spanish settlement of the Americas shortly after. The crops grown in the new colonies, sugar cane, tobacco, and cotton, were labor intensive, and there were not enough settlers or indentured servants to cultivate all the new land. American Natives were enslaved, but many died from new diseases, while others effectively resisted. And so to meet the massive demand for labor, the Europeans looked to Africa. African slavery had existed for centuries in various forms. Some slaves were indentured servants, with a limited term and the chance to buy one's freedom. Others were more like European serfs. In some societies, slaves could be part of a master's family, own land, and even rise to positions of power. But when white captains came offering manufactured goods, weapons, and rum for slaves, African kings and merchants had little reason to hesitate. They viewed the people they sold not as fellow Africans but criminals, debtors, or prisoners of war from rival tribes. By selling them, kings enriched their own realms, and strengthened them against neighboring enemies. African kingdoms prospered from the slave trade, but meeting the European's massive demand created intense competition. Slavery replaced other criminal sentences, and capturing slaves became a motivation for war, rather than its result. To defend themselves from slave raids, neighboring kingdoms needed European firearms, which they also bought with slaves. The slave trade had become an arms race, altering societies and economies across the continent. As for the slaves themselves, they faced unimaginable brutality. After being marched to slave forts on the coast, shaved to prevent lice, and branded, they were loaded onto ships bound for the Americas. About 20% of them would never see land again. Most captains of the day were tight packers, cramming as many men as possible below deck. While the lack of sanitation caused many to die of disease, and others were thrown overboard for being sick, or as discipline, the captain's ensured their profits by cutting off slave's ears as proof of purchase. Some captives took matters into their own hands. Many inland Africans had never seen whites before, and thought them to be cannibals, constantly taking people away and returning for more. Afraid of being eaten, or just to avoid further suffering, they committed suicide or starved themselves, believing that in death, their souls would return home. Those who survived were completley dehumanized, treated as mere cargo. Women and children were kept above deck and abused by the crew, while the men were made to perform dances in order to keep them exercised and curb rebellion. What happened to those Africans who reached the New World and how the legacy of slavery still affects their descendants today is fairly well known. But what is not often discussed is the effect that the Atlantic slave trade had on Africa's future. Not only did the continent lose tens of millions of its able-bodied population, but because most of the slaves taken were men, the long-term demographic effect was even greater. When the slave trade was finally outlawed in the Americas and Europe, the African kingdoms whose economies it had come to dominate collapsed, leaving them open to conquest and colonization. And the increased competition and influx of European weapons fueled warfare and instability that continues to this day. The Atlantic slave trade also contributed to the development of racist ideology. Most African slavery had no deeper reason than legal punishment or intertribal warfare, but the Europeans who preached a universal religion, and who had long ago outlawed enslaving fellow Christians, needed justification for a practice so obviously at odds with their ideals of equality. So they claimed that Africans were biologically inferior and destined to be slaves, making great efforts to justify this theory. Thus, slavery in Europe and the Americas acquired a racial basis, making it impossible for slaves and their future descendants to attain equal status in society. In all of these ways, the Atlantic slave trade was an injustice on a massive scale whose impact has continued long after its abolition.

**P176 2014-12-19 The evolution of the human eye - Joshua Harvey**

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The human eye is an amazing mechanism, able to detect anywhere from a few photons to direct sunlight, or switch focus from the screen in front of you to the distant horizon in a third of a second. In fact, the structures required for such incredible flexibility were once considered so complex that Charles Darwin himself acknowledged that the idea of there having evolved seemed absurd in the highest possible degree. And yet, that is exactly what happened, starting more than 500 million years ago. The story of the human eye begins with a simple light spot, such as the one found in single-celled organisms, like euglena. This is a cluster of light-sensitive proteins linked to the organism's flagellum, activating when it finds light and, therefore, food. A more complex version of this light spot can be found in the flat worm, planaria. Being cupped, rather than flat, enables it to better sense the direction of the incoming light. Among its other uses, this ability allows an organism to seek out shade and hide from predators. Over the millenia, as such light cups grew deeper in some organisms, the opening at the front grew smaller. The result was a pinhole effect, which increased resolution dramatically, reducing distortion by only allowing a thin beam of light into the eye. The nautilus, an ancestor of the octopus, uses this pinhole eye for improved resolution and directional sensing. Although the pinhole eye allows for simple images, the key step towards the eye as we know it is a lens. This is thought to have evolved through transparent cells covering the opening to prevent infection, allowing the inside of the eye to fill with fluid that optimizes light sensitivity and processing. Crystalline proteins forming at the surface created a structure that proved useful in focusing light at a single point on the retina. It is this lens that is the key to the eye's adaptability, changing its curvature to adapt to near and far vision. This structure of the pinhole camera with a lens served as the basis for what would eventually evolve into the human eye. Further refinements would include a colored ring, called the iris, that controls the amount of light entering the eye, a tough white outer layer, known as the sclera, to maintain its structure, and tear glands that secrete a protective film. But equally important was the accompanying evolution of the brain, with its expansion of the visual cortex to process the sharper and more colorful images it was receiving. We now know that far from being an ideal masterpiece of design, our eye bares traces of its step by step evolution. For example, the human retina is inverted, with light-detecting cells facing away from the eye opening. This results in a blind spot, where the optic nerve must pierce the retina to reach the photosensitive layer in the back. The similar looking eyes of cephalopods, which evolved independently, have a front-facing retina, allowing them to see without a blind spot. Other creatures' eyes display different adaptations. Anableps, the so called four-eyed fish, have eyes divided in two sections for looking above and under water, perfect for spotting both predators and prey. Cats, classically nighttime hunters, have evolved with a reflective layer maximizing the amount of light the eye can detect, granting them excellent night vision, as well as their signature glow. These are just a few examples of the huge diversity of eyes in the animal kingdom. So if you could design an eye, would you do it any differently? This question isn't as strange as it might sound. Today, doctors and scientists are looking at different eye structures to help design biomechanical implants for the vision impaired. And in the not so distant future, the machines built with the precision and flexibilty of the human eye may even enable it to surpass its own evolution.

**P177 2014-12-23 Could a blind eye regenerate - David Davila**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=177)

Imagine that day by day, your field of vision becomes slightly smaller, narrowing or dimming until eventually you go completely blind. We tend to think of blindness as something you're born with, but in fact, with many diseases like Retinitis pigmentosa and Usher syndrome, blindness can start developing when you're a kid, or even when you're an adult. Both of these rare genetic diseases affect the retina, the screen at the back of the eye that detects light and helps us see. Now imagine if the eye could regenerate itself so that a blind person could see again. To understand if that's possible, we need to grasp how the retina works and what it has to do with a multitalented creature named the zebrafish. The human retina is made of different layers of cells, with special neurons that live in the back of the eye called rod and cone photoreceptors. Photoreceptors convert the light coming into your eye into signals that the brain uses to generate vision. People who have Usher syndrome and retinitis pigmentosa experience a steady loss of these photoreceptors until finally that screen in the eye can no longer detect light nor broadcast signals to the brain. Unlike most of your body's cells, photoreceptors don't divide and multiply. We're born with all the photoreceptors we'll ever have, which is why babies have such big eyes for their faces and part of why they're so cute. But that isn't the case for all animals. Take the zebrafish, a master regenerator. It can grow back its skin, bones, heart and retina after they've been damaged. If photoreceptors in the zebrafish retina are removed or killed by toxins, they just regenerate and rewire themselves to the brain to restore sight. Scientists have been investigating this superpower because zebrafish retina are also structured very much like human retina. Scientists can even mimic the effects of disorders like Usher syndrome or retinitis pigmentosa on the zebrafish eye. This allows them to see how zebrafish go about repairing their retinas so they might use similar tactics to fix human eyes one day, too. So what's behind the zebrafish's superpower? The main players are sets of long cells that stretch across the retina called Müller glia. When the photoreceptors are damaged, these cells transform, taking on a new character. They become less like Müller cells and more like stem cells, which can turn into any kind of cell. Then these long cells divide, producing extras that will eventually grow into new photoreceptors, travel to the back of the eye and rewire themselves into the brain. And now some researchers even think they've found the key to how this works with the help of one of two chemicals that create activity in the brain called glutamate and aminoadipate. In mouse eyes, these make the Müller glia divide and transform into photoreceptors, which then travel to the back of the retina, like they're replenishing a failing army with new soldiers. But remember, none of this has happened in our retinas yet, so the question is how do we trigger this transformation of the Müller glia in the human eye? How can we fully control this process? How do photoreceptors rewire themselves into the retina? And is it even possible to trigger this in humans? Or has this mechanism been lost over time in evolution? Until we tease apart the origins of this ability, retinal regeneration will remain a mysterious superpower of the common zebrafish.

**P178 2014-12-23 How do vaccines work - Kelwalin Dhanasarnsombut**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=178)

In 1796, the scientist Edward Jenner injected material from a cowpox virus into an eight-year-old boy with a hunch that this would provide the protection needed to save people from deadly outbreaks of the related smallpox virus. It was a success. The eight-year-old was inoculated against the disease and this became the first ever vaccine. But why did it work? To understand how vaccines function, we need to know how the immune system defends us against contagious diseases in the first place. When foreign microbes invade us, the immune system triggers a series of responses in an attempt to identify and remove them from our bodies. The signs that this immune response is working are the coughing, sneezing, inflammation and fever we experience, which work to trap, deter and rid the body of threatening things, like bacteria. These innate immune responses also trigger our second line of defense, called adaptive immunity. Special cells called B cells and T cells are recruited to fight microbes, and also record information about them, creating a memory of what the invaders look like, and how best to fight them. This know-how becomes handy if the same pathogen invades the body again. But despite this smart response, there's still a risk involved. The body takes time to learn how to respond to pathogens and to build up these defenses. And even then, if a body is too weak or young to fight back when it's invaded, it might face very serious risk if the pathogen is particularly severe. But what if we could prepare the body's immune response, readying it before someone even got ill? This is where vaccines come in. Using the same principles that the body uses to defend itself, scientists use vaccines to trigger the body's adaptive immune system, without exposing humans to the full strength disease. This has resulted in many vaccines, which each work uniquely, separated into many different types. First, we have live attenuated vaccines. These are made of the pathogen itself but a much weaker and tamer version. Next, we have inactive vaccines, in which the pathogens have been killed. The weakening and inactivation in both types of vaccine ensures that pathogens don't develop into the full blown disease. But just like a disease, they trigger an immune response, teaching the body to recognize an attack by making a profile of pathogens in preparation. The downside is that live attenuated vaccines can be difficult to make, and because they're live and quite powerful, people with weaker immune systems can't have them, while inactive vaccines don't create long-lasting immunity. Another type, the subunit vaccine, is only made from one part of the pathogen, called an antigen, the ingredient that actually triggers the immune response. By even further isolating specific components of antigens, like proteins or polysaccharides, these vaccines can prompt specific responses. Scientists are now building a whole new range of vaccines called DNA vaccines. For this variety, they isolate the very genes that make the specific antigens the body needs to trigger its immune response to specific pathogens. When injected into the human body, those genes instruct cells in the body to make the antigens. This causes a stronger immune response, and prepares the body for any future threats, and because the vaccine only includes specific genetic material, it doesn't contain any other ingredients from the rest of the pathogen that could develop into the disease and harm the patient. If these vaccines become a success, we might be able to build more effective treatments for invasive pathogens in years to come. Just like Edward Jenner's amazing discovery spurred on modern medicine all those decades ago, continuing the development of vaccines might even allow us to treat diseases like HIV, malaria, or Ebola, one day.

**P179 2014-12-24 Einstein's miracle year - Larry Lagerstrom**

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As 1905 dawned, the soon-to-be 26-year-old Albert Einstein faced life as a failed academic. Most physicists of the time would have scoffed at the idea that this minor civil servant could have much to contribute to science. Yet within the following year, Einstein would publish not one, not two, not three, but four extraordinary papers, each on a different topic, that were destined to radically transform our understanding of the universe. The myth that Einstein had failed math is just that. He had mastered calculus on his own by the age of 15 and done well at both his Munich secondary school and at the Swiss Polytechnic, where he studied for a math and physics teaching diploma. But skipping classes to spend more time in the lab and neglecting to show proper deference to his professors had derailed his intended career path. Passed over even for a lab assistant position, he had to settle for a job at the Swiss patent office, obtained with the help of a friend's father. Working six days a week as a patent clerk, Einstein still managed to make some time for physics, discussing the latest work with a few close friends, and publishing a couple of minor papers. It came as a major surprise when in March 1905 he submitted a paper with a shocking hypothesis. Despite decades of evidence that light was a wave, Einstein proposed that it could, in fact, be a particle, showing that mysterious phenomena, such as the photoelectric effect, could be explained by his hypothesis. The idea was derided for years to come, but Einstein was simply twenty years ahead of his time. Wave-particle duality was slated to become a cornerstone of the quantum revolution. Two months later in May, Einstein submitted a second paper, this time tackling the centuries old question of whether atoms actually exist. Though certain theories were built on the idea of invisible atoms, some prominent scientists still believed them to be a useful fiction, rather than actual physical objects. But Einstein used an ingenious argument, showing that the behavior of small particles randomly moving around in a liquid, known as Brownian motion, could be precisely predicted by the collisions of millions of invisible atoms. Experiments soon confirmed Einstein's model, and atomic skeptics threw in the towel. The third paper came in June. For a long time, Einstein had been troubled by an inconsistency between two fundamental principles of physics. The well established principle of relativity, going all the way back to Galileo, stated that absolute motion could not be defined. Yet electromagnetic theory, also well established, asserted that absolute motion did exist. The discrepancy, and his inability to resolve it, left Einstein in what he described as a state of psychic tension. But one day in May, after he had mulled over the puzzle with his friend Michele Besso, the clouds parted. Einstein realized that the contradiction could be resolved if it was the speed of light that remained constant, regardless of reference frame, while both time and space were relative to the observer. It took Einstein only a few weeks to work out the details and formulate what came to be known as special relativity. The theory not only shattered our previous understanding of reality but would also pave the way for technologies, ranging from particle accelerators, to the global positioning system. One might think that this was enough, but in September, a fourth paper arrived as a "by the way" follow-up to the special relativity paper. Einstein had thought a little bit more about his theory, and realized it also implied that mass and energy, one apparently solid and the other supposedly ethereal, were actually equivalent. And their relationship could be expressed in what was to become the most famous and consequential equation in history: E=mc^2. Einstein would not become a world famous icon for nearly another fifteen years. It was only after his later general theory of relativity was confirmed in 1919 by measuring the bending of starlight during a solar eclipse that the press would turn him into a celebrity. But even if he had disappeared back into the patent office and accomplished nothing else after 1905, those four papers of his miracle year would have remained the gold standard of startling unexpected genius.

**P180 2015-01-07 How I responded to sexism in gaming with empathy - Lilian Chen**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=180)

Peking House is my family-owned Chinese restaurant in Willimantic, Connecticut, where I spent nearly 20 years growing up, before we sold it. My brother and I spent most of our time in the room in the back called "the office." "The office" was really just a storage room, but it had our gaming systems, and the game that we played the most was called Super Smash Brothers Melee. For those who don't know, Super Smash Brothers Melee is an older fighting game made for the Nintendo GameCube. My brother and I spent hours playing this game, so much that we even challenged restaurant customers to matches. Eventually, my friends dragged me out to a local tournament, where I ended up placing 13th out of 33. Not bad, but definitely far from the best. After training with higher level players, and taking notes on matches I found online, I started to travel to national tournaments, and before I knew it, I was being whisked around the United States at the age of 17, all because of a video game. Totally living the dream life, right? This is how I ran head first into the competitive Super Smash Brothers Melee community, a scene that I've been a part of for nearly ten years. I'm sure that when I say competitive gaming, you guys are imagining a room of people hunched over their laptops. Sometimes it can look like that, but more often it looks something like this. (Laughter) Because Smash Brothers Melee is such an old game, it requires those big, boxy TVs to be played on. Our players are so dedicated, that they will actually lug these things onto their flights as carry-ons. (Laughter) The community is also absurdly diverse. This is a photo of Apex, an annual tournament held in New Jersey. In 2013, over 1500 people showed up from 16 different countries. I feel like if 16 countries are flying out to New Jersey, that's saying something. Sorry, New Jersey. (Laughter) In the gaming community, I was known by my gamer tag "\_milktea," but in real life, I was still very much just Lilian. When I was 17, I was shy and quiet, and I was often bullied by my classmates for being different, for being Asian. Some of them made fun of the clothes I wore. Others asked me out on dates as a joke. Another called me a Chinese prostitute. But when I was "\_milktea," I was part of a community that welcomed and accepted me. Except what's missing from this picture? Do you see any women? When the gender imbalance is this large, social dynamics can become a bit skewed. You get a lot more attention than you normally would. [milktea is an angel] At the time, I didn't understand why I was getting this attention. I just knew that it was so much better than what I was dealing with at school. [I love Milktea.] Here's one of my favorites. [Milktea chan you are really attractive.] [If I had to rate you for beauty I give you a 8 out of 10] [Only because I've been crushing on another girl for a long time] (Laughter) But then, things took a turn for the worse. [Why is everyone blaming milktea lol?] [She is a harlot.] [She doesn't like Smash, she just wants attention.] And then you started to see comments like this. [coz you're only known in the scene for being the subject of nerdy fantasies] [suck a \*\*\*\* in crappy smasher's dreams] Over years, I began internalizing all of this, and then I took these attitudes and projected them onto other women. "Ew, why is she so girly? Is she even a real gamer?" I felt my voice shrinking and the resent growing inside of me, and eventually, I distanced myself from the Smash community altogether. Fast forward a few years. I landed my first job in New York City. There, I realized that sexist behavior didn't have to be the norm. But nevertheless, I stayed quiet and withdrawn. Public speaking? Never going to happen. (Laughter) But then, this Facebook comment appeared in my feed. [Stop chalking up the terror of the internet to the Smash community.] [In general, we're very accepting of females] I swear, at that very moment, my inner wallflower spontaneously combusted. I started writing blog posts that talked about my experiences and issues I had faced within the community, and to my surprise, they went viral within our scene. A well-known fighting game website picked up one of my posts and later on, Polygon, a gaming site, covered my future work. All of this led to the creation of The New Meta, a panel that I cofounded and moderated with the NYU Game Center. We roped in tons of women from different gaming communities to talk about issues of sexism within gaming. But the entire panel's point was to raise awareness in a way that did not shame male gamers. As a woman, I was sexist, and even misogynistic, against my own gender. Sometimes, when you've been immersed in an environment for long enough, it can be hard to differentiate between harmful behaviors and normal ones. While some gamers are intentionally malicious, some may not even realize that they're perpetuating sexist behaviors in the first place. Empathizing with these gamers is more productive than outright dismissing them. Initiate a conversation. Deconstruct these behaviors, no matter how obvious they might seem to you. And please, leave the accusatory tone behind. If I had been dismissed as a sexist neckbeard, I wouldn't be on this stage talking to you right now. And to my surprise, I found that people were willing to change, and they wanted to help. [As a guy, how to treat girls in eSports equally?] [Trying my hardest, but advice would help.] And whenever I had any doubts, I started to receive feedback like this. [I got a few female Smashers into the scene because of you.] This entire experience has shown me that my silence only further enabled sexism within gaming. Nobody is perfect. Internalizing biases and becoming lost in them is deceptively easy. By being vocal, you force yourself and those around you to reevaluate their actions and their perceptions. Everyone in this room has a voice. You have to use it, and you have to use it responsibly. Not only can you provoke change, but you can empower others to do so, too. Thank you. (Applause)

**P181 2015-01-12 Why the Arctic is climate change's canary in the coal mine - William**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=181)

The area surrounding the North Pole may seem like a frozen and desolate environment where nothing ever changes. But it is actually a complex and finely balanced natural system, and its extreme location makes it vulnerable to feedback processes that can magnify even tiny changes in the atmosphere. In fact, scientists often describe the Arctic as the canary in the coal mine when it comes to predicting the impact of climate change. One major type of climate feedback involves reflectivity. White surfaces, like snow and ice, are very effective at reflecting the sun's energy back into space, while darker land and water surfaces absorb much more incoming sunlight. When the Arctic warms just a little, some of the snow and ice melts, exposing the ground and ocean underneath. The increased heat absorbed by these surfaces causes even more melting, and so on. And although the current situation in the Arctic follows the warming pattern, the opposite is also possible. A small drop in temperatures would cause more freezing, increasing the amount of reflective snow and ice. This would result in less sunlight being absorbed, and lead to a cycle of cooling, as in previous ice ages. Arctic sea ice is also responsible for another feedback mechanism through insulation. By forming a layer on the ocean's surface, the ice acts as a buffer between the frigid arctic air and the relatively warmer water underneath. But when it thins, breaks, or melts in any spot, heat escapes from the ocean, warming the atmosphere and causing more ice to melt in turn. Both of these are examples of positive feedback loops, not because they do something good, but because the initial change is amplified in the same direction. A negative feedback loop, on the other hand, is when the initial change leads to effects that work in the opposite direction. Melting ice also causes a type of negative feedback by releasing moisture into the atmosphere. This increases the amount and thickness of clouds present, which can cool the atmosphere by blocking more sunlight. But this negative feedback loop is short-lived, due to the brief Arctic summers. For the rest of the year, when sunlight is scarce, the increased moisture and clouds actually warm the surface by trapping the Earth's heat, turning the feedback loop positive for all but a couple of months. While negative feedback loops encourage stability by pushing a system towards equilibrium, positive feedback loops destabilize it by enabling larger and larger deviations. And the recently increased impact of positive feedbacks may have consequences far beyond the Arctic. On a warming planet, these feedbacks ensure that the North Pole warms at a faster rate than the equator. The reduced temperature differences between the two regions may lead to slower jet stream winds and less linear atmospheric circulation in the middle latitudes, where most of the world's population lives. Many scientists are concerned that shifts in weather patterns will last longer and be more extreme, with short term fluctuations becoming persistent cold snaps, heat waves, droughts and floods. So the Arctic sensitivity doesn't just serve as an early warning alarm for climate change for the rest of the planet. Its feedback loops can affect us in much more direct and immediate ways. As climate scientists often warn, what happens in the Arctic doesn't always stay in the Arctic.

**P182 2015-01-16 What triggers a chemical reaction - Kareem Jarrah**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=182)

You know how sometimes you go to bake a cake but your bananas have all gone rotten, your utensils have rusted, you trip and pour all of your baking soda into the vinegar jug, and then your oven explodes? My friend, you and your chemical reactions have fallen victim to enthalpy and entropy and, boy, are they forces to be reckoned with. Now, your reactants are all products. So, what are these "E" words, and what's their big idea? Let's start with enthalpy, an increase or decrease of energy during a chemical reaction. Every molecule has a certain amount of chemical potential energy stored within the bonds between its atoms. Chemicals with more energy are less stable, and thus, more likely to react. Let's visualize the energy flow in a reaction, the combustion of hydrogen and oxygen, by playing a round of crazy golf. Our goal is to get a ball, the reactant, up a small rise and down the other much steeper slope. Where the hill goes up, we need to add energy to the ball, and where it goes down, the ball releases energy into its surroundings. The hole represents the product, or result of the reaction. When the reaction period ends, the ball is inside the hole, and we have our product: water. This, like when our oven exploded, is an exothermic reaction, meaning that the chemical's final energy is less than its starting energy, and the difference has been added to the surrounding environment as light and heat. We can also play out the opposite type of reaction, an endothermic reaction, where the final energy is greater than the starting energy. That's what we were trying to achieve by baking our cake. The added heat from the oven would change the chemical structure of the proteins in the eggs and various compounds in the butter. So that's enthalpy. As you might suspect, exothermic reactions are more likely to happen than endothermic ones because they require less energy to occur. But there's another independent factor that can make reactions happen: entropy. Entropy measures a chemical's randomness. Here's an enormous pyramid of golf balls. Its ordered structure means it has low entropy. However, when it collapses, we have chaos everywhere, balls bouncing high and wide. So much so that some even go over the hill. This shift to instability, or higher entropy, can allow reactions to happen. As with the golf balls, in actual chemicals this transition from structure to disorder gets some reactants past the hump and lets them start a reaction. You can see both enthalpy and entropy at play when you go to light a campfire to cook dinner. Your match adds enough energy to activate the exothermic reaction of combustion, converting the high-energy combustible material in the wood to lower energy carbon dioxide and water. Entropy also increases and helps the reaction along because the neat, organized log of wood is now converted into randomly moving water vapor and carbon dioxide. The energy shed by this exothermic reaction powers the endothermic reaction of cooking your dinner. Bon appétit!

**P183 2015-01-20 Why do buildings fall in earthquakes - Vicki V. May**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=183)

Earthquakes have always been a terrifying phenomenon, and they've become more deadly as our cities have grown, with collapsing buildings posing one of the largest risks. Why do buildings collapse in an earthquake, and how can it be prevented? If you've watched a lot of disaster films, you might have the idea that building collapse is caused directly by the ground beneath them shaking violently, or even splitting apart. But that's not really how it works. For one thing, most buildings are not located right on a fault line, and the shifting tectonic plates go much deeper than building foundations. So what's actually going on? In fact, the reality of earthquakes and their effect on buildings is a bit more complicated. To make sense of it, architects and engineers use models, like a two-dimensional array of lines representing columns and beams, or a single line lollipop with circles representing the building's mass. Even when simplified to this degree, these models can be quite useful, as predicting a building's response to an earthquake is primarily a matter of physics. Most collapses that occur during earthquakes aren't actually caused by the earthquake itself. Instead, when the ground moves beneath a building, it displaces the foundation and lower levels, sending shock waves through the rest of the structure and causing it to vibrate back and forth. The strength of this oscillation depends on two main factors: the building's mass, which is concentrated at the bottom, and its stiffness, which is the force required to cause a certain amount of displacement. Along with the building's material type and the shape of its columns, stiffness is largely a matter of height. Shorter buildings tend to be stiffer and shift less, while taller buildings are more flexible. You might think that the solution is to build shorter buildlings so that they shift as little as possible. But the 1985 Mexico City earthquake is a good example of why that's not the case. During the quake, many buildings between six and fifteen stories tall collapsed. What's strange is that while shorter buildings nearby did keep standing, buildings taller than fifteen stories were also less damaged, and the midsized buildings that collapsed were observed shaking far more violently than the earthquake itself. How is that possible? The answer has to do with something known as natural frequency. In an oscillating system, the frequency is how many back and forth movement cycles occur within a second. This is the inverse of the period, which is how many seconds it takes to complete one cycle. And a building's natural frequency, determined by its mass and stiffness, is the frequency that its vibrations will tend to cluster around. Increasing a building's mass slows down the rate at which it naturally vibrates, while increasing stiffness makes it vibrate faster. So in the equation representing their relationship, stiffness and natural frequency are proportional to one another, while mass and natural frequency are inversely proportional. What happened in Mexico City was an effect called resonance, where the frequency of the earthquake's seismic waves happen to match the natural frequency of the midsized buildings. Like a well-timed push on a swingset, each additional seismic wave amplified the building's vibration in its current direction, causing it to swing even further back, and so on, eventually reaching a far greater extent than the initial displacement. Today, engineers work with geologists and seismologists to predict the frequency of earthquake motions at building sites in order to prevent resonance-induced collapses, taking into account factors such as soil type and fault type, as well as data from previous quakes. Low frequencies of motion will cause more damage to taller and more flexible buildings, while high frequencies of motion pose more threat to structures that are shorter and stiffer. Engineers have also devised ways to abosrb shocks and limit deformation using innovative systems. Base isolation uses flexible layers to isolate the foundation's displacement from the rest of the building, while tuned mass damper systems cancel out resonance by oscillating out of phase with the natural frequency to reduce vibrations. In the end, it's not the sturdiest buildings that will remain standing but the smartest ones.

**P184 2015-01-23 Why Shakespeare loved iambic pentameter - David T. Freeman and Gregor**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=184)

To someone first encountering the works of William Shakespeare, the language may seem strange. But there is a secret to appreciating it. Although he was famous for his plays, Shakespeare was first and foremost a poet. One of the most important things in Shakespeare's language is his use of stress. Not that kind of stress, but the way we emphasize certain syllables in words more than others. We're so used to doing this that we may not notice it at first. But if you say the word slowly, you can easily identify them. Playwright, computer, telephone. Poets are very aware of these stresses, having long experimented with the number and order of stressed and unstressed syllables, and combined them in different ways to create rhythm in their poems. Like songwriters, poets often express their ideas through a recognizable repetition of these rhythms or poetic meter. And like music, poetry has its own set of terms for describing this. In a line of verse, a foot is a certain number of stressed and unstressed syllables forming a distinct unit, just as a musical measure consists of a certain number of beats. One line of verse is usually made up of several feet. For example, a dactyl is a metrical foot of three syllables with the first stressed, and the second and third unstressed. Dactyls can create lines that move swiftly and gather force, as in Robert Browning's poem, "The Lost Leader." "Just for a handful of silver he left us. Just for a rib and to stick in his coat." Another kind of foot is the two-syllable long trochee, a stressed syllable followed by an unstressed one. The trochees in these lines from Shakespeare's "Macbeth" lend an ominous and spooky tone to the witches' chant. "Double, double, toil and trouble; fire burn and cauldron bubble." But with Shakespeare, it's all about the iamb. This two-syllable foot is like a reverse trochee, so the first syllable is unstressed and the second is stressed, as in, "To be, or not to be." Shakespeare's favorite meter, in particular, was iambic pentameter, where each line of verse is made up of five two-syllable iambs, for a total of ten syllables. And it's used for many of Shakespeare's most famous lines: "Shall I compare thee to a summer's day?" "Arise fair sun, and kill the envious moon." Notice how the iambs cut across both punctuation and word separation. Meter is all about sound, not spelling. Iambic pentameter may sound technical, but there's an easy way to remember what it means. The word iamb is pronounced just like the phrase, "I am." Now, let's expand that to a sentence that just happens to be in iambic pentameter. "I am a pirate with a wooden leg." The pirate can only walk in iambs, a living reminder of Shakespeare's favorite meter. Iambic pentameter is when he takes ten steps. Our pirate friend can even help us remember how to properly mark it if we image the footprints he leaves walking along a deserted island beach: A curve for unstressed syllables, and a shoe outline for stressed ones. "If music be the food of love, play on." Of course, most lines of Shakespeare's plays are written in regular prose. But if you read carefully, you'll notice that Shakespeare's characters turn to poetry, and iambic pentameter in particular, for many of the same reasons that we look to poetry in our own lives. Feeling passionate, introspective, or momentous. Whether it's Hamlet pondering his existence, or Romeo professing his love, the characters switch to iambic pentameter when speaking about their emotions and their place in the world. Which leaves just one last question. Why did Shakespeare choose iambic pentameter for these moments, rather than, say, trochaic hexameter or dactylic tetrameter? It's been said that iambic pentameter was easy for his actors to memorize and for the audience to understand because it's naturally suited to the English language. But there might be another reason. The next time you're in a heightened emotional situation, like the ones that make Shakespeare's characters burst into verse, put your hand over the left side of your chest. What do you feel? That's your heart beating in iambs. Da duhm, da duhm, da duhm, da duhm, da duhm. Shakespeare's most poetic lines don't just talk about matters of the heart. They follow its rhythm.

**P185 2015-01-26 How does your smartphone know your location - Wilton L. Virgo**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=185)

How does your smartphone know exactly where you are? The answer lies 12,000 miles over your head in an orbiting satellite that keeps time to the beat of an atomic clock powered by quantum mechanics. Phew. Let's break that down. First of all, why is it so important to know what time it is on a satellite when location is what we're concerned about? The first thing your phone needs to determine is how far it is from a satellite. Each satellite constantly broadcasts radio signals that travel from space to your phone at the speed of light. Your phone records the signal arrival time and uses it to calculate the distance to the satellite using the simple formula, distance = c x time, where c is the speed of light and time is how long the signal traveled. But there's a problem. Light is incredibly fast. If we were only able to calculate time to the nearest second, every location on Earth, and far beyond, would seem to be the same distance from the satellite. So in order to calculate that distance to within a few dozen feet, we need the best clock ever invented. Enter atomic clocks, some of which are so precise that they would not gain or lose a second even if they ran for the next 300 million years. Atomic clocks work because of quantum physics. All clocks must have a constant frequency. In other words, a clock must carry out some repetitive action to mark off equivalent increments of time. Just as a grandfather clock relies on the constant swinging back and forth of a pendulum under gravity, the tick tock of an atomic clock is maintained by the transition between two energy levels of an atom. This is where quantum physics comes into play. Quantum mechanics says that atoms carry energy, but they can't take on just any arbitrary amount. Instead, atomic energy is constrained to a precise set of levels. We call these quanta. As a simple analogy, think about driving a car onto a freeway. As you increase your speed, you would normally continuously go from, say, 20 miles/hour up to 70 miles/hour. Now, if you had a quantum atomic car, you wouldn't accelerate in a linear fashion. Instead, you would instantaneously jump, or transition, from one speed to the next. For an atom, when a transition occurs from one energy level to another, quantum mechanics says that the energy difference is equal to a characteristic frequency, multiplied by a constant, where the change in energy is equal to a number, called Planck's constant, times the frequency. That characteristic frequency is what we need to make our clock. GPS satellites rely on cesium and rubidium atoms as frequency standards. In the case of cesium 133, the characteristic clock frequency is 9,192,631,770 Hz. That's 9 billion cycles per second. That's a really fast clock. No matter how skilled a clockmaker may be, every pendulum, wind-up mechanism and quartz crystal resonates at a slightly different frequency. However, every cesium 133 atom in the universe oscillates at the same exact frequency. So thanks to the atomic clock, we get a time reading accurate to within 1 billionth of a second, and a very precise measurement of the distance from that satellite. Let's ignore the fact that you're almost definitely on Earth. We now know that you're at a fixed distance from the satellite. In other words, you're somewhere on the surface of a sphere centered around the satellite. Measure your distance from a second satellite and you get another overlapping sphere. Keep doing that, and with just four measurements, and a little correction using Einstein's theory of relativity, you can pinpoint your location to exactly one point in space. So that's all it takes: a multibillion-dollar network of satellites, oscillating cesium atoms, quantum mechanics, relativity, a smartphone, and you. No problem.

**P186 2015-01-28 How do dogs 'see' with their noses - Alexandra Horowitz**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=186)

"Hi, Bob." "Morning, Kelly. The tulips looks great." Have you ever wondered how your dog experiences the world? Here's what she sees. Not terribly interesting. But what she smells, that's a totally different story. And it begins at her wonderfully developed nose. As your dog catches the first hints of fresh air, her nose's moist, spongy outside helps capture any scents the breeze carries. The ability to smell separately with each nostril, smelling in stereo, helps to determine the direction of the smell's source so that within the first few moments of sniffing, the dog starts to become aware of not just what kind of things are out there but also where they're located. As air enters the nose, a small fold of tissue divides it into two separate folds, one for breathing and one just for smelling. This second airflow enters a region filled with highly specialized olfactory receptor cells, several hundred millions of them, compaired to our five million. And unlike our clumsy way of breathing in and out through the same passage, dogs exhale through slits at the side of their nose, creating swirls of air that help draw in new odor molecules and allow odor concentration to build up over mulitple sniffs. But all that impressive nasal architecture wouldn't be much help without something to process the loads of information the nose scoops up. And it turns out that the olfactory system dedicated to proessing smells takes up many times more relative brain area in dogs than in humans. All of this allows dogs to distinguish and remember a staggering variety of specific scents at concentrations up to 100 million times less than what our noses can detect. If you can smell a spritz of perfume in a small room, a dog would have no trouble smelling it in an enclosed stadium and distinguishing its ingredients, to boot. And everything in the street, every passing person or car, any contents of the neighbor's trash, each type of tree, and all the birds and insects in it has a distinct odor profile telling your dog what it is, where it is, and which direction it's moving in. Besides being much more powerful than ours, a dog's sense of smell can pick up things that can't even be seen at all. A whole separate olfactory system, called the vomeronasal organ, above the roof of the mouth, detects the hormones all animals, Including humans, naturally release. It lets dogs identify potential mates, or distinguish between friendly and hostile animals. It alerts them to our various emotional states, and it can even tell them when someone is pregnant or sick. Because olfaction is more primal than other senses, bypassing the thalamus to connect directly to the brain structures involving emotion and instinct, we might even say a dog's perception is more immediate and visceral than ours. But the most amazing thing about your dog's nose is that it can traverse time. The past appears in tracks left by passersby, and by the warmth of a recently parked car where the residue of where you've been and what you've done recently. Landmarks like fire hydrants and trees are aromatic bulletin boards carrying messages of who's been by, what they've been eating, and how they're feeling. And the future is in the breeze, alerting them to something or someone approaching long before you see them. Where we see and hear something at a single moment, a dog smells an entire story from start to finish. In some of the best examples of canine-human collaboration, dogs help us by sharing and reacting to those stories. They can respond with kindness to people in distress, or with aggression to threats because stress and anger manifest as a cloud of hormones recognizable to the dog's nose. With the proper training, they can even alert us to invisible threats ranging from bombs to cancer. As it turns out, humanity's best friend is not one who experiences the same things we do, but one whose incredible nose reveals a whole other world beyond our eyes.

**P187 2015-01-30 Why are some people left-handed - Daniel M. Abrams**

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If you know an older left-handed person, chances are they had to learn to write or eat with their right hand. And in many parts of the world, it's still common practice to force children to use their "proper" hand. Even the word for right also means correct or good, not just in English, but many other languages, too. But if being left-handed is so wrong, then why does it happen in the first place? Today, about 1/10 of the world's population are left-handed. Archeological evidence shows that it's been that way for as long as 500,000 years, with about 10% of human remains showing the associated differences in arm length and bone density, and some ancient tools and artifacts showing evidence of left-hand use. And despite what many may think, handedness is not a choice. It can be predicted even before birth based on the fetus' position in the womb. So, if handedness is inborn, does that mean it's genetic? Well, yes and no. Identical twins, who have the same genes, can have different dominant hands. In fact, this happens as often as it does with any other sibling pair. But the chances of being right or left-handed are determined by the handedness of your parents in surprisingly consistent ratios. If your father was left-handed but your mother was right-handed, you have a 17% chance of being born left-handed, while two righties will have a left-handed child only 10% of the time. Handedness seems to be determined by a roll of the dice, but the odds are set by your genes. All of this implies there's a reason that evolution has produced this small proportion of lefties, and maintained it over the course of millennia. And while there have been several theories attempting to explain why handedness exists in the first place, or why most people are right-handed, a recent mathematical model suggests that the actual ratio reflects a balance between competitive and cooperative pressures on human evolution. The benefits of being left-handed are clearest in activities involving an opponent, like combat or competitive sports. For example, about 50% of top hitters in baseball have been left-handed. Why? Think of it as a surprise advantage. Because lefties are a minority to begin with, both right-handed and left-handed competitors will spend most of their time encountering and practicing against righties. So when the two face each other, the left-hander will be better prepared against this right-handed opponent, while the righty will be thrown off. This fighting hypothesis, where an imbalance in the population results in an advantage for left-handed fighters or athletes, is an example of negative frequency-dependent selection. But according to the principles of evolution, groups that have a relative advantage tend to grow until that advantage disappears. If people were only fighting and competing throughout human evolution, natural selection would lead to more lefties being the ones that made it until there were so many of them, that it was no longer a rare asset. So in a purely competitive world, 50% of the population would be left-handed. But human evolution has been shaped by cooperation, as well as competition. And cooperative pressure pushes handedness distribution in the opposite direction. In golf, where performance doesn't depend on the opponent, only 4% of top players are left-handed, an example of the wider phenomenon of tool sharing. Just as young potential golfers can more easily find a set of right-handed clubs, many of the important instruments that have shaped society were designed for the right-handed majority. Because lefties are worse at using these tools, and suffer from higher accident rates, they would be less successful in a purely cooperative world, eventually disappearing from the population. So by correctly predicting the distribution of left-handed people in the general population, as well as matching data from various sports, the model indicates that the persistence of lefties as a small but stable minority reflects an equilibrium that comes from competitive and cooperative effects playing out simultaneously over time. And the most intriguing thing is what the numbers can tell us about various populations. From the skewed distribution of pawedness in cooperative animals, to the slightly larger percentage of lefties in competitive hunter-gatherer societies, we may even find that the answers to some puzzles of early human evolution are already in our hands.

**P188 2015-02-04 Why do we have museums - J. V. Maranto**

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Hello, everyone. Let's begin our guided tour. Welcome to the Museum of Museums. Museums have been a part of human history for over 2000 years. But they weren't always like the ones we visit today. The history of museums is far older and much stranger than you might imagine. We'll start over here in the Greek wing. Our word museum comes from the Greek mouseion, temples built for the Muses, the goddesses of the arts and the sciences. Supplicants asked the Muses to keep watch over academics and grant ingenuity to those they deemed worthy. The temples were filled with offerings of sculptures, mosaics, complex scientific apparatuses, poetic and literary inscriptions, and any other tribute that would demonstrate a mortal's worthiness for divine inspiration. We have arrived at the Mesopotamian wing. The first museum was created in 530 B.C. in what is now Iraq. And the first curator was actually a princess. Ennigaldi-Nanna started to collect and house Mesopotamian antiquities in E-Gig-Par, her house. When archeologists excavated the area, they discovered dozens of artifacts neatly arranged in rows, with clay labels written in three languages. She must have had interesting parties. The tradition of collecting and displaying intriguing items began to be mimicked, as you can see here in the Roman Empire wing. Treasure houses of politicians and generals were filled with the spoils of war, and royal menageries displayed exotic animals to the public on special occasions, like gladiator tournaments. As you can see, we have a lion here and a gladiator, and, well, the janitor ought to be in this wing clearly. Moving on, hurry along. The next step in the evolution of museums occurred in the Renaissance, when the study of the natural world was once again encouraged after almost a millennium of Western ignorance. Curiosity cabinets, also referred to as Wunderkammers, were collections of objects that acted as a kind of physical encyclopedia, showcasing artifacts. Just step into the wardrobe here. There you go. Mind the coats. And we'll tour Ole Worm's cabinet, One of the most notable Wunderkammers belonged to a wealthy 17th-century naturalist, antiquarian, and physician Ole Worm. Ole Worm collected natural specimens, human skeletons, ancient runic texts, and artifacts from the New World. In other curiosity cabinets, you could find genetic anomalies, precious stones, works of art, and religious and historic relics. Oh my. You might not want to touch that. These cabinets were private, again, often in residencies, curated by their owners, rulers and aristocrats, as well as merchants and early scientists. Now, who hears a circus organ? In the 1840s, an enterprising young showman named Phineas T. Barnum purchased some of the more famous cabinets of curiosity from Europe and started Barnum's American Museum in New York City. A spectacular hodgepodge of zoo, lecture hall, wax museum, theater, and freak show that was known for its eclectic residents, such as bears, elephants, acrobats, giants, Siamese twins, a Fiji mermaid, and a bearded lady, along with a host of modern machinery and scientific instruments. Museums open to the public are a relatively new phenomenon. Before Barnum, the first public museums were only accessible by the upper and middle classes, and only on certain days. Visitors would have to apply to visit the museum in writing prior to admision, and only small groups could visit the museum each day. The Louvre famously allowed all members of the public into the museum but only three days a week. In the 19th century, the museum as we know it began to take shape. Institutions like the Smithsonian were started so that objects could be seen and studied, not just locked away. American museums, in particular, commissioned experiments and hired explorers to seek out and retrieve natural samples. Museums became centers for scholarship and artistic and scientific discovery. This is often called the Museum Age. Nowadays, museums are open to everybody, are centers of learning and research, and are turning into more hands-on institutions. But the question of who gets to go is still relevant as ticket prices can sometimes bar admission to those future scholars, artists and targets of divine inspiration who can't afford to satisfy their curiosity. Thank you all for coming, and please, feel free to stop by the gift shop of gift shops on your way out.

**P189 2015-02-05 How do your kidneys work - Emma Bryce**

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It's a hot day, and you've just downed several glasses of water, one after the other. Behind the sudden urge that follows are two bean-shaped organs that work as fine-tuned internal sensors. They balance the amount of fluid in your body, detect waste in your blood, and know when to release the vitamins, minerals, and hormones you need to stay alive. Say hello to your kidneys. The main role of these organs is to dispose of waste products and to turn them into urine. The body's eight liters of blood pass through the kidneys between 20 and 25 times each day, meaning that, together, these organs filter about 180 liters every 24 hours. The ingredients in your blood are constantly changing as you ingest food and drink, which explains why the kidneys need to be on permanent duty. Blood enters each kidney through arteries that branch and branch, until they form tiny vessels that entwine with special internal modules, called nephrons. In each kidney, 1 million of these nephrons form a powerful array of filters and sensors that carefully sift through the blood. This is where we see just how refined and accurate this internal sensing system is. To filter the blood, each nephron uses two powerful pieces of equipment: a blob-like structure called a glomerulus, and a long, stringy, straw-like tubule. The glomerulus works like a sieve, allowing only certain ingredients, such as vitamins and minerals, to pass into the tubule. Then, this vessel's job is to detect whether any of those ingredients are needed in the body. If so, they're reabsorbed in amounts that the body needs, so they can circulate in the blood again. But the blood doesn't only carry useful ingredients. It contains waste products, too. And the nephrons have to figure out what to do with them. The tubules sense compounds the body doesn't need, like urea, left over from the breakdown of proteins, and redirects them as urine out of the kidneys and through two long sewers called ureters. The tubes empty their contents into the bladder to be discharged, ridding your body of that waste once and for all. There's water in that urine, too. If the kidney detects too much of it in your blood, for instance, when you've chugged several glasses at once, it sends the extra liquid to the bladder to be removed. On the other hand, low water levels in the blood prompt the kidney to release some back into the blood stream, meaning that less water makes it into the urine. This is why urine appears yellower when you're less hydrated. By controlling water, your kidneys stabilize the body's fluid levels. But this fine balancing act isn't the kidney's only skill. These organs have the power to activate vitamin D to secrete a hormone called renin that raises blood pressure, and another hormone called erythropoietin, which increases red blood cell production. Without the kidneys, our bodily fluids would spiral out of control. Every time we ate, our blood would receive another load of unsifted ingredients. Soon, the buildup of waste would overload our systems and we'd expire. So each kidney not only keeps things running smoothly. It also keeps us alive. Lucky then that we have two of these magical beans.

**P190 2015-02-09 How we think complex cells evolved - Adam Jacobson**

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What if you could absorb another organism and take on its abilities? Imagine you swallowed a small bird and suddenly gained the ability to fly. Or if you engulfed a cobra and were then able to spit poisonous venom from your teeth. Throughout the history of life, specifically during the evolution of complex eukaryotic cells, things like this happened all the time. One organism absorbed another, and they united to become a new organism with the combined abilities of both. We think that around 2 billion years ago, the only living organisms on Earth were prokaryotes, single-celled organisms lacking membrane-bound organelles. Let's look closely at just three of them. One was a big, simple blob-like cell with the ability to absorb things by wrapping its cell membrane around them. Another was a bacterial cell that converted solar energy into sugar molecules through photosynthesis. A third used oxygen gas to break down materials like sugar and release its energy into a form useful for life activities. The blob cells would occasionally absorb the little photosynthetic bacteria. These bacteria then lived inside the blob and divided like they always had, but their existence became linked. If you stumbled upon this living arrangement, you might just think that the whole thing was one organism, that the green photosynthetic bacteria were just a part of the blob that performed one of its life functions, just like your heart is a part of you that performs the function of pumping your blood. This process of cells living together is called endosymbiosis, one organism living inside another. But the endosymbiosis didn't stop there. What would happen if the other bacteria moved in, too? Now the cells of this species started becoming highly complex. They were big and full of intricate structures that we call chloroplasts and mitochondria. These structures work together to harness sunlight, make sugar, and break down that sugar using the oxygen that right around this time started to appear in the Earth's atmosphere. Organisms absorbing other organisms was one way species adapted to the changing environmental conditions of their surroundings. This little story highlights what biologists call the endosymbiotic theory, the current best explanation of how complex cells evolved. There's a lot of evidence that supports this theory, but let's look at three main pieces. First, the chloroplasts and mitochondria in our cells multiply the very same way as those ancient bacteria, which are still around, by the way. In fact, if you destroy these structures in a cell, no new ones will appear. The cell can't make them. They can only make more of themselves. Second piece of evidence. Chloroplasts and mitochondria both contain their own DNA and ribosomes. Their DNA has a circular structure that is strikingly similar to the DNA of the ancient bacteria, and it also contains many similar genes. The ribosomes, or protein assembly machines of chloroplasts and mitochondria, also have the same structure as ribosomes of ancient bacteria, but are different from the ribosomes hanging around the rest of eukaryotic cell. Lastly, think about the membranes involved in the engulfing process. Chloroplasts and mitochondria both have two membranes surrounding them, an inner and outer membrane. Their inner membrane contains some particular lipids and proteins that are not present in the outer membrane. Why is that significant? Because their outer membrane used to belong to the blob cell. When they were engulfed in the endosymbiosis process, they got wrapped up in that membrane and kept their own as their inner one. Surely enough, those same lipids and proteins are found on the membranes of the ancient bacteria. Biologists now use this theory to explain the origin of the vast variety of eukaryotic organisms. Take the green algae that grow on the walls of swimming pools. A larger eukaryotic cell with spinning tail structures, or flagella, at some point absorbed algae like these to form what we now call euglena. Euglena can perform photosynthesis, break down sugar using oxygen, and swim around pond water. And as the theory would predict, the chloroplasts in these euglena have three membranes since they had two before being engulfed. The absorbing process of endosymbiotic theory allowed organisms to combine powerful abilities to become better adapted to life on Earth. The results were species capable of much more than when they were separate organisms, and this was an evolutionary leap that lead to the microorganisms, plants, and animals we observe on the planet today.

**P191 2015-02-09 The sonic boom problem - Katerina Kaouri**

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Humans have been fascinated with speed for ages. The history of human progress is one of ever-increasing velocity, and one of the most important achievements in this historical race was the breaking of the sound barrier. Not long after the first successful airplane flights, pilots were eager to push their planes to go faster and faster. But as they did so, increased turbulence and large forces on the plane prevented them from accelerating further. Some tried to circumvent the problem through risky dives, often with tragic results. Finally, in 1947, design improvements, such as a movable horizontal stabilizer, the all-moving tail, allowed an American military pilot named Chuck Yeager to fly the Bell X-1 aircraft at 1127 km/h, becoming the first person to break the sound barrier and travel faster than the speed of sound. The Bell X-1 was the first of many supersonic aircraft to follow, with later designs reaching speeds over Mach 3. Aircraft traveling at supersonic speed create a shock wave with a thunder-like noise known as a sonic boom, which can cause distress to people and animals below or even damage buildings. For this reason, scientists around the world have been looking at sonic booms, trying to predict their path in the atmosphere, where they will land, and how loud they will be. To better understand how scientists study sonic booms, let's start with some basics of sound. Imagine throwing a small stone in a still pond. What do you see? The stone causes waves to travel in the water at the same speed in every direction. These circles that keep growing in radius are called wave fronts. Similarly, even though we cannot see it, a stationary sound source, like a home stereo, creates sound waves traveling outward. The speed of the waves depends on factors like the altitude and temperature of the air they move through. At sea level, sound travels at about 1225 km/h. But instead of circles on a two-dimensional surface, the wave fronts are now concentric spheres, with the sound traveling along rays perpendicular to these waves. Now imagine a moving sound source, such as a train whistle. As the source keeps moving in a certain direction, the successive waves in front of it will become bunched closer together. This greater wave frequency is the cause of the famous Doppler effect, where approaching objects sound higher pitched. But as long as the source is moving slower than the sound waves themselves, they will remain nested within each other. It's when an object goes supersonic, moving faster than the sound it makes, that the picture changes dramatically. As it overtakes sound waves it has emitted, while generating new ones from its current position, the waves are forced together, forming a Mach cone. No sound is heard as it approaches an observer because the object is traveling faster than the sound it produces. Only after the object has passed will the observer hear the sonic boom. Where the Mach cone meets the ground, it forms a hyperbola, leaving a trail known as the boom carpet as it travels forward. This makes it possible to determine the area affected by a sonic boom. What about figuring out how strong a sonic boom will be? This involves solving the famous Navier-Stokes equations to find the variation of pressure in the air due to the supersonic aircraft flying through it. This results in the pressure signature known as the N-wave. What does this shape mean? Well, the sonic boom occurs when there is a sudden change in pressure, and the N-wave involves two booms: one for the initial pressure rise at the aircraft's nose, and another for when the tail passes, and the pressure suddenly returns to normal. This causes a double boom, but it is usually heard as a single boom by human ears. In practice, computer models using these principles can often predict the location and intensity of sonic booms for given atmospheric conditions and flight trajectories, and there is ongoing research to mitigate their effects. In the meantime, supersonic flight over land remains prohibited. So, are sonic booms a recent creation? Not exactly. While we try to find ways to silence them, a few other animals have been using sonic booms to their advantage. The gigantic Diplodocus may have been capable of cracking its tail faster than sound, at over 1200 km/h, possibly to deter predators. Some types of shrimp can also create a similar shock wave underwater, stunning or even killing pray at a distance with just a snap of their oversized claw. So while we humans have made great progress in our relentless pursuit of speed, it turns out that nature was there first.

**P192 2015-02-10 The law of conservation of mass - Todd Ramsey**

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Where does all this stuff come from? This rock? That cow? Your heart? Not the things themselves, mind you, but what they're made of: the atoms that are the fabric of all things. To answer that question, we look to the law of conservation of mass. This law says take an isolated system defined by a boundary that matter and energy cannot cross. Inside this system, mass, a.k.a. matter and energy, can neither be created nor destroyed. The universe, to the best of our knowledge, is an isolated system. But before we get to that, let's look at a much smaller and simpler one. Here we have six carbon atoms, 12 hydrogen atoms, and 18 oxygen atoms. With a little energy, our molecules can really get moving. These atoms can bond together to form familiar molecules. Here's water, and here's carbon dioxide. We can't create or destroy mass. We're stuck with what we've got, so what can we do? Ah, they have a mind of their own. Let's see. They've formed more carbon dioxide and water, six of each. Add a little energy, and we can get them to reshuffle themselves to a simple sugar, and some oxygen gas. Our atoms are all accounted for: 6 carbon, 12 hydrogen, and 18 oxygen. The energy we applied is now stored in the bonds between atoms. We can rerelease that energy by breaking that sugar back into water and carbon dioxide, and still, same atoms. Let's put a few of our atoms aside and try something a little more explosive. This here is methane, most commonly associated with cow flatulence, but also used for rocket fuel. If we add some oxygen and a little bit of energy, like you might get from a lit match, it combusts into carbon dioxide, water and even more energy. Notice our methane started with four hydrogen, and at the end we still have four hydrogen captured in two water molecules. For a grand finale, here's propane, another combustible gas. We add oxygen, light it up, and boom. More water and carbon dioxide. This time we get three CO2s because the propane molecule started with three carbon atoms, and they have nowhere else to go. There are many other reactions we can model with this small set of atoms, and the law of conservation of mass always holds true. Whatever matter and energy go into a chemical reaction are present and accounted for when it's complete. So if mass can't be created or destroyed, where did these atoms come from in the first place? Let's turn back the clock and see. Further, further, further, too far. Okay, there it is. The Big Bang. Our hydrogen formed from a high-energy soup of particles in the three minutes that followed the birth of our universe. Eventually, clusters of atoms accumulated and formed stars. Within these stars, nuclear reactions fused light elements, such as hydrogen and helium, to form heavier elements, such as carbon and oxygen. At first glance, these reactions may look like they're breaking the law because they release an astounding amount of energy, seemingly out of nowhere. However, thanks to Einstein's famous equation, we know that energy is equivalent to mass. It turns out that the total mass of the starting atoms is very slightly more than the mass of the products, and that loss of mass perfectly corresponds to the gain in energy, which radiates out from the star as light, heat and energetic particles. Eventually, this star went supernova and scattered its elements across space. Long story short, they found each other and atoms from other supernovas, formed the Earth, and 4.6 billion years later got scooped up to play their parts in our little isolated system. But they're not nearly as interesting as the atoms that came together to form you, or that cow, or this rock. And that is why, as Carl Sagan famously told us, we are all made of star stuff.

**P193 2015-02-11 History vs. Richard Nixon - Alex Gendler**

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The presidency of the United States of America is often said to be one of the most powerful positions in the world. But of all the U.S. presidents accused of misusing that power, only one has left office as a result. Does Richard Nixon deserve to be remembered for more than the scandal that ended his presidency? Find out as we put this disgraced president's legacy on trial in History vs. Richard Nixon. "Order, order. Now, who's the defendant today, some kind of crook?" "Cough. No, your Honor. This is Richard Milhous Nixon, the 37th president of the United States, who served from 1969 to 1974." "Hold on. That's a weird number of years for a president to serve." "Well, you see, President Nixon resigned for the good of the nation and was pardoned by President Ford, who took over after him." "He resigned because he was about to be impeached, and he didn't want the full extent of his crimes exposed." "And what were these crimes?" "Your Honor, the Watergate scandal was one of the grossest abuses of presidential power in history. Nixon's men broke into the Democratic National Committee headquarters to wiretap the offices and dig up dirt on opponents for the reelection campaign." "Cough It was established that the President did not order this burglary." "But as soon as he learned of it, he did everything to cover it up, while lying about it for months." "Uh, yes, but it was for the good of the country. He did so much during his time in office and could have done so much more without a scandal jeopardizing his accomplishments." "Uh, accomplishments?" "Yes, your Honor. Did you know it was President Nixon who proposed the creation of the Environmental Protection Agency, and signed the National Environmental Policy Act into law? Not to mention the Endangered Species Act, Marine Mammal Protection Act, expansion of the Clean Air Act." "Sounds pretty progressive of him." "Progressive? Hardly. Nixon's presidential campaign courted Southern voters through fear and resentment of the civil rights movement." "Speaking of civil rights, the prosecution may be surprised to learn that he signed the Title IX amendment, banning gender-based discrimination in education, and ensured that desegregation of schools occurred peacefully, and he lowered the voting age to 18, so that students could vote." "He didn't have much concern for students after four were shot by the National Guard at Kent State. Instead, he called them bums for protesting the Vietnam War, a war he had campaigned on ending." "But he did end it." "He ended it two years after taking office. Meanwhile, his campaign had sabotaged the previous president's peace talks, urging the South Vietnamese government to hold out for supposedly better terms, which, I might add, didn't materialize. So, he protracted the war for four years, in which 20,000 more U.S. troops, and over a million more Vietnamese, died for nothing." "Hmm, a presidential candidate interfering in foreign negotiations -- isn't that treason?" "It is, your Honor, a clear violation of the Logan Act of 1799." "Uh, I think we're forgetting President Nixon's many foreign policy achievements. It was he who normalized ties with China, forging economic ties that continue today." "Are we so sure that's a good thing? And don't forget his support of the coup in Chile that replaced the democratically-elected President Allende with a brutal military dictator." "It was part of the fight against communism." "Weren't tyranny and violence the reasons we opposed communism to begin with? Or was it just fear of the lower class rising up against the rich?" "President Nixon couldn't have predicted the violence of Pinochet's regime, and being anti-communist didn't mean neglecting the poor. He proposed a guaranteed basic income for all American families, still a radical concept today. And he even pushed for comprehensive healthcare reform, just the kind that passed 40 years later." "I'm still confused about this burglary business. Was he a crook or not?" "Your Honor, President Nixon may have violated a law or two, but what was the real harm compared to all he accomplished while in office?" "The harm was to democracy itself. The whole point of the ideals Nixon claimed to promote abroad is that leaders are accountable to the people, and when they hold themselves above the law for whatever reason, those ideals are undermined." "And if you don't hold people accountable to the law, I'll be out of a job." Many politicians have compromised some principles to achieve results, but law-breaking and cover-ups threaten the very fabric the nation is built on. Those who do so may find their entire legacy tainted when history is put on trial.

**P194 2015-02-17 Did Shakespeare write his plays - Natalya St. Clair and Aaron William**

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"Some are born great, some achieve greatness, and others have greatness thrust upon them", quoth William Shakespeare. Or did he? Some people question whether Shakespeare really wrote the works that bear his name, or whether he even existed at all. They speculate that Shakespeare was a pseudonym for another writer, or a group of writers. Proposed candidates for the real Shakespeare include other famous playwrights, politicians and even some prominent women. Could it be true that the greatest writer in the English language was as fictional as his plays? Most Shakespeare scholars dismiss these theories based on historical and biographical evidence. But there is another way to test whether Shakespeare's famous lines were actually written by someone else. Linguistics, the study of language, can tell us a great deal about the way we speak and write by examining syntax, grammar, semantics and vocabulary. And in the late 1800s, a Polish philosopher named Wincenty Lutosławski formalized a method known as stylometry, applying this knowledge to investigate questions of literary authorship. So how does stylometry work? The idea is that each writer's style has certain characteristics that remain fairly uniform among individual works. Examples of characteristics include average sentence length, the arrangement of words, and even the number of occurrences of a particular word. Let's look at use of the word thee and visualize it as a dimension, or axis. Each of Shakespeare's works can be placed on that axis, like a data point, based on the number of occurrences of that word. In statistics, the tightness of these points gives us what is known as the variance, an expected range for our data. But, this is only a single characteristic in a very high-dimensional space. With a clustering tool called Principal Component Analysis, we can reduce the multidimensional space into simple principal components that collectively measure the variance in Shakespeare's works. We can then test the works of our candidates against those principal components. For example, if enough works of Francis Bacon fall within the Shakespearean variance, that would be pretty strong evidence that Francis Bacon and Shakespeare are actually the same person. What did the results show? Well, the stylometrists who carried this out have concluded that Shakespeare is none other than Shakespeare. The Bard is the Bard. The pretender's works just don't match up with Shakespeare's signature style. However, our intrepid statisticians did find some compelling evidence of collaborations. For instance, one recent study concluded that Shakespeare worked with playwright Christopher Marlowe on "Henry VI," parts one and two. Shakespeare's identity is only one of the many problems stylometry can resolve. It can help us determine when a work was written, whether an ancient text is a forgery, whether a student has committed plagiarism, or if that email you just received is of a high priority or spam. And does the timeless poetry of Shakespeare's lines just boil down to numbers and statistics? Not quite. Stylometric analysis may reveal what makes Shakespeare's works structurally distinct, but it cannot capture the beauty of the sentiments and emotions they express, or why they affect us the way they do. At least, not yet.

**P195 2015-02-26 Rhythm in a box - The story of the cajon drum - Paul Jennings**

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Many modern musical instruments are cumbersome or have a lot of parts. Some need a stand or a stool. But the cajon is a drum, a stand and a seat all in one convenient box. And this simplicity may be key to its journey across continents and cultures to become one of the most popular percussion instruments in the world today. The cajon's story begins in West Africa, whose indigenousness people had rich musical traditions centered on drumming and dancing. When many of them were captured and brought to the Americas as slaves, they brought this culture with them, but without their native instruments, they had to improvise. African slaves in coastal Peru didn't have the materials or the opportunity to craft one of their traditional drums such as a djembe or a djun djun. But what they did have were plenty of shipping crates. Not only were these readily accessible, but their inconspicuous appearance may have helped get around laws prohibiting slaves from playing music. Early Peruvian cajons consisted of a simple box with five thick wooden sides. The sixth side, made of a thinner sheet of wood, would be used as the striking surface, or more commonly known as the tapa. A sound hole was also cut into the back to allow the sound to escape. As an Afro-Peruvian culture developed, and new forms of music and dance, such as Zamacueca, Festejo and Landó were born, the cajon became a dedicated musical instrument in its own right. Early modifications involved simply bending the planks of the box to tweak the sound, and when abolition of slavery introduced the cajon to a broader population, more improvisation and experimentation soon followed. Perhaps the person most responsible for introducing the cajon to European audiences was Spanish Flamenco guitarist Paco de Lucía. When touring in Peru in 1977, he and his percussionist Rubem Dantas discovered the cajon and brought it back to Spain, recognizing its potential for use in Flamenco music. By stretching guitar strings along the inside of the tapa, the flamenco musicians were able to create a buzz-like snare sound. Combined with the regular base tone, this gave the cajon a sound close to a basic drum set. The cajon quickly caught on, not only becoming standard in Flamenco, but being used in genres like folk, jazz, blues and rock. Today, many specialized cajons are manufactured, some with adjustable strings, some with multiple playing surfaces, and some with a snare mechansim. But the basic concept remains the same, and the story of the cajon shows that the simplest things can have the most amazing potential when you think outside and inside the box.

**P196 2015-02-27 Why sitting is bad for you - Murat Dalkilinç**

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Right now, you're probably sitting down to watch this video and staying seated for a few minutes to view it is probably okay. But the longer you stay put, the more agitated your body becomes. It sits there counting down the moments until you stand up again and take it for a walk. That may sound ridiculous. Our bodies love to sit, right? Not really. Sure, sitting for brief periods can help us recover from stress or recuperate from exercise. But nowadays, our lifestyles make us sit much more than we move around, and our bodies simply aren't built for such a sedentary existence. In fact, just the opposite is true. The human body is built to move, and you can see evidence of that in the way it's structured. Inside us are over 360 joints, and about 700 skeletal muscles that enable easy, fluid motion. The body's unique physical structure gives us the ability to stand up straight against the pull of gravity. Our blood depends on us moving around to be able to circulate properly. Our nerve cells benefit from movement, and our skin is elastic, meaning it molds to our motions. So if every inch of the body is ready and waiting for you to move, what happens when you just don't? Let's start with the backbone of the problem, literally. Your spine is a long structure made of bones and the cartilage discs that sit between them. Joints, muscles and ligaments that are attached to the bones hold it all together. A common way of sitting is with a curved back and slumped shoulders, a position that puts uneven pressure on your spine. Over time, this causes wear and tear in your spinal discs, overworks certain ligaments and joints, and puts strain on muscles that stretch to accommodate your back's curved position. This hunched shape also shrinks your chest cavity while you sit, meaning your lungs have less space to expand into when you breath. That's a problem because it temporarily limits the amount of oxygen that fills your lungs and filters into your blood. Around the skeleton are the muscles, nerves, arteries and veins that form the body's soft tissue layers. The very act of sitting squashes, pressurizes and compresses, and these more delicate tissues really feel the brunt. Have you ever experienced numbness and swelling in your limbs when you sit? In areas that are the most compressed, your nerves, arteries and veins can become blocked, which limits nerve signaling, causing the numbness, and reduces blood flow in your limbs, causing them to swell. Sitting for long periods also temporarily deactivates lipoprotein lipase, a special enzyme in the walls of blood capillaries that breaks down fats in the blood, so when you sit, you're not burning fat nearly as well as when you move around. What effect does all of this stasis have on the brain? Most of the time, you probably sit down to use your brain, but ironically, lengthy periods of sitting actually run counter to this goal. Being stationary reduces blood flow and the amount of oxygen entering your blood stream through your lungs. Your brain requires both of those things to remain alert, so your concentration levels will most likely dip as your brain activity slows. Unfortunately, the ill effects of being seated don't only exist in the short term. Recent studies have found that sitting for long periods is linked with some types of cancers and heart disease and can contribute to diabetes, kidney and liver problems. In fact, researchers have worked out that, worldwide, inactivity causes about 9% of premature deaths a year. That's over 5 million people. So what seems like such a harmless habit actually has the power to change our health. But luckily, the solutions to this mounting threat are simple and intuitive. When you have no choice but to sit, try switching the slouch for a straighter spine, and when you don't have to be bound to your seat, aim to move around much more, perhaps by setting a reminder to yourself to get up every half hour. But mostly, just appreciate that bodies are built for motion, not for stillness. In fact, since the video's almost over, why not stand up and stretch right now? Treat your body to a walk. It'll thank you later.

**P197 2015-03-02 How does the thyroid manage your metabolism - Emma Bryce**

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Nestled in the tissues of your neck is a small unassuming organ that wields enormous power over your body. It's called the thyroid. Like the operations manager in a company, its role is to make sure that the cells in your body are working properly. It does that by using hormones to deliver messages to every single one of them. This high-ranking organ is made up of lobules that each contains smaller cells called follicles, which store the hormones the thyroid sends out into your blood. Two of the most important hormones it produces are thyroxine and triiodothyronine, or T3 and T4. As messengers, the hormone's job is to instruct every cell in the body when to consume oxygen and nutrients. That maintains the body's metabolism, the series of reactions our cells perform to provide us with energy. This hormonal notification from the thyroid gets the heart pumping more efficiently, and makes our cells break down nutrients faster. When you need more energy, the thyroid helps by sending out hormones to increase metabolism. Ultimately, the thyroid allows our cells to use energy, grow and reproduce. The thyroid is controlled by the pituitary gland, a hormonal gland deep in the brain that oversees the thyroid's tasks, making sure it knows when to send out its messengers. The pituitary's role is to sense if hormone levels in the blood are too low or too high, in which case it sends out instructions in the form of the thyroid- stimulating hormone. Even in this tightly controlled system, however, management sometimes slips up. Certain diseases, growths in the thryoid or chemical imbalances in the body can confuse the organ and make it deaf to the pituitary's guiding commands. The first problem this causes is hyperthyroidism, which happens when the organ sends out too many hormones. That means the cells are overloaded with instructions to consume nutrients and oxygen. They become overactive as a result, meaning a person with hyperthyroidism experiences a higher metabolism signaled by a faster heartbeat, constant hunger, and rapid weight loss. They also feel hot, sweaty, anxious, and find it difficult to sleep. The opposite problem is hypothyroidism, which happens when the thyroid sends out too few hormones, meaning the body's cells don't have as many messengers to guide them. In response, cells grow listless and metabolism slows. People with hypothyroidism see symptoms in weight gain, sluggishness, sensitivity to cold, swollen joints and feeling low. Luckily, there are medical treatments that can help trigger the thyroid's activities again, and bring the body back to a steady metabolic rate. For such a little organ, the thyroid wields an awful lot of power. But a healthy thyroid manages our cells so effectively that it can keep us running smoothly without us even noticing it's there.

**P198 2015-03-02 Learning from smallpox - How to eradicate a disease - Julie Garon and**

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For most of human history, medical workers sought to treat diseases or cure them. The rise of vaccination in the 19th century enhanced the potential to prevent people from contracting illnesses in the first place. But only in recent decades did it become possible to ensure that a particular disease never threatens humanity again. The story of smallpox, the first and, so far, the only disease to be permanently eradicated from the world, shows how disease eradication can happen and why it is so difficult to achieve. Smallpox emerged in human populations thousands of years ago as a contagious virus that spread rapidly, primarily through close, face to face contact, causing fever, aches and rashes. It killed up to 30% of its victims and often left survivors with life-long disfiguring scars. The devastating impact of smallpox was so great that several cultures had religious deities specifically dedicated to it. In the 20th century alone, it is estimated to have killed more than 300 million people worldwide. With the effective deployment of vaccination, the number of cases began to decrease. By seeking out infected individuals, isolating them, and vaccinating their contacts to prevent further transmission, scientists realized that the spread of the disease could be haulted. In fact, because smallpox could only survive in human hosts, vaccinating all of an infected persons' potential contacts would stop the virus dead in its tracks and eliminate it from that region. Once this strategy had succeeded in ridding most industrialized countries from disease, health officials realized that eradicating it worldwide was within reach. But this was not an easy process, proving especially difficult in places suffering from poor infrastructure or civil wars. The eradication effort took decades and involved millions of people working together, from world leaders and international organizations to rural doctors and community workers. In India, one of the last strongholds of the disease, health workers visited every one of the country's 100 million households to search for cases. Through this unprecedented worldwide effort, in which even rival superpowers cooperated, smallpox was finally declared eradicated in 1980, saving approximately 40 million lives over the following two decades. There were several factors that made smallpox an ideal candidate for eradication. First, humans are essential to the smallpox lifecycle, so breaking the chain of human to human transmission causes the virus to die out. In contrast, many other pathogens, like ebola or the bubonic plague, can survive in animal carriers, while the bacteria that cause tetanus can even live in the soil. Secondly, individuals infected with smallpox displayed a characteristic rash, making them easy to identify, even without a lab test. The lack of such practical diagnostic tools for diseases with non-specific symptoms, or that have long incubation periods, such as AIDS, makes their eradication more difficult. Third, the availability of a smallpox vaccine that provided immunity for five to ten years in a single dose meant that there was an effective intervention to stop the virus from spreading. And finally, the initial success of several countries in eliminating the disease within their borders served as a proof of principle for its eradication worldwide. Today, the same criteria are applied to determine whether other diseases can be similarly eliminated. And even though smallpox remains the only success story thus far, several other pathogens may be next in line. Great progress has been made towards eradicating guinea worm disease simply by use of water filters. And vaccination for polio, which previously disabled hundreds of thousands of people each year is estimated to have prevented 13 million cases of paralysis, and 650,000 deaths since 1988. With a 99% drop in infections since the eradication effort began, one final push is all that is needed to ensure that polio will never paralyze another child. Disease eradication is one public health effort that benefits all of humanity and challenges us to work together as a global community. Beyond eliminating specific diseases, eradication programs benefit local populations by improving health infrastructure. For example, Nigeria recently used facilities and personnel from their polio eradication program to effectively control an ebola outbreak. Further more, globalization and international travel means that even a single infection anywhere in the world can potentially spread to other regions. By helping to protect others, we help to protect ourselves. Disease eradication is the ultimate gift we can give to everyone alive today, as well as all future generations of humanity.

**P199 2015-03-03 How parasites change their host's behavior - Jaap de Roode**

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Which of these entities has evolved the ability to manipulate an animal many times its size? The answer is all of them. These are all parasites, organisms that live on or inside another host organism, which they harm and sometimes even kill. Parasite survival depends on transmitting from one host to the next, sometimes through an intermediate species. Our parasites elegantly achieve this by manipulating their host's behavior, sometimes through direct brain hijacking. For example, this is the Gordian worm. One of its hosts, this cricket. The Gordian worm needs water to mate, but the cricket prefers dry land. So once it's big enough to reproduce, the worm produces proteins that garble the cricket's navigational system. The confused cricket jumps around erratically, moves closer to water, and eventually leaps in, often drowning in the process. The worm then wriggles out to mate and its eggs get eaten by little water insects that mature, colonize land, and are, in turn, eaten by new crickets. And thus, the Gordian worm lives on. And here's the rabies virus, another mind-altering parasite. This virus infects mammals, often dogs, and travels up the animal's nerves to its brain where it causes inflammation that eventually kills the host. But before it does, it often increases its host's aggressiveness and ramps up the production of rabies-transmitting saliva, while making it hard to swallow. These factors make the host more likely to bite another animal and more likely to pass the virus on when it does. And now, meet Ophiocordyceps, also known as the zombie fungus. Its host of choice is tropical ants that normally live in treetops. After Ophiocordyceps spores pierce the ant's exoskeleton, they set off convulsions that make the ant fall from the tree. The fungus changes the ant's behavior, compelling it to wander mindlessly until it stumbles onto a plant leaf with the perfect fungal breeding conditions, which it latches onto. The ant then dies, and the fungus parasitizes its body to build a tall, thin stalk from its neck. Within several weeks, the stalk shoots off spores, which turn more ants into six-legged leaf-seeking zombies. One of humanity's most deadly assailants is a behavior-altering parasite, though if it's any consolation, it's not our brains that are being hijacked. I'm talking about Plasmodium, which causes malaria. This parasite needs mosquitoes to shuttle it between hosts, so it makes them bite more frequently and for longer. There's also evidence that humans infected with malaria are more attractive to mosquitoes, which will bite them and transfer the parasite further. This multi-species system is so effective, that there are hundreds of millions of malaria cases every year. And finally, there are cats. Don't worry, there probably aren't any cats living in your body and controlling your thoughts. I mean, probably. But there is a microorganism called Toxoplasma that needs both cats and rodents to complete its life cycle. When a rat gets infected by eating cat feces, the parasite changes chemical levels in the rat's brain, making it less cautious around the hungry felines, maybe even attracted to them. This makes them easy prey, so these infected rodents get eaten and pass the parasite on. Mind control successful. There's even evidence that the parasite affects human behavior. In most cases, we don't completely understand how these parasites manage their feats of behavior modification. But from what we do know, we can tell that they have a pretty diverse toolbox. Gordian worms seem to affect crickets' brains directly. The malaria parasite, on the other hand, blocks an enzyme that helps the mosquitoes feed, forcing them to bite over and over and over again. The rabies virus may cause that snarling, slobbering behavior by putting the immune system into overdrive. But whatever the method, when you think about how effectively these parasites control the behavior of their hosts, you may wonder how much of human behavior is actually parasites doing the talking. Since more than half of the species on Earth are parasites, it could be more than we think.

**P200 2015-03-05 Earworms - Those songs that get stuck in your head - Elizabeth Hellmu**

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Have you ever been waiting in line at the grocery store, innocently perusing the magazine rack, when a song pops into your head? Not the whole song, but a fragment of it that plays and replays until you find yourself unloading the vegetables in time to the beat. You've been struck by an earworm, and you're not alone. Over 90% of people are plagued by earworms at least once a week, and about a quarter of people experience them several times a day. They tend to burrow in during tasks that don't require much attention, say, when waiting on water to boil or a traffic light to change. This phenomenon is one of the mind's great mysteries. Scientists don't know exactly why it's so easy for tunes to get stuck in our heads. From a psychological perspective, earworms are an example of mental imagery. This imagery can be visual, like when you close your eyes and imagine a red wagon, or it can be auditory, like when you imagine the sound of a baby screaming, or oil sizzling in a pan. Earworms are a special form of auditory imagery because they're involuntary. You don't plug your ears and try to imagine "Who Let the Dogs Out," or, well, you probably don't. It just intrudes onto your mental soundscape and hangs around like an unwanted house guest. Earworms tend to be quite vivid and they're normally made up of a tune, rather than, say, harmonies. A remarkable feature of earworms is their tendency to get stuck in a loop, repeating again and again for minutes or hours. Also remarkable is the role of repetition in sparking earworms. Songs tend to get stuck when we listen to them recently and repeatedly. If repetition is such a trigger, then perhaps we can blame our earworms on modern technology. The last hundred years have seen an incredible proliferation of devices that help you listen to the same thing again and again. Records, cassettes, CDs, or streamed audio files. Have these technologies bread some kind of unique, contemporary experience, and are earworms just a product of the late 20th century? The answer comes from an unlikely source: Mark Twain. In 1876, just one year before the phonograph was invented, he wrote a short story imagining a sinister takeover of an entire town by a rhyming jingle. This reference, and others, show us that earworms seem to be a basic psychological phenomenon, perhaps exacerbated by recording technology but not new to this century. So yes, every great historical figure, from Shakespeare to Sacajawea, may well have wandered around with a song stuck in their head. Besides music, it's hard to think of another case of intrusive imagery that's so widespread. Why music? Why don't watercolors get stuck in our heads? Or the taste of cheesy taquitos? One theory has to do with the way music is represented in memory. When we listen to a song we know, we're constantly hearing forward in time, anticipating the next note. It's hard for us to think about one particular musical moment in isolation. If we want to think about the pitch of the word "you" in "Happy Birthday," we have to start back at "Happy," and sing through until we get to "you." In this way, a tune is sort of like a habit. Just like once you start tying your shoe, you're on automatic until you tighten the bow, once a tune is suggested because, for example, someone says, "my umbrella," we have to play through until it reaches a natural stopping point, "ella, ella, ella." But this is largely speculation. The basic fact remains we don't know exactly why we're susceptible to earworms. But understanding them better could give us important clues to the workings of the human brain. Maybe the next time we're plagued by a Taylor Swift tune that just won't go away, we'll use it as the starting point for a scientific odyssey that will unlock important mysteries about basic cognition. And if not, well, we can just shake it off.

**P201 2015-03-12 Plato’s Allegory of the Cave - Alex Gendler**

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What is reality, knowledge, the meaning of life? Big topics you might tackle figuratively explaining existence as a journey down a road or across an ocean, a climb, a war, a book, a thread, a game, a window of opportunity, or an all-too-short-lived flicker of flame. 2,400 years ago, one of history's famous thinkers said life is like being chained up in a cave, forced to watch shadows flitting across a stone wall. Pretty cheery, right? That's actually what Plato suggested in his Allegory of the Cave, found in Book VII of "The Republic," in which the Greek philosopher envisioned the ideal society by examining concepts like justice, truth and beauty. In the allegory, a group of prisoners have been confined in a cavern since birth, with no knowledge of the outside world. They are chained, facing a wall, unable to turn their heads, while a fire behind them gives off a faint light. Occasionally, people pass by the fire, carrying figures of animals and other objects that cast shadows on the wall. The prisoners name and classify these illusions, believing they're perceiving actual entities. Suddenly, one prisoner is freed and brought outside for the first time. The sunlight hurts his eyes and he finds the new environment disorienting. When told that the things around him are real,` while the shadows were mere reflections, he cannot believe it. The shadows appeared much clearer to him. But gradually, his eyes adjust until he can look at reflections in the water, at objects directly, and finally at the Sun, whose light is the ultimate source of everything he has seen. The prisoner returns to the cave to share his discovery, but he is no longer used to the darkness, and has a hard time seeing the shadows on the wall. The other prisoners think the journey has made him stupid and blind, and violently resist any attempts to free them. Plato introduces this passage as an analogy of what it's like to be a philosopher trying to educate the public. Most people are not just comfortable in their ignorance but hostile to anyone who points it out. In fact, the real life Socrates was sentenced to death by the Athenian government for disrupting the social order, and his student Plato spends much of "The Republic" disparaging Athenian democracy, while promoting rule by philosopher kings. With the cave parable, Plato may be arguing that the masses are too stubborn and ignorant to govern themselves. But the allegory has captured imaginations for 2,400 years because it can be read in far more ways. Importantly, the allegory is connected to the theory of forms, developed in Plato's other dialogues, which holds that like the shadows on the wall, things in the physical world are flawed reflections of ideal forms, such as roundness, or beauty. In this way, the cave leads to many fundamental questions, including the origin of knowledge, the problem of representation, and the nature of reality itself. For theologians, the ideal forms exist in the mind of a creator. For philosophers of language viewing the forms as linguistic concepts, the theory illustrates the problem of grouping concrete things under abstract terms. And others still wonder whether we can really know that the things outside the cave are any more real than the shadows. As we go about our lives, can we be confident in what we think we know? Perhaps one day, a glimmer of light may punch a hole in your most basic assumptions. Will you break free to struggle towards the light, even if it costs you your friends and family, or stick with comfortable and familiar illusions? Truth or habit? Light or shadow? Hard choices, but if it's any consolation, you're not alone. There are lots of us down here.

**P202 2015-03-12 Why it’s so hard to cure HIV\_AIDS - Janet Iwasa**

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In 2008, something incredible happened: a man was cured of HIV. In over 70 million HIV cases, that was a first and, so far, a last. We don't yet understand exactly how he was cured. We can cure people of various diseases, such as malaria and hepatitis C, so why can't we cure HIV? Well, first let's examine how HIV infects people and progresses into AIDS. HIV spreads through exchanges of bodily fluids. Unprotected sex and contaminated needles are the leading cause of transmission. It, fortunately, cannot spread through air, water, or casual contact. Individuals of any age, sexual orientation, gender and race can contract HIV. Once inside the body, HIV infects cells that are part of the immune system. It particularly targets helper T cells, which help defend the body against bacterial and fungal infections. HIV is a retrovirus, which means it can write its genetic code into the genome of infected cells, co-opting them into making more copies of itself. During the first stage of HIV infection, the virus replicates within helper T cells, destroying many of them in the process. During this stage, patients often experience flu-like symptoms, but are typically not yet in mortal danger. However, for a period ranging from a few months to several years, during which time the patient may look and feel completely healthy, the virus continues to replicate and destroy T cells. When T cell counts drop too low, patients are in serious danger of contracting deadly infections that healthy immune systems can normally handle. This stage of HIV infection is known as AIDS. The good news is there are drugs that are highly effective at managing levels of HIV and preventing T cell counts from getting low enough for the disease to progress to AIDS. With antiretroviral therapy, most HIV-positive people can expect to live long and healthy lives, and are much less likely to infect others. However, there are two major catches. One is that HIV-positive patients must keep taking their drugs for the rest of their lives. Without them, the virus can make a deadly comeback. So, how do these drugs work? The most commonly prescribed ones prevent the viral genome from being copied and incorporated into a host cell's DNA. Other drugs prevent the virus from maturing or assembling, causing HIV to be unable to infect new cells in the body. But HIV hides out somewhere our current drugs cannot reach it: inside the DNA of healthy T cells. Most T cells die shortly after being infected with HIV. But in a tiny percentage, the instructions for building more HIV viruses lies dormant, sometimes for years. So even if we could wipe out every HIV virus from an infected person's body, one of those T cells could activate and start spreading the virus again. The other major catch is that not everyone in the world has access to the therapies that could save their lives. In Sub-Saharan Africa, which accounts for over 70% of HIV patients worldwide, antiretrovirals reached only about one in three HIV-positive patients in 2012. There is no easy answer to this problem. A mix of political, economic and cultural barriers makes effective prevention and treatment difficult. And even in the U.S., HIV still claims more than 10,000 lives per year. However, there is ample cause for hope. Researchers may be closer than ever to developing a true cure. One research approach involves using a drug to activate all cells harboring the HIV genetic information. This would both destroy those cells and flush the virus out into the open, where our current drugs are effective. Another is looking to use genetic tools to cut the HIV DNA out of cells genomes altogether. And while one cure out of 70 million cases may seem like terrible odds, one is immeasurably better than zero. We now know that a cure is possible, and that may give us what we need to beat HIV for good.

**P203 2015-03-13 Can robots be creative - Gil Weinberg**

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How does this music make you feel? Do you find it beautiful? Is it creative? Now, would you change your answers if you learned the composer was this robot? Believe it or not, people have been grappling with the question of artificial creativity, alongside the question of artifcial intelligence, for over 170 years. In 1843, Lady Ada Lovelace, an English mathematician considered the world's first computer programmer, wrote that a machine could not have human-like intelligence as long as it only did what humans intentionally programmed it to do. According to Lovelace, a machine must be able to create original ideas if it is to be considered intelligent. The Lovelace Test, formalized in 2001, proposes a way of scrutinizing this idea. A machine can pass this test if it can produce an outcome that its designers cannot explain based on their original code. The Lovelace Test is, by design, more of a thought experiment than an objective scientific test. But it's a place to start. At first glance, the idea of a machine creating high quality, original music in this way might seem impossible. We could come up with an extremely complex algorithm using random number generators, chaotic functions, and fuzzy logic to generate a sequence of musical notes in a way that would be impossible to track. But although this would yield countless original melodies never heard before, only a tiny fraction of them would be worth listening to. With the computer having no way to distinguish between those which we would consider beautiful and those which we won't. But what if we took a step back and tried to model a natural process that allows creativity to form? We happen to know of at least one such process that has lead to original, valuable, and even beautiful outcomes: the process of evolution. And evolutionary algorithms, or genetic algorithms that mimic biological evolution, are one promising approach to making machines generate original and valuable artistic outcomes. So how can evolution make a machine musically creative? Well, instead of organisms, we can start with an initial population of musical phrases, and a basic algorithm that mimics reproduction and random mutations by switching some parts, combining others, and replacing random notes. Now that we have a new generation of phrases, we can apply selection using an operation called a fitness function. Just as biological fitness is determined by external environmental pressures, our fitness function can be determined by an external melody chosen by human musicians, or music fans, to represent the ultimate beautiful melody. The algorithm can then compare between our musical phrases and that beautiful melody, and select only the phrases that are most similar to it. Once the least similar sequences are weeded out, the algorithm can reapply mutation and recombination to what's left, select the most similar, or fitted ones, again from the new generation, and repeat for many generations. The process that got us there has so much randomness and complexity built in that the result might pass the Lovelace Test. More importantly, thanks to the presence of human aesthetic in the process, we'll theoretically generate melodies we would consider beautiful. But does this satisfy our intuition for what is truly creative? Is it enough to make something original and beautiful, or does creativity require intention and awareness of what is being created? Perhaps the creativity in this case is really coming from the programmers, even if they don't understand the process. What is human creativity, anyways? Is it something more than a system of interconnected neurons developed by biological algorithmic processes and the random experiences that shape our lives? Order and chaos, machine and human. These are the dynamos at the heart of machine creativity initiatives that are currently making music, sculptures, paintings, poetry and more. The jury may still be out as to whether it's fair to call these acts of creation creative. But if a piece of art can make you weep, or blow your mind, or send shivers down your spine, does it really matter who or what created it?

**P204 2015-03-13 The real story behind Archimedes’ Eureka! - Armand D'Angour**

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When you think of Archimedes' "Eureka!" moment, you probably think of this. As it turns out, it may have been more like this. In the third century BC, Hieron, king of the Sicilian city of Syracuse, chose Archimedes to supervise an engineering project of unprecedented scale. Hieron commissioned a sailing vessel 50 times bigger than a standard ancient warship, named the Syracusia after his city. Hieron wanted to construct the largest ship ever, which was destined to be given as a present for Egypt's ruler, Ptolemy. But could a boat the size of a palace possibly float? In Archimedes's day, no one had attempted anything like this. It was like asking, "Can a mountain fly?" King Hieron had a lot riding on that question. Hundreds of workmen were to labor for years on constructing the Syracusia out of beams of pine and fir from Mount Etna, ropes from hemp grown in Spain, and pitch from France. The top deck, on which eight watchtowers were to stand, was to be supported not by columns, but by vast wooden images of Atlas holding the world on his shoulders. On the ship's bow, a massive catapult would be able to fire 180 pound stone missiles. For the enjoyment of its passengers, the ship was to feature a flower-lined promenade, a sheltered swimming pool, and bathhouse with heated water, a library filled with books and statues, a temple to the goddess Aphrodite, and a gymnasium. And just to make things more difficult for Archimedes, Hieron intended to pack the vessel full of cargo: 400 tons of grain, 10,000 jars of pickled fish, 74 tons of drinking water, and 600 tons of wool. It would have carried well over a thousand people on board, including 600 soldiers. And it housed 20 horses in separate stalls. To build something of this scale, only for that to sink on its maiden voyage? Well, let's just say that failure wouldn't have been a pleasant option for Archimedes. So he took on the problem: will it sink? Perhaps he was sitting in the bathhouse one day, wondering how a heavy bathtub can float, when inspiration came to him. An object partially immersed in a fluid is buoyed up by a force equal to the weight of the fluid displaced by the object. In other words, if a 2,000 ton Syracusia displaced exactly 2,000 tons of water, it would just barely float. If it displaced 4,000 tons of water, it would float with no problem. Of course, if it only displaced 1,000 tons of water, well, Hieron wouldn't be too happy. This is the law of buoyancy, and engineers still call it Archimedes' Principle. It explains why a steel supertanker can float as easily as a wooden rowboat or a bathtub. If the weight of water displaced by the vessel below the keel is equivalent to the vessel's weight, whatever is above the keel will remain afloat above the waterline. This sounds a lot like another story involving Archimedes and a bathtub, and it's possible that's because they're actually the same story, twisted by the vagaries of history. The classical story of Archimedes' Eureka! and subsequent streak through the streets centers around a crown, or corona in Latin. At the core of the Syracusia story is a keel, or korone in Greek. Could one have been mixed up for the other? We may never know. On the day the Syracusia arrived in Egypt on its first and only voyage, we can only imagine how residents of Alexandria thronged the harbor to marvel at the arrival of this majestic, floating castle. This extraordinary vessel was the Titanic of the ancient world, except without the sinking, thanks to our pal, Archimedes.

**P205 2015-03-14 Where did Earth’s water come from - Zachary Metz**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=205)

It has no taste, color or smell, and we often look right through it. It covers over 70% of the Earth, cycling from the oceans and rivers to the clouds and back again. It even makes up about 60% of our bodies. With all this water around and inside us, it's easy to take its presence for granted. But in the rest of the solar system, liquid water is almost impossible to find. So how did our planet end up with so much of this substance and where did it come from? As you probably know, a water molecule consists of two basic parts. Hydrogen, the simplest of all elements, has been around since close to the beginning of our universe. Oxygen entered the scene several hundred million years later after stars began to form. The massive pressure at the center of these fiery infernos was so great that hydrogen atoms fused together to form helium. Helium, in turn, fused to form heavier elements, like beryllium, carbon and oxygen in a process known as nucleosynthesis. When stars eventually collapsed and exploded into supernovas, these new elements were spread across the universe and combined into new compounds, like the now familiar H2O. These water molecules were present in the dusty cloud that formed our solar system and more collided with our planet after its formation. But there's a big question that we don't have the answer to: how much water arrived on Earth, and when? If, as one theory goes, relatively small amounts of water were present on Earth when the rock formed, the high temperatures and lack of any surrounding atmosphere would have caused it to evaporate back into space. Water would have been unable to remain on the planet until hundreds of millions of years later when our first atmosphere formed through a process called outgassing. This occurred when molten rock in the Earth's core released volcanic gasses to the surface, creating a layer that could then trap escaping water. So how then did water get back to the planet? Scientists have long suspected that much of it was brought by ice-bearing comets, or more likely asteroids that bombarded the Earth over millions of years. Recent research has challenged this theory. In examining carbonaceous chondrite meterorites that formed shorty after the birth of our solar system, scientists have found that not only did they contain water, but their mineral chemical composition matched rocks on Earth and samples from an asteroid that formed at the same time as our planet. This suggests that the Earth may have accumulated a substantial amount of water early on that was able to stay put, despite the lack of an atmosphere, though asteroids may have brought more over the eons. If this turns out to be true, life may have formed much earlier than previously thought. So we do not yet definitively know whether the water on Earth came from its initial formation, later impacts, or some combination of the two. Regardless, the water that runs from our showers, drinking fountains and faucets is something that didn't just come from a nearby lake or river, but first underwent a cosmic and chaotic journey to get here.

**P206 2015-03-23 What did democracy really mean in Athens - Melissa Schwartzberg**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=206)

Hey, congratulations! You've just won the lottery, only the prize isn't cash or a luxury cruise. It's a position in your country's national legislature. And you aren't the only lucky winner. All of your fellow lawmakers were chosen in the same way. This might strike you as a strange way to run a government, let alone a democracy. Elections are the epitome of democracy, right? Well, the ancient Athenians who coined the word had another view. In fact, elections only played a small role in Athenian democracy, with most offices filled by random lottery from a pool of citizen volunteers. Unlike the representative democracies common today, where voters elect leaders to make laws and decisions on their behalf, 5th Century BC Athens was a direct democracy that encouraged wide participation through the principle of ho boulomenos, or anyone who wishes. This meant that any of its approximately 30,000 eligible citizens could attend the ecclesia, a general assembly meeting several times a month. In principle, any of the 6,000 or so who showed up at each session had the right to address their fellow citizens, propose a law, or bring a public lawsuit. Of course, a crowd of 6,000 people trying to speak at the same time would not have made for effective government. So the Athenian system also relied on a 500 member governing council called the Boule, to set the agenda and evaluate proposals, in addition to hundreds of jurors and magistrates to handle legal matters. Rather than being elected or appointed, the people in these positions were chosen by lot. This process of randomized selection is know as sortition. The only positions filled by elections were those recognized as requiring expertise, such as generals. But these were considered aristocratic, meaning rule by the best, as opposed to democracies, rule by the many. How did this system come to be? Well, democracy arose in Athens after long periods of social and political tension marked by conflict among nobles. Powers once restricted to elites, such as speaking in the assembly and having their votes counted, were expanded to ordinary citizens. And the ability of ordinary citizens to perform these tasks adequately became a central feature of the democratice ideology of Athens. Rather than a privilege, civic participation was the duty of all citizens, with sortition and strict term limits preventing governing classes or political parties from forming. By 21st century standards, Athenian rule by the many excluded an awful lot of people. Women, slaves and foreigners were denied full citizenship, and when we filter out those too young to serve, the pool of eligible Athenians drops to only 10-20% of the overall population. Some ancient philosophers, including Plato, disparaged this form of democracy as being anarchic and run by fools. But today the word has such positive associations, that vastly different regimes claim to embody it. At the same time, some share Plato's skepticism about the wisdom of crowds. Many modern democracies reconcile this conflict by having citizens elect those they consider qualified to legislate on their behalf. But this poses its own problems, including the influence of wealth, and the emergence of professional politicians with different interests than their constituents. Could reviving election by lottery lead to more effective government through a more diverse and representative group of legislatures? Or does modern political office, like Athenian military command, require specialized knowledge and skills? You probably shouldn't hold your breath to win a spot in your country's government. But depending on where you live, you may still be selected to participate in a jury, a citizens' assembly, or a deliberative poll, all examples of how the democratic principle behind sortition still survives today.

**P207 2015-03-24 The science of static electricity - Anuradha Bhagwat**

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It can strike without warning, at any moment. You may be walking across a soft carpet and reaching for the door knob when suddenly...zap! To understand static electricity, we first need to know a bit about the nature of matter. All matter is made up of atoms that consist of three types of smaller particles: negatively charged electrons, positively charged protons, and neutral neutrons. Normally, the electrons and protons in an atom balance out, which is why most matter you come across is electrically neutral. But electrons are tiny and almost insignificant in mass, and rubbing or friction can give loosely bound electrons enough energy to leave their atoms and attach to others, migrating between different surfaces. When this happens, the first object is left with more protons than electrons and becomes positively charged, while the one with more electrons accumulates a negative charge. This situation is called a charge imbalance, or net charge separation. But nature tends towards balance, so when one of these newly charged bodies comes into contact with another material, the mobile electrons will take the first chance they get to go where they're most needed, either jumping off the negatively charged object, or jumping onto the positively charged one in an attempt to restore the neutral charge equilibrium. And this quick movement of electrons, called static discharge, is what we recognize as that sudden spark. This process doesn't happen with just any objects. Otherwise you'd be getting zapped all the time. Conductors like metals and salt water tend to have loosely bound outer electrons, which can easily flow between molecules. On the other hand, insulators like plastics, rubber and glass have tightly bound electrons that won't readily jump to other atoms. Static build-up is most likely to occur when one of the materials involved is an insulator. When you walk across a rug, electrons from your body will rub off onto it, while the rug's insulating wool will resist losing its own electrons. Although your body and the rug together are still electrically neutral, there is now a charge polarization between the two. And when you reach to touch the door knob, zap! The metal door knob's loosely bound electrons hop to your hand to replace the electrons your body has lost. When it happens in your bedroom, it's a minor nuisance. But in the great outdoors, static electricity can be a terrifying, destructive force of nature. In certain conditions, charge separation will occur in clouds. We don't know exactly how this happens. It may have to do with the circulation of water droplets and ice particles within them. Regardless, the charge imbalance is neutralized by being released towards another body, such as a building, the Earth, or another cloud in a giant spark that we know as lightning. And just as your fingers can be zapped over and over in the same spot, you better believe that lightning can strike the same place more than once.

**P208 2015-03-26 How do geckos defy gravity - Eleanor Nelsen**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=208)

It's midnight and all is still, except for the soft skittering of a gecko hunting a spider. Geckos seem to defy gravity, scaling vertical surfaces and walking upside down without claws, adhesive glues or super-powered spiderwebs. Instead, they take advantage of a simple principle: that positive and negative charges attract. That attraction binds together compounds, like table salt, which is made of positively charged sodium ions stuck to negatively charged chloride ions. But a gecko's feet aren't charged and neither are the surfaces they're walking on. So, what makes them stick? The answer lies in a clever combination of intermolecular forces and stuctural engineering. All the elements in the periodic table have a different affinity for electrons. Elements like oxygen and fluorine really, really want electrons, while elements like hydrogen and lithium don't attract them as strongly. An atom's relative greed for electrons is called its electronegativity. Electrons are moving around all the time and can easily relocate to wherever they're wanted most. So when there are atoms with different electronegativities in the same molecule, the molecules cloud of electrons gets pulled towards the more electronegative atom. That creates a thin spot in the electron cloud where positive charge from the atomic nuclei shines through, as well as a negatively charged lump of electrons somewhere else. So the molecule itself isn't charged, but it does have positively and negatively charged patches. These patchy charges can attract neighboring molecules to each other. They'll line up so that the positive spots on one are next to the negative spots on the other. There doesn't even have to be a strongly electronegative atom to create these attractive forces. Electrons are always on the move, and sometimes they pile up temporarily in one spot. That flicker of charge is enough to attract molecules to each other. Such interactions between uncharged molecules are called van der Waals forces. They're not as strong as the interactions between charged particles, but if you have enough of them, they can really add up. That's the gecko's secret. Gecko toes are padded with flexible ridges. Those ridges are covered in tiny hair-like structures, much thinner than human hair, called setae. And each of the setae is covered in even tinier bristles called spatulae. Their tiny spatula-like shape is perfect for what the gecko needs them to do: stick and release on command. When the gecko unfurls its flexible toes onto the ceiling, the spatulae hit at the perfect angle for the van der Waals force to engage. The spatulae flatten, creating lots of surface area for their positively and negatively charged patches to find complimentary patches on the ceiling. Each spatula only contributes a minuscule amount of that van der Waals stickiness. But a gecko has about two billion of them, creating enough combined force to support its weight. In fact, the whole gecko could dangle from a single one of its toes. That super stickiness can be broken, though, by changing the angle just a little bit. So, the gecko can peel its foot back off, scurrying towards a meal or away from a predator. This strategy, using a forest of specially shaped bristles to maximize the van der Waals forces between ordinary molecules has inspired man-made materials designed to imitate the gecko's amazing adhesive ability. Artificial versions aren't as strong as gecko toes quite yet, but they're good enough to allow a full-grown man to climb 25 feet up a glass wall. In fact, our gecko's prey is also using van der Waals forces to stick to the ceiling. So, the gecko peels up its toes and the chase is back on.

**P209 2015-03-27 Eye vs. camera - Michael Mauser**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=209)

Watch the center of this disk. You are getting sleepy. No, just kidding. I'm not going to hypnotize you. But are you starting to see colors in the rings? If so, your eyes are playing tricks on you. The disk was only ever black and white. You see, your eyes don't always capture the world as a video camera would. In fact, there are quite a few differences, owing to the anatomy of your eye and the processing that takes place in your brain and its outgrowth, the retina. Let's start with some similarities. Both have lenses to focus light and sensors to capture it, but even those things behave differently. The lens in a camera moves to stay focused on an object hurtling towards it, while the one in your eye responds by changing shape. Most camera lenses are also achromatic, meaning they focus both red and blue light to the same point. Your eye is different. When red light from an object is in focus, the blue light is out of focus. So why don't things look partially out of focus all the time? To answer that question, we first need to look at how your eye and the camera capture light: photoreceptors. The light-sensitive surface in a camera only has one kind of photoreceptor that is evenly distributed throughout the focusing surface. An array of red, green and blue filters on top of these photoreceptors causes them to respond selectively to long, medium and short wavelength light. Your eye's retinas, on the other hand, have several types of photoreceptors, usually three for normal light conditions, and only one type for lowlight, which is why we're color blind in the dark. In normal light, unlike the camera, we have no need for a color filter because our photoreceptors already respond selectively to different wavelengths of light. Also in contrast to a camera, your photoreceptors are unevenly distributed, with no receptors for dim light in the very center. This is why faint stars seem to disappear when you look directly at them. The center also has very few receptors that can detect blue light, which is why you don't notice the blurred blue image from earlier. However, you still perceive blue there because your brain fills it in from context. Also, the edges of our retinas have relatively few receptors for any wavelength light. So our visual acuity and ability to see color falls off rapidly from the center of our vision. There is also an area in our eyes called the blind spot where there are no photoreceptors of any kind. We don't notice a lack of vision there because once again, our brain fills in the gaps. In a very real sense, we see with our brains, not our eyes. And because our brains, including the retinas, are so involved in the process, we are susceptible to visual illusions. Here's another illusion caused by the eye itself. Does the center of this image look like it's jittering around? That's because your eye actually jiggles most of the time. If it didn't, your vision would eventually shut down because the nerves on the retina stop responding to a stationary image of constant intensity. And unlike a camera, you briefly stop seeing whenever you make a larger movement with your eyes. That's why you can't see your own eyes shift as you look from one to the other in a mirror. Video cameras can capture details our eyes miss, magnify distant objects and accurately record what they see. But our eyes are remarkably efficient adaptations, the result of hundreds of millions of years of coevolution with our brains. And so what if we don't always see the world exactly as it is. There's a certain joy to be found watching stationary leaves waving on an illusive breeze, and maybe even an evolutionary advantage. But that's a lesson for another day.

**P210 2015-03-27 The effects of underwater pressure on the body - Neosha S Kashef**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=210)

Sometimes when a fish is reeled up to the surface it will appear inflated, with its eyes bulging out of their sockets and its stomach projecting out of its mouth, as if its been blown up like a balloon. This type of bodily damage, caused by rapid changes in pressure, is called barotrauma. Under the sea, pressure increases by 14.7 pounds per square inch for every 33 foot increase in depth. So, take the yelloweye rockfish, which can live as deep as 1800 feet, where there's over 800 pounds of pressure on every square inch. That's equivalent to the weight of a polar bear balancing on a quarter. Now, Boyle's gas law states that the volume of a gas is inversely related to pressure. So, any air-filled spaces, like a rockfish's swim bladder, or human lungs, will compress as they descend deeper and expand as they ascend. After a fish bites a fisherman's hook and is quickly reeled up to the surface, the air in its swim bladder begins to expand. Its rapid expansion actually forces the fish's stomach out of its mouth, while the increased internal pressure pushes its eyes out of their sockets, a condition called exophthalmia. Sometimes rockfish eyes will even have a crystallized appearance from corneal emphysemas, little gas bubbles that build up inside the cornea. Thankfully, a scuba diver doesn't have a closed swim bladder to worry about. A diver can regulate pressure in her lungs by breathing out as she ascends, but must be wary of other laws of physics that are at play under the sea. Henry's law states that the amount of a gas that dissolves in a liquid is proportional to its partial pressure. The air a diver breathes is 78% nitrogen. At a higher pressure under the sea, the nitrogen from the air in a scuba tank diffuses into a diver's tissues in greater concentrations than it would on land. If the diver ascends too quickly, this built up nitrogen can come out of solution and form microbubbles in her tissues, blood and joints, causing decompression sickness, aka the bends. This is similar to the fizz of carbon dioxide coming out of your soda. Gas comes out of solution when the pressure's released. But for a diver, the bubbles cause severe pain and sometimes even death. Divers avoid falling victim to the bends by rising slowly and taking breaks along the way, called decompression stops, so the gas has time to diffuse back out of their tissues and to be released through their breath. Just as a diver needs decompression, for a fish to recover, it needs recompression, which can be accomplished by putting it back in the sea. But that doesn't mean that fish should just be tossed overboard. An inflated body will float and get scooped up by a hungry sea lion or pecked at by seagulls. There's a common myth that piercing its stomach with a needle will let air escape, allowing the fish to swim back down on its own. But that is one balloon that shouldn't be popped. To return a fish properly to its habitat, fisherman can use a descending device instead to lower it on a fishing line and release it at the right depth. As it heads home and recompression reduces gas volume, its eyes can return to their sockets and heal, and its stomach can move back into place. This fish will live to see another day, once more free to swim, eat, reproduce and replenish the population.

**P211 2015-03-27 What causes bad breath - Mel Rosenberg**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=211)

There is a curse that has plagued humanity since ancient times. The Greeks fought it by chewing aromatic resins, while the Chinese resorted to egg shells. In the ancient Jewish Talmud, it's even considered legal grounds for divorce. This horrible scourge is halitosis, otherwise known as bad breath. But what causes it, and why is it so universally terrifying? Well, think of some of the worst odors you can imagine, like garbage, feces or rotting meat. All of these smells come from the activity of microorganisms, particularly bacteria, and, as disgusting as it may sound, similar bacteria live in the moisture-rich environment of your mouth. Don't panic. The presence of bacteria in your body is not only normal, it's actually vital for all sorts of things, like digestion and disease prevention. But like all living things, bacteria need to eat. The bacteria in your mouth feed off of mucus, food remnants, and dead tissue cells. In order to absorb nutrients through their cell membranes, they must break down the organic matter into much smaller molecules. For example, they'll break proteins into their component amino acids and then break those down even further into various compounds. Some of the foul-smelling byproducts of these reactions, such as hydrogen sulfide and cadaverine, escape into the air and waft their way towards unsuspecting noses. Our sensitivity to these odors and interpretation of them as bad smells may be an evolutionary mechanism warning us of rotten food and the presence of disease. Smell is one of our most intimate and primal senses, playing a huge role in our attraction to potential mates. In one poll, 59% of men and 70% of women said they wouldn't go on a date with someone who has bad breath, which may be why Americans alone spend $1 billion a year on various breath products. Fortunately, most bad breath is easily treated. The worst smelling byproducts come from gram-negative bacteria that live in the spaces between gums and teeth and on the back of the tongue. By brushing and flossing our teeth, using antibacterial mouthwash at bedtime, gently cleaning the back of the tongue with a plastic scraper and even just eating a healthy breakfast, we can remove many of these bacteria and their food sources. In some cases, these measures may not be enough due to dental problems, nasal conditions, or rarer ailments, such as liver disease and uncontrolled diabetes. Behaviors like smoking and excessive alcohol consumption also have a very recognizable odor. Regardless of cause, the bad smell almost always originates in the mouth and not the stomach or elsewhere in the body. But one of the biggest challenges lies in actually determining how our breath smells in the first place, and it's unclear why. It may be that we're too acclimatized to the smell inside our own mouths to judge it. And methods like cupping your hands over your mouth, or licking and smelling your wrist don't work perfectly either. One study showed that even when people do this, they tend to rate the smell subjectively according to how bad they thought it was going to be. But there's one simple, if socially difficult, way of finding out how your breath smells: just take a deep breath and ask a friend.

**P212 2015-03-31 What really happens to the plastic you throw away - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=212)

This is the story of three plastic bottles, empty and discarded. Their journeys are about to diverge with outcomes that impact nothing less than the fate of the planet. But they weren't always this way. To understand where these bottles end up, we must first explore their origins. The heroes of our story were conceived in this oil refinery. The plastic in their bodies was formed by chemically bonding oil and gas molecules together to make monomers. In turn, these monomers were bonded into long polymer chains to make plastic in the form of millions of pellets. Those were melted at manufacturing plants and reformed in molds to create the resilient material that makes up the triplets' bodies. Machines filled the bottles with sweet bubbily liquid and they were then wrapped, shipped, bought, opened, consumed and unceremoniously discarded. And now here they lie, poised at the edge of the unknown. Bottle one, like hundreds of millions of tons of his plastic brethren, ends up in a landfill. This huge dump expands each day as more trash comes in and continues to take up space. As plastics sit there being compressed amongst layers of other junk, rainwater flows through the waste and absorbs the water-soluble compounds it contains, and some of those are highly toxic. Together, they create a harmful stew called leachate, which can move into groundwater, soil and streams, poisoning ecosystems and harming wildlife. It can take bottle one an agonizing 1,000 years to decompose. Bottle two's journey is stranger but, unfortunately, no happier. He floats on a trickle that reaches a stream, a stream that flows into a river, and a river that reaches the ocean. After months lost at sea, he's slowly drawn into a massive vortex, where trash accumulates, a place known as the Great Pacific Garbage Patch. Here the ocean's currents have trapped millions of pieces of plastic debris. This is one of five plastic-filled gyres in the world's seas. Places where the pollutants turn the water into a cloudy plastic soup. Some animals, like seabirds, get entangled in the mess. They, and others, mistake the brightly colored plastic bits for food. Plastic makes them feel full when they're not, so they starve to death and pass the toxins from the plastic up the food chain. For example, it's eaten by lanternfish, the lanternfish are eaten by squid, the squid are eaten by tuna, and the tuna are eaten by us. And most plastics don't biodegrade, which means they're destined to break down into smaller and smaller pieces called micro plastics, which might rotate in the sea eternally. But bottle three is spared the cruel purgatories of his brothers. A truck brings him to a plant where he and his companions are squeezed flat and compressed into a block. Okay, this sounds pretty bad, too, but hang in there. It gets better. The blocks are shredded into tiny pieces, which are washed and melted, so they become the raw materials that can be used again. As if by magic, bottle three is now ready to be reborn as something completely new. For this bit of plastic with such humble origins, suddenly the sky is the limit.

**P213 2015-04-06 How brass instruments work - Al Cannon**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=213)

What gives the trumpet its clarion ring and the tuba its gut-shaking "omm pah pah?" And what makes the trombone so jazzy? The answer lies not in the brass these instruments are made of, but in the journey air takes from the musician's lungs to the instrument's bell. Like any sound, music consists of vibrations traveling through air. Instruments are classified based on how those vibrations are produced. Percussion instruments are struck. String instruments are plucked or bowed. Woodwinds have air blown against a reed or sharp edge. For brass instruments, however, the vibration come directly from the musician's mouth. One of the first things a brass player must learn is to breathe in deeply, until every possible particle of air is crammed into the lungs. Once all that air is inside, it must come out through the mouth, but there, an internal battle takes place as the musician simultaneously tries to hold their lips firmly closed while blowing enough air to force them open. The escaping air meets resistance from the lip muscles, forms an opening called the aperture and creates the vibration that brass players call "the buzz." When a mouthpiece is held up to those vibrating lips, it slightly refines the buzz, amplifying the vibration at certain frequencies. But things get really interesting depending on what instrument is attached to that mouthpiece. A brass instrument's body is essentially a tube that resonates with the air column blowing through it. The way that sound waves travel through this column forms a limited pattern of pitches known as the harmonic series, with notes spaced far apart at the lower end, but coming closer together as the pitch increases. The musician can alter the pitch of the note through slight contractions of the lips and alterations to air volume and speed. Slower, warm sighing air produces lower pitches, and faster, cool, flowing air produces higher pitches in the series. But any single harmonic series has gaps where pitches are missing and the versatility of brass instruments lies in their ability to switch between multiple series. On instruments like the trumpet, valves can be lowered to increase the length of tubing the air travels through, while on a trombone, this is done by extending its slide. Lengthening the tube stretches the vibrating air column, reducing the frequency of vibrations and resulting in a lower pitch. This is why the tuba, the largest brass instrument, is also the one capable of playing the lowest notes. So changing the instrument length shifts its harmonic series, while slight variations of the air flow and the player's lips produce the different notes within it. And those notes finally emerge through the flared bell opening at the end. What started as a deep breath and a vibrating buzz on the lips has now been transformed into a bold and brassy tune. The musician's skillful manipulation of every part of the process from lungs, to lips, to the mouthpiece, to the instrument itself creates an amazing palette of pitches that can be heard in musical genres across the globe. By harnessing the power of natural resonance in a flexible and controllable way, brass instruments are great examples of the fusion of human creativity with the physics of our world.

**P214 2015-04-06 Why are manhole covers round - Marc Chamberland**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=214)

Why are most manhole covers round? Sure, it makes them easy to roll and slide into place in any alignment but there's another more compelling reason involving a peculiar geometric property of circles and other shapes. Imagine a square separating two parallel lines. As it rotates, the lines first push apart, then come back together. But try this with a circle and the lines stay exactly the same distance apart, the diameter of the circle. This makes the circle unlike the square, a mathematical shape called a curve of constant width. Another shape with this property is the Reuleaux triangle. To create one, start with an equilateral triangle, then make one of the vertices the center of a circle that touches the other two. Draw two more circles in the same way, centered on the other two vertices, and there it is, in the space where they all overlap. Because Reuleaux triangles can rotate between parallel lines without changing their distance, they can work as wheels, provided a little creative engineering. And if you rotate one while rolling its midpoint in a nearly circular path, its perimeter traces out a square with rounded corners, allowing triangular drill bits to carve out square holes. Any polygon with an odd number of sides can be used to generate a curve of constant width using the same method we applied earlier, though there are many others that aren't made in this way. For example, if you roll any curve of constant width around another, you'll make a third one. This collection of pointy curves fascinates mathematicians. They've given us Barbier's theorem, which says that the perimeter of any curve of constant width, not just a circle, equals pi times the diameter. Another theorem tells us that if you had a bunch of curves of constant width with the same width, they would all have the same perimeter, but the Reuleaux triangle would have the smallest area. The circle, which is effectively a Reuleaux polygon with an infinite number of sides, has the largest. In three dimensions, we can make surfaces of constant width, like the Reuleaux tetrahedron, formed by taking a tetrahedron, expanding a sphere from each vertex until it touches the opposite vertices, and throwing everything away except the region where they overlap. Surfaces of constant width maintain a constant distance between two parallel planes. So you could throw a bunch of Reuleaux tetrahedra on the floor, and slide a board across them as smoothly as if they were marbles. Now back to manhole covers. A square manhole cover's short edge could line up with the wider part of the hole and fall right in. But a curve of constant width won't fall in any orientation. Usually they're circular, but keep your eyes open, and you just might come across a Reuleaux triangle manhole.

**P215 2015-04-10 What's the difference between accuracy and precision - Matt Anticole**

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As the story goes, the legendary marksman William Tell was forced into a cruel challenge by a corrupt lord. William's son was to be executed unless William could shoot an apple off his head. William succeeded, but let's imagine two variations on the tale. In the first variation, the lord hires a bandit to steal William's trusty crossbow, so he is forced to borrow an inferior one from a peasant. However, the borrowed crossbow isn't adjusted perfectly, and William finds that his practice shots cluster in a tight spread beneath the bullseye. Fortunately, he has time to correct for it before it's too late. Variation two: William begins to doubt his skills in the long hours before the challenge and his hand develops a tremor. His practice shots still cluster around the apple but in a random pattern. Occasionally, he hits the apple, but with the wobble, there is no guarantee of a bullseye. He must settle his nervous hand and restore the certainty in his aim to save his son. At the heart of these variations are two terms often used interchangeably: accuracy and precision. The distinction between the two is actually critical for many scientific endeavours. Accuracy involves how close you come to the correct result. Your accuracy improves with tools that are calibrated correctly and that you're well-trained on. Precision, on the other hand, is how consistently you can get that result using the same method. Your precision improves with more finely incremented tools that require less estimation. The story of the stolen crossbow was one of precision without accuracy. William got the same wrong result each time he fired. The variation with the shaky hand was one of accuracy without precision. William's bolts clustered around the correct result, but without certainty of a bullseye for any given shot. You can probably get away with low accuracy or low precision in everyday tasks. But engineers and researchers often require accuracy on microscopic levels with a high certainty of being right every time. Factories and labs increase precision through better equipment and more detailed procedures. These improvements can be expensive, so managers must decide what the acceptable uncertainty for each project is. However, investments in precision can take us beyond what was previously possible, even as far as Mars. It may surprise you that NASA does not know exactly where their probes are going to touch down on another planet. Predicting where they will land requires extensive calculations fed by measurements that don't always have a precise answer. How does the Martian atmosphere's density change at different elevations? What angle will the probe hit the atmosphere at? What will be the speed of the probe upon entry? Computer simulators run thousands of different landing scenarios, mixing and matching values for all of the variables. Weighing all the possibilities, the computer spits out the potential area of impact in the form of a landing ellipse. In 1976, the landing ellipse for the Mars Viking Lander was 62 x 174 miles, nearly the area of New Jersey. With such a limitation, NASA had to ignore many interesting but risky landing areas. Since then, new information about the Martian atmosphere, improved spacecraft technology, and more powerful computer simulations have drastically reduced uncertainty. In 2012, the landing ellipse for the Curiosity Lander was only 4 miles wide by 12 miles long, an area more than 200 times smaller than Viking's. This allowed NASA to target a specific spot in Gale Crater, a previously un-landable area of high scientific interest. While we ultimately strive for accuracy, precision reflects our certainty of reliably achieving it. With these two principles in mind, we can shoot for the stars and be confident of hitting them every time.

**P216 2015-04-15 How to spot a counterfeit bill - Tien Nguyen**

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It's estimated that for every 10,000 bills in the U.S., one of those bills is fake. That may not sound like much, but it adds up to millions of dollars in cold hard cash. Counterfeit money has the potential to cause all sorts of problems, from leaving you short $20 to destabilizing national economies. But don't worry. You can help catch the counterfeits. All you need are some simple tools and a bit of chemistry. First up, the anti-counterfeit detection pen. The pen looks like a highlighter and contains a solution of potassium iodide and elemental iodine. It reveals of the presence of starch, which is commonly used to strengthen regular printer paper, but won't be found in real money. That's because authentic bills are made of cotton and linen and are threaded with tiny red and blue fibers. That material is made by a single, highly-guarded company called Crane and Company, which has been printing currency since Paul Revere asked them to help finance the Revolutionary War. The starch in many counterfeit bills, on the other hand, is made of two molecules: amylopectin and amylose. It's amylose that gives the fake away. Its long chain of sugar molecules connected by oxygen atoms forms a helical structure, like DNA. Iodide likes to squeeze inside this coil, forming a new compound that leaves a dark mark on the paper. However, in the absence of starch, there is no chemical reaction and the mark will look light yellow. So if the fake isn't printed on starchy paper, iodine solutions can't help you. That's one of the reasons U.S. bills printed since 1996 have been chemically enhanced to include another counterfeit countermeasure: a strip that fluoresces under UV light. That's the same kind of light used at black light parties and airport security lines. The polyester strip printed with invisble ink is just one millimeter wide and is found in different positions depending on a bill's value. If you hold your dollar up to natural light, you can see the amount and the word USA printed on the band. But under UV light, these strips really shine. They contain molecules that can be excited by absorbing certain amounts of energy, specifically, that given off by common UV light sources. As these excited molecules return to their original states, they lose a bit of energy as heat and then radiate the rest as light. Energy is inversely related to wavelength, which means that the longer wavelengths have lower energy. So the lower energy light given off by the strip means longer wavelengths that fall in the visible range, and suddenly we can see that which had been invisible. And if a glowing strip doesn't show up on a recent bill, you have a fake on your hands. For times when you're not dealing with counterfeit masterminds, looking for simple visual cues will do. Make sure the portrait looks lifelike and not flat, the seal has perfectly even sawtooth points, the inked border is unbroken, and the serial number has precisely equal spacing between each number. So the next time you come across some dubious dough, have a closer look, pull out your iodine solution, or take it to a rave and you just might catch a counterfeit.

**P217 2015-04-20 Why is biodiversity so important - Kim Preshoff**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=217)

Our planet's diverse thriving ecosystems may seem like permanent fixtures, but they're actually vulnerable to collapse. Jungles can become deserts, and reefs can become lifeless rocks, even without cataclysmic events, like volcanoes and asteroids. What makes one ecosystem strong and another weak in the face of change? The answer, to a large extent, is biodiversity. Biodiversity is built out of three intertwined features: ecosystem diversity, species diversity, and genetic diversity. The more intertwining there is between these features, the denser and more resilient the weave becomes. Take the Amazon rainforest, one of the most biodiverse regions on Earth due to its complex ecosystems, huge mix of species, and the genetic variety within those species. Here are tangled liana vines, which crawl up from the forest floor to the canopy, intertwining with treetops and growing thick wooden stems that support these towering trees. Helped along by the vines, trees provide the seeds, fruits and leaves to herbivores, such as the tapir and the agouti, which disperse their seeds throughout the forest so they can grow. Leftovers are consumed by the millions of insects that decompose and recycle nutrients to create rich soil. The rainforest is a huge system filled with many smaller systems, like this, each packed with interconnected species. Every link provides stability to the next, strengthening biodiversity's weave. That weave is further reinforced by the genetic diversity within individual species, which allows them to cope with changes. Species that lack genetic diversity due to isolation or low population numbers, are much more vulnerable to fluctuations caused by climate change, disease or habitat fragmentation. Whenever a species disappears because of its weakened gene pool, a knot is untied and parts of the net disintegrate. So, what if we were to remove one species from the rainforest? Would the system fall apart? Probably not. The volume of species, their genetic diversity, and the complexity of the ecosystems form such rich biodiversity in this forest that one species gap in the weave won't cause it to unravel. The forest can stay resilient and recover from change. But that's not true in every case. In some environments, taking away just one important component can undermine the entire system. Take coral reefs, for instance. Many organisms in a reef are dependent on the coral. It provides key microhabitats, shelter and breeding grounds for thousand of species of fish, crustaceans and mollusks. Corals also form interdependent relationships with fungi and bacteria. The coral itself is a loom that allows the tangled net of biodiversity to be woven. That makes coral a keystone organism, one that many others depend on for their suvival. So what happens when destructive fishing practices, pollution and ocean acidification weaken coral or even kill it altogether? Exactly what you might think. The loss of this keystone species leaves its dependents at a loss, too, threatening the entire fabric of the reef. Ecosystem, species and genetic diversity together form the complex tangled weave of biodiversity that is vital for the survival of organisms on Earth. We humans are woven into this biodiversity, too. When just a few strands are lost, our own well-being is threatened. Cut too many links, and we risk unraveling it all. What the future brings is unpredictable, but biodiversity can give us an insurance policy, Earth's own safety net to safeguard our survival.

**P218 2015-04-22 Could your brain repair itself - Ralitsa Petrova**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=218)

Imagine the brain could reboot, updating its withered and damaged cells with new, improved units. That may sound like science fiction, but it's a potential reality scientists are investigating right now. Will our brains one day be able to self-repair? It's well known that embryonic cells in our young developing brains produce new neurons, the microscopic units that make up the brain's tissue. Those newly generated neurons migrate to various parts of the developing brain, making it self-organize into different structures. But until recently, scientists thought cell production came to an abrupt halt soon after this initial growth, leading them to conclude that neurological diseases, like Alzheimer's and Parkinson's, and damaging events, like strokes, are irreversible. But a series of recent discoveries has revealed that adult brains actually do continue to produce new cells in at least three specialized locations. This process, known as neurogenesis, involves dedicated brain cells, called neural stem cells and progenitor cells, which manufacture new neurons or replace the old ones. The three regions where neurogenesis has been discovered are the dentate gyrus, associated with learning and memory, the subventricular zone, which may supply neurons to the olfactory bulb for communication between the nose and brain, and the striatum, which helps manage movement. Scientists don't yet have a good grasp on exactly what role neurogenesis plays in any of these regions, or why they have this ability that's absent from the rest of the brain, but the mere presence of a mechanism to grown new neurons in the adult brain opens up an amazing possibility. Could we harness that mechanism to get the brain to heal its scars similar to how new skin grows to patch up a wound, or a broken bone stitches itself back together? So here's where we stand. Certain proteins and other small molecules that mimick those proteins can be administered to the brain to make neural stem cells and progenitor cells produce more neurons in those three locations. This technique still needs improvement so that the cells reproduce more efficiently and more cells survive. But research shows that progenitor cells from these areas can actually migrate to places where injury has occurred and give rise to new neurons there. And another promising possible approach is to transplant healthy human neural stem cells, which are cultured in a laboratory, to injured tissue, like we can do with skin. Scientists are currently experimenting to determine whether transplanted donor cells can divide, differentiate and successfully give rise to new neurons in a damaged brain. They've also discovered that we might be able to teach other kinds of brain cells, such as astrocytes or oligodendrocytes to behave like neural stem cells and start generating neurons, too. So, a couple of decades from now will our brains be able to self-repair? We can't say for sure, but that has become one of the major goals of regenerative medicine. The human brain has 100 billion neurons and we're still figuring out the wiring behind this huge biological motherboard. But everyday, research on neurogenesis brings us closer to that reboot switch.

**P219 2015-04-22 How to unboil an egg - Eleanor Nelsen**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=219)

It's so obvious that it's practically proverbial. You can't unboil an egg. Well, it turns out you can, sort of. What thermal energy does to the eggs' molecules, mechanical energy can undo. Eggs are mostly made of water and proteins. The proteins start off folded up into intricate shapes, held together by weak chemical bonds. Adding heat disrupts those bonds, allowing the proteins to unfold, uncoil, unwind and wiggle freely. This process is called denaturing. The newly liberated proteins bump up against their neighbors and start to form new bonds with each other, more and more as the heat increases, until finally, they're so entangled that they gel into a solid mass, a boiled egg. That entanglement might look permanent, but it's not. According to a chemical idea called the principle of microscopic reversibility, anything that happens, like egg proteins seizing up, can theoretically unhappen if you retrace your steps. But adding more heat will tangle the proteins further, and cooling them down will only freeze them, so here's the trick: spin them around ridiculously fast. I'm not kidding. Here's how it works. First, scientists dissolve boiled egg whites in water with a chemical called urea, a small molecule that acts as a lubricant, coating the proteins' long strands and making it easier for them to glide past each other. Then, they spin that solution in a glass tube at a breakneck 5000 rotations per minute, making the solution spread out into a thin film. Here's the key part. The solution nearest the wall spins faster than the solution closer to the middle. That difference in velocity creates sheer stresses that repeatedly stretch and contract the proteins until eventually they snap back into their native shapes and stay there. By the time the centrifuge stops spinning, the egg white is back in its original unboiled state. This technique works with all sorts of proteins. Bigger, messier proteins can be more resistant to being pulled apart, so scientists attach a plastic bead to one end that adds extra stress and encourages it to fold up first. This unboiling method won't work with a whole egg in its shell since the solution has to spread throughout a cylindrical chamber. But the applications go way beyond uncooking your breakfast, anyhow. Many pharmaceuticals consist of proteins that are extremely expensive to produce, partly because they get stuck in tangled up aggregates, just like cooked egg whites and have to be untangled and refolded before they can do their jobs. This spinning technique has the potential to be an easier, cheaper and quicker method than other ways to refold proteins, so it may allow new drugs to be made available to more people faster. And there's one more thing you need to keep in mind before trying to uncook all of your food. Boiling an egg is actually an unusual cooking process because even though it changes the way proteins are shaped and bound together, it doesn't actually change their chemical identity. Most types of cooking are more like the famous Maillard reaction, which makes chemical changes that turn sugars and proteins into delicious caramel crunchiness and are a lot harder to undo. So you might be able to unboil your egg, but I'm sorry to say you can't unfry it...yet.

**P220 2015-04-27 Why neutrinos matter - Sílvia Bravo Gallart**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=220)

They're everywhere, but you will never see one. Trillions of them are flying through you right this second, but you can't feel them. These ghost particles are called neutrinos and if we can catch them, they can tell us about the furthest reaches and most extreme environments of the universe. Neutrinos are elementary particles, meaning that they can't be subdivided into other particles the way atoms can. Elementary particles are the smallest known building blocks of everything in the universe, and the neutrino is one of the smallest of the small. A million times less massive than an electron, neutrinos fly easily through matter, unaffected by magnetic fields. In fact, they hardly ever interact with anything. That means that they can travel through the universe in a straight line for millions, or even billions, of years, safely carrying information about where they came from. So where do they come from? Pretty much everywhere. They're produced in your body from the radioactive decay of potassium. Cosmic rays hitting atoms in the Earth's atmosphere create showers of them. They're produced by nuclear reactions inside the sun and by radioactive decay inside the Earth. And we can generate them in nuclear reactors and particle accelerators. But the highest energy neutrinos are born far out in space in environments that we know very little about. Something out there, maybe supermassive black holes, or maybe some cosmic dynamo we've yet to discover, accelerates cosmic rays to energies over a million times greater than anything human-built accelerators have achieved. These cosmic rays, most of which are protons, interact violently with the matter and radiation around them, producing high-energy neutrinos, which propagate out like cosmic breadcrumbs that can tell us about the locations and interiors of the universe's most powerful cosmic engines. That is, if we can catch them. Neutrinos' limited interactions with other matter might make them great messengers, but it also makes them extremely hard to detect. One way to do so is to put a huge volume of pure transparent material in their path and wait for a neutrino to reveal itself by colliding with the nucleus of an atom. That's what's happening in Antarctica at IceCube, the world's largest neutrino telescope. It's set up within a cubic kilometer of ice that has been purified by the pressure of thousands of years of accumulated ice and snow, to the point where it's one of the clearest solids on Earth. And even though it's shot through with boreholes holding over 5,000 detectors, most of the cosmic neutrinos racing through IceCube will never leave a trace. But about ten times a year, a single high-energy neutrino collides with a molecule of ice, shooting off sparks of charged subatomic particles that travel faster through the ice than light does. In a similar way to how a jet that exceeds the speed of sound produces a sonic boom, these superluminal charged particles leave behind a cone of blue light, kind of a photonic boom. This light spreads through IceCube, hitting some of its detectors located over a mile beneath the surface. Photomultiplier tubes amplify the signal, which contains information about the charged particles' paths and energies. The data are beamed to astrophysicists around the world who look at the patterns of light for clues about the neutrinos that produced them. These super energetic collisions are so rare that IceCube's scientists give each neutrino nicknames, like Big Bird and Dr. Strangepork. IceCube has already observed the highest energy cosmic neutrinos ever seen. The neutrinos it detects should finally tell us where cosmic rays come from and how they reached such extreme energies. Light, from infrared, to x-rays, to gamma rays, has given us increasingly energetic and continuously surprising views of the universe. We are now at the dawn of the age of neutrino astronomy, and we have no idea what revelations IceCube and other neutrino telescopes may bring us about the universe's most violent, most energetic phenomena.

**P221 2015-04-28 What causes economic bubbles - Prateek Singh**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=221)

How much would you pay for a bouquet of tulips? A few dollars? A hundred dollars? How about a million dollars? Probably not. Well, how much would you pay for this house, or partial ownership of a website that sells pet supplies? At different points in time, tulips, real estate and stock in pets.com have all sold for much more than they were worth. In each instance, the price rose and rose and then abruptly plummeted. Economists call this a bubble. So what is exactly is going on with a bubble? Well, let's start with the tulips to get a better idea. The 17th century saw the Netherlands enter the Dutch golden age. By the 1630s, Amsterdam was an important port and commercial center. Dutch ships imported spices from Asia in huge quantities to earn profits in Europe. So Amsterdam was brimming with wealthy, skilled merchants and traders who displayed their prosperity by living in mansions surrounded by flower gardens. And there was one flower in particularly high demand: the tulip. The tulip was brought to Europe on trading vessels that sailed from the East. Because of this, it was considered an exotic flower that was also difficult to grow, since it could take years for a single tulip to bloom. During the 1630s, an outbreak of tulip breaking virus made select flowers even more beautiful by lining petals with multicolor, flame-like streaks. A tulip like this was scarcer than a normal tulip and as a result, prices for these flowers started to rise, and with them, the tulip's popularity. It wasn't long before the tulip became a nationwide sensation and tulip mania was born. A mania occurs when there is an upward movement of price combined with a willingness to pay large sums of money for something valued much lower in intrinsic value. A recent example of this is the dot-com mania of the 1990s. Stocks in new, exciting websites were like the tulips of the 17th century. Everybody wanted some. The more people who wanted the tulip, the higher the price could go. At one point, a single tulip bulb sold for more than ten times the annual salary of a skilled craftsman. In the stock market, the price of stock is based on the supply and demand of investors. Stock prices tend to rise when it seems like a company will earn more in the future. Investors might then buy more of the stock, raising the prices even further due to an increased demand. This can result in a feedback loop where investors get caught up in the hype and ultimately drive prices far above intrinsic value, creating a bubble. All that is needed for a mania to end and for a bubble to burst is the collective realization that the price of the stock, or a tulip, far exceeds its worth. That's what happened with both manias. Suddenly the demand ended. Prices were pushed to staggering lows, and pop! The bubbles burst, and the market crashed. Today, scholars work long and hard trying to predict what causes a bubble and how to avoid them. Tulip mania is an effective illustration of the underlying principles at work in a bubble and can help us understand more recent examples like the real estate bubble of the late 2000s. The economy will continue to go through phases of booms and busts. So while we wait for the next mania to start, and the next bubble to burst, treat yourself to a bouquet of tulips and enjoy the fact that you didn't have to pay an arm and a leg for them.

**P222 2015-04-28 What is leukemia - Danilo Allegra and Dania Puggioni**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=222)

Despite advances in medicine, cancer remains one of the most frightening diagnoses patients can receive. What makes it so difficult to cure is that it's not one illness, but a family of over 100 diseases occurring in different types of cells. And one type of cancer has the unfortunate distinction of afflicting children more than any other type. This is leukemia, a cancer that begins in stem cells found in the bone marrow. A stem cell is a bit like an infant, undeveloped but possessing great potential. Many stem cells specialize and become cells of organs, like the liver, brain and heart. But in some tissues, they can continue to divide into new stem cells throughout development, and into adulthood in order to frequently generate new cells and keep up with the body's needs. One example is the bone marrow, where stem cells differentiate into many types of blood cells. That includes red blood cells, which carry oxygen from the lungs to all tissues, platelets, which help stop bleeding by sticking to damaged blood vessels, and white blood cells, which patrol the body, destroying potentially harmful invaders. Every once in a while, something goes wrong during a stem cell's specialization process and harmful mutations occur in the cell's DNA. Cells with compromised DNA are supposed to self-destruct, but some damaged cells ignore this order, replicating uncontrollably, even as they lose their original function. These are what we know as cancer cells. It is not yet clear why leukemia is the most common childhood cancer, but one contributing factor may be that leukemias are often caused by just one or two DNA modifications, while most cancers require many of them, allowing leukemias to arise faster than other types of cancer. Moreover, some DNA alterations can occur in white blood cells during fetal development, further increasing the risk of early leukemia. But though it affects more children than any other cancer, adults constitute the majority of leukemia patients overall. Once leukemia strikes, the damaged cells reproduce in the blood and the bone marrow until they take up all available space and resources. When the bone marrow can no longer produce the required amount of functional cells, the blood becomes depleted. The lack of red blood cells means that muscles don't get enough oxygen, the reduced number of platelets is not sufficient to repair wounds, and the dearth of functional white blood cells impairs the immune system, increasing the risk of infections. To restore the normal function of the blood, leukemic cells have to be eliminated. But because leukemias are not solid tumors, they can't be removed surgically. Instead, the cells are killed inside the body using various treatments that include chemotherapy, a combination of drugs that destroys quickly multiplying cells. Unfortunately, this has the side effect of killing healthy cells, such as those found in hair follicles or intestines. And in some cases, the dosage required is so high that it kills all cells in the bone marrow, including stem cells. When this happens, the body is no longer able to create new blood cells on its own. Fortunately, outside help can come in the form of stem cells from the bone marrow of a donor. Once transplanted into the patient, they rapidly repopulate the bone marrow and the blood. However, bone marrow transplants are a complicated process requiring antigen compatibility between the donor and recipient to keep the transplanted cells from from attacking the patient's own cells as foreign bodies. Unlike with blood transplants, there are thousands of HLA types, and even siblings and close relatives may not have compatible bone marrow. If this is the case, the search is expanded to a database containing the genetic makeup of millions of voluntary bone marrow donors. The more potential donors there are, the more patients lives can be saved through successful transplants. Leukemia may be a frightening disease, but there is strength and hope in numbers.

**P223 2015-05-01 Why do your knuckles pop - Eleanor Nelsen**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=223)

What's that sound? Depending on whom you ask, the crackle of popping joints is either the sound of sweet relief or the noxious tones of a stomach-turning habit. Really, though. What's that sound? I mean, why does bending your joints in a certain way make them pop like that? Scientists have offered several explanations, including rapidly stretching ligaments, and in severe cases, actual bones grinding against each other. But the most common explanation for why your stretched-out joints sound like bubbles popping is that, well, there are bubbles in there. The joints in your fingers are the easiest ones to crack, but many people also crack the joints between vertebrae in their neck and back, and even their hips, wrists, shoulders and so on. All these joints are synovial joints, and they're the most flexible ones in your body. The space between the two bones is filled with a viscous liquid, synovial fluid, which contains long, lubricating molecules, like hyaluronic acid and lubricin. Synovial fluid is more or less the texture of egg yolk and its primary purpose is to cushion the bones and help them glide past each other. It also contains phagocytic cells that help clean up any bone or cartilage debris that ends up in the joint. But the reason it's important for knuckle cracking is that, like other fluids in your body, it contains lots of dissolved gas molecules. Knuckle-crackers know that to get that satisfying pop, you stretch the joint farther than it normally goes by bending your fingers backwards, for example. When you do that, the bones move away from each other. The space between bones gets bigger, but the amount of synovial fluid stays constant. That creates a low-pressure zone that pulls dissolved gases out of the synovial fluid, just like the carbon dioxide that fizzes out of soda when you twist open the cap. Inside the joint, the escaping gases form a bubble with a pop. But the bubble doesn't last long. The surrounding fluid presses on it until it finally collapses. The bubble's gases scatter throughout the synovial cavity and slowly dissolve back into the fluid over the course of about twenty minutes, which is why it can take a while before you can pop the same joint again. Some scientists think there may actually be two pops. One when the bubble forms, and another when it bursts. Popping a joint temporarily enlarges it, which may be why dedicated knuckle-, neck- and back-crackers say the habit makes their joints feel looser and more flexible. But you may have heard from a concerned relative or annoyed officemate that cracking your joints will give you arthritis. A doctor named Donald Unger heard this, too. So, determined to disprove his mother's warnings, he cracked the knuckles of his left hand repeatedly for 50 years, while the right-hand knuckles went unpopped. 36,500 cracks later, both hands were arthritis-free. For this selfless act of devotion to science, Dr. Unger received an Ig Nobel Prize, a parody of the Nobel Prize that recognizes wacky, but weirdly fascinating, scientific accomplishments. Unger wrote that his results should prompt investigation into other parental beliefs, like the importance of eating spinach. The jury's still out on that one. As for knuckle-cracking, one study suggests that all that joint stretching and bubble bursting can cause your hands to swell and weaken your grip. But the biggest proven danger seems to be annoying those around you.

**P224 2015-05-07 How in vitro fertilization (IVF) works - Nassim Assefi and Brian A. L**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=224)

In 1978, Louise Brown became the world's first baby to be born by in vitro fertilization, or IVF. Her birth revolutionized the field of reproductive medicine. Given that approximately one in eight heterosexual couples has difficulty conceiving, and that homosexual couples and single parents often need clinical help to make a baby, the demand for IVF has been growing. IVF is so common, that more than 5 million babies have been born through this technology. IVF works by mimicking the brilliant design of sexual reproduction. In order to understand IVF, we first need to take a look at the natural process of baby making. Believe it or not, it all starts in the brain. Roughly fifteen days before fertilization can happen, the anterior pituitary gland secretes follicle stimulating hormone, FSH, which ripens a handful of follicles of the ovary that then release estrogen. Each follicle contains one egg, and on average, only one follicle becomes fully mature. As it grows and continues to release estrogen, this hormone not only helps coordinate growth and preparation of the uterus, it also communicates to the brain how well the follicle is developing. When the estrogen level is high enough, the anterior pituitary releases a surge of luteinizing hormone, LH, which triggers ovulation and causes the follicle to rupture and release the egg. Once the egg leaves the ovary, it is directed into the Fallopian tube by the finger-like fimbriae. If the egg is not fertilized by sperm within 24 hours, the unfertilized egg will die, and the entire system will reset itself, preparing to create a new egg and uterine lining the following month. The egg is the largest cell in the body and is protected by a thick, extracellular shell of sugar and protein called the zona pellucida. The zona thwarts the entry and fusion of more than one sperm, the smallest cell in the body. It takes a man two to three months to make sperm, and the process constantly renews. Each ejaculation during sexual intercourse releases more than 100 million sperm. But only 100 or so will ultimately make it to the proximity of the egg, and only one will successfully penetrate through the armor of the zona pellucida. Upon successful fertilization, the zygote immediately begins developing into an embryo, and takes about three days to reach the uterus. There, it requires another three or so days to implant firmly into the endometrium, the inner lining of the uterus. Once implanted, the cells that are to become the placenta secrete a hormone that signals to the ovulated follicle that there is a pregnancy in the uterus. This helps rescue that follicle, now called the corpus luteum, from degenerating as it normally would do in that stage of the menstrual cycle. The corpus luteum is responsible for producing the progesterone required to maintain the pregnancy until six to seven weeks of gestation, when the placenta develops and takes over, until the baby is born approximately 40 weeks later. Now, how do you make a baby in a lab? In patients undergoing IVF, FSH is administered at levels that are higher than naturally occuring to cause a controlled overstimulation of the ovaries so that they ultimately produce multiple eggs. The eggs are then retrieved just before ovulation would occur, while the woman is under anesthesia, through an aspirating needle that is guided by ultrasound. Most sperm samples are produced by masturbation. In the laboratory, the identified eggs are stripped of surrounding cells and prepared for fertilization in a petri dish. Fertilization can occur by one of two techniques. In the first, the eggs are incubated with thousands of sperm and fertilization occurs naturally over a few hours. The second technique maximizes certainty of fertilization by using a needle to place a single sperm inside the egg. This is particularly useful when there is a problem with the quality of the sperm. After fertilization, embryos can be further screened for genetic suitability, frozen for later attempted pregnancies, or delivered into the woman's uterus via catheter. Common convention is to transfer the embryo three days after fertilization, when the embryo has eight cells, or on day five, when the embryo is called a blastocyst, and has hundreds of cells. If the woman's eggs are of poor quality due to age or toxic exposures, or have been removed due to cancer, donor eggs may be used. In the case that the intended mother has a problematic uterus, or lacks one, another woman, called the gestational carrier or surrogate, can use her uterus to carry the pregnancy. To increase the odds of success, which are as high as 40% for a woman younger than 35, doctors sometimes transfer multiple embryos at once, which is why IVF results in twins and triplets more often than natural pregnancies. However, most clinics seek to minimize the chances of multiple pregnancies, as they are riskier for mothers and babies. Millions of babies, like Louise Brown, have been born from IVF and have had normal, healthy lives. The long-term health consequences of ovarian stimulation with IVF medicines are less clear, though so far, IVF seems safe for women. Because of better genetic testing, delayed childbearing, increased accessibility and diminishing cost, it's not inconceivable that artificial baby making via IVF and related techniques could outpace natural reproduction in years to come.

**P225 2015-05-07 The wars that inspired Game of Thrones - Alex Gendler**

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As far as we know, Medieval England was never invaded by ice zombies, or terrorized by dragons, but it was shaken by a power struggle between two noble families spanning generations and involving a massive cast of characters with complex motives and shifting loyalties. If that sounds familiar, it's because the historical conflicts known as the Wars of the Roses served as the basis for much of the drama in Game of Thrones. The real-life seeds of war were sewn by the death of King Edward III in 1377. Edward's oldest son had died before his father, but his ten-year-old son, Richard II, succeeded to the throne ahead of Edward's three surviving sons. This skipping of an entire generation left lingering claims to the throne among their various offspring, particularly the Lancasters, descended from Edward's third son, and the Yorks, descended from his fourth son. The name of the ensuing wars comes from the symbols associated with the two families, the white rose of York and the red rose of Lancaster. The Lancasters first gained the throne when Richard II was deposed by his cousin Henry IV in 1399. Despite sporadic unrest, their reign remained secure until 1422, when Henry V's death in a military campaign left an infant Henry VI as king. Weak-willed and dominated by advisors, Henry was eventually convinced to marry Margaret of Anjou to gain French support. Margaret was beautiful, ambitious, and ruthless in persecuting any threat to her power, and she distrusted Richard of York, most of all. York had been the King's close advisor and loyal General, but was increasingly sidelined by the Queen, who promoted her favorite supporters, like the Earls of Suffolk and Somerset. York's criticism of their inept handling of the war against France led to his exclusion from court and transfer to Ireland. Meanwhile, mounting military failures, and corrupt rule by Margaret and her allies caused widespread discontent, and in the midst of this chaos, Richard of York returned with an army to arrest Somerset and reform the court. Initially unsuccessful, he soon got his chance when he was appointed Protector of the Realm after Henry suffered a mental breakdown. However, less than a year later, Henry suddendly recovered and the Queen convinced him to reverse York's reforms. York fled and raised an army once more. Though he was unable to directly seize the throne, he managed to be reinstated as Protector and have himself and his heirs designated to succeed Henry. But instead of a crown, York's head acquired a pike after he was killed in battle with the Queen's loyalists. His young son took up the claim and was crowned Edward IV. Edward enjoyed great military success against the Lancasters. Henry was captured, while Margaret fled into exile with their reportedly cruel son, Edward of Westminster. But the newly crowned King made a tragic political mistake by backing out of his arranged marriage with a French Princess to secretly marry the widow of a minor Noble. This alienated his most powerful ally, the Earl of Warwick. Warwick allied with the Lancasters, turned Edward's jealous younger brother, George, against him, and even briefly managed to restore Henry as King, but it didn't last. Edward recaptured the throne, the Lancaster Prince was killed in battle, and Henry himself died in captivity not long after. The rest of Edward IV's reign was peaceful, but upon his death in 1483, the bloodshed resumed. Though his twelve-year-old son was due to succeed him, Edward's younger brother Richard III declared his nephews illegitimate due to their father's secret marriage. He assumed the regency himself and threw the boys in prison. Though no one knows what ultimately became of them, after a while, the Princes disappeared and Richard's power seemed secure. But his downfall would come only two years later from across the narrow sea of the English Channel. Henry Tudor was a direct descendant of the first Duke of Lancaster, raised in exile after his father's death in a previous rebellion. With Richard III's power grab causing a split in the York faction, Henry won support for his royal claim. Raising an army in France, he crossed the Channel in 1485 and quickly defeated Richard's forces. And by marrying Elizabeth of York, elder sister of the disappeared Princes, the newly crowned Henry VII joined the two roses, finally ending nearly a century of war. We often think of historical wars as decisive conflicts with clearly defined winners and losers. But the Wars of the Roses, like the fiction they inspired, show us that victories can be uncertain, alliances unstable, and even the power of Kings as fleeting as the seasons.

**P226 2015-05-08 Sunlight is way older than you think - Sten Odenwald**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=226)

You may know that it takes light a zippy eight minutes to reach us from the surface of the Sun, so how long do you think it takes light to travel from the Sun's core to its surface? A few seconds or a minute at most? Well, oddly enough, the answer is many thousands of years. Here's why. Photons are produced by the nuclear reactions deep in the core of our Sun. As the photons flow out of the core, they interact with matter and lose energy, becoming longer wavelength forms of light. They start out as gamma rays in the core, but end up as x-rays, ultraviolet or visible light as they near the surface. However, that journey is neither simple nor direct. Upon being born, each photon travels at a speed of 300,000 kilometers per second until it collides with a proton and is diverted in another direction, acting like a bullet ricocheting off of every charged particle it strikes. The question of how far this photon gets from the center of the Sun after each collision is known as the random walk problem. The answer is given by this formula: distance equals step size times the square root of the number of steps. So if you were taking a random walk from your front door with a one meter stride each second, it would take you a million steps and eleven days just to travel one kilometer. So then how long does it take for a photon generated in the center of the sun to reach you? We know the mass of the Sun and can use that to calculate the number of protons within it. Let's assume for a second that all the Sun's protons are evenly spread out, making the average distance between them about 1.0 x 10^-10 meters. To random walk the 690,000 kilometers from the core to the solar surface would then require 3.9 x 10^37 steps, giving a total travel time of 400 billion years. Hmm, that can't be right. The Sun is only 4.6 billion years old, so what went wrong? Two things: The Sun isn't actually of uniform density and photons will miss quite a few protons between every collision. In actuality, a photon's energy, which changes over the course of its journey, determines how likely it is to interact with a proton. On the density question, our models show that the Sun has a hot core, where the fusion reactions occur. Surrounding that is the radiative zone, followed by the convective zone, which extends all the way to the surface. The material in the core is much denser than lead, while the hot plasma near the surface is a million times less dense with a continuum of densities in between. And here's the photon-energy relationship. For a photon that carries a small amount of energy, a proton is effectively huge, and it's much more likely to cause the photon to ricochet. And for a high-energy photon, the opposite is true. Protons are effectively tiny. Photons start off at very high energies compared to when they're finally radiated from the Sun's surface. Now when we use a computer and a sophisticated solar interior model to calculate the random walk equation with these changing quantities, it spits out the following number: 170,000 years. Future discoveries about the Sun may refine this number further, but for now, to the best of our understanding, the light that's hitting your eyes today spent 170,000 years pinballing its way towards the Sun's surface, plus eight miniscule minutes in space. In other words, that photon began its journey two ice ages ago, around the same time when humans first started wearing clothes.

**P227 2015-05-14 Mansa Musa, one of the wealthiest people who ever lived - Jessica Smi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=227)

If someone asked you who the richest people in history were, who would you name? Perhaps a billionaire banker or corporate mogul, like Bill Gates or John D. Rockefeller. How about African King Musa Keita I? Ruling the Mali Empire in the 14th century CE, Mansa Musa, or the King of Kings, amassed a fortune that possibly made him one of the wealthiest people who ever lived. But his vast wealth was only one piece of his rich legacy. When Mansa Musa came to power in 1312, much of Europe was racked by famine and civil wars. But many African kingdoms and the Islamic world were flourishing, and Mansa Musa played a great role in bringing the fruits of this flourishing to his own realm. By strategically annexing the city of Timbuktu, and reestablishing power over the city of Gao, he gained control over important trade routes between the Mediterranean and the West African Coast, continuing a period of expansion, which dramatically increased Mali's size. The territory of the Mali Empire was rich in natural resources, such as gold and salt. The world first witnessed the extent of Mansa Musa's wealth in 1324 when he took his pilgrimage to Mecca. Not one to travel on a budget, he brought a caravan stretching as far as the eye could see. Accounts of this journey are mostly based on an oral testimony and differing written records, so it's difficult to determine the exact details. But what most agree on is the extravagant scale of the excursion. Chroniclers describe an entourage of tens of thousands of soldiers, civilians, and slaves, 500 heralds bearing gold staffs and dressed in fine silks, and many camels and horses bearing an abundance of gold bars. Stopping in cities such as Cairo, Mansa Musa is said to have spent massive quantities of gold, giving to the poor, buying souvenirs, and even having mosques built along the way. In fact, his spending may have destabilized the regional economy, causing mass inflation. This journey reportedly took over a year, and by the time Mansa Musa returned, tales of his amazing wealth had spread to the ports of the Mediterranean. Mali and its king were elevated to near legendary status, cemented by their inclusion on the 1375 Catalan Atlas. One of the most important world maps of Medieval Europe, it depicted the King holding a scepter and a gleaming gold nugget. Mansa Musa had literally put his empire and himself on the map. But material riches weren't the king's only concern. As a devout Muslim, he took a particular interest in Timbuktu, already a center of religion and learning prior to its annexation. Upon returning from his pilgrimage, he had the great Djinguereber Mosque built there with the help of an Andalusian architect. He also established a major university, further elevating the city's reputation, and attracting scholars and students from all over the Islamic world. Under Mansa Musa, the Empire became urbanized, with schools and mosques in hundreds of densely populated towns. The king's rich legacy persisted for generations and to this day, there are mausoleums, libraries and mosques that stand as a testament to this golden age of Mali's history.

**P228 2015-05-14 The complex geometry of Islamic design - Eric Broug**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=228)

In Islamic culture, geometry is everywhere. You can find it in mosques, madrasas, palaces and private homes. This tradition began in the 8th century CE during the early history of Islam, when craftsmen took preexisting motifs from Roman and Persian cultures and developed them into new forms of visual expression. This period of history was a golden age of Islamic culture, during which many achievements of previous civilizations were preserved and further developed, resulting in fundamental advancements in scientific study and mathematics. Accompanying this was an increasingly sophisticated use of abstraction and complex geometry in Islamic art, from intricate floral motifs adorning carpets and textiles, to patterns of tilework that seemed to repeat infinitely, inspiring wonder and contemplation of eternal order. Despite the remarkable complexity of these designs, they can be created with just a compass to draw circles and a ruler to make lines within them. And from these simple tools emerges a kaleidoscope multiplicity of patterns. So how does that work? Well, everything starts with a circle. The first major decision is how will you divide it up? Most patterns split the circle into four, five or six equal sections. And each division gives rise to distinctive patterns. There's an easy way to determine whether any pattern is based on fourfold, fivefold, or sixfold symmetry. Most contain stars surrounded by petal shapes. Counting the number of rays on a starburst, or the number of petals around it, tells us what category the pattern falls into. A star with six rays, or surrounded by six petals, belongs in the sixfold category. One with eight petals is part of the fourfold category, and so on. There's another secret ingredient in these designs: an underlying grid. Invisible, but essential to every pattern, the grid helps determine the scale of the composition before work begins, keeps the pattern accurate, and facilitates the invention of incredible new patterns. Let's look at an example of how these elements come together. We'll start with a circle within a square, and divide it into eight equal parts. We can then draw a pair of criss-crossing lines and overlay them with another two. These lines are called construction lines, and by choosing a set of their segments, we'll form the basis of our repeating pattern. Many different designs are possible from the same construction lines just by picking different segments. And the full pattern finally emerges when we create a grid with many repetitions of this one tile in a process called tessellation. By choosing a different set of construction lines, we might have created this pattern, or this one. The possibilities are virtually endless. We can follow the same steps to create sixfold patterns by drawing construction lines over a circle divided into six parts, and then tessellating it, we can make something like this. Here's another sixfold pattern that has appeared across the centuries and all over the Islamic world, including Marrakesh, Agra, Konya and the Alhambra. Fourfold patterns fit in a square grid, and sixfold patterns in a hexagonal grid. Fivefold patterns, however, are more challenging to tessellate because pentagons don't neatly fill a surface, so instead of just creating a pattern in a pentagon, other shapes have to be added to make something that is repeatable, resulting in patterns that may seem confoundingly complex, but are still relatively simple to create. Also, tessellation is not constrained to simple geometric shapes, as M.C. Escher's work demonstrates. And while the Islamic geometric design tradition doesn't tend to employ elements like fish and faces, it does sometimes make use of multiple shapes to craft complex patterns. This more than 1,000-year-old tradition has wielded basic geometry to produce works that are intricate, decorative and pleasing to the eye. And these craftsmen prove just how much is possible with some artistic intuition, creativity, dedication and a great compass and ruler.

**P229 2015-05-15 Debunking the myths of OCD - Natascha M. Santos**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=229)

There's a common misconception that if you like to meticulously organize your things, keep your hands clean, or plan out your weekend to the last detail, you might have OCD. In fact, OCD, which stands for obsessive compulsive disorder, is a serious psychiatric condition that is frequently misunderstood by society and mental health professionals alike. So let's start by debunking some myths. Myth one: repetitive or ritualistic behaviors are synonymous with OCD. As its name suggests, obsessive compulsive disorder has two aspects: the intrusive thoughts, images, or impulses, known as obsessions, and the behavioral compulsions people engage in to relieve the anxiety the obsessions cause. The kinds of actions that people often associate with OCD, like excessive hand washing, or checking things repeatedly, may be examples of obsessive or compulsive tendencies that many of us exhibit from time to time. But the actual disorder is far more rare and can be quite debilitating. People affected have little or no control over their obsessive thoughts and compulsive behaviors, which tend to be time consuming and interfere with work, school or social life to the point of causing significant distress. This set of diagnostic criteria is what separates people suffering from OCD from those who may just be a bit more meticulous or hygiene obsessed than usual. Myth two: the main symptom of OCD is excessive hand washing. Although hand washing is the most common image of OCD in popular culture, obsessions and compulsions can take many different forms. Obsessions can manifest as fears of contamination and illness, worries about harming others, or preoccupations with numbers, patterns, morality, or sexual identity. And compulsions can range from excessive cleaning or double checking, to the fastidious arrangement of objects, or walking in predetermined patterns. Myth three: individuals with OCD don't understand that they are acting irrationally. Many individuals with OCD actually understand the relationship between their obsessions and compulsions quite well. Being unable to avoid these thoughts and actions despite being aware of their irrationality is part of the reason why OCD is so distressing. OCD sufferers report feeling crazy for experiencing anxiety based on irrational thoughts and finding it difficult to control their responses. So what exactly causes OCD? The frustrating answer is we don't really know. However, we have some important clues. OCD is considered a neurobiological disorder. In other words, research suggests that OCD sufferers brains are actually hardwired to behave in a certain fashion. Research has implicated three regions of the brain variously involved in social behavior and complex cognitive planning, voluntary movement, and emotional and motivational responses. The other piece of the puzzle is that OCD is associated with low levels of serotonin, a neurotransmitter that communicates between brain structures and helps regulate vital processes, such as mood, aggression, impulse control, sleep, appetite, body temperature and pain. But are serotonin and activity in these brain regions the sources of OCD or symptoms of an unknown underlying cause of the disorder. We probably won't know until we have a much more intimate understanding of the brain. The good news is there are effective treatments for OCD, including medications, which increase serotonin in the brain by limiting its reabsorption by brain cells, behavioral therapy that gradually desensitizes patients to their anxieties, and in some cases, electroconvulsive therapy, or surgery, when OCD doesn't respond to other forms of treatment. Knowing that your own brain is lying to you while not being able to resist its commands can be agonizing. But with knowledge and understanding comes the power to seek help, and future research into the brain may finally provide the answers we're looking for.

**P230 2015-05-19 How batteries work - Adam Jacobson**

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You probably know the feeling. Your phone utters its final plaintive "bleep" and cuts out in the middle of your call. In that moment, you may feel more like throwing your battery across the room than singing its praises, but batteries are a triumph of science. They allow smartphones and other technologies to exist without anchoring us to an infernal tangle of power cables. Yet even the best batteries will diminish daily, slowly losing capacity until they finally die. So why does this happen, and how do our batteries even store so much charge in the first place? It all started in the 1780s with two Italian scientists, Luigi Galvani and Alessandro Volta, and a frog. Legend has it that as Galvani was studying a frog's leg, he brushed a metal instrument up against one of its nerves, making the leg muscles jerk. Galvani called this animal electricity, believing that a type of electricity was stored in the very stuff of life. But Volta disagreed, arguing that it was the metal itself that made the leg twitch. The debate was eventually settled with Volta's groundbreaking experiment. He tested his idea with a stack of alternating layers of zinc and copper, separated by paper or cloth soaked in a salt water solution. What happened in Volta's cell is something chemists now call oxidation and reduction. The zinc oxidizes, which means it loses electrons, which are, in turn, gained by the ions in the water in a process called reduction, producing hydrogen gas. Volta would have been shocked to learn that last bit. He thought the reaction was happening in the copper, rather than the solution. None the less, we honor Volta's discovery today by naming our standard unit of electric potential "the volt." This oxidation-reduction cycle creates a flow of electrons between two substances and if you hook a lightbulb or vacuum cleaner up between the two, you'll give it power. Since the 1700s, scientists have improved on Volta's design. They've replaced the chemical solution with dry cells filled with chemical paste, but the principle is the same. A metal oxidizes, sending electrons to do some work before they are regained by a substance being reduced. But any battery has a finite supply of metal, and once most of it has oxidized, the battery dies. So rechargeable batteries give us a temporary solution to this problem by making the oxidation-reduction process reversible. Electrons can flow back in the opposite direction with the application of electricity. Plugging in a charger draws the electricity from a wall outlet that drives the reaction to regenerate the metal, making more electrons available for oxidation the next time you need them. But even rechargeable batteries don't last forever. Over time, the repetition of this process causes imperfections and irregularities in the metal's surface that prevent it from oxidizing properly. The electrons are no longer available to flow through a circuit and the battery dies. Some everyday rechargeable batteries will die after only hundreds of discharge-recharge cycles, while newer, advanced batteries can survive and function for thousands. Batteries of the future may be light, thin sheets that operate on the principles of quantum physics and last for hundreds of thousands of charge cycles. But until scientists find a way to take advantage of motion to recharge your cell battery, like cars do, or fit solar panels somewhere on your device, plugging your charger into the wall, rather than expending one battery to charge another is your best bet to forestall that fatal "bleep."

**P231 2015-05-21 The battle of the Greek tragedies - Melanie Sirof**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=231)

Good afternoon, ladies and gentlemen. Let us welcome you to the final day of dramatic battle between great tragedians. It is a spring day here in Ancient Greece. Nearly 17,000 patrons are filing into the Theatre of Dionysus to watch top playwrights, including favorites Aeschylus and Sophocles duke it out to see whose hero may be deemed most tragic, whose story most awful. Well Seacrestopolis, in last week's battle of the choruses, all 50 members of each playwright's chorus traveled back and forth across the stage, singing the strophe and antistrophe, telling misbegotten tales of woe. Today's first chorus is entering through the parados, taking their positions in the orchestra at the bottom of the stage. Mario Lopedokia, this is nothing we haven't seen before. All 50 members speaking from the depths of their souls. Wait, what is this? I've not seen this before, Seacrestopolis. There is one actor stepping out of choral formation, assuming an independent role in this play. Can you make out who it is? That looks like Thespis. It seems he's changing his mask, and taking on the role of another character. Incredible. Surely, Thespis will go down in history as the very first actor. He has changed the face of theater forever. And that was just the warm-up act. On to the main attraction. Aeschylus will have the stage first. Let's see what he does. We expect great things. Last competition, Sophocles beat him by a smidge, but Aeschylus is still considered the Father of Tragedy. Now, Aeschylus frequently competes at this festival, the city Dionysia. Though his plays are violent, the bloodshed is never seen by the audience, which allows the dramatic tension to take center stage. Let's see what he does today to try to win his title back. Here comes Aeschylus's chorus, but they seem to be missing quite a few people. What is going on here? Not only are they down a few people. There are two actors taking center stage. This is absolutely unheard of. He has build on Thespis's idea and added a second actor to the mix. Aeschylus is relying on the two individuals to tell the story. The dialogue possible in tragedy now has taken precedence over the chorus. No wonder he drastically shrunk its size. This applause is well deserved. The crowd has hushed. Sophocles's actors and chorus are taking the stage for the play, "Oedipus Rex." As usual, the chorus is set up in the orchestra. And what's this? Sophocles has added a third actor. Will this one-upmanship never end? Three actors, and they are changing their masks to take on several different roles as they weave the tale of Oedipus, a nice fellow who kills his father and marries his mother. Kills his father and marries his mother. That sounds pretty tragic to me. It is most tragic, Mario Lopedokia. Call me crazy, but I'm willing to bet that future generations will hold this play up as the perfect example of tragedy. Excuse me, Seacrestopolis. Oedipus has left the stage after realizing Jocasta was his wife and also his mother. Where has he gone? I can't even imagine. Wait. The messenger has stepped on stage and is telling us of the great king's actions. He says that Oedipus, upon finding his mother, wife, whatever, Jocasta, dead of her own hand in their incestuous bedroom, took the broaches from her dress and stabbed his eyes repeatedly. You can't blame the guy, can you? Bedded his mother, killed his father, is father and brother to his children. I might do the same. My friend, I do believe we've seen it all. Indeed, we have. There is nothing more tragic than Oedipus. And sure enough, the judges who have been chosen by lot from all over Greece are ready to announce the winner. Oh, folks! This is one for the history books. Dark horse playwright, Philocles, has taken first prize. What an upset. What a tragedy. What a night, folks. We have witnessed the laying of the foundation of modern theater and some great innovations: the shrinking of the chorus, the addition of three actors, and such catharsis. Doesn't a great tragedy just make you feel renewed and cleansed? It sure does, but now we are out of time. I'm Seacrestopolis, and I'm Mario Lopedokia. Peace, love and catharsis.

**P232 2015-05-21 What’s the big deal with gluten - William D. Chey**

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Maybe you've recently seen the phrase "gluten-free" on food packaging, or take-out menus, shampoo bottles, apartment listings, the tag of your shirt, on a hammer, as a lower back tattoo, or in your friend's resume. Next time someone starts telling you about their newfound freedom from gluten, here are some questions you can ask, and the well-informed answers that your friend, being a reasonable individual making educated dietary choices, and by no means just following the latest diet craze, will tell you. What is gluten? Gluten is an insoluble protein composite made up of two proteins named gliadin and glutenin. Where might you encounter gluten? Gluten is found in certain grains, particularly wheat, rye and barley. What has gluten been doing for the previous entirety of human history, and why do you suddenly care about it? Gluten is responsible for the elastic consistency of dough and the chewiness of foods made from wheat flour, like bread and pasta. For some people, these foods cause problems, namely wheat allergy, celiac disease, and non-celiac gluten sensitivity. Wheat allergy is an uncommon condition that occurs when a person's immune system mounts an allergic response to wheat proteins, leading to mild problems, and in rare cases, a potential dangerous reaction called anaphylaxis. Celiac disease is an inherited disease, in which eating foods with gluten leads to inflammation and damage of the lining of the small intestine. This impairs intestinal function, leading to problems like belly pain, bloating, gas, diarrhea, weight loss, skin rash, bone problems like osteoporosis, iron deficiency, small stature, infertility, fatigue and depression. Untreated, celiac disease increases the risk of developing certain types of cancer. Celiac disease is present in one in every 100 to 200 persons in the U.S. When blood tests suggest the possibility of celiac, the diagnosis is confirmed with a biopsy. The most effective treatment is a gluten-free diet, which helps heal intestinal damage and improve symptoms. Some people don't have celiac disease or a wheat allergy, but still experience symptoms when they eat foods with gluten. These people have non-celiac gluten sensitivity. They experience painful gut symptoms and suffer from fatigue, brain fog, joint pain or skin rash. A gluten-free diet typically helps with these symptoms. So how many people actually have this gluten sensitivity you speak of? Gluten sensitivity's occurrence in the general population is unclear, but likely much more common than wheat allergy or celiac disease. Diagnosis is based on the development of symptoms, the absence of wheat allergy and celiac disease, and subsequent improvement on a gluten-free diet. There's no reliable blood or tissue test, partly because gluten sensitivity isn't a single disease, and has a number of different possible causes. For example, it may be the case that gluten can activate the immune system in the small intestine, or cause it to become leaky. But sometimes, people claiming gluten sensitivity are actually sensitive not to wheat proteins, but sugars found in wheat and other foods, called fructans. The human intestine can't break down or absorb fructans, so they make their way to the large intestine or colon, where they're fermented by bacteria, producing short-chain fatty acids and gases. This leads to unpleasant symptoms in some people with bowel problems. Another possible explanation behind gluten sensitivity is the nocebo effect. This occurs when a person believes something will cause problems, and because of that belief, it does. It's the opposite of the more well-known and much more fortuitous placebo effect. Given how much bad press gluten is getting in the media, the nocebo response may play a role for some people who think they're sensitive to gluten. For all these reasons, it's clear that the problems people develop when they eat wheat and other grains aren't exclusively due to gluten. So a better name than non-celiac gluten sensitivty might be wheat intolerance.

**P233 2015-05-26 How plants tell time - Dasha Savage**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=233)

In the 18th century, Swedish botanist Carolus Linnaeus designed the flower clock, a timepiece made of flowering plants that bloom and close at specific times of day. Linnaeus's plan wasn't perfect, but the idea behind it was correct. Flowers can indeed sense time, after a fashion. Mornings glories unfurl their petals like clockwork in the early morning. A closing white water lily signals that it's late afternoon, and moon flowers, as the name suggests, only bloom under the night sky. But what gives plants this innate sense of time? It's not just plants, in fact. Many organisms on Earth have a seemingly inherent awareness of where they are in the day's cycle. That's because of circadian rhythms, the internal timekeepers that tick away inside many living things. These biological clocks allow organisms to keep track of time and pick up on environmental cues that help them adapt. That's important, because the planet's rotations and revolutions put us in a state of constant flux, although it plays out in a repetitive, predictable way. Circadian rhythms incorporate various cues to regulate when an organism should wake and sleep, and perform certain activities. For plants, light and temperature are the cues which trigger reactions that play out at a molecular scale. The cells in stems, leaves, and flowers contain phytochromes, tiny molecules that detect light. When that happens, phytochromes initiate a chain of chemical reactions, passing the message down into the cellular nuclei. There, transcription factors trigger the manufacture of proteins required to carry out light-dependent processes, like photosynthesis. These phytochromes not only sense the amount of light the plant receives, but can also detect tiny differences in the distribution of wavelengths the plant takes in. With this fine-tuned sensing, phytochromes allow the plant to discern both time, the difference between the middle of the day and the evening, and place, whether it is in direct sunlight or shade, enabling the plant to match its chemical reactions to its environment. This makes for early risers. A few hours before sunrise, a typical plant is already active, creating mRNA templates for its photosynthesizing machinery. As the phytochromes detect increasing sunlight, the plant readies its light-capturing molecules so it can photosynthesize and grow throughout the morning. After harvesting their morning light, plants use the rest of the day to build long chains of energy in the form of glucose polymers, like starch. The sun sets, and the day's work is done, though a plant is anything but inactive at night. In the absence of sunlight, they metabolize and grow, breaking down the starch from the previous day's energy harvest. Many plants have seasonal rhythms as well. As spring melts the winter frost, phytochromes sense the longer days and increasing light, and a currently unknown mechanism detects the temperature change. These systems pass the news throughout the plant and make it produce blooming flowers in preparation for the pollinators brought out by warmer weather. Circadian rhythms act as a link between a plant and its environment. These oscillations come from the plants themselves. Each one has a default rhythm. Even so, these clocks can adapt their oscillations to environmental changes and cues. On a planet that's in constant flux, it's the circadian rhythms that enable a plant to stay true to its schedule and to keep its own time.

**P234 2015-05-26 The math behind Michael Jordan’s legendary hang time - Andy Peterson**

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Michael Jordan once said, "I don't know whether I'll fly or not. I know that when I'm in the air sometimes I feel like I don't ever have to come down." But thanks to Isaac Newton, we know that what goes up must eventually come down. In fact, the human limit on a flat surface for hang time, or the time from when your feet leave the ground to when they touch down again, is only about one second, and, yes, that even includes his airness, whose infamous dunk from the free throw line has been calculated at .92 seconds. And, of course, gravity is what's making it so hard to stay in the air longer. Earth's gravity pulls all nearby objects towards the planet's surface, accelerating them at 9.8 meters per second squared. As soon as you jump, gravity is already pulling you back down. Using what we know about gravity, we can derive a fairly simple equation that models hang time. This equation states that the height of a falling object above a surface is equal to the object's initial height from the surface plus its initial velocity multiplied by how many seconds it's been in the air, plus half of the gravitational acceleration multiplied by the square of the number of seconds spent in the air. Now we can use this equation to model MJ's free throw dunk. Say MJ starts, as one does, at zero meters off the ground, and jumps with an initial vertical velocity of 4.51 meters per second. Let's see what happens if we model this equation on a coordinate grid. Since the formula is quadratic, the relationship between height and time spent in the air has the shape of a parabola. So what does it tell us about MJ's dunk? Well, the parabola's vertex shows us his maximum height off the ground at 1.038 meters, and the X-intercepts tell us when he took off and when he landed, with the difference being the hang time. It looks like Earth's gravity makes it pretty hard for even MJ to get some solid hang time. But what if he were playing an away game somewhere else, somewhere far? Well, the gravitational acceleration on our nearest planetary neighbor, Venus, is 8.87 meters per second squared, pretty similar to Earth's. If Michael jumped here with the same force as he did back on Earth, he would be able to get more than a meter off the ground, giving him a hang time of a little over one second. The competition on Jupiter with its gravitational pull of 24.92 meters per second squared would be much less entertaining. Here, Michael wouldn't even get a half meter off the ground, and would remain airborne a mere .41 seconds. But a game on the moon would be quite spectacular. MJ could take off from behind half court, jumping over six meters high, and his hang time of over five and half seconds, would be long enough for anyone to believe he could fly.

**P235 2015-05-27 How to detect a supernova - Samantha Kuula**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=235)

Just now, somewhere in the universe, a star exploded. There goes another one. In fact, a supernova occurs every second or so in the observable universe, and there is one on average every 25 to 50 years in a galaxy the size and age of the Milky Way. Yet we've never actually been able to watch one happen from its first violent moments. Of course, how would we? There are hundreds of billions of stars close enough that we could watch the supernova explosion break through the surface of the star. But we'd have to have our best telescopes focused on the right one at precisely the right time to get meaningful data. Suffice it to say, the odds of that happening are astronomically low. But what if we could anticipate a supernova before its light reached us? That may seem impossible. After all, nothing travels faster than the speed of light, right? As far as we know, yes. But in a race, fast doesn't matter if you take a detour while someone else beelines it for the finish line. For exactly that reason, photons don't win the supernova race to Earth. Neutrinos do. Here's why. There are two types of supernova. Type 1 is when a star accumulates so much matter from a neighboring star, that a runaway nuclear reaction ignites and causes it to explode. In type 2, the star runs out of nuclear fuel, so the gravitational forces pulling in overwhelm the quantum mechanical forces pushing out, and the stellar core collapses under its own weight in a hundredth of a second. While the outer reaches of the star are unaffected by the collapsed core, the inner edges accelerate through the void, smash into the core, and rebound to launch the explosion. In both of these scenarios, the star expels an unparalleled amount of energy, as well as a great deal of matter. In fact, all atoms heavier than nickel, including elements like gold and silver, only form in supernova reactions. In type 2 supernovae, about 1% of the energy consists of photons, which we know of as light, while 99% radiates out as neutrinos, the elementary particles that are known for rarely interacting with anything. Starting from the center of the star, the exploding matter takes tens of minutes, or even hours, or in rare cases, several days, to reach and break through the surface of the star. However, the neutrinos, thanks to their non-interactivity, take a much more direct route. By the time there is any visible change in the star's suface, the neutrinos typically have a several hour head start over the photons. That's why astronomers and physicists have been able to set up a project called SNEWS, the Supernova Early Warning System. When detectors around the world pick up bursts of neutrinos, they send messages to a central computer in New York. If multiple detectors receive similar signals within ten seconds, SNEWS will trigger an alert warning that a supernova is imminent. Aided by some distance and direction information from the neutrino detectors, the amateur astronomers and scientists alike will scan the skies and share information to quickly identify the new galactic supernova and turn the world's major telescopes in that direction. The last supernova that sent detectable neutrinos to Earth was in 1987 on the edge of the Tarantula Nebula in the large Magellanic Cloud, a nearby galaxy. Its neutrinos reached Earth about three hours ahead of the visible light. We're due for another one any day now, and when that happens, SNEWS should give you the opportunity to be among the first to witness something that no human has ever seen before.

**P236 2015-05-27 Will future spacecraft fit in our pockets - Dhonam Pemba**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=236)

When you picture a spaceship, you probably think of something like this, or this, or maybe this. What do they all have in common? Among other things, they're huge because they have to carry people, fuel, and all sorts of supplies, scientific instruments, and, in rare cases, planet-killing lasers. But the next real-world generation of spacecraft may be much, much smaller. We're talking fit-inside-your-pocket tiny. Imagine sending a swarm of these microspacecraft out into the galaxy. They could explore distant stars and planets by carrying sophisticated electronic sensors that would measure everything from temperature to cosmic rays. You could deploy thousands of them for the cost of a single space shuttle mission, exponentially increasing the amount of data we could collect about the universe. And they're individually expendable, meaning that we could send them into environments that are too risky for a billion dollar rocket or probe. Several hundred small spacecraft are already orbiting the Earth, taking pictures of outer space, and collecting data on things, like the behavior of bacteria in the Earth's atmosphere and magnetic signals that could help predict earthquakes. But imagine how much more we could learn if they could fly beyond Earth's orbit. That's exactly what organizations, like NASA, want to do: send microspacecraft to scout habitable planets and describe astronomical phenomena we can't study from Earth. But something so small can't carry a large engine or tons of fuel, so how would such a vessel propel itself? For microspacecraft, it turns out, you need micropropulsion. On really small scales, some of the familiar rules of physics don't apply, in particular, everyday Newtonian mechanics break down, and forces that are normally negligible become powerful. Those forces include surface tension and capillary action, the phenomena that govern other small things. Micropropulsion systems can harness these forces to power spacecraft. One example of how this might work is called microfluidic electrospray propulsion. It's a type of ion thruster, which means that it shoots out charged particles to generate momentum. One model being developed at NASA's jet propulsion laboratory is only a couple centimeters on each side. Here's how it works. That postage-stamp sized metal plate is studded with a hundred skinny needles and coated with a metal that has a low melting point, like indium. A metal grid sits above the needles, and an electric field is set up between the grid and the plate. When the plate is heated, the indium melts and capillary action draws the liquid metal up the needles. The electric field tugs the molten metal upwards, while surface tension pulls it back, causing the indium to deform into a cone. The small radius of the tips of the needles makes it possible for the electric field to overcome the surface tension, and when that happens, positively charged ions shoot off at speeds of tens of kilometers per second. That stream of ions propels the spacecraft in the opposite direction, thanks to Newton's third law. And while each ion is an extremely small particle, the combined force of so many of them pushing away from the craft is enough to generate significant acceleration. And unlike the exhaust that pours out of a rocket engine, this stream is much smaller and far more fuel efficient, which makes it better suited for long deep-space missions. These micropropulsion systems haven't been fully tested yet, but some scientists think that they will provide enough thrust to break small craft out of Earth's orbit. In fact, they're predicting that thousands of microspacecraft will be launched in the next ten years to gather data that today we can only dream about. And that is micro-rocket science.

**P237 2015-05-29 Can you solve the famously difficult green-eyed logic puzzle - Alex G**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=237)

Imagine an island where 100 people, all perfect logicians, are imprisoned by a mad dictator. There's no escape, except for one strange rule. Any prisoner can approach the guards at night and ask to leave. If they have green eyes, they'll be released. If not, they'll be tossed into the volcano. As it happens, all 100 prisoners have green eyes, but they've lived there since birth, and the dictator has ensured they can't learn their own eye color. There are no reflective surfaces, all water is in opaque containers, and most importantly, they're not allowed to communicate among themselves. Though they do see each other during each morning's head count. Nevertheless, they all know no one would ever risk trying to leave without absolute certainty of success. After much pressure from human rights groups, the dictator reluctantly agrees to let you visit the island and speak to the prisoners under the following conditions: you may only make one statement, and you cannot tell them any new information. What can you say to help free the prisoners without incurring the dictator's wrath? After thinking long and hard, you tell the crowd, "At least one of you has green eyes." The dictator is suspicious but reassures himself that your statement couldn't have changed anything. You leave, and life on the island seems to go on as before. But on the hundredth morning after your visit, all the prisoners are gone, each having asked to leave the previous night. So how did you outsmart the dictator? It might help to realize that the amount of prisoners is arbitrary. Let's simplify things by imagining just two, Adria and Bill. Each sees one person with green eyes, and for all they know, that could be the only one. For the first night, each stays put. But when they see each other still there in the morning, they gain new information. Adria realizes that if Bill had seen a non-green-eyed person next to him, he would have left the first night after concluding the statement could only refer to himself. Bill simultaneously realizes the same thing about Adria. The fact that the other person waited tells each prisoner his or her own eyes must be green. And on the second morning, they're both gone. Now imagine a third prisoner. Adria, Bill and Carl each see two green-eyed people, but aren't sure if each of the others is also seeing two green-eyed people, or just one. They wait out the first night as before, but the next morning, they still can't be sure. Carl thinks, "If I have non-green eyes, Adria and Bill were just watching each other, and will now both leave on the second night." But when he sees both of them the third morning, he realizes they must have been watching him, too. Adria and Bill have each been going through the same process, and they all leave on the third night. Using this sort of inductive reasoning, we can see that the pattern will repeat no matter how many prisoners you add. The key is the concept of common knowledge, coined by philosopher David Lewis. The new information was not contained in your statement itself, but in telling it to everyone simultaneously. Now, besides knowing at least one of them has green eyes, each prisoner also knows that everyone else is keeping track of all the green-eyed people they can see, and that each of them also knows this, and so on. What any given prisoner doesn't know is whether they themselves are one of the green-eyed people the others are keeping track of until as many nights have passed as the number of prisoners on the island. Of course, you could have spared the prisoners 98 days on the island by telling them at least 99 of you have green eyes, but when mad dictators are involved, you're best off with a good headstart.

**P238 2015-06-01 Football physics - The 'impossible' free kick - Erez Garty**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=238)

In 1997, in a game between France and Brazil, a young Brazilian player named Roberto Carlos set up for a 35 meter free kick. With no direct line to the goal, Carlos decided to attempt the seemingly impossible. His kick sent the ball flying wide of the players, but just before going out of bounds, it hooked to the left and soared into the goal. According to Newton's first law of motion, an object will move in the same direction and velocity until a force is applied on it. When Carlos kicked the ball, he gave it direction and velocity, but what force made the ball swerve and score one of the most magnificent goals in the history of the sport? The trick was in the spin. Carlos placed his kick at the lower right corner of the ball, sending it high and to the right, but also rotating around its axis. The ball started its flight in an apparently direct route, with air flowing on both sides and slowing it down. On one side, the air moved in the opposite direction to the ball's spin, causing increased pressure, while on the other side, the air moved in the same direction as the spin, creating an area of lower pressure. That difference made the ball curve towards the lower pressure zone. This phenomenon is called the Magnus effect. This type of kick, often referred to as a banana kick, is attempted regularly, and it is one of the elements that makes the beautiful game beautiful. But curving the ball with the precision needed to both bend around the wall and back into the goal is difficult. Too high and it soars over the goal. Too low and it hits the ground before curving. Too wide and it never reaches the goal. Not wide enough and the defenders intercept it. Too slow and it hooks too early, or not at all. Too fast and it hooks too late. The same physics make it possible to score another apparently impossible goal, an unassisted corner kick. The Magnus effect was first documented by Sir Isaac Newton after he noticed it while playing a game of tennis back in 1670. It also applies to golf balls, frisbees and baseballs. In every case, the same thing happens. The ball's spin creates a pressure differential in the surrounding air flow that curves it in the direction of the spin. And here's a question. Could you theoretically kick a ball hard enough to make it boomerang all the way around back to you? Sadly, no. Even if the ball didn't disintegrate on impact, or hit any obstacles, as the air slowed it, the angle of its deflection would increase, causing it to spiral into smaller and smaller circles until finally stopping. And just to get that spiral, you'd have to make the ball spin over 15 times faster than Carlos's immortal kick. So good luck with that.

**P239 2015-06-02 How people rationalize fraud - Kelly Richmond Pope**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=239)

If you ask people whether they think stealing is wrong, most of them would answer, "Yes." And yet, in 2013, organizations all over the world lost an estimated total of 3.7 trillion dollars to fraud, which includes crimes like embezzlement, pyramid schemes, and false insurance claims. This wasn't just the work of a few bad apples. The truth is that many people are susceptible not only to the temptation to commit fraud but to convincing themselves that they've done nothing wrong. So why does fraud happen? While individual motivations may differ from case to case, the fraud triangle, a model developed by criminologist Donald Cressey, shows three conditions that make fraud likely: pressure, opportunity, and rationalization. Pressure is often what motivates someone to engage in fraud to begin with. It could be a personal debt, an addiction, an earnings quota, a sudden job loss, or an illness in the family. As for opportunity, many people in both public and private sectors have access to tools that enable them to commit and conceal fraud: corporate credit cards, internal company data, or control over the budget. The combination of pressure and being exposed to such opportunities on a daily basis can create a strong temptation. But even with these two elements, most fraud still requires rationalization. Many fraudsters are first time offenders, so in order to commit an act most would regard as wrong, they need to justify it to themselves. Some feel entitled to the money because they are underpaid and overworked and others believe their fraud is victimless, perhaps even planning to return the money once their crisis is resolved. Some of the most common types of fraud don't even register as such to the perpetrator. Examples include employees fudging time sheets or expense reports, taxpayers failing to report cash earnings, or service providers overbilling insurance companies. Though these may seem small, and can sometimes only involve hundreds of dollars, they all contribute to the big picture. And then there's fraud on a massive scale. In 2003, Italian dairy food giant Parmalat went bankrupt after it was found to have fabricated a 4 billion dollar bank account and falsified financial statements to hide the fact that its subsidiaries had been losing money. Because it was family controlled, corporate governance and regulator supervision were difficult, and the company likely hoped that the losses could be recouped before anyone found out. And it's not just corporate greed. Governments and non-profits are also susceptible to fraud. During her time as City Comptroller for Dixon, Illinois, Rita Crundwell embezzled over 53 million dollars. Rita was one of the country's leading quarter horse breeders and winner of 52 world championships. But the cost of maintaining the herd ran to 200,000 dollars per month. Because her position gave her complete control over city finances, she was easily able to divert money to an account she used for private expenses, and the scheme went unnoticed for 20 years. It is believed that Crundwell felt entitled to a lavish lifestyle based on her position, and the notoriety her winnings brought to the city. It's tempting to think of fraud as a victimless crime because corporations and civic institutions aren't people. But fraud harms real people in virtually every case: the employees of Parmalat who lost their jobs, the citizens of Dixon whose taxes subsidized horse breeding, the customers of companies which raise their prices to offset losses. Sometimes the effects are obvious and devestating, like when Bernie Madoff caused thousands of people to lose their life savings. But often they're subtle and not easy to untangle. Yet someone, somewhere is left holding the bill.

**P240 2015-06-08 How to make a mummy - Len Bloch**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=240)

Death and taxes are famously inevitable, but what about decomposition? As anyone who's seen a mummy knows, ancient Egyptians went to a lot of trouble to evade decomposition. So, how successful were they? Living cells constantly renew themselves. Specialized enzymes decompose old structures, and the raw materials are used to build new ones. But what happens when someone dies? Their dead cells are no longer able to renew themselves, but the enzymes keep breaking everything down. So anyone looking to preserve a body needed to get ahead of those enzymes before the tissues began to rot. Neurons die quickly, so brains were a lost cause to Ancient Egyptian mummifiers, which is why, according to Greek historian Herodotus, they started the process by hammering a spike into the skull, mashing up the brain, flushing it out the nose and pouring tree resins into the skull to prevent further decomposition. Brains may decay first, but decaying guts are much worse. The liver, stomach and intestines contain digestive enzymes and bacteria, which, upon death, start eating the corpse from the inside. So the priests removed the lungs and abdominal organs first. It was difficult to remove the lungs without damaging the heart, but because the heart was believed to be the seat of the soul, they treated it with special care. They placed the visceral organs in jars filled with a naturally occurring salt called natron. Like any salt, natron can prevent decay by killing bacteria and preventing the body's natural digestive enzymes from working. But natron isn't just any salt. It's mainly a mixture of two alkaline salts, soda ash and baking soda. Alkaline salts are especially deadly to bacteria. And they can turn fatty membranes into a hard, soapy substance, thereby maintaining the corpse's structure. After dealing with the internal organs, the priest stuffed the body cavity with sacks of more natron and washed it clean to disinfect the skin. Then, the corpse was set in a bed of still more natron for about 35 days to preserve its outer flesh. By the time of its removal, the alkaline salts had sucked the fluid from the body and formed hard brown clumps. The corpse wasn't putrid, but it didn't exactly smell good, either. So, priests poured tree resin over the body to seal it, massaged it with a waxy mixture that included cedar oil, and then wrapped it in linen. Finally, they placed the mummy in a series of nested coffins and sometimes even a stone sarcophagus. So how successful were the ancient Egyptians at evading decay? On one hand, mummies are definitely not intact human bodies. Their brains have been mashed up and flushed out, their organs have been removed and salted like salami, and about half of their remaining body mass has been drained away. Still, what remains is amazingly well-preserved. Even after thousands of years, scientists can perform autopsies on mummies to determine their causes of death, and possibly even isolate DNA samples. This has given us new information. For example, it seems that air pollution was a serious problem in ancient Egypt, probably because of indoor fires used to bake bread. Cardiovascular disease was also common, as was tuberculosis. So ancient Egyptians were somewhat successful at evading decay. Still, like death, taxes are inevitable. When some mummies were transported, they were taxed as salted fish.

**P241 2015-06-15 How X-rays see through your skin - Ge Wang**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=241)

In 1895, a physicist named Wilhelm Roentgen was doing experiments with a cathode tube, a glass container in which a beam of electrons lights up a fluorescent window. He had wrapped cardboard around the tube to keep the fluorescent light from escaping, when something peculiar happened. Another screen outside the tube was glowing. In other words, invisible rays had passed through the cardboard. Wilhelm had no idea what those rays were, so he called them X-rays, and his discovery eventually won him a Nobel Prize. Here's what we now know was happening. When high energy electrons in the cathode tube hit a metal component, they either got slowed down and released extra energy, or kicked off electrons from the atoms they hit, which triggered a reshuffling that again released energy. In both cases, the energy was emitted in the form of X-rays, which is a type of electromagnetic radiation with higher energy than visible light, and lower energy than Gamma rays. X-rays are powerful enough to fly through many kinds of matter as if they are semi-transparent, and they're particularly useful for medical applications because they can make images of organs, like bones, without harming them, although they do have a small chance of causing mutations in reproductive organs, and tissues like the thyroid, which is why lead aprons are often used to block them. When X-rays interact with matter, they collide with electrons. Sometimes, the X-ray transfers all of its energy to the matter and gets absorbed. Other times, it only transfers some of its energy, and the rest is scattered. The frequency of these outcomes depends on how many electrons the X-rays are likely to hit. Collisions are more likely if a material is dense, or if it's made of elements with higher atomic numbers, which means more electrons. Bones are dense and full of calcium, which has a relatively high atomic number, so they absorb X-rays pretty well. Soft tissue, on the other hand, isn't as dense, and contains mostly lower atomic number elements, like carbon, hydrogen, and oxygen. So more of the X-rays penetrate tissues like lungs and muscles, darkening the film. These 2-D pictures are only useful up to a point, though. When X-rays travel through the body, they can interact with many atoms along the path. What is recorded on the film reflects the sum of all those interactions. It's like trying to print 100 pages of a novel on a single sheet of paper. To see what's really going on, you would have to take X-ray views from many angles around the body and use them to construct an internal image. And that's something doctors do all the time in a procedure called a CT, Computed Tomography scan, another Nobel Prize winning invention. Think of CT like this. With just one X-ray, you might be able to see the density change due to a solid tumor in a patient, but you wouldn't know how deep it is beneath the surface. However, if you take X-rays from multiple angles, you should be able to find the tumor's position and shape. A CT scanner works by sending a fan or cone of X-rays through a patient to an array of detectors. The X-ray beam is rotated around the patient, and often also moved down the patient's body, with the X-ray source tracing a spiral trajectory. Spiral CT scans produce data that can be processed into cross sections detailed enough to spot anatomical features, tumors, blood clots, and infections. CT scans can even detect heart disease and cavities in mummies buried thousands of years ago. So what began as Roentgen's happy accident has become a medical marvel. Hospitals and clinics now conduct over 100 millions scans each year worldwide to treat diseases and save lives.

**P242 2015-06-17 The benefits of a bilingual brain - Mia Nacamulli**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=242)

¿Hablas español? Parlez-vous français? 你会说中文吗？ If you answered, "sí," "oui," or "会" and you're watching this in English, chances are you belong to the world's bilingual and multilingual majority. And besides having an easier time traveling or watching movies without subtitles, knowing two or more languages means that your brain may actually look and work differently than those of your monolingual friends. So what does it really mean to know a language? Language ability is typically measured in two active parts, speaking and writing, and two passive parts, listening and reading. While a balanced bilingual has near equal abilities across the board in two languages, most bilinguals around the world know and use their languages in varying proportions. And depending on their situation and how they acquired each language, they can be classified into three general types. For example, let's take Gabriella, whose family immigrates to the US from Peru when she's two-years old. As a compound bilingual, Gabriella develops two linguistic codes simultaneously, with a single set of concepts, learning both English and Spanish as she begins to process the world around her. Her teenage brother, on the other hand, might be a coordinate bilingual, working with two sets of concepts, learning English in school, while continuing to speak Spanish at home and with friends. Finally, Gabriella's parents are likely to be subordinate bilinguals who learn a secondary language by filtering it through their primary language. Because all types of bilingual people can become fully proficient in a language regardless of accent or pronunciation, the difference may not be apparent to a casual observer. But recent advances in brain imaging technology have given neurolinguists a glimpse into how specific aspects of language learning affect the bilingual brain. It's well known that the brain's left hemisphere is more dominant and analytical in logical processes, while the right hemisphere is more active in emotional and social ones, though this is a matter of degree, not an absolute split. The fact that language involves both types of functions while lateralization develops gradually with age, has lead to the critical period hypothesis. According to this theory, children learn languages more easily because the plasticity of their developing brains lets them use both hemispheres in language acquisition, while in most adults, language is lateralized to one hemisphere, usually the left. If this is true, learning a language in childhood may give you a more holistic grasp of its social and emotional contexts. Conversely, recent research showed that people who learned a second language in adulthood exhibit less emotional bias and a more rational approach when confronting problems in the second language than in their native one. But regardless of when you acquire additional languages, being multilingual gives your brain some remarkable advantages. Some of these are even visible, such as higher density of the grey matter that contains most of your brain's neurons and synapses, and more activity in certain regions when engaging a second language. The heightened workout a bilingual brain receives throughout its life can also help delay the onset of diseases, like Alzheimer's and dementia by as much as five years. The idea of major cognitive benefits to bilingualism may seem intuitive now, but it would have surprised earlier experts. Before the 1960s, bilingualism was considered a handicap that slowed a child's development by forcing them to spend too much energy distinguishing between languages, a view based largely on flawed studies. And while a more recent study did show that reaction times and errors increase for some bilingual students in cross-language tests, it also showed that the effort and attention needed to switch between languages triggered more activity in, and potentially strengthened, the dorsolateral prefrontal cortex. This is the part of the brain that plays a large role in executive function, problem solving, switching between tasks, and focusing while filtering out irrelevant information. So, while bilingualism may not necessarily make you smarter, it does make your brain more healthy, complex and actively engaged, and even if you didn't have the good fortune of learning a second language as a child, it's never too late to do yourself a favor and make the linguistic leap from, "Hello," to, "Hola," "Bonjour" or "你好’s" because when it comes to our brains a little exercise can go a long way.

**P243 2015-06-22 How to grow a bone - Nina Tandon**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=243)

Can you grow a human bone outside the human body? The answer may soon be yes, but before we can understand how that's possible, we need to look at how bones grow naturally inside the body. Most bones start in a growing fetus as a soft, flexible cartilage. Bone-forming cells replace the cartilage with a spongy mineral lattice made of elements like calcium and phosphate. This lattice gets harder, as osteoblasts, which are specialized bone-forming cells, deposit more mineral, giving bones their strength. While the lattice itself is not made of living cells, networks of blood vessels, nerves and other living tissues grow through special channels and passages. And over the course of development, a legion of osteoblasts reinforce the skeleton that protects our organs, allows us to move, produces blood cells and more. But this initial building process alone is not enough to make bones strong and functional. If you took a bone built this way, attached muscles to it, and tried to use it to lift a heavy weight, the bone would probably snap under the strain. This doesn't usually happen to us because our cells are constantly reinforcing and building bone wherever they're used, a principle we refer to as Wolff's Law. However, bone materials are a limited resource and this new, reinforcing bone can be formed only if there is enough material present. Fortunately, osteoblasts, the builders, have a counterpart called osteoclasts, the recyclers. Osteoclasts break down the unneeded mineral lattice using acids and enzymes so that osteoblasts can then add more material. One of the main reasons astronauts must exercise constantly in orbit is due to the lack of skeletal strain in free fall. As projected by Wolff's Law, that makes osteoclasts more active than osteoblasts, resulting in a loss of bone mass and strength. When bones do break, your body has an amazing ability to reconstruct the injured bone as if the break had never happened. Certain situations, like cancer removal, traumatic accidents, and genetic defects exceed the body's natural ability for repair. Historical solutions have included filling in the resulting holes with metal, animal bones, or pieces of bone from human donors, but none of these are optimal as they can cause infections or be rejected by the immune system, and they can't carry out most of the functions of healthy bones. An ideal solution would be to grow a bone made from the patient's own cells that's customized to the exact shape of the hole, and that's exactly what scientists are currently trying to do. Here's how it works. First, doctors extract stem cells from a patient's fat tissue and take CT scans to determine the exact dimensions of the missing bone. They then model the exact shape of the hole, either with 3D printers, or by carving decellularized cow bones. Those are the bones where all of the cells have been stripped away, leaving only the sponge-like mineral lattice. They then add the patient's stem cells to this lattice and place it in a bioreactor, a device that will simulate all of the conditions found inside the body. Temperature, humidity, acidity and nutrient composition all need to be just right for the stem cells to differentiate into osteoblasts and other cells, colonize the mineral lattice, and remodel it with living tissue. But there's one thing missing. Remember Wolff's Law? An artificial bone needs to experience real stress, or else it will come out weak and brittle, so the bioreactor constantly pumps fluids around the bone, and the pressure tells the osteoblasts to add bone density. Put all of this together, and within three weeks, the now living bone is ready to come out of the bioreactor and to be implanted into the patient's body. While it isn't yet certain that this method will work for humans, lab grown bones have already been successfully implanted in pigs and other animals, and human trials may begin as early as 2016.

**P244 2015-06-25 Why do blood types matter - Natalie S. Hodge**

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It's often said that despite humanity's many conflicts, we all bleed the same blood. It's a nice thought but not quite accurate. In fact, our blood comes in a few different varieties. Our red blood cells contain a protein called hemoglobin that binds to oxygen, allowing the cells to transport it throughout the body. But they also have another kind of complex protein on the outside of the cell membrane. These proteins, known as antigens, communicate with white blood cells, immune cells that protect against infection. Antigens serve as identifying markers, allowing the immune system to recognize your body's own cells without attacking them as foreign bodies. The two main kinds of antigens, A and B, determine your blood type. But how do we get four blood types from only two antigens? Well, the antigens are coded for by three different alleles, varieties of a particular gene. While the A and B alleles code for A and B antigens, the O allele codes for neither, and because we inherit one copy of each gene from each parent, every individual has two alleles determining blood type. When these happen to be different, one overrides the other depending on their relative dominance. For blood types, the A and B alleles are both dominant, while O is recessive. So A and A gives you type A blood, while B and B gives you type B. If you inherit one of each, the resulting codominance will produce both A and B antigens, which is type AB. The O allele is recessive, so either of the others will override it when they're paired, resulting in either type A or type B. But if you happen to inherit two Os, instructions will be expressed that make blood cells without the A or the B antigen. Because of these interactions, knowing both parents' blood types lets us predict the relative probability of their children's blood types. Why do blood types matter? For blood transfusions, finding the correct one is a matter of life and death. If someone with type A blood is given type B blood, or vice versa, their antibodies will reject the foreign antigens and attack them, potentially causing the transfused blood to clot. But because people with type AB blood produce both A and B antigens, they don't make antibodies against them, so they will recognize either as safe, making them universal recipients. On the other hand, people with blood type O do not produce either antigen, which makes them universal donors, but will cause their immune system to make antibodies that reject any other blood type. Unfortunately, matching donors and recipients is a bit more complicated due to additional antigen systems, particular the Rh factor, named after the Rhesus monkeys in which it was first isolated. Rh+ or Rh- refers to the presence or absence of the D antigen of the Rh blood group system. And in addition to impeding some blood transfusions, it can cause severe complications in pregnancy. If an Rh- mother is carrying an Rh+ child, her body will produce Rh antibodies that may cross the placenta and attack the fetus, a condition known as hemolytic disease of the newborn. Some cultures believe blood type to be associated with personality, though this is not supported by science. And though the proportions of different blood types vary between human populations, scientists aren't sure why they evolved; perhaps as protection against blood born diseases, or due to random genetic drift. Finally, different species have different sets of antigens. In fact, the four main blood types shared by us apes seem paltry in comparison to the thirteen types found in dogs.

**P245 2015-06-26 History vs. Genghis Khan - Alex Gendler**

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He was one of the most fearsome warlords who ever lived, waging an unstoppable conquest across the Eurasian continent. But was Genghis Khan a vicious barbarian or a unifier who paved the way for the modern world? We'll see in "History vs. Genghis Khan." "Order, order. Now who's the defendant today? Khan!" "I see Your Honor is familiar with Genghis Khan, the 13th century warlord whose military campaigns killed millions and left nothing but destruction in their wake." "Objection. First of all, it's pronounced Genghis Kahn." "Really?" "In Mongolia, yes. Regardless, he was one of the greatest leaders in human history. Born Temüjin, he was left fatherless and destitute as a child but went on to overcome constant strife to unite warring Mongol clans and forge the greatest empire the world had seen, eventually stretching from the Pacific to Europe's heartland." "And what was so great about invasion and slaughter? Northern China lost 2/3 of its population." "The Jin Dynasty had long harassed the northern tribes, paying them off to fight each other and periodically attacking them. Genghis Khan wasn't about to suffer the same fate as the last Khan who tried to unite the Mongols, and the demographic change may reflect poor census keeping, not to mention that many peasants were brought into the Khan's army." "You can pick apart numbers all you want, but they wiped out entire cities, along with their inhabitants." "The Khan preferred enemies to surrender and pay tribute, but he firmly believed in loyalty and diplomatic law. The cities that were massacred were ones that rebelled after surrendering, or killed as ambassadors. His was a strict understanding of justice." "Multiple accounts show his army's brutality going beyond justice: ripping unborn children from mothers' wombs, using prisoners as human shields, or moat fillers to support siege engines, taking all women from conquered towns--" "Enough! How barbaric!" "Is that really so much worse than other medieval armies?" "That doesn't excuse Genghis Khan's atrocities." "But it does make Genghis Khan unexceptional for his time rather than some bloodthirsty savage. In fact, after his unification of the tribes abolished bride kidnapping, women in the Mongol ranks had it better than most. They controlled domestic affairs, could divorce their husbands, and were trusted advisors. Temüjin remained with his first bride all his life, even raising her possibly illegitimate son as his own." "Regardless, Genghis Khan's legacy was a disaster: up to 40 million killed across Eurasia during his descendents' conquests. 10% of the world population. That's not even counting casualties from the Black Plague brought to Europe by the Golden Horde's Siege of Kaffa." "Surely that wasn't intentional." "Actually, when they saw their own troops dying of the Plague, they catapulted infected bodies over the city walls." "Blech." "The accounts you're referencing were written over a hundred years after the fact. How reliable do you think they are? Plus, the survivors reaped the benefits of the empire Genghis Khan founded." "Benefits?" "The Mongol Empire practiced religious tolerance among all subjects, they treated their soldiers well, promoted based on merit, rather than birth, established a vast postal system, and inforced universal rule of law, not to mention their contribution to culture." "You mean like Hulagu Khan's annihilation of Baghdad, the era's cultural capital? Libraries, hospitals and palaces burned, irrigation canals buried?" "Baghdad was unfortunate, but its Kalif refused to surrender, and Hulagu was later punished by Berke Khan for the wanton destruction. It wasn't Mongol policy to destroy culture. Usually they saved doctors, scholars and artisans from conquered places, and transferred them throughout their realm, spreading knowledge across the world." "What about the devastation of Kievan Rus, leaving its people in the Dark Ages even as the Renaissance spread across Western Europe?" "Western Europe was hardly peaceful at the time. The stability of Mongol rule made the Silk Road flourish once more, allowing trade and cultural exchange between East and West, and its legacy forged Russia and China from warring princedoms into unified states. In fact, long after the Empire, Genghis Khan's descendants could be found among the ruling nobility all over Eurasia." "Not surprising that a tyrant would inspire further tyrants." "Careful what you call him. You may be related." "What?" "16 million men today are descended from Genghis Khan. That's one in ever 200." For every great conqueror, there are millions of conquered. Whose stories will survive? And can a leader's historical or cultural signifigance outweigh the deaths they caused along the way? These are the questions that arise when we put history on trial.

**P246 2015-06-29 The incredible history of China's terracotta warriors - Megan Campisi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=246)

What happens after death? Is there a restful paradise? An eternal torment? A rebirth? Or maybe just nothingness? Well, one Chinese emperor thought that whatever the hereafter was, he better bring an army. We know that because in 1974, farmers digging a well near their small village stumbled upon one of the most important finds in archeological history: vast underground chambers surrounding that emperor's tomb, and containing more than 8,000 life-size clay soldiers ready for battle. The story of the subterranean army begins with Ying Zheng, who came to power as the king of the Qin state at the age of 13 in 246 BCE. Ambitious and ruthless, he would go on to become Qin Shi Huangdi, the first emperor of China after uniting its seven warring kingdoms. His 36 year reign saw many historic accomplishments, including a universal system of weights and measures, a single standardized writing script for all of China, and a defensive barrier that would later come to be known as the Great Wall. But perhaps Qin Shi Huangdi dedicated so much effort to securing his historical legacy because he was obsessed with his mortality. He spent his last years desperately employing alchemists and deploying expeditions in search of elixirs of life that would help him achieve immortality. And as early as the first year of his reign, he began the construction of a massive underground necropolis filled with monuments, artifacts, and an army to accompany him into the next world and continue his rule. This magnificent army is still standing in precise battle formation and is split across several pits. One contains a main force of 6,000 soldiers, each weighing several hundred pounds, a second has more than 130 war chariots and over 600 horses, and a third houses the high command. An empty fourth pit suggests that the grand project could not be finished before the emperor's death. In addition, nearby chambers contain figures of musicians and acrobats, workers and government officials, and various exotic animals, indicating that Emperor Qin had more plans for the afterlife than simply waging war. All the figurines are sculpted from terracotta, or baked earth, a type of reddish brown clay. To construct them, multiple workshops and reportedly over 720,000 laborers were commandeered by the emperor, including groups of artisans who molded each body part separately to construct statues as individual as the real warriors in the emperor's army. They stand according to rank and feature different weapons and uniforms, distinct hairstyles and expressions, and even unique ears. Originally, each warrior was painted in bright colors, but their exposure to air caused the paint to dry and flake, leaving only the terracotta base. It is for this very reason that another chamber less than a mile away has not been excavated. This is the actual tomb of Qin Shi Huangdi, reported to contain palaces, precious stones and artifacts, and even rivers of mercury flowing through mountains of bronze. But until a way can be found to expose it without damaging the treasures inside, the tomb remains sealed. Emperor Qin was not alone in wanting company for his final destination. Ancient Egyptian tombs contain clay models representing the ideal afterlife, the dead of Japan's Kofun period were buried with sculptures of horses and houses, and the graves of the Jaina island off the Mexican coast are full of ceramic figurines. Fortunately, as ruthless as he was, Emperor Qin chose to have servants and soldiers built for this purpose, rather than sacrificing living ones to accompany him, as had been practiced in Egypt, West Africa, Anatolia, parts of North America and even China during the previous Shang and Zhou dynasties. And today, people travel from all over the world to see these stoic soldiers silently awaiting their battle orders for centuries to come.

**P247 2015-07-01 How to use a semicolon - Emma Bryce**

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It may seem like the semicolon is struggling with an identity crisis. It looks like a comma crossed with a period. Maybe that's why we toss these punctuation marks around like grammatical confetti. We're confused about how to use them properly. In fact, it's the semicolon's half-half status that makes it useful. It's stronger than a comma, and less final than a period. It fills the spaces in between, and for that reason, it has some specific and important tasks. For one, it can clarify ideas in a sentence that's already festooned with commas. "Semicolons: At first, they may seem frightening, then, they become enlightening, finally, you'll find yourself falling for these delightful punctuation marks." Even though the commas separate different parts of the sentence, it's easy to lose track of what belongs where. But then the semicolon edges in to the rescue. In list-like sentences, it can exert more force than commas do, cutting sentences into compartments and grouping items that belong together. The semicolon breaks things up, but it also builds connections. Another of its tasks is to link together independent clauses. These are sentences that can stand on their own, but when connected by semicolons, look and sound better because they're related in some way. "Semicolons were once a great mystery to me. I had no idea where to put them." Technically, there's nothing wrong with that. These two sentences can stand alone. But imagine they appeared in a long list of other sentences, all of the same length, each separated by periods. Things would get monotonous very fast. In that situation, semicolons bring fluidity and variation to writing by connecting related clauses. But as beneficial as they are, semicolons don't belong just anywhere. There are two main rules that govern their use. Firstly, unless they're being used in lists, semicolons should only connect clauses that are related in some way. You wouldn't use one here, for instance: "Semicolons were once a great mystery to me; I'd really like a sandwich." Periods work best here because these are two totally different ideas. A semicolon's job is to reunite two independent clauses that will benefit from one another's company because they refer to the same thing. Secondly, you'll almost never find a semicolon willingly stationed before coordinating conjunctions: the words, "and," "but," "for," "nor," "or," "so," and "yet." That's a comma's place, in fact. But a semicolon can replace a conjunction to shorten a sentence or to give it some variety. Ultimately, this underappreciated punctuation mark can give writing clarity, force, and style, all encompassed in one tiny dot and squiggle that's just waiting to be put in the right place.

**P248 2015-07-02 How do pregnancy tests work - Tien Nguyen**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=248)

The earliest known pregnancy test dates back to 1350 BC in Ancient Egypt. According to the Egyptians, all you have to do is urinate on wheat and barley seeds, and wait. If either sprouts, congratulations, you're pregnant! And if wheat sprouts faster, it's a girl, but if barley, it's a boy. In 1963, a small study reproduced this test and found that it predicted pregnancy with a respectable 70% accuracy, though it couldn't reliably tell the sex of the baby. Scientists hypothesized that the test worked because pregnant women's urine contains more estrogen, which can promote seed growth. Now it's easy to take this ancient method for granted because modern pregnancy tests give highly accurate results within minutes. So how do they work? Over-the-counter pregnancy tests are all designed to detect one thing: a hormone called HCG. HCG is produced in the earliest stages of pregnancy and starts a game of telephone that tells the body not to shed the inner lining of the uterus that month. As the pregnancy progresses, HCG supports the formation of the placenta, which transfers nutrients from mother to fetus. The test starts when urine is applied to the exposed end of the strip. As the fluid travels up the absorbent fibers, it will cross three separate zones, each with an important task. When the wave hits the first zone, the reaction zone, Y-shaped proteins called antibodies will grab onto any HCG. Attached to these antibodies is a handy enzyme with the ability to turn on dye molecules, which will be crucial later down the road. Then the urine picks up all the AB1 enzymes and carries them to the test zone, which is where the results show up. Secured to this zone are more Y-shaped antibodies that will also stick to HCG on one of its five binding sites. Scientists call this type of test a sandwich assay. If HCG is present, it gets sandwiched between the AB1 enzyme and AB2, and sticks to the test zone, allowing the attached dye-activating enzyme to do its job and create a visible pattern. If there's no HCG, the wave of urine and enzymes just passes on by. Finally, there's one last stop to make, the control zone. As in any good experiment, this step confirms that the test is working properly. Whether the AB1 enzymes never saw HCG, or they're extras because Zone 1 is overstocked with them, all the unbound AB1 enzymes picked up in Zone 1 should end up here and activate more dye. So if no pattern appears, that indicates that the test was faulty. These tests are pretty reliable, but they're not failproof. For instance, false negatives can occur if concentrations of HCG aren't high enough for detection. After implantation, HCG levels double every two to three days, so it may just be too early to tell. And beverages can dilute the urine sample, which is why doctors recommend taking the test first thing in the morning. On the other hand, false positives can come from other sources of HCG, like IVF injections, ectopic pregnancies, or certain cancers such as uterine cancer or testicular cancer, making it possible for one of these tests to tell a man he's pregnant. The best way for a woman to find out for sure is at the doctor's office. The doctors are also looking for HCG, but with tests that are more sensitive and quantitative, which means they can determine the exact level of HCG in your blood. A few minutes can feel like forever when you're waiting on the results of a pregnancy test. But in that brief time, you're witnessing the power of the scientific method. That one little stick lets you ask a question, perform a controlled experiment, and then analyze the results to check your original hypothesis. And the best part is you won't even have to wait until the next harvest.

**P249 2015-07-02 Why tragedies are alluring - David E. Rivas**

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The story goes something like this: a royal, rich or righteous individual, who otherwise happens to be a lot like us, makes a mistake that sends his life, and the lives of those around him, spiraling into ruin. Sound familiar? This is the classic story pattern for Greek tragedy. For thousands of years, we've spun spellbinding tales that fit this pattern, and modern storytellers around the world continue to do so. Three critical story components influenced by Aristotle's "Poetics" help us understand the allure. First, the tragic hero should be elevated in rank and ability, but also relatable. Perhaps he is a king, or extraordinary in some other way. But because you and I are neither unusually good nor unusually bad, neither is the hero. And he has one particular tragic flaw, or hamartia, something like ambition, tyranny, stubbornness, or excess pride that causes him to make a critical mistake. And from that mistake comes disaster and downfall. As an example of these elements in action, let's look to Sophocles's "Oedipus Rex," about a man who doesn't know he was adopted, and is warned by an oracle that he's destined to murder his father and marry his mother. In trying to escape this fate, he kills a man who won't get out of his way at a crossroad. He then cleverly answers the riddle of the monstrous Sphynx, freeing the Kingdom of Thebes from a plague. He marries the widowed queen and becomes king. But after he finds out that the murdered man was his father, and the queen he married is his mother, Oedipus gouges out his eyes and retreats into the wilderness. At the beginning of his story, Oedipus is elevated in ability, and he's elevated in rank. He's neither unusually evil nor saintly. He's relatable. Notice the height of the fall. Once a king, but now homeless and blind. It's more tragic, after all, if a king falls from a tall throne than if a jester falls off his step stool. Oedipus's tragic flaw is hubris, or excessive pride, and it causes him to attempt to avoid the fate prophesied for him, which is exactly what makes it happen. He's a particularly unlucky soul because his mistake of killing his father and marrying his mother is done in complete ignorance. Of course, these narrative principles transcend classic Greek tragedy. In Shakespeare's canon, we see Hamlet's indecisiveness lead to a series of bad decisions, or perhaps non-decisions, that culminate in the death of almost every character in the play, and Macbeth's ambition catapults him to the top before sending him careening to his grave. Even modern pop culture staples like "Game of Thrones" and "The Dark Knight" resonate with the tropes Aristotle identified over 2000 years ago. So what's the point of all of this suffering? According to Aristotle, and many scholars since, a good tragedy can evoke fear and pity in the audience: Fear of falling victim to the same or similar catastrophe, and pity for the height of the hero's downfall. Ideally, after watching these tragic events unfold, we experience catharsis, a feeling of relief and emotional purification. Not everyone agrees why this happens. It may be that empathizing with the hero allows us to experience and release strong emotions that we keep bottled up, or maybe it just lets us forget about our own problems for a little while. But regardless of how you feel when you watch poor Oedipus, never has there been a more salient reminder that no matter how bad things get, at least you didn't kill your father and marry your mother.

**P250 2015-07-07 What is a calorie - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=250)

We hear about calories all the time. How many calories are in this cookie? How many are burned by 100 jumping jacks, or long distance running, or fidgeting? But what is a calorie, really, and how many of them do we actually need? Calories are a way of keeping track of the body's energy budget. A healthy balance occurs when we put in about as much energy as we lose. If we consistently put more energy into our bodies than we burn, the excess will gradually be stored as fat in our cells, and we'll gain weight. If we burn off more energy than we replenish, we'll lose weight. So we have to be able to measure the energy we consume and use, and we do so with a unit called the calorie. One calorie, the kind we measure in food, also called a large calorie, is defined as the amount of energy it would take to raise the temperature of one kilogram of water by one degree Celsius. Everything we consume has a calorie count, a measure of how much energy the item stores in its chemical bonds. The average pizza slice has 272 calories, there are about 78 in a piece of bread, and an apple has about 52. That energy is released during digestion, and stored in other molecules that can be broken down to provide energy when the body needs it. It's used in three ways: about 10% enables digestion, about 20% fuels physical activity, and the biggest chunk, around 70%, supports the basic functions of our organs and tissues. That third usage corresponds to your basal metabolic rate, a number of calories you would need to survive if you weren't eating or moving around. Add in some physical activity and digestion, and you arrive at the official guidelines for how many calories the average person requires each day: 2000 for women and 2500 for men. Those estimates are based on factors like average weight, physical activity and muscle mass. So does that mean everyone should shoot for around 2000 calories? Not necessarily. If you're doing an energy guzzling activity, like cycling the Tour de France, your body could use up to 9000 calories per day. Pregnancy requires slightly more calories than usual, and elderly people typically have a slower metabolic rate, energy is burned more gradually, so less is needed. Here's something else you should know before you start counting calories. The calorie counts on nutrition labels measure how much energy the food contains, not how much energy you can actually get out of it. Fibrous foods like celery and whole wheat take more energy to digest, so you'd actually wind up with less energy from a 100 calorie serving of celery than a 100 calorie serving of potato chips. Not to mention the fact that some foods offer nutrients like protein and vitamins, while others provide far less nutritional value. Eating too many of those foods could leave you overweight and malnourished. And even with the exact same food, different people might not get the same number of calories. Variations in things like enzyme levels, gut bacteria, and even intestine length, means that every individual's ability to extract energy from food is a little different. So a calorie is a useful energy measure, but to work out exactly how many of them each of us requires we need to factor in things like exercise, food type, and our body's ability to process energy. Good luck finding all of that on a nutrition label.

**P251 2015-07-10 Inside the minds of animals - Bryan B Rasmussen**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=251)

Your dog loves to curl up on the couch, but so do you, so you shoo him off and settle in for a cozy evening. After all, you're the human around here. You're an intelligent being, not a simple creature of instinct. You can plan and dream, and oh- Did your dog just outsmart you and feel happy about it? Or was he just following his instincts? Is there even a difference? What is he thinking? Well, it depends on what we mean by "thinking" and the criteria we use to evaluate it. Aristotle and Descartes both use the criteria of instinct and intelligence to divide animals from humans. Aristotle believed that humans possess reason, while animals could only follow brute instincts for survival and reproduction. Almost 2000 years later, Descartes suggested a more extreme version of that idea, arguing that animals following instincts were indistinguishable from robots responding mechanically to stimuli in their environments. But the consensus against animal intelligence began to unravel with Darwin's Theory of Evolution. Darwin hypothesized that intelligence could evolve from simpler instincts. He had observed earthworms making choices about how to drag oddly shaped leaves into their boroughs, and was struck that a human might employ similar means to solve a similar problem. And if, as he thought, humans are descended from simpler creatures, then perhaps our minds lie at the far end of a continuum, differing from theirs in degree, but not in kind. Recent experiments showing that many species can solve complex problems confirm Darwin's initial hypothesis. Elephants use objects to reach inaccessible places. Crows make their own tools, and can use water displacement to get a reward. Octopuses can open jars after watching others do so, and can even remember the process months later. Such tasks involve considering aspects of a problem separately from the immediate situation, and retaining the strategy for later use. Still, while animals can solve complex problems, how do we know what, or even that, they are thinking? Behaviorists, such as Pavlov and Thorndike, argue that animals that appear to think are usually only responding to reward or punishment. This was the case with Clever Hans, a horse with the amazing ability to tap out answers to math problems. But it turns out Hans wasn't especially good at math, but at reading his unwitting trainer's subtle nonverbal cues for when to stop tapping. So Hans couldn't count, but does that mean he wasn't thinking? After all, he could interpret nuanced social messages, a quality he shared with many other non-human animals. Elephants recognize each other after years apart, and even seem to mourn their dead. Bees communicate using a special waggle dance to indicate the location and quality of a food source to other bees. Chimpanzees engage in complex deception schemes, suggesting not only do they think, but they understand that others do, too. And then there is Alex the Grey Parrot, who could use human language to distinguish the colors and shapes of absent objects, and even understand abstract concepts, like bigger and smaller. That sounds a lot like intelligence, and not just the work of mindless machines. But while a non-human animal can solve problems and even communicate, for humans, thinking also involves consciousness, the ability to reflect on our actions, not simply to perform them. So far, none of our studies tell us if having the intelligence to outsmart us means that our dog can also feel good about doing so. What we really want to know is what is it like to be a dog, or an octopus, or a crow? Philosophers of mind call this The Hard Problem, because while you and I can report what it feels like to be a human, nobody speaks horse. Even a talking parrot, like Alex, couldn't tell us how he feels about the colors he could name. And what if consciousness comes in different forms? Would we even recognize the consciousness of bees? For that matter, how can we know for sure that other people have consciouness? Perhaps they're just well-functioning zombies. Regardless, animal minds continue to test the limits of our understanding and how we frame them may reveal more about our minds than theirs.

**P252 2015-07-14 Where did English come from - Claire Bowern**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=252)

When we talk about English, we often think of it as a single language but what do the dialects spoken in dozens of countries around the world have in common with each other, or with the writings of Chaucer? And how are any of them related to the strange words in Beowulf? The answer is that like most languages, English has evolved through generations of speakers, undergoing major changes over time. By undoing these changes, we can trace the language from the present day back to its ancient roots. While modern English shares many similar words with Latin-derived romance languages, like French and Spanish, most of those words were not originally part of it. Instead, they started coming into the language with the Norman invasion of England in 1066. When the French-speaking Normans conquered England and became its ruling class, they brought their speech with them, adding a massive amount of French and Latin vocabulary to the English language previously spoken there. Today, we call that language Old English. This is the language of Beowulf. It probably doesn't look very familiar, but it might be more recognizable if you know some German. That's because Old English belongs to the Germanic language family, first brought to the British Isles in the 5th and 6th centuries by the Angles, Saxons, and Jutes. The Germanic dialects they spoke would become known as Anglo-Saxon. Viking invaders in the 8th to 11th centuries added more borrowings from Old Norse into the mix. It may be hard to see the roots of modern English underneath all the words borrowed from French, Latin, Old Norse and other languages. But comparative linguistics can help us by focusing on grammatical structure, patterns of sound changes, and certain core vocabulary. For example, after the 6th century, German words starting with "p," systematically shifted to a "pf" sound while their Old English counterparts kept the "p" unchanged. In another split, words that have "sk" sounds in Swedish developed an "sh" sound in English. There are still some English words with "sk," like "skirt," and "skull," but they're direct borrowings from Old Norse that came after the "sk" to "sh" shift. These examples show us that just as the various Romance languages descended from Latin, English, Swedish, German, and many other languages descended from their own common ancestor known as Proto-Germanic spoken around 500 B.C.E. Because this historical language was never written down, we can only reconstruct it by comparing its descendants, which is possible thanks to the consistency of the changes. We can even use the same process to go back one step further, and trace the origins of Proto-Germanic to a language called Proto-Indo-European, spoken about 6000 years ago on the Pontic steppe in modern day Ukraine and Russia. This is the reconstructed ancestor of the Indo-European family that includes nearly all languages historically spoken in Europe, as well as large parts of Southern and Western Asia. And though it requires a bit more work, we can find the same systematic similarities, or correspondences, between related words in different Indo-European branches. Comparing English with Latin, we see that English has "t" where Latin has "d", and "f" where latin has "p" at the start of words. Some of English's more distant relatives include Hindi, Persian and the Celtic languages it displaced in what is now Britain. Proto-Indo-European itself descended from an even more ancient language, but unfortunately, this is as far back as historical and archeological evidence will allow us to go. Many mysteries remain just out of reach, such as whether there might be a link between Indo-European and other major language families, and the nature of the languages spoken in Europe prior to its arrival. But the amazing fact remains that nearly 3 billion people around the world, many of whom cannot understand each other, are nevertheless speaking the same words shaped by 6000 years of history.

**P253 2015-07-17 How blood pressure works - Wilfred Manzano**

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If you lined up all the blood vessels in your body, they'd be 95,000 kilometers long and everyday, they carry the equivalent of over 7,500 liters of blood, though that's actually the same four or five liters recycled over and over, delivering oxygen, and precious nutrients like glucose and amino acids to the body's tissues. All that blood exerts a force on the muscular walls of the blood vessels. That force is called blood pressure, and it rises and falls with the phases of the heartbeat. It's highest during systole, when the heart contracts to force blood through the arteries. This is your systolic blood pressure. When the heart is at rest between beats, blood pressure falls to its lowest value, the diastolic pressure. A typical healthy individual produces a systolic pressure between 90 and 120 millimeters of mercury, and diastolic pressure between 60 and 80. Taken together, a normal reading is a bit less than 120 over 80. The blood traverses the landscape of the body through the pipes of the circulatory system. In any plumbing system, several things can increase the force on the walls of the pipes: the properties of the fluid, extra fluid, or narrower pipes. So if the blood thickens, a higher pressure is needed to push it, so the heart will pump harder. A high-salt diet will lead to a similar result. The salt promotes water retention, and the extra fluid increases the blood volume and blood pressure, and stress, like the fight or flight response, releases hormones, like epinephrine and norepinephrine that constrict key vessels, increasing the resistance to flow and raising the pressure upstream. Blood vessels can usually handle these fluctuations easily. Elastic fibers embedded in their walls make them resilient, but if your blood pressure regularly rises above about 140 over 90, what we call hypertension, and stays there, it can cause serious problems. That's because the extra strain on the arterial wall can produce small tears. When the injured tissue swells up, substances that respond to the inflammation, like white blood cells, collect around the tears. Fat and cholesterol floating in the blood latch on, too, eventually building up to form a plaque that stiffens and thickens the inner arterial wall. This condition is called atherosclerosis, and it can have dangerous consequences. If the plaque ruptures, a blood clot forms on top of the tear, clogging the already narrowed pipe. If the clot is big enough, it can completely block the flow of oxygen and nutrients to cells downstream. In vessels that feed the heart, that will cause a heart attack, when oxygen-deprived cardiac muscle cells start to die. If the clot cuts off blood flow to the brain, it causes a stroke. Dangerously clogged blood vessels can be widened by a procedure called an angioplasty. There, doctors thread a wire through the vessel to the obstructed site, and then place a deflated balloon catheter over the wire. When the balloon is inflated, it forces the passageway open again. Sometimes a rigid tube called a stent is placed in a vessel to held hold it open, letting the blood flow freely to replenish the oxygen-starved cells downstream. Staying flexible under pressure is a tough job for arteries. The fluid they pump is composed of substances that can get sticky and clog them, and your typical healthy heart beats about 70 times a minute, and at least 2.5 billion times during an average lifetime. That may sound like an insurmountable amount of pressure, but don't worry, your arteries are well suited for the challenge.

**P254 2015-07-17 The Akune brothers - Siblings on opposite sides of war - Wendell Oshi**

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There are many stories that can be told about World War II, from the tragic to the inspring. But perhaps one of the most heartrending experiences was that of the Akune family, divided by the war against each other and against their own identities. Ichiro Akune and his wife Yukiye immigrated to America from Japan in 1918 in search of opportunity, opening a small grocery store in central California and raising nine children. But when Mrs. Akune died in 1933, the children were sent to live with relatives in Japan, their father following soon after. Though the move was a difficult adjustment after having been born and raised in America, the oldest son, Harry, formed a close bond with his grand uncle, who taught him the Japanese language, culture and values. Nevertheless, as soon as Harry and his brother Ken were old enough to work, they returned to the country they considered home, settling near Los Angeles. But then, December 7, 1941, the attack on Pearl Harbor. Now at war with Japan, the United States government did not trust the loyalty of those citizens who had family or ancestral ties to the enemy country. In 1942, about 120,000 Japanese Americans living on the West Coast were stripped of their civil rights and forcibly relocated to internment camps, even though most of them, like Harry and Ken, were Nisei, American or dual citizens who had been born in the US to Japanese immigrant parents. The brothers not only had very limited contact with their family in Japan, but found themselves confined to a camp in a remote part of Colorado. But their story took another twist when recruiters from the US Army's military intelligence service arrived at the camp looking for Japanese-speaking volunteers. Despite their treatment by the government, Harry and Ken jumped at the chance to leave the camp and prove their loyalty as American citizens. Having been schooled in Japan, they soon began their service, translating captured documents, interrogating Japanese soldiers, and producing Japanese language propaganda aimed at persuading enemy forces to surrender. The brothers' work was invaluable to the war effort, providing vital strategic information about the size and location of Japanese forces. But they still faced discrimination and mistrust from their fellow soldiers. Harry recalled an instance where his combat gear was mysteriously misplaced just prior to parachuting into enemy territory, with the white officer reluctant to give him a weapon. Nevertheless, both brothers continued to serve loyally through the end of the war. But Harry and Ken were not the only Akune brothers fighting in the Pacific. Unbeknownst to them, two younger brothers, the third and fourth of the five Akune boys, were serving dutifully in the Imperial Japanese Navy, Saburo in the Naval Airforce, and 15-year-old Shiro as an orientation trainer for new recruits. When the war ended, Harry and Ken served in the allied occupational forces and were seen as traitors by the locals. When all the Akune brothers gathered at a family reunion in Kagoshima for the first time in a decade, it was revealed that the two pairs had fought on opposing sides. Tempers flared and a fight almost broke out until their father stepped in. The brothers managed to make peace and Saburo and Shiro joined Harry and Ken in California, and later fought for the US Army in Korea. It took until 1988 for the US government to acknowledge the injustice of its internment camps and approve reparations payments to survivors. For Harry, though, his greatest regret was not having the courage to thank his Japanese grand uncle who had taught him so much. The story of the Akune brothers is many things: a family divided by circumstance, the unjust treatment of Japanese Americans, and the personal struggle of reconciling two national identities. But it also reveals a larger story about American history: the oppression faced by immigrant groups and their perseverance in overcoming it.

**P255 2015-07-17 The scientific origins of the Minotaur - Matt Kaplan**

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Far beneath the palace of the treacherous King Minos, in the damp darkness of an inescapable labryinth, a horrific beast stalks the endless corridors of its prison, enraged with a bloodlust so intense that its deafening roar shakes the Earth. It is easy to see why the Minotaur myth has a long history of being disregarded as pure fiction. However, there's a good chance that the Minotaur and other monsters and gods were created by our early ancestors to rationalize the terrifying things that they saw in the natural world but did not understand. And while we can't explain every aspect of their stories, there may be some actual science that reveals itself when we dissect them for clues. So, as far as we know, there have never been human-bull hybrids. But the earliest material written about the Minotaur doesn't even mention its physical form. So that's probably not the key part of the story. What the different tellings do agree upon, however, is that the beast lives underground, and when it bellows, it causes tremendous problems. The various myths are also specific in stating that genius inventor Daedalus, carved out the labyrinth beneath the island of Crete. Archeological attempts to find the fabled maze have come up empty handed. But Crete itself has yielded the most valuable clue of all in the form of seismic activity. Crete sits on a piece of continental crust called the Aegean Block, and has a bit of oceanic crust known as the Nubian Block sliding right beneath it. This sort of geologic feature, called a subduction zone, is common all over the world and results in lots of earthquakes. However, in Crete the situation is particularly volatile as the Nubian Block is attached to the massive buoyant continental crust that is Africa. When the Nubian Block moves, it does not go down nearly as easily or as steeply as oceanic crust does in most other subduction zones. Instead, it violently and abruptly forces sections of the Mediterranean upwards in an event called uplift, and Crete is in uplift central. In the year 2014, Crete had more than 1300 earthquakes of magnitude 2.0 or higher. By comparison, in the same period of time, Southern California, a much larger area, experienced a mere 255 earthquakes. Of course, we don't have detailed seismic records from the days of King Minos, but we do know from fossil records and geologic evidence that Crete has experienced serious uplift events that sometimes exceeded 30 feet in a single moment. Contrast this for a moment with the island of Hawaii, where earthquakes and volcanic activity were tightly woven to legends surrounding Pele, a goddess both fiery and fair. Like the Minotaur, her myths included tales of destruction, but they also contained elements of dance and creation. So why did Hawaii end up with Pele and Crete end up with the Minotaur? The difference likely comes down to the lava that followed many of Hawaii's worst earthquakes. The lava on Hawaii is made of basalt, which once cooled, is highly fertile. Within a couple of decades of terrible eruptions, Islanders would have seen vibrant green life thriving on new peninsulas made of lava. So it makes sense that the mythology captured this by portraying Pele as creator as well as a destroyer. As for the people of Crete, their earthquakes brought only destruction and barren lands, so perhaps for them the unnatural and deadly Minotaur was born. The connections between mythical stories and the geology of the regions where they originated teach us that mythology and science are actually two sides of the same coin. Both are rooted in explaining and understanding the world. The key difference is that where mythology uses gods, monsters and magic, science uses measurements, records and experiments.

**P256 2015-07-20 Who am I A philosophical inquiry - Amy Adkins**

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Throughout the history of mankind, three little words have sent poets to the blank page, philosophers to the Agora, and seekers to the oracles: "Who am I?" From the ancient Greek aphorism inscribed on the Temple of Apollo, "Know thyself," to The Who's rock anthem, "Who Are You?" philosophers, psychologists, academics, scientists, artists, theologians and politicians have all tackled the subject of identity. Their hypotheses are widely varied and lack significant consensus. These are smart, creative people, so what's so hard about coming up with the right answer? One challenge certainly lies with the complex concept of the persistence of identity. Which you is who? The person you are today? Five years ago? Who you'll be in 50 years? And when is "am"? This week? Today? This hour? This second? And which aspect of you is "I"? Are you your physical body? Your thoughts and feelings? Your actions? These murky waters of abstract logic are tricky to navigate, and so it's probably fitting that to demonstrate the complexity, the Greek historian Plutarch used the story of a ship. How are you "I"? As the tale goes, Theseus, the mythical founder King of Athens, single-handedly slayed the evil Minotaur at Crete, then returned home on a ship. To honor this heroic feat, for 1000 years Athenians painstakingly maintained his ship in the harbor, and annually reenacted his voyage. Whenever a part of the ship was worn or damaged, it was replaced with an identical piece of the same material until, at some point, no original parts remained. Plutarch noted the Ship of Theseus was an example of the philosophical paradox revolving around the persistence of identity. How can every single part of something be replaced, yet it still remains the same thing? Let's imagine there are two ships: the ship that Theseus docked in Athens, Ship A, and the ship sailed by the Athenians 1000 years later, Ship B. Very simply, our question is this: does A equal B? Some would say that for 1000 years there has been only one Ship of Theseus, and because the changes made to it happened gradually, it never at any point in time stopped being the legendary ship. Though they have absolutely no parts in common, the two ships are numerically identical, meaning one and the same, so A equals B. However, others could argue that Theseus never set foot on Ship B, and his presence on the ship is an essential qualitative property of the Ship of Theseus. It cannot survive without him. So, though the two ships are numerically identical, they are not qualitatively identical. Thus, A does not equal B. But what happens when we consider this twist? What if, as each piece of the original ship was cast off, somebody collected them all, and rebuilt the entire original ship? When it was finished, undeniably two physical ships would exist: the one that's docked in Athens, and the one in some guy's backyard. Each could lay claim to the title, "The Ship of Theseus," but only would could actually be the real thing. So which one is it, and more importantly, what does this have to do with you? Like the Ship of Theseus, you are a collection of constantly changing parts: your physical body, mind, emotions, circumstances, and even your quirks, always changing, but still in an amazing and sometimes illogical way, you stay the same, too. This is one of the reasons that the question, "Who am I?" is so complex. And in order to answer it, like so many great minds before you, you must be willing to dive into the bottomless ocean of philosophical paradox. Or maybe you could just answer, "I am a legendary hero sailing a powerful ship on an epic journey." That could work, too.

**P257 2015-07-23 The benefits of good posture - Murat Dalkilinç**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=257)

Has anyone ever told you, "Stand up straight!" or scolded you for slouching at a family dinner? Comments like that might be annoying, but they're not wrong. Your posture, the way you hold your body when you're sitting or standing, is the foundation for every movement your body makes, and can determine how well your body adapts to the stresses on it. These stresses can be things like carrying weight, or sitting in an awkward position. And the big one we all experience all day every day: gravity. If your posture isn't optimal, your muscles have to work harder to keep you upright and balanced. Some muscles will become tight and inflexbile. Others will be inhibited. Over time, these dysfunctional adaptations impair your body's ability to deal with the forces on it. Poor posture inflicts extra wear and tear on your joints and ligaments, increases the likelihood of accidents, and makes some organs, like your lungs, less efficient. Researchers have linked poor posture to scoliosis, tension headaches, and back pain, though it isn't the exclusive cause of any of them. Posture can even influence your emotional state and your sensitivity to pain. So there are a lot of reasons to aim for good posture. But it's getting harder these days. Sitting in an awkward position for a long time can promote poor posture, and so can using computers or mobile devices, which encourage you to look downward. Many studies suggest that, on average, posture is getting worse. So what does good posture look like? When you look at the spine from the front or the back, all 33 vertebrae should appear stacked in a straight line. From the side, the spine should have three curves: one at your neck, one at your shoulders, and one at the small of your back. You aren't born with this s-shaped spine. Babies' spines just have one curve like a "c." The other curves usually develop by 12-18 months as the muscles strengthen. These curves help us stay upright and absorb some of the stress from activities like walking and jumping. If they are aligned properly, when you're standing up, you should be able to draw a straight line from a point just in front of your shoulders, to behind your hip, to the front of your knee, to a few inches in front of your ankle. This keeps your center of gravity directly over your base of support, which allows you to move efficiently with the least amount of fatigue and muscle strain. If you're sitting, your neck should be vertical, not tilted forward. Your shoulders should be relaxed with your arms close to your trunk. Your knees should be at a right angle with your feet flat on the floor. But what if your posture isn't that great? Try redesigning your environment. Adjust your screen so it's at or slightly below eyelevel. Make sure all parts of your body, like your elbows and wrists, are supported, using ergonomic aids if you need to. Try sleeping on your side with your neck supported and with a pillow between your legs. Wear shoes with low heels and good arch support, and use a headset for phone calls. It's also not enough to just have good posture. Keeping your muscles and joints moving is extremely important. In fact, being stationary for long periods with good posture can be worse than regular movement with bad posture. When you do move, move smartly. Keep anything you're carrying close to your body. Backpacks should be in contact with your back carried symetrically. If you sit a lot, get up and move around on occassion, and be sure to exercise. Using your muscles will keep them strong enough to support you effectively, on top of all the other benefits to your joints, bones, brain and heart. And if you're really worried, check with a physical therapist, because yes, you really should stand up straight.

**P258 2015-07-23 When to use apostrophes - Laura McClure**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=258)

Is it a flying comma, or a quotation mark chopped in half? Either way, you may already be well-versed in how to use the apostrophe, but here's a quick refresher on its usage. The apostrophe can be used in three ways: to mark possession, to mark contraction, to mark the plural of single letters. Most of the time, if you see an apostrophe hovering helpfully near a word, it's trying to mark possession or contraction. First, let's look at how the apostrophe marks possession. As you can see, the placement of this punctuation mark can really change the meaning of a sentence. "Those robots in the sand are my sister's." "Those robots in the sand are my sisters.'" "Those robots in the sand are my sisters." When showing possession, the apostrophe belongs next to the noun that owns or possesses something. The noun can be singular or plural. Proper nouns work, too. So if Lucy needs to get her robots under control before they cause mayhem, those dangerous creatures would be "Lucy's robots." But what if Lucy was Lucas? Would we write "Lucas' robots" or "Lucas's robots"? And what if Lucas gave his robots to the Robinsons family? Would it be "The Robinsons' robots," or "The Robinsons's robots"? The truth is, even grammar nerds disagree on the right thing to do. The use of 's after a proper noun ending in s is a style issue, not a hard and fast grammar rule. It's a conundrum without a simple answer. Professional writers solve this problem by learning what's considered correct for a publication, and doing that. The important thing is to pick one style and stick with it throughout a piece of writing. One more wrinkle. Certain pronouns already have possession built in and don't need an apostrophe. Remembering that will help you avoid one of the trickiest snags in English grammar: its vs. it's. "It's" only take an apostrophe when it's a contraction for "it is" or "it has." If you can replace "it's" with one of those two phrases, use the apostrophe. If you're showing possession, leave it out. Otherwise, contractions are pretty straightforward. The apostrophe stands in for missing letters, and lets common phrases squash into a single word. In rare cases, you can have a double contraction, though those generally aren't accepted in writing, with the exception of dialogue. So it's possessive, it's often followed by s's, and it's sometimes tricky when it comes to its usage. It's the apostrophe.

**P259 2015-07-27 Solid, liquid, gas and … plasma - Michael Murillo**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=259)

Have you ever seen static electricity cause a spark of light? What is that spark? What about lightning, the Northern Lights, or the tail of a comet? All of those things, and many others, in fact 99.9% of the universe, are made of plasma. Plasma is a state of matter drastically different from the more familiar forms. Take ice, for example. Ice, a solid, melts to become water, a liquid, which, when heated, vaporizes into steam, a gas. Continued heating of the steam at a high enough temperature causes the water molecules in it to separate into freely roaming hydrogen and oxygen atoms. With a little more heat, the ionization process occurs and the negatively charged electrons escape the atoms, leaving behind positively charged ions. This mixture of freely roaming negative and positive charges is plasma, and at a high enough temperature, any gas can be made into one. These freely moving charged particles behave very differently from the particles in other types of matter. When a doorknob, a solid, has static electricity on it, it doesn't look or behave any differently. And with the exception of a compass or other magnetic object, we rarely see matter respond to a magnetic field. But put a plasma in an electric field or magnetic field, and you'll get a very different reaction. Because plasmas are charged, electric fields accelerate them, and magnetic fields steer them in circular orbits. And when the particles within plasma collide, or accelerated by electricity or magnetism, light is generated, which is what we see when we look at plasmas like the Aurora Borealis. Plasmas aren't just beautiful, celestial phenomena, though. Imagine a tiny cube made of normal gas with a very high voltage across it. The resulting electric field pushes some of the electrons off the atoms and accelerates them to high speeds causing the ionization of other atoms. Imbedded impurities in the tiny cube of gas cause it to gain and release a precise amount of energy in the form of ultraviolet radiation. Attached to each tiny cube, a fluorescent material glows with a specific color when ultraviolet light at just the right intensity reaches it. Now, make a rectangle out of a million of these tiny cubes, each separately controlled by sophisticated electronics. You may be looking at one now. This is called a plasma TV. Plasmas also have implications for health care. Plasma chemists create highly specific plasmas that can destroy or alter targeted chemicals, thereby killing pathogenic organisms on food or hospital surfaces. Plasmas are all around us, in forms that are both spectacular and practical. And in the future, plasma could be used to permanently rid landfills of their waste, efficiently remove toxins from our air and water, and provide us with a potentially unlimited supply of renewable clean energy.

**P260 2015-07-30 How does a jellyfish sting - Neosha S Kashef**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=260)

You're swimming in the ocean when something brushes your leg. When the tingling sets in, you realize you've been stung by a jellyfish. How do these beautiful, gelatinous creatures pack such a painful punch? Jellyfish are soft because they are 95% water and are mostly made of a translucent gel-like substance called mesoglea. With such delicate bodies, they rely on thousands of venom-containing stinging cells called cnidocytes for protection and prey capture. Even baby jellyfish, the size of a pencil eraser, have the ability to sting. Larval jellyfish, ephyrae, look like tiny flowers pulsating in the sea. As they grow, they become umbrella-shaped with a bell at the top and descending tentacles around the margin. The largest species of jellyfish, the lion's mane, has tentacles that can extend more than 100 feet, longer than a blue whale. These tentacles contain most of the stinging cells, although some species have them on their bells, too. Venom is ejected via a nematocyst, a whip-like hollow tubule, which lies coiled under high osmotic pressure. When mechanical or chemical stimuli activate an external trigger, the lid of the cell pops open and sea water rushes in. This forces a microscopic barbed harpoon to shoot out, penetrate and inject venom into its victim. Nematocyst discharge can occur in less than a millionth of a second, making it one of nature's fastest biomechanical processes. Nematocysts can continue to fire even after a jellyfish has died, so it's important to remove lingering tentacles stuck to the skin. Rinsing with vinegar will usually render undischarged nematocysts inactive. Seawater can also help remove residual nematocysts. But don't use fresh water because any change in salt balance alters the osmotic pressure outside of the cnidocyte and will trigger the nematocyst to fire. That's why urinating on the affected area, a common folk remedy, may do more harm that good, depending on the composition of the urine. Most jellyfish stings are a painful nuisance, but some can be deadly. An Indo-Pacific box jelly, also called a sea wasp, releases venom which can cause contraction of the heart muscles and rapid death in large doses. There's an anti-venom, but the venom is fast-acting, so you'd need immediate medical intervention. Despite the impressive power in their tentacles, jellies aren't invincible. Their stinging cells are no match for the armor of thick-skin predators, like the leatherback turtle and ocean sunfish. These predators both have adaptations that prevents slippery jellyfish from escaping after they are engulfed: backwards pointing spines in the turtle's mouth and esophagus and recurved teeth behind the sunfish's cheeks. Even tiny lobster slipper larvae can cling to the bell of a jellyfish and hitch a ride, snacking on the jelly while they preserve their own energy for growth. Small agile fish use the jellies as moving reefs for protection, darting between tentacles without ever touching them. Nudibranchs, which are sea slugs covered in protective slime, can actually steal the jelly's defenses by eating the cnidocytes and transferring them to specialized sacks for later use, as weapons against their own predators. Even humans might benefit from the sting of a jellyfish one day. Scientists are working on manipulating cnidocytes to deliver medicine, with nematocysts rarely 3% of the size of a typical syringe needle. So, the next time you're out in the ocean, be careful. But also, take a second to marvel at its wonders.

**P261 2015-08-03 The physics of playing guitar - Oscar Fernando Perez**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=261)

Hendrix, Cobain and Page. They can all shred, but how exactly do the iconic contraptions in their hands produce notes, rhythm, melody and music. When you pluck a guitar string, you create a vibration called a standing wave. Some points on the string, called nodes, don't move at all, while other points, anti-nodes, oscillate back and forth. The vibration translates through the neck and bridge to the guitar's body, where the thin and flexible wood vibrates, jostling the surrounding air molecules together and apart. These sequential compressions create sound waves, and the ones inside the guitar mostly escape through the hole. They eventually propagate to your ear, which translates them into electrical impulses that your brain interprets as sound. The pitch of that sound depends on the frequency of the compressions. A quickly vibrating string will cause a lot of compressions close together, making a high-pitched sound, and a slow vibration produces a low-pitched sound. Four things affect the frequency of a vibrating string: the length, the tension, the density and the thickness. Typical guitar strings are all the same length, and have similar tension, but vary in thickness and density. Thicker strings vibrate more slowly, producing lower notes. Each time you pluck a string, you actually create several standing waves. There's the first fundamental wave, which determines the pitch of the note, but there are also waves called overtones, whose frequencies are multiples of the first one. All these standing waves combine to form a complex wave with a rich sound. Changing the way you pluck the string affects which overtones you get. If you pluck it near the middle, you get mainly the fundamental and the odd multiple overtones, which have anti-nodes in the middle of the string. If you pluck it near the bridge, you get mainly even multiple overtones and a twangier sound. The familiar Western scale is based on the overtone series of a vibrating string. When we hear one note played with another that has exactly twice its frequency, its first overtone, they sound so harmonious that we assign them the same letter, and define the difference between them as an octave. The rest of the scale is squeezed into that octave divided into twelve half steps whose frequency is each 2^(1/12) higher than the one before. That factor determines the fret spacing. Each fret divides the string's remaining length by 2^(1/12), making the frequencies increase by half steps. Fretless instruments, like violins, make it easier to produce the infinite frequencies between each note, but add to the challenge of playing intune. The number of strings and their tuning are custom tailored to the chords we like to play and the physiology of our hands. Guitar shapes and materials can also vary, and both change the nature and sound of the vibrations. Playing two or more strings at the same time allows you to create new wave patterns like chords and other sound effects. For example, when you play two notes whose frequencies are close together, they add together to create a sound wave whose amplitude rises and falls, producing a throbbing effect, which guitarists call the beats. And electric guitars give you even more to play with. The vibrations still start in the strings, but then they're translated into electrical signals by pickups and transmitted to speakers that create the sound waves. Between the pickups and speakers, it's possible to process the wave in various ways, to create effects like distortion, overdrive, wah-wah, delay and flanger. And lest you think that the physics of music is only useful for entertainment, consider this. Some physicists think that everything in the universe is created by the harmonic series of very tiny, very tense strings. So might our entire reality be the extended solo of some cosmic Jimi Hendrix? Clearly, there's a lot more to strings than meets the ear.

**P262 2015-08-05 Buffalo buffalo buffalo - One-word sentences and how they work - Emma**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=262)

You may think you know the words that sit plainly in black on your page, but don't be fooled. Some words are capable of taking on different guises, masquerading as nouns, verbs and adjectives that alter their meanings entirely. This seeming superpower is called lexical ambiguity. It can turn words and sentences into mazes that mess with our minds. For example, consider the following: Buffalo buffalo Buffalo buffalo buffalo buffalo Buffalo buffalo. That may sound like nonsense, but it's actually a grammatically correct sentence. How? Well, Buffalo is proper noun, a noun, and a verb. It refers to an animal also known as a bison, an American city, and it can also mean to bully. These different interpretations create a sequence of words that is grammatically correct as it stands, though it helps to add in a few implied phrases and punctuation marks to reveal what's really going on. Buffalo buffalo are bison from the city of Buffalo, and this sentence has three groups of them. Group A, which is bullied by Group B, bullies Group C. In other words, bison from Buffalo that other bison from Buffalo bully also bully bison from Buffalo. If you let each buffalo perform its role, the meaning becomes apparent. What if the bunch of bullying buffalo decides to cross the ocean? Not just on any ship, but a ship-shipping ship shipping shipping-ships? That sentence sounds just as outrageous, but there's logic to the babble. Ship can mean a vessel and to transport. When we sub in those meanings, a clearer picture emerges. Here we have a huge ship-carrying vessel transporting ships that themselves are designed to carry goods across the sea. A ship-shipping ship, shipping shipping-ships. How about some entertainment on board this unusual vessel to offset the scuffling buffalo? Consider the can-can. Can-can can-can can can can can can-can. Here, the word can comes in many guises. There's can-can, the flamboyant dance, can, that means able to, and can, figuratively meaning to outperform. By sticking in a comma and including the implied meanings, this sentence becomes clearer. Can-can dances that can-can dances are able to outperform, can also outperform other can-can dances. You wouldn't necessarily use any of these sentences in a conversation. They're just too ridiculous. Yet they serve as an extreme example on just how tangled everyday language can be. Lexical ambiguities sail into our speech and writing all the time, spreading confusion and misunderstanding wherever they can-can.

**P263 2015-08-07 Can you solve the bridge riddle - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=263)

Taking that internship in a remote mountain lab might not have been the best idea. Pulling that lever with the skull symbol just to see what it did probably wasn't so smart, either, but now is not the time for regrets because you need to get away from these mutant zombies fast. With you are the janitor, the lab assistant, and the old professor. You've gotten a headstart, but there's only one way to safety: across an old rope bridge spanning a massive gorge. You can dash across in a minute, while the lab assistant takes two minutes. The janitor is a bit slower and needs five minutes, and the professor takes a whole ten minutes, holding onto the ropes every step of the way. By the professor's calculations, the zombies will catch up to you in just over 17 minutes, so you only have that much time to get everyone across and cut the ropes. Unfortunately, the bridge can only hold two people at a time. To make matters worse, it's so dark out that you can barely see, and the old lantern you grabbed on your way only illuminates a tiny area. Can you figure out a way to have everyone escape in time? Remember: no more than two people can cross the bridge together, anyone crossing must either hold the lantern or stay right next to it, and any of you can safely wait in the dark on either side of the gorge. Most importantly, everyone must be safely across before the zombies arrive. Otherwise, the first zombie could step on the bridge while people are still on it. Finally, there are no tricks to use here. You can't swing across, use the bridge as a raft, or befriend the zombies. Pause the video now if you want to figure it out for yourself! Answer in: 3 Answer in: 2 Answer in: 1 At first it might seem like no matter what you do, you're just a minute or two short of time, but there is a way. The key is to minimize the time wasted by the two slowest people by having them cross together. And because you'll need to make a couple of return trips with the lantern, you'll want to have the fastest people available to do so. So, you and the lab assistant quickly run across with the lantern, though you have to slow down a bit to match her pace. After two minutes, both of you are across, and you, as the quickest, run back with the lantern. Only three minutes have passed. So far, so good. Now comes the hard part. The professor and the janitor take the lantern and cross together. This takes them ten minutes since the janitor has to slow down for the old professor who keeps muttering that he probably shouldn't have given the zombies night vision. By the time they're across, there are only four minutes left, and you're still stuck on the wrong side of the bridge. But remember, the lab assistant has been waiting on the other side, and she's the second fastest of the group. So she grabs the lantern from the professor and runs back across to you. Now with only two minutes left, the two of you make the final crossing. As you step on the far side of the gorge, you cut the ropes and collapse the bridge behind you, just in the nick of time. Maybe next summer, you'll just stick to the library.

**P264 2015-08-11 A poetic experiment - Walt Whitman, interpreted by three animators -**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=264)

As an experiment, we gave recordings of the same Walt Whitman poem to 3 different animators. Each interpreted the text with no knowledge of what the others were creating Here's the result. "A Noiseless Patient Spider" by Walt Whitman Interpretation #1 by Jeremiah Dickey, Medium: Paint on Glass "A noiseless patient spider, I mark'd where on a little promontory it stood isolated, Mark'd how to explore the vacant vast surrounding, It launch'd forth filament, filament, filament, out of itself, Ever unreeling them, ever tirelessly speeding them. And you O my soul where you stand, Surrounded, detached, in measureless oceans of space, Ceaselessly musing, venturing, throwing, seeking the spheres to connect them, Till the bridge you will need be form'd, till the ductile anchor hold, Till the gossamer thread you fling catch somewhere, O my soul." Interpretation #2 by Biljana Labovic, Medium: Video "A noiseless patient spider, I mark’d where on a little promontory it stood isolated, Mark’d how to explore the vacant vast surrounding, It launch’d forth filament, filament, filament, out of itself, Ever unreeling them, ever tirelessly speeding them. And you O my soul where you stand, Surrounded, detached, in measureless oceans of space, Ceaselessly musing, venturing, throwing, seeking the spheres to connect them, Till the bridge you will need be form’d, till the ductile anchor hold, Till the gossamer thread you fling catch somewhere, O my soul." Interpretation #3 by Lisa LaBracio, Medium: Scratchboard "A noiseless patient spider, I mark’d where on a little promontory it stood isolated, Mark’d how to explore the vacant vast surrounding, It launch’d forth filament, filament, filament, out of itself, Ever unreeling them, ever tirelessly speeding them. And you O my soul where you stand, Surrounded, detached, in measureless oceans of space, Ceaselessly musing, venturing, throwing, seeking the spheres to connect them, Till the bridge you will need be form’d, till the ductile anchor hold, Till the gossamer thread you fling catch somewhere, O my soul."

**P265 2015-08-14 Could we actually live on Mars - Mari Foroutan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=265)

So, you're thinking of moving to Mars. Have you picked out a spot for your new home? No? Well, I'm here to help. First things first, here are some of the things you'll need to bring to The Red Planet: a high tolerance for cold, loneliness, and radiation; a lifetime supply of breathable air and food; a multibillion dollar spaceship; a desire to just get away from it all; and water. You're definitely going to need water. So what sort of real estate are you looking for? How about a mansion in the maze-like Noctis Labyrinthus? A hideaway in the Happy Face Crater? A fortress on the Face Mesa? An oceanview? Uh, bad news on the last one. You're about 4 billion years late. We're pretty sure that Mars used to have oceans, lakes, rivers, the whole package. But over time, almost all of it froze beneath the surface, or evaporated off into space. There's probably still some trapped beneath the seasonally expanding and contracting carbon dioxide ice caps, though. So what might Mars look like today if it had surface water? That, of course, depends on how much we're talking about, but maybe something like this. The relatively flat northern hemisphere is below the average elevation, so it would become one giant ocean, while the crater-ridden southern hemisphere would stay mostly high and dry. That difference between hemispheres is a bit bizarre, and we don't know why it's like that. The southern half is probably much older, judging by features like the number of craters, and the evidence of increased volcanic activity in the north. Okay, so who knows? Maybe one day Mars will have oceans again, but for now, what we've got is essentially one giant dusty desert. In fact, it's similar enough to deserts on Earth, that we've been able to learn a great deal about Mars on our home planet. For instance, Martian sand dunes form and behave similarly to our sand dunes, though the Martian versions often grow twice as large thanks to a gravitational pull that's about a third as strong as ours. And Mars has some features you won't see on Earth, like tars, which are crestless sand dunes up to fifteen meters tall, whose formations we have yet to understand. You're probably wondering, "What do you get when you combine a planet-wide desert with an atmosphere that, like ours, is subject to wind-generating pressure differentials, dust storms?" These will be your main weather hazards on the Red Planet. They play a large part in making the planet red by distributing rusted iron particles across the surface and into the air. Thanks to the low gravity and lack of moisture, these dust storms can last for months and cover the planet. So, you might want to build your home as high as possible. Well, look no further. This is Olympus Mons, the largest volcano in the Solar System. Even if Mars had a breathable atmosphere, you'd find the views from the 25 kilometer summit breathtaking. Or are volcanos not your thing? Then how about Valles Marineris, the largest canyon in the Solar System? It's so wide that from one side, the opposite rim would be below the curve of the horizon. Still, you'll catch some spectacular blue sunsets in the normally red sky, which gets its color from the dust absorbing most of the blue light, and the way sunlight is scattered by the atmosphere. Have you got spirit, curiosity, or are you just looking for opportunity? Then stop stalling and make the move to Mars today. Mars: Redder than Ever.

**P266 2015-08-17 Bring TED to the classroom with TED-Ed Clubs**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=266)

These are sounds. Sounds are our way of communication. Our way of understanding. Have you ever thought that your voice sounds much better in the bath? What is the extent of teachers' rights? What if you could become something like an animal? Is that possible? What separates those who primarily have an idea and those who want to bring it to life is simple. A society assumes that that is the story of every black man walking the Earth. It is assumed that that is my story, before I even begin to tell it. Because everything I've just told you so far is a lie and I just made it all up. My talk is actually about the art of lying and convincing people that what you're saying is true. We've developed technologies to give ourselves more and more pleasure. We're turning into a world like the "Brave New World" of Aldous Huxley . This is Ted-ED and this is what we do.

**P267 2015-08-21 How smart are dolphins - Lori Marino**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=267)

In 1985, three researchers on a dolphin-studying expedition got a little bored. To lighten things up, one pretended to be Poseidon by placing a seaweed garland on his head and then throwing it into the ocean. Moments later, a dolphin surfaced with the seaweed crowning her head. Sure, this could have been a coincidence, but it's also entirely possible that the dolphin was mimicking the scientist. That's because dolphins are one of the smartest animals species on Earth. So exactly how smart are they? Like whales and porpoises, dolphins belong to the group of aquatic mammals known as cetaceans who comprise 86 different species, and share a common link with ungulates, or hoofed animals. Originally land mammals, the first cetaceans entered the water about 55 million years ago as large predators with sharp teeth. Then, a shift in ocean temperatures about 35 million years ago reduced the availability of prey. One group of cetaceans who survived this distruption, the odontocetes, wound up smaller with less sharp teeth, but also larger and more complex brains that allowed for complex social relationships, as well as echolocation to navigate and communicate. Jump ahead to the present, and modern dolphins' brains are so large that their encephalization quotient, their brain size compared to the average for their body size, is second only to humans. Dolphins have evolved to survive through their ability to form complex social networks that hunt, ward off rivals, and raise offspring together. For example, one group of Florida dolphins practices a sophisticated form of cooperation to hunt fish. A dolphin designated as "the net-maker" kicks up mud while another gives the signal for the other dolphins to simultaneously line up and catch the escaping fish. Achieving a goal like this requires deliberate planning and cooperation, which, in turn, requires some form of intentional communication. Dolphins pass down their communication methods and other skills from generation to generation. Different dolphin populations exhibit variations in greetings, hunting strategies, and other behaviors. This sort of cultural transmission even extends to tool use. One group of bottlenose dolphins off the Australian coast nicknamed The Dolphin Sponge Club, has learned how to cover their rostrums with sponges when rooting in sharp corals, passing the knowledge from mother to daughter. Dolphins have even demonstrated language comprehension. When taught a language based on whistles and hand gestures, they not only understood what the signals meant, but that their order had meaning: the difference between bringing the ball to the hoop and bringing the hoop to the ball. So they were able to process two of the main elements of human language: symbols that stand for objects and actions, and syntax that governs how they are structured. Dolphins are also one of the few species who pass the mirror test. By recognizing themselves in mirrors, they indicate physical self-awareness, and research shows they can recognize not just their bodies, but also their own thoughts, a property called metacognition. In one study, dolphins comparing two sounds could indicate a same, different, or uncertain response. Just like humans, they indicated uncertainty more often with difficult trials, suggesting they're aware of what they know, and how confident they feel about that knowledge. But some of the most amazing things about dolphins are their senses of empathy, altruism, and attachment. The habit of helping injured individuals extends across the species barrier as evidenced by the many accounts of dolphins carrying humans to the surface to breathe. And like us, dolphins mourn their dead. When we consider all the evidence, we may wonder why humans still hunt dolphins for meat, endanger them through fishing and pollution, or imprison them to perform tricks. The ultimate question may not be whether dolphins are intelligent and complex beings, but whether humans can empathize with them enough to keep them safe and free.

**P268 2015-08-24 How false news can spread - Noah Tavlin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=268)

There's a quote usually attributed to the writer Mark Twain that goes, "A lie can travel halfway around the world while the truth is putting on its shoes." Funny thing about that. There's reason to doubt that Mark Twain ever said this at all, thus, ironically, proving the point. And today, the quote, whoever said it, is truer than ever before. In previous decades, most media with global reach consisted of several major newspapers and networks which had the resources to gather information directly. Outlets like Reuters and the Associated Press that aggregate or rereport stories were relatively rare compared to today. The speed with which information spreads now has created the ideal conditions for a phenomenon known as circular reporting. This is when publication A publishes misinformation, publication B reprints it, and publication A then cites B as the source for the information. It's also considered a form of circular reporting when multiple publications report on the same initial piece of false information, which then appears to another author as having been verified by multiple sources. For instance, the 1998 publication of a single pseudoscientific paper arguing that routine vaccination of children causes autism inspired an entire antivaccination movement, despite the fact that the original paper has repeatedly been discredited by the scientific community. Deliberately unvaccinated children are now contracting contagious diseases that had been virtually eradicated in the United States, with some infections proving fatal. In a slightly less dire example, satirical articles that are formatted to resemble real ones can also be picked up by outlets not in on the joke. For example, a joke article in the reputable British Medical Journal entitled "Energy Expenditure in Adolescents Playing New Generation Computer Games," has been referenced in serious science publications over 400 times. User-generated content, such as wikis, are also a common contributer to circular reporting. As more writers come to rely on such pages for quick information, an unverified fact in a wiki page can make its way into a published article that may later be added as a citation for the very same wiki information, making it much harder to debunk. Recent advances in communication technology have had immeasurable benefits in breaking down the barriers between information and people. But our desire for quick answers may overpower the desire to be certain of their validity. And when this bias can be multiplied by billions of people around the world, nearly instantaneously, more caution is in order. Avoiding sensationalist media, searching for criticisms of suspicious information, and tracing the original source of a report can help slow down a lie, giving the truth more time to put on its shoes.

**P269 2015-08-24 Why do some people go bald - Sarthak Sinha**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=269)

What do Charles Darwin, Michael Jordan, and Yoda have in common? They, like many other historical and fictive individuals, are bald, in some cases by their own choice. For centuries, a shining dome has been a symbol of intelligence, but despite this, many balding people still wish their hair would return. Scientists have long pondered, "Why do some people lose their hair, and how can we bring it back?" The full-headed among us have about 100,000 to 150,000 hairs on our scalps, and scientists have discovered two things about this dense thicket. Firstly, the sprouting hair we see is mostly made up of keratin, the protein leftover from dead cells that are forced upwards as new cells grow beneath them. Secondly, the structures that drive hair growth are called hair follicles, a network of complex organs that forms before we're born, and grows hair in an everlasting cycle. This cycle has three main phases. The first is anagen, the growth phase, which up to 90% of your hair follicles are experiencing right now, causing them to push up hair at a rate of one centimeter per month. Anagen can last for two to seven years, depending on your genes. After this productive period, signals within the skin instruct some follicles to enter a new phase known as catagen, or the regressing stage, causing hair follicles to shrink to a fraction of their original length. Catagen lasts for about two to three weeks and cuts blood supply to the follicle, creating a club hair, meaning it's ready to be shed. Finally, hairs enter telogen, the resting phase, which lasts for ten to twelve weeks, and affects about 5-15% of your scalp follicles. During telogen, up to 200 club hairs can be shed in a day, which is quite normal. Then, the growth cycle begins anew. But not all heads are hairy, and, in fact, some of them grow increasingly patchy over time in response to bodily changes. 95% of baldness in men can be attributed to male pattern baldness. Baldness is inherited, and in people with this condition, follicles become incredibly sensitive to the effects of dihydrotestosterone, a hormonal product made from testosterone. DHT causes shrinkage in these overly sensitive follicles, making hair shorter and wispier. But loss isn't sudden. It happens gradually, along a metric known as the Norwood Scale, which describes the severity of hair loss. First, hair recedes along the temples, then hair on the crown begins to thin in a circular pattern. At the highest rating on the scale, these balding areas meet and expand dramatically, eventually leaving only a ring of sparse hair around the temples and the back of the head. Genetics isn't all that drives hair loss. Long periods of stress can release signals that shock follicles and force them into the resting phase prematurely. Some women experience this after childbirth. Follicles might also lose the ability to go into anagen, the growth phase. People going through chemotherapy treatment temporarily experience this. But while balding may look permanent, scientific investigation has revealed the opposite. Below the skin's surface, the roots that give rise to our hair actually remain alive. Using this knowledge, scientists have developed drugs that shorten the resting phase, and force follicles into anagen. Other drugs combat male pattern baldness by blocking the conversion of testosterone to DHT so that it doesn't affect those sensitive follicles. Stem cells also play a role in regulating the growth cycle, and so scientists are investigating whether they can manipulate the activity of these cells to encourage follicles to start producing hair again. And in the meantime, while scientists hone their hair-reviving methods, anyone going bald, or considering baldness, can remember that they're in great company.

**P270 2015-09-01 The ancient origins of the Olympics - Armand D'Angour**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=270)

Thousands of years in the making, what began as part of a religious festival honoring the Greek god Zeus in the rural Greek town of Olympia has today become the greatest show of sporting excellence on Earth. The inception date in 776 BC became the basis for the Greek's earliest calendar, where time was marked in four-year increments called olympiads. What could it be? Why, it's the Olympic games, of course. Competition fosters excellence, or so thought the Ancient Greeks. In addition to sporting events, contests were held for music, singing, and poetry. You can read about them all yourself in classical literary works, like Homer's "Iliad" and Virgil's "Aeneid." Even mythical heroes appreciate a good contest every now and then, wouldn't you say? For the first thirteen games, the Ancient Greek Olympics featured just one event, the two hundred yard dash. But over time, new exciting contests, like boxing, chariot and mule racing, and even a footrace where the competitors wore a full suit of armor enticed many hopeful champions into the Olympic stadium. The combined running, jumping, wrestling, javelin throwing, and hurling the discus events known as the pentathlon inspired world-class competition, and the pankration, a no holds barred fight where only biting and eye-gouging were prohibited, ensured the toughest men were victorious. And victorious they were. Nobody tops the local baker Coroebus, who 776 BC became the very first Olympic champion. And we'll never forget Orsippus of Megara, the 720 BC Olympic victor tore away his loincloth so he could race unimpeded, inaugurating the Ancient Greek tradition of competing in the nude. Now there's a winning streak, if ever we've seen one. But all good things must end. In 391 AD, the Christian Roman Emperor Theodosius banned pagan practices, so the world soon bid a fond farewell to the Olympic games. But just like those early pankration athletes, you can't keep a good one down, and 1500 years later in 1896, the modern Olympic games kicked off in Athens, Greece. Today, the Summer and Winter Olympics bring international world-class athletes together by the thousands, uniting fans by the billions for the world's foremost sporting competition. Citius, Altius, Fortius. Three cheers for the Olympics.

**P271 2015-09-02 How misused modifiers can hurt your writing - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=271)

This just in: "Thief robs town with world's largest chocolate bunny." Wait, so are we talking about this, or this? That's a classic case of a misplaced modifier, a common grammatical mistake that can dramatically change the meaning of a sentence. And lest you think this is a bit far-fetched, confusing headlines like this appear all the time. Modifiers are words, phrases, and clauses that add information about other parts of a sentence, which is usually helpful. But when modifiers aren't linked clearly enough to the words they're actually referring to, they can create unintentional ambiguity. That happens because the modifying words, in this case, "with world's largest chocolate bunny," modify the wrong thing, the robber's actions instead of the town. To correct this particular sentence, we simply rephrase to make it clearer what the modifying phrase is talking about. "Town with world's largest chocolate bunny robbed by thief." Now, at least it's clear that the thief wasn't armed with a giant chocolate animal. Sometimes, modifying words, phrases, or clauses don't appear to be modifying anything at all. That's called a dangling modifier. "Having robbed the bank in record time, it was possible to make off with the town's chocolate rabbit as well." The modifying phrase in this sentence seems unrelated to anything else, and so we're clueless about who the chocolate-loving criminal could possibly be. Giving the modifier something to modify will solve the problem. Then there's another group called the squinting modifiers because they're stuck between two things and could feasibly refer to either. Often, these modifiers are adverbs, like the one in this sentence: "Robbers who steal chocolate bunnies rapidly attract the outrage of onlookers." "Rapidly" is the modifier, here, but what's not clear is whether it's referring to the speed of the chocolate thievery, or how quickly it alerts the furious onlookers. To clarify, we can either put the modifier closer to its intended phrase, which works in some cases, or we can entirely reword the sentence so that the modifier no longer squints, but clearly applies to only one part. "Chocolate bunny-thieving robbers rapidly attract the outrage of onlookers." Justice will eventually come to the chocolate thief, but in the meantime, our task is to avoid verbal ambiguity by making it clear which parts of the sentences modifiers belong to. That way, we can at least maintain grammatical law and order.

**P272 2015-09-03 When to use 'me', 'myself' and 'I' - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=272)

Me, myself, and I. You may be tempted to use these words interchangeably because they all refer to the same thing, but in fact, each one has a specific role in a sentence. "I" is a subject pronoun, "me" is an object pronoun, and "myself" is a reflexive or intensive pronoun. So what does that reveal about where each word belongs? Let's start with the difference between subject and object. Imagine the subject as the actor in a sentence and the object as the word that is acted upon. "I invited her but she invited me." The object can also be the object of a preposition. "She danced around me, while he shimmied up to me." In some languages, like Latin and Russian, most nouns have different forms that distinguish subjects from objects. However, in English, that's only true of pronouns. But so long as you know how to distinguish subjects from objects, you can figure out what belongs where. And when you encounter a more complicated sentence, say one that involves multiple subjects or objects, and you're not sure whether to use "I" or "me," just temporarily eliminate the other person, and once again distinguish subject from object. Here's another. You wouldn't say, "Me heard gossip," but sub in "I" and you're good to go. Then what about "myself?" This grand character is often substituted for "me" and "I" because it seems more impressive. "Please tell Jack or myself" may sound elegant, but in fact, "me" is the right pronoun here. So where should you use "myself"? In its function as a reflexive pronoun, "myself" only works if it's the object of a sentence whose subject is "I." "I consider myself the most important pronoun at this year's party." "Myself" can also add emphasis as an intensive pronoun. "I, myself, have heard others agree." The sentence works without it, but that extra pronoun gives it oomph. To check if "myself" belongs in a sentence, simply ensure that there's also an "I" that it's reflecting or intensifying. So that's "me," "myself," and "I," ever ready to represent you, yourself, and you.

**P273 2015-09-10 Do animals have language - Michele Bishop**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=273)

All animals communicate. Crabs wave their claws at each other to signal that they're healthy and ready to mate. Cuttlefish use pigmented skin cells called chromatophores to create patterns on their skin that act as camouflage or warnings to rivals. Honeybees perform complex dances to let other bees know the location and quality of a food source. All of these animals have impressive communication systems, but do they have language? To answer that question, we can look at four specific qualities that are often associated with language: discreteness, grammar, productivity, and displacement. Discreteness means that there is a set of individual units, such as sounds or words, that can be combined to communicate new ideas, like a set of refrigerator poetry magnets you can rearrange to create different phrases. Grammar provides a system of rules that tells you how to combine those individual units. Productivity is the ability to use language to create an infinite number of messages. And displacement is the ability to talk about things that aren't right in front of you, such as past, future, or fictional events. So, does animal communication exhibit any of these qualities? For crabs and cuttlefish, the answer is no. They don't combine their signals in creative ways. Those signals also don't have to be in a grammatical order, and they only communicate current conditions, like, "I am healthy," or "I am poisonous." But some animals actually do display some of these properties. Bees use the moves, angle, duration, and intensity of their waggle dance to describe the location and richness of a food source. That source is outside the hive, so they exhibit the property of displacement. They share that language trait with prairie dogs, which live in towns of thousands, and are hunted by coyotes, hawks, badgers, snakes, and humans. Their alarms calls indicate the predator's size, shape, speed, and, even for human predators, what the person is wearing and if he's carrying a gun. Great apes, like chimps and gorillas, are great communicators, too. Some have even learned a modified sign language. A chimpanzee named Washoe demonstrated discreteness by combining multiple signs into original phrases, like, "Please open. Hurry." Coco, a female gorilla who understands more than 1000 signs, and around 2000 words of spoken English referred to a beloved kitten that had died. In doing so, she displayed displacement, though it's worth noting that the apes in both of these examples were using a human communication system, not one that appeared naturally in the wild. There are many other examples of sophisticated animal communication, such as in dolphins, which use whistles to identify age, location, names, and gender. They can also understand some grammar in a gestural language researchers use to communicate with them. However, grammar is not seen in the dolphin's natural communication. While these communication systems may have some of the qualities of language we've identified, none display all four. Even Washoe and Coco's impressive abilities are still outpaced by the language skills of most three-year-old humans. And animals' topics of conversation are usually limited. Bees talk about food, prairie dogs talk about predators, and crabs talk about themselves. Human language stands alone due to the powerful combination of grammar and productivity, on top of discreteness and displacement. The human brain can take a finite number of elements and create an infinite number of messages. We can craft and understand complex sentences, as well as words that have never been spoken before. We can use language to communicate about an endless range of subjects, talk about imaginary things, and even lie. Research continues to reveal more and more about animal communication. It may turn out that human language and animal communication aren't entirely different but exist on a continuum. After all, we are all animals.

**P274 2015-09-11 The mathematical secrets of Pascal’s triangle - Wajdi Mohamed Ratemi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=274)

This may look like a neatly arranged stack of numbers, but it's actually a mathematical treasure trove. Indian mathematicians called it the Staircase of Mount Meru. In Iran, it's the Khayyam Triangle. And in China, it's Yang Hui's Triangle. To much of the Western world, it's known as Pascal's Triangle after French mathematician Blaise Pascal, which seems a bit unfair since he was clearly late to the party, but he still had a lot to contribute. So what is it about this that has so intrigued mathematicians the world over? In short, it's full of patterns and secrets. First and foremost, there's the pattern that generates it. Start with one and imagine invisible zeros on either side of it. Add them together in pairs, and you'll generate the next row. Now, do that again and again. Keep going and you'll wind up with something like this, though really Pascal's Triangle goes on infinitely. Now, each row corresponds to what's called the coefficients of a binomial expansion of the form (x+y)^n, where n is the number of the row, and we start counting from zero. So if you make n=2 and expand it, you get (x^2) + 2xy + (y^2). The coefficients, or numbers in front of the variables, are the same as the numbers in that row of Pascal's Triangle. You'll see the same thing with n=3, which expands to this. So the triangle is a quick and easy way to look up all of these coefficients. But there's much more. For example, add up the numbers in each row, and you'll get successive powers of two. Or in a given row, treat each number as part of a decimal expansion. In other words, row two is (1x1) + (2x10) + (1x100). You get 121, which is 11^2. And take a look at what happens when you do the same thing to row six. It adds up to 1,771,561, which is 11^6, and so on. There are also geometric applications. Look at the diagonals. The first two aren't very interesting: all ones, and then the positive integers, also known as natural numbers. But the numbers in the next diagonal are called the triangular numbers because if you take that many dots, you can stack them into equilateral triangles. The next diagonal has the tetrahedral numbers because similarly, you can stack that many spheres into tetrahedra. Or how about this: shade in all of the odd numbers. It doesn't look like much when the triangle's small, but if you add thousands of rows, you get a fractal known as Sierpinski's Triangle. This triangle isn't just a mathematical work of art. It's also quite useful, especially when it comes to probability and calculations in the domain of combinatorics. Say you want to have five children, and would like to know the probability of having your dream family of three girls and two boys. In the binomial expansion, that corresponds to girl plus boy to the fifth power. So we look at the row five, where the first number corresponds to five girls, and the last corresponds to five boys. The third number is what we're looking for. Ten out of the sum of all the possibilities in the row. so 10/32, or 31.25%. Or, if you're randomly picking a five-player basketball team out of a group of twelve friends, how many possible groups of five are there? In combinatoric terms, this problem would be phrased as twelve choose five, and could be calculated with this formula, or you could just look at the sixth element of row twelve on the triangle and get your answer. The patterns in Pascal's Triangle are a testament to the elegantly interwoven fabric of mathematics. And it's still revealing fresh secrets to this day. For example, mathematicians recently discovered a way to expand it to these kinds of polynomials. What might we find next? Well, that's up to you.

**P275 2015-09-14 The treadmill's dark and twisted past - Conor Heffernan**

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The constant thud underneath your feet, the constrained space, and the monotony of going nowhere fast. It feels like hours have gone by, but it's only been eleven minutes, and you wonder, "Why am I torturing myself? This thing has got to be considered a cruel and unusual punishment." Actually, that's exactly what it is, or was. You see, in the 1800s, treadmills were created to punish English prisoners. At the time, the English prison system was abysmally bad. Execution and deportation were often the punishments of choice, and those who were locked away faced hours of solitude in filthy cells. So social movements led by religious groups, philanthropies, and celebrities, like Charles Dickens, sought to change these dire conditions and help reform the prisoners. When their movement succeeded, entire prisons were remodeled and new forms of rehabilitation, such as the treadmill, were introduced. Here's how the original version, invented in 1818 by English engineer Sir William Cubitt, worked. Prisoners stepped on 24 spokes of a large paddle wheel. As the wheel turned, the prisoner was forced to keep stepping up or risk falling off, similar to modern stepper machines. Meanwhile, the rotation made gears pump out water, crush grain, or power mills, which is where the name "treadmill" originated. These devices were seen as a fantastic way of whipping prisoners into shape, and that added benefit of powering mills helped to rebuild a British economy decimated by the Napoleonic Wars. It was a win for all concerned, except the prisoners. It's estimated that, on average, prisoners spent six or so hours a day on treadmills, the equivalent of climbing 5,000 to 14,000 feet. 14,000 feet is roughly Mount Everest's halfway point. Imagine doing that five days a week with little food. Cubitt's idea quickly spread across the British Empire and America. Within a decade of its creation, over 50 English prisons boasted a treadmill, and America, a similar amount. Unsurprisingly, the exertion combined with poor nutrition saw many prisoners suffer breakdowns and injuries, not that prison guards seemed to care. In 1824, New York prison guard James Hardie credited the device with taming his more boisterous inmates, writing that the "monotonous steadiness, and not its severity...constitutes its terror," a quote many still agree with. And treadmills lasted in England until the late 19th century, when they were banned for being excessively cruel under the Prison's Act of 1898. But of course the torture device returned with a vengeance, this time targeting the unsuspecting public. In 1911, a treadmill patent was registered in the U.S., and by 1952, the forerunner for today's modern treadmill had been created. When the jogging craze hit the U.S. in the 1970s, the treadmill was thrust back into the limelight as an easy and convenient way to improve aerobic fitness, and lose unwanted pounds, which, to be fair, it's pretty good at doing. And the machine has maintained its popularity since. So the next time you voluntarily subject yourself to what was once a cruel and unusual punishment, just be glad you can control when you'll hop off.

**P276 2015-09-14 What makes the Great Wall of China so extraordinary - Megan Campisi a**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=276)

A 13,000 mile dragon of earth and stone winds its way through the countryside of China with a history almost as long and serpentine as the structure. The Great Wall began as multiple walls of rammed earth built by individual feudal states during the Chunqiu period to protect against nomadic raiders north of China and each other. When Emperor Qin Shi Huang unified the states in 221 BCE, the Tibetan Plateau and Pacific Ocean became natural barriers, but the mountains in the north remained vulnerable to Mongol, Turkish, and Xiongnu invasions. To defend against them, the Emperor expanded the small walls built by his predecessors, connecting some and fortifying others. As the structures grew from Lintao in the west to Liaodong in the east, they collectively became known as The Long Wall. To accomplish this task, the Emperor enlisted soldiers and commoners, not always voluntarily. Of the hundreds of thousands of builders recorded during the Qin Dynasty, many were forcibly conscripted peasants and others were criminals serving out sentences. Under the Han Dynasty, the wall grew longer still, reaching 3700 miles, and spanning from Dunhuang to the Bohai Sea. Forced labor continued under the Han Emperor Han-Wudi , and the walls reputation grew into a notorious place of suffering. Poems and legends of the time told of laborers buried in nearby mass graves, or even within the wall itself. And while no human remains have been found inside, grave pits do indicate that many workers died from accidents, hunger and exhaustion. The wall was formidable but not invincible. Both Genghis and his son Khublai Khan managed to surmount the wall during the Mongol invasion of the 13th Century. After the Ming dynasty gained control in 1368, they began to refortify and further consolidate the wall using bricks and stones from local kilns. Averaging 23 feet high and 21 feet wide, the walls 5500 miles were punctuated by watchtowers. When raiders were sighted, fire and smoke signals traveled between towers until reinforcements arrived. Small openings along the wall let archers fire on invaders, while larger ones were used to drop stones and more. But even this new and improved wall was not enough. In 1644, northern Manchu clans overthrew the Ming to establish the Qing dynasty, incorporating Mongolia as well, Thus, for the second time, China was ruled by the very people the wall had tried to keep out. With the empire's borders now extending beyond the Great Wall, the fortifications lost their purpose. And without regular reinforcement, the wall fell into disrepair, rammed earth eroded, while brick and stone were plundered for building materials. But its job wasn't finished. During World War II, China used sections for defense against Japanese invasion, and some parts are still rumored to be used for military training. But the Wall's main purpose today is cultural. As one of the largest man-made structures on Earth, it was granted UNESCO World Heritage Status in 1987. Originally built to keep people out of China, the Great Wall now welcomes millions of visitors each year. In fact, the influx of tourists has caused the wall to deteriorate, leading the Chinese government to launch preservation initiatives. It's also often acclaimed as the only man-made structure visible from space. Unfortunately, that's not at all true. In low Earth orbit, all sorts of structures, like bridges, highways and airports are visible, and the Great Wall is only barely discernible. From the moon, it doesn't stand a chance. But regardless, it's the Earth we should be studying it from because new sections are still discovered every few years, branching off from the main body and expanding this remarkable monument to human achievement.

**P277 2015-09-21 How memories form and how we lose them - Catharine Young**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=277)

Think back to a really vivid memory. Got it? Okay, now try to remember what you had for lunch three weeks ago. That second memory probably isn't as strong, but why not? Why do we remember some things, and not others? And why do memories eventually fade? Let's look at how memories form in the first place. When you experience something, like dialing a phone number, the experience is converted into a pulse of electrical energy that zips along a network of neurons. Information first lands in short term memory, where it's available from anywhere from a few seconds to a couple of minutes. It's then transferred to long-term memory through areas such as the hippocampus, and finally to several storage regions across the brain. Neurons throughout the brain communicate at dedicated sites called synapses using specialized neurotransmitters. If two neurons communicate repeatedly, a remarkable thing happens: the efficiency of communication between them increases. This process, called long term potentiation, is considered to be a mechanism by which memories are stored long-term, but how do some memories get lost? Age is one factor. As we get older, synapses begin to falter and weaken, affecting how easily we can retrieve memories. Scientists have several theories about what's behind this deterioration, from actual brain shrinkage, the hippocampus loses 5% of its neurons every decade for a total loss of 20% by the time you're 80 years old to the drop in the production of neurotransmitters, like acetylcholine, which is vital to learning and memory. These changes seem to affect how people retrieve stored information. Age also affects our memory-making abilities. Memories are encoded most strongly when we're paying attention, when we're deeply engaged, and when information is meaningful to us. Mental and physical health problems, which tend to increase as we age, interfere with our ability to pay attention, and thus act as memory thieves. Another leading cause of memory problems is chronic stress. When we're constantly overloaded with work and personal responsibilites, our bodies are on hyperalert. This response has evolved from the physiological mechanism designed to make sure we can survive in a crisis. Stress chemicals help mobilize energy and increase alertness. However, with chronic stress our bodies become flooded with these chemicals, resulting in a loss of brain cells and an inability to form new ones, which affects our ability to retain new information. Depression is another culprit. People who are depressed are 40% more likely to develop memory problems. Low levels of serotonin, a neurotransmitter connected to arousal, may make depressed individuals less attentive to new information. Dwelling on sad events in the past, another symptom of depression, makes it difficult to pay attention to the present, affecting the ability to store short-term memories. Isolation, which is tied to depression, is another memory thief. A study by the Harvard School of Public Health found that older people with high levels of social integration had a slower rate of memory decline over a six-year period. The exact reason remains unclear, but experts suspect that social interaction gives our brain a mental workout. Just like muscle strength, we have to use our brain or risk losing it. But don't despair. There are several steps you can take to aid your brain in preserving your memories. Make sure you keep physically active. Increased blood flow to the brain is helpful. And eat well. Your brain needs all the right nutrients to keep functioning correctly. And finally, give your brain a workout. Exposing your brain to challenges, like learning a new language, is one of the best defenses for keeping your memories intact.

**P278 2015-09-22 A curable condition that causes blindness - Andrew Bastawrous**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=278)

An estimated 20 million cases of blindness worldwide are caused by cataracts, a curable condition affecting the lens that focuses images onto the eye's retina. A cataract occurs when proteins in the lens lose their normal arrangement, clumping together in a way that causes discoloration or clouding, and eventually blocks most vision. Cataracts can be caused by eye injury, certain medications, ultraviolet radiation, diabetes, smoking, or some genetic disorders. But the most common cause is aging. In the United States, more than 50% of people over the age of 80 develop them. Cataracts were treated over 2,500 years ago in India, though similar procedures may have existed even earlier in Ancient Egypt and Babylon. The most common procedure, called couching, involved pressing a sharp instrument into the eye to loosen and push the clouded lens out of the way. Although this could increase the amount of light entering the eye, the lack of a lens would leave the patient's vision out of focus. Despite its low success rate, and high risk of infection or injury, couching is still performed in some parts of the world. Later procedures would also focus on removing the cloudy lens, for example, by making an opening in the cornea to pull out the lens along with the membrane capsule surrounding it. While the invention of eyeglasses allowed for some restoration of focus, they had to be extremely thick to help. Furthermore, such techniques still caused complications, like damaging the retina, or leaving the eye with uncomfortable stitches. But in the 20th century, something unexpected happened. Eye surgeon Sir Harold Ridley was treating World War II casualties when he noticed that acrylic plastic from a shattered aircraft cockpit had become lodged in a pilot's eyes without triggering an adverse reaction. This led him to propose surgically implanting artificial lenses into the eye to replace cataracts. And despite initial resistance, the method became standard practice by the 1980s. Since Ridley's discovery, the intraocular lens has undergone several improvements. Modern lenses can fit into the membrane capsule that the cataract is extracted from, leaving more of the eye's natural anatomy intact. And the ability to fine-tune the lens curvature allows the surgery to restore a patient's normal vision without the need for glasses. Of course, surgical techniques have also progressed. Microscopic procedures use small instruments or lasers to make precise incisions of one or two millimeters in the cornea, while an ultrasound probe breaks up and removes the cataracted lens with minimal trauma to the eye. Low-tech versions of this operation have made the surgery quick and inexpensive, helping it spread across the developing world. Places like Aravind Eye Hospital in India have pioneered high-volume, low-cost cataract surgery for as little as six dollars. Why then, with all these advances, are there still so many blind people in the world? The main issue is access to health care, with poor infrastructure and a shortage of doctors being a major barrier in many regions. But this is not the only problem. In many rural areas with poor education, blindness is often accepted as an inevitable part of aging, for which someone might not think to seek treatment. This is why information is crucial. Increased community awareness programs and the spread of mobile phones mean that many of those who might have remained blind for the rest of their lives due to cataracts are now reachable. And for them, a brighter future is in sight.

**P279 2015-09-28 The race to sequence the human genome - Tien Nguyen**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=279)

Packed inside every cell in your body is a set of genetic instructions, 3.2 billion base pairs long. Deciphering these directions would be a monumental task but could offer unprecedented insight about the human body. In 1990, a consortium of 20 international research centers embarked on the world's largest biological collaboration to accomplish this mission. The Human Genome Project proposed to sequence the entire human genome over 15 years with $3 billion of public funds. Then, seven years before its scheduled completion, a private company called Celera announced that they could accomplish the same goal in just three years and at a fraction of the cost. The two camps discussed a joint venture, but talks quickly fell apart as disagreements arose over legal and ethical issues of genetic property. And so the race began. Though both teams used the same technology to sequence the entire human genome, it was their strategies that made all the difference. Their paths diverged in the most critical of steps: the first one. In the Human Genome Project's approach, the genome was first divided into smaller, more manageable chunks about 150,000 base pairs long that overlapped each other a little bit on both ends. Each of these fragments of DNA was inserted inside a bacterial artificial chromosome where they were cloned and fingerprinted. The fingerprints showed scientists where the fragments overlapped without knowing the actual sequence. Using the overlapping bits as a guide, the researchers marked each fragment's place in the genome to create a contiguous map, a process that took about six years. The cloned fragments were sequenced in labs around the world following one of the project's two major principles: that collaboration on our shared heritage was open to all nations. In each case, the fragments were arbitrarily broken up into small, overlapping pieces about 1,000 base pairs long. Then, using a technology called the Sanger method, each piece was sequenced letter by letter. This rigorous map-based approach called hierarchical shotgun sequencing minimized the risk of misassembly, a huge hazard of sequencing genomes with many repetitive portions, like the human genome. The consortium's "better safe than sorry" approach contrasted starkly with Celera's strategy called whole genome shotgun sequencing. It hinged on skipping the mapping phase entirely, a faster, though foolhardy, approach according to some. The entire genome was directly chopped up into a giant heap of small, overlapping bits. Once these bits were sequenced via the Sanger method, Celera would take the formidable risk of reconstructing the genome using just the overlaps. But perhaps their decision wasn't such a gamble because guess whose freshly completed map was available online for free? The Human Genome Consortium, in accordance with the project's second major principle which held that all of the project's data would be shared publicly within 24 hours of collection. So in 1998, scientists around the world were furiously sequencing lines of genetic code using the tried and true, yet laborious, Sanger method. Finally, after three exhausting years of continuous sequencing and assembling, the verdict was in. In February 2001, both groups simultaneously published working drafts of more than 90% of the human genome, several years ahead of the consortium's schedule. The race ended in a tie. The Human Genome Project's practice of immediately sharing its data was an unusual one. It is more typical for scientists to closely guard their data until they are able to analyze it and publish their conclusions. Instead, the Human Genome Project accelerated the pace of research and created an international collaboration on an unprecedented scale. Since then, robust investment in both the public and private sector has led to the identification of many disease related genes and remarkable advances in sequencing technology. Today, a person's genome can be sequenced in just a few days. However, reading the genome is only the first step. We're a long way away from understanding what most of our genes do and how they are controlled. Those are some of the challenges for the next generation of ambitious research initiatives.

**P280 2015-09-29 The incredible collaboration behind the International Space Station -**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=280)

Have you ever been gazing at a starry sky when suddenly a bright dot glided into view? If it wasn't blinking, then you've had the distinct pleasure of seeing one of mankind's greatest collaborative feats with your own eyes: The International Space Station. Roughly the size of six-bedroom house, and weighing more than 320 cars, the International Space Station is so large that no single rocket could have lifted it into orbit. Instead, it was assembled piece by piece while hurtling through space at 28,000 kilometers per hour, lapping the Earth once every 90 minutes. It all started when sixteen nations signed the Space Station Intergovernmental Agreement, laying out each partner's expected contributions to the ISS, from modules and maintenance to sharing information and finances. At an estimated 100 billion U.S. dollars, the Space Station would be the most expensive object ever built. The whole world watched as a Russian rocket launched the first module of the ISS into the sky. Zarya, meaning sunrise, was equipped with two solar panels and a propulsion system that had the important task of keeping the young station from crashing into the Earth by staying a safe 400 kilometers away. The U.S. Space Shuttle Endeavour followed two weeks later carrying Unity, a node module to which other modules could be connected, and an international six-person assembly crew. Then came Zvezda, which brought communications and living accommodations. Ever since the International Space Station's first tenants arrived, it's been continually occupied with more than 200 visitors spending an average of six months on board. Astronaut Samantha Cristoforetti holds the record for the longest single space flight by a woman at 199 days on the ISS. 2001 saw the arrival of Destiny, the first of four research modules, where astronauts spend approximately 36 hours a week conducting extraordinary experiments in microgravity. Their schedules are packed with exercise, two hours a day to fend off muscle atrophy, station maintenance and repair, and connecting with family or awe-inspired minds around the world. But they still find time for fun, with regular movie nights and even shooting the first music video in space. Destiny also controls the seven-jointed robotic Canadarm2. Capable of moving more than 100,000 kilograms, it's perfect for unloading new arrivals from shuttles. 2001 was a busy year for the Space Station with the addition of Quest, the main airlock for strolls outside, and Pirs, a pier for Russian spacecrafts to dock including the ever-ready emergency escape vehicle, Soyuz. Then, on February 1st, 2003, after delivering research modules to the ISS, the space shuttle Columbia exploded during reentry tragically killing the seven-member crew on board. After a four-year hiatus, work quickly picked up pace with the addition of more hubs, airlocks, docks, and an observation cupola for stunning 360-degree views of our world and beyond. Other critical components included platforms and trusses to support radiators that direct all the heat generated by the station's electronics into space and solar panels that are efficient enough to power 55 homes. It took ten years and over 30 missions, but finally, the International Space Station was complete, coinciding with the U.S. Space Shuttle Program's retirement. The Space Station continues to serve as an incredible model for international collaboration. This year, two people began a one-year stay on the ISS, allowing scientists to study the long-term physical and psychological effects of being in space, which would prove useful for increasingly ambitious space travel, like trips to Mars. Over its lifetime, we've learned an immense amount scientifically, but also about our capacity to work together and accomplish truly remarkable acts.

**P281 2015-09-30 What 'Orwellian' really means - Noah Tavlin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=281)

If you've watched the news or followed politics chances are you've heard the term Orwellian thrown around in one context or another. But have you ever stopped to think about what it really means, or why it's used so often? The term was named after British author Eric Blair known by his pen name George Orwell. Because his most famous work, the novel "1984," depicts an oppressive society under a totalitarian government, "Orwellian" is often used simply to mean authoritarian. But using the term in this way not only fails to fully convey Orwell's message, it actually risks doing precisely what he tried to warn against. Orwell was indeed opposed to all forms of tyranny, spending much of his life fighting against anti-democratic forces of both the left-wing and the right. But he was also deeply concerned with how such ideologies proliferate. And one of his most profound insights was the importance that language plays in shaping our thoughts and opinions. The government of "1984"'s Oceania controls its people's actions and speech in some ways that are obvious. Their every move and word is watched and heard, and the threat of what happens to those who step out of line is always looming overhead. Other forms of control are not so obvious. The population is inundated with a constant barrage of propaganda made up of historical facts and statistics manufactured in the Ministry of Truth. The Ministry of Peace is the military. Labor camps are called "Joycamps." Political prisoners are detained and tortured in the Ministry of Love. This deliberate irony is an example of doublespeak, when words are used not to convey meaning but to undermine it, corrupting the very ideas they refer to. The regime's control of language goes even further, eliminating words from the English language to create the official dialect of Newspeak, a crudely limited collection of acronyms and simple concrete nouns lacking any words complex enough to encourage nuanced or critical thought. This has an effect on the psyche Orwell calls, "Doublethink," a hypnotic state of cognitive dissonance in which one is compelled to disregard their own perception in place of the officially dictated version of events, leaving the individual completely dependent on the State's definition of reality itself. The result is a world in which even the privacy of one's own thought process is violated, where one may be found guilty of thoughtcrime by talking in their sleep, and keeping a diary or having a love affair equals a subversive act of rebellion. This might sound like something that can only happen in totalitarian regimes, but Orwell was warning us about the potential for this occurring even in democratic societies. And this is why "authoritarian" alone does not "Orwellian" make. In his essay, "Politics and the English Language," he described techniques like using pretentious words to project authority, or making atrocities sound acceptable by burying them in euphemisms and convoluted sentence structures. But even more mundane abuses of language can affect the way we think about things. The words you see and hear in everyday advertising have been crafted to appeal to you and affect your behavior, as have the soundbites and talking points of political campaigns which rarely present the most nuanced perspective on the issues. And the way that we use ready-made phrases and responses gleaned from media reports or copied from the Internet makes it easy to get away with not thinking too deeply or questioning your assumptions. So the next time you hear someone use the word Orwellian, pay close attention. If they're talking about the deceptive and manipulative use of language, they're on the right track. If they're talking about mass surveillance and intrusive government, they're describing something authoritarian but not necessarily Orwellian. And if they use it as an all-purpose word for any ideas they dislike, it's possible their statements are more Orwellian than whatever it is they're criticizing. Words have the power to shape thought. Language is the currency of politics, forming the basis of society from the most common, everyday interactions to the highest ideals. Orwell urged us to protect our language because ultimately our ability to think and communicate clearly is what stands between us and a world where war is peace and freedom is slavery.

**P282 2015-10-01 3 tips to boost your confidence - TED-Ed**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=282)

Translator: Jennifer Cody Reviewer: Jessica Ruby When faced with a big challenge where potential failure seems to lurk at every corner, maybe you've heard this advice before: "Be more confident." And most likely, this is what you think when you hear it: "If only it were that simple." But what is confidence? Take the belief that you are valuable, worthwhile, and capable, also known as self-esteem, add in the optimism that comes when you are certain of your abilities, and then empowered by these, act courageously to face a challenge head-on. This is confidence. It turns thoughts into action. So where does confidence even come from? There are several factors that impact confidence. One: what you're born with, such as your genes, which will impact things like the balance of neurochemicals in your brain. Two: how you're treated. This includes the social pressures of your environment. And three: the part you have control over, the choices you make, the risks you take, and how you think about and respond to challenges and setbacks. It isn't possible to completely untangle these three factors, but the personal choices we make certainly play a major role in confidence development. So, by keeping in mind a few practical tips, we do actually have the power to cultivate our own confidence. Tip 1: a quick fix. There are a few tricks that can give you an immediate confidence boost in the short term. Picture your success when you're beginning a difficult task, something as simple as listening to music with deep bass; it can promote feelings of power. You can even strike a powerful pose or give yourself a pep talk. Tip two: believe in your ability to improve. If you're looking for a long-term change, consider the way you think about your abilities and talents. Do you think they are fixed at birth, or that they can be developed, like a muscle? These beliefs matter because they can influence how you act when you're faced with setbacks. If you have a fixed mindset, meaning that you think your talents are locked in place, you might give up, assuming you've discovered something you're not very good at. But if you have a growth mindset and think your abilities can improve, a challenge is an opportunity to learn and grow. Neuroscience supports the growth mindset. The connections in your brain do get stronger and grow with study and practice. It also turns out, on average, people who have a growth mindset are more successful, getting better grades, and doing better in the face of challenges. Tip three: practice failure. Face it, you're going to fail sometimes. Everyone does. J.K. Rowling was rejected by twelve different publishers before one picked up "Harry Potter." The Wright Brothers built on history's failed attempts at flight, including some of their own, before designing a successful airplane. Studies show that those who fail regularly and keep trying anyway are better equipped to respond to challenges and setbacks in a constructive way. They learn how to try different strategies, ask others for advice, and perservere. So, think of a challenge you want to take on, realize it's not going to be easy, accept that you'll make mistakes, and be kind to yourself when you do. Give yourself a pep talk, stand up, and go for it. The excitement you'll feel knowing that whatever the result, you'll have gained greater knowledge and understanding. This is confidence.

**P283 2015-10-01 Can you solve the prisoner hat riddle - Alex Gendler**

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You and nine other individuals have been captured by super intelligent alien overlords. The aliens think humans look quite tasty, but their civilization forbids eating highly logical and cooperative beings. Unfortunately, they're not sure whether you qualify, so they decide to give you all a test. Through its universal translator, the alien guarding you tells you the following: You will be placed in a single-file line facing forward in size order so that each of you can see everyone lined up ahead of you. You will not be able to look behind you or step out of line. Each of you will have either a black or a white hat on your head assigned randomly, and I won't tell you how many of each color there are. When I say to begin, each of you must guess the color of your hat starting with the person in the back and moving up the line. And don't even try saying words other than black or white or signaling some other way, like intonation or volume; you'll all be eaten immediately. If at least nine of you guess correctly, you'll all be spared. You have five minutes to discuss and come up with a plan, and then I'll line you up, assign your hats, and we'll begin. Can you think of a strategy guaranteed to save everyone? Pause the video now to figure it out for yourself. Answer in: 3 Answer in: 2 Answer in: 1 The key is that the person at the back of the line who can see everyone else's hats can use the words "black" or "white" to communicate some coded information. So what meaning can be assigned to those words that will allow everyone else to deduce their hat colors? It can't be the total number of black or white hats. There are more than two possible values, but what does have two possible values is that number's parity, that is whether it's odd or even. So the solution is to agree that whoever goes first will, for example, say "black" if he sees an odd number of black hats and "white" if he sees an even number of black hats. Let's see how it would play out if the hats were distributed like this. The tallest captive sees three black hats in front of him, so he says "black," telling everyone else he sees an odd number of black hats. He gets his own hat color wrong, but that's okay since you're collectively allowed to have one wrong answer. Prisoner two also sees an odd number of black hats, so she knows hers is white, and answers correctly. Prisoner three sees an even number of black hats, so he knows that his must be one of the black hats the first two prisoners saw. Prisoner four hears that and knows that she should be looking for an even number of black hats since one was behind her. But she only sees one, so she deduces that her hat is also black. Prisoners five through nine are each looking for an odd number of black hats, which they see, so they figure out that their hats are white. Now it all comes down to you at the front of the line. If the ninth prisoner saw an odd number of black hats, that can only mean one thing. You'll find that this strategy works for any possible arrangement of the hats. The first prisoner has a 50% chance of giving a wrong answer about his own hat, but the parity information he conveys allows everyone else to guess theirs with absolute certainty. Each begins by expecting to see an odd or even number of hats of the specified color. If what they count doesn't match, that means their own hat is that color. And everytime this happens, the next person in line will switch the parity they expect to see. So that's it, you're free to go. It looks like these aliens will have to go hungry, or find some less logical organisms to abduct.

**P284 2015-10-02 Where did Russia come from - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=284)

Where did Russia come from, why is it so big, and what are the differences between it and its neighbors? The answers lie in an epic story of seafaring warriors, nomadic invaders, and the rise and fall of a medieval state known as Kievan Rus. In the first millennium, a large group of tribes spread through the dense woodlands of Eastern Europe. Because they had no writing system, much of what we know about them comes from three main sources: archaeological evidence, accounts from literate scholars of the Roman Empire and the Middle East, and, lastly, an epic history called the Primary Chronicle compiled in the 12th century by a monk named Nestor. What they tell us is that these tribes who shared a common Slavic language and polytheistic religion had by the 7th century split into western, southern and eastern branches, the latter stretching from the Dniester River to the Volga and the Baltic Sea. As Nestor's story goes, after years of subjugation by Vikings from the north, who, by the way, did not wear horned helmets in battle, the region's tribes revolted and drove back the Northmen, but left to their own devices, they turned on each other. Such chaos ensued that, ironically, the tribes reached out to the foreigners they had just expelled, inviting them to return and establish order. The Vikings accepted, sending a prince named Rurik and his two brothers to rule. With Rurik's son, Oleg, expanding his realm into the south, and moving the capitol to Kiev, a former outpost of the Khazar Empire, the Kievan Rus was born, "Rus" most likely deriving from an old Norse word for "the men who row." The new princedom had complex relations with its neighbors, alternating between alliance and warfare with the Khazar and Byzantine Empires, as well as neighboring tribes. Religion played an important role in politics, and as the legend goes, in 987, the Rus prince Vladamir I decided it was time to abandon Slavic paganism, and sent emissaries to explore neighboring faiths. Put off by Islam's prohibition on alcohol and Judaism's expulsion from its holy land, the ruler settled on Orthodox Christianity after hearing odd accounts of its ceremonies. With Vladimir's conversion and marriage to the Byzantine emperor's sister, as well as continued trade along the Volga route, the relationship between the two civilizations deepened. Byzantine missionaries created an alphabet for Slavic languages based on a modified Greek script while Rus Viking warriors served as the Byzantine Emperor's elite guard. For several generations, the Kievan Rus flourished from its rich resources and trade. Its noblemen and noblewomen married prominent European rulers, while residents of some cities enjoyed great culture, literacy, and even democratic freedoms uncommon for the time. But nothing lasts forever. Fratricidal disputes over succession began to erode central power as increasingly independent cities ruled by rival princes vied for control. The Fourth Crusade and decline of Constantinople devastated the trade integral to Rus wealth and power, while Teutonic crusaders threatened northern territories. The final blow, however, would come from the east. Consumed by their squabbles, Rus princes paid little attention to the rumors of a mysterious unstoppable hoard until 1237, when 35,000 mounted archers led by Batu Khan swept through the Rus cities, sacking Kiev before continuing on to Hungary and Poland. The age of Kievan Rus had come to an end, its people now divided. In the east, which remained under Mongol rule, a remote trading post, known as Moscow, would grow to challenge the power of the Khans, conquering parts of their fragmenting empire, and, in many ways, succeeding it. As it absorbed other eastern Rus territories, it reclaimed the old name in its Greek form, Ruscia. Meanwhile, the western regions whose leaders had avoided destruction through political maneuvering until the hoard withdrew came under the influence of Poland and Lithuania. For the next few centuries, the former lands of Kievan Rus populated by Slavs, ruled by Vikings, taught by Greeks, and split by Mongols would develop differences in society, culture and language that remain to the present day.

**P285 2015-10-06 Where does gold come from - David Lunney**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=285)

In medieval times, alchemists tried to achieve the seemingly impossible. They wanted to transform lowly lead into gleaming gold. History portrays these people as aged eccentrics, but if only they'd known that their dreams were actually achievable. Indeed, today we can manufacture gold on Earth thanks to modern inventions that those medieval alchemists missed by a few centuries. But to understand how this precious metal became embedded in our planet to start with, we have to gaze upwards at the stars. Gold is extraterrestrial. Instead of arising from the planet's rocky crust, it was actually cooked up in space and is present on Earth because of cataclysmic stellar explosions called supernovae. Stars are mostly made up of hydrogen, the simplest and lightest element. The enormous gravitational pressure of so much material compresses and triggers nuclear fusion in the star's core. This process releases energy from the hydrogen, making the star shine. Over many millions of years, fusion transforms hydrogen into heavier elements: helium, carbon, and oxygen, burning subsequent elements faster and faster to reach iron and nickel. However, at that point nuclear fusion no longer releases enough energy, and the pressure from the core peters out. The outer layers collapse into the center, and bouncing back from this sudden injection of energy, the star explodes forming a supernova. The extreme pressure of a collapsing star is so high, that subatomic protons and electrons are forced together in the core, forming neutrons. Neutrons have no repelling electric charge so they're easily captured by the iron group elements. Multiple neutron captures enable the formation of heavier elements that a star under normal circumstances can't form, from silver to gold, past lead and on to uranium. In extreme contrast to the million year transformation of hydrogen to helium, the creation of the heaviest elements in a supernova takes place in only seconds. But what becomes of the gold after the explosion? The expanding supernova shockwave propels its elemental debris through the interstellar medium, triggering a swirling dance of gas and dust that condenses into new stars and planets. Earth's gold was likely delivered this way before being kneaded into veins by geothermal activity. Billions of years later, we now extract this precious product by mining it, an expensive process that's compounded by gold's rarity. In fact, all of the gold that we've mined in history could be piled into just three Olympic-size swimming pools, although this represents a lot of mass because gold is about 20 times denser than water. So, can we produce more of this coveted commodity? Actually, yes. Using particle accelerators, we can mimic the complex nuclear reactions that create gold in stars. But these machines can only construct gold atom by atom. So it would take almost the age of the universe to produce one gram at a cost vastly exceeding the current value of gold. So that's not a very good solution. But if we were to reach a hypothetical point where we'd mined all of the Earth's buried gold, there are other places we could look. The ocean holds an estimated 20 million tons of dissolved gold but at extremely miniscule concentrations making its recovery too costly at present. Perhaps one day, we'll see gold rushes to tap the mineral wealth of the other planets of our solar system. And who knows? Maybe some future supernova will occur close enough to shower us with its treasure and hopefully not eradicate all life on Earth in the process.

**P286 2015-10-13 What are the universal human rights - Benedetta Berti**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=286)

The idea of human rights is that each one of us, no matter who we are or where we are born, is entitled to the same basic rights and freedoms. Human rights are not privileges, and they cannot be granted or revoked. They are inalienable and universal. That may sound straighforward enough, but it gets incredibly complicated as soon as anyone tries to put the idea into practice. What exactly are the basic human rights? Who gets to pick them? Who enforces them, and how? The history behind the concept of human rights is a long one. Throughout the centuries and across societies, religions, and cultures we have struggled with defining notions of rightfulness, justice, and rights. But one of the most modern affirmations of universal human rights emerged from the ruins of World War II with the creation of the United Nations. The treaty that established the UN gives as one of its purposes to reaffirm faith in fundamental human rights. And with the same spirit, in 1948, the UN General Assembly adopted the Universal Declaration of Human Rights. This document, written by an international committee chaired by Eleanor Roosevelt, lays the basis for modern international human rights law. The declaration is based on the principle that all human beings are born free and equal in dignity and rights. It lists 30 articles recognizing, among other things, the principle of nondiscrimination and the right to life and liberty. It refers to negative freedoms, like the freedom from torture or slavery, as well as positive freedoms, such as the freedom of movement and residence. It encompasses basic civil and political rights, such as freedom of expression, religion, or peaceful assembly, as well as social, economic, and cultural rights, such as the right to education and the right to freely choose one's occupation and be paid and treated fairly. The declaration takes no sides as to which rights are more important, insisting on their universality, indivisibility, and interdependence. And in the past decades, international human rights law has grown, deepening and expanding our understanding of what human rights are, and how to better protect them. So if these principles are so well-developed, then why are human rights abused and ignored time and time again all over the world? The problem in general is that it is not at all easy to universally enforce these rights or to punish transgressors. The UDHR itself, despite being highly authoritative and respected, is a declaration, not a hard law. So when individual countries violate it, the mechanisms to address those violations are weak. For example, the main bodies within the UN in charge of protecting human rights mostly monitor and investigate violations, but they cannot force states to, say, change a policy or compensate a victim. That's why some critics say it's naive to consider human rights a given in a world where state interests wield so much power. Critics also question the universality of human rights and emphasize that their development has been heavily guided by a small number of mostly Western nations to the detriment of inclusiveness. The result? A general bias in favor of civil policital liberties over sociopolitical rights and of individual over collective or groups rights. Others defend universal human rights laws and point at the positive role they have on setting international standards and helping activists in their campaigns. They also point out that not all international human rights instruments are powerless. For example, the European Convention on Human Rights establishes a court where the 47 member countries and their citizens can bring cases. The court issues binding decisions that each member state must comply with. Human rights law is constantly evolving as are our views and definitions of what the basic human rights should be. For example, how basic or important is the right to democracy or to development? And as our lives are increasingly digital, should there be a right to access the Internet? A right to digital privacy? What do you think?

**P287 2015-10-14 How computers translate human language - Ioannis Papachimonas**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=287)

How is it that so many intergalactic species in movies and TV just happen to speak perfect English? The short answer is that no one wants to watch a starship crew spend years compiling an alien dictionary. But to keep things consistent, the creators of Star Trek and other science-fiction worlds have introduced the concept of a universal translator, a portable device that can instantly translate between any languages. So is a universal translator possible in real life? We already have many programs that claim to do just that, taking a word, sentence, or entire book in one language and translating it into almost any other, whether it's modern English or Ancient Sanskrit. And if translation were just a matter of looking up words in a dictionary, these programs would run circles around humans. The reality, however, is a bit more complicated. A rule-based translation program uses a lexical database, which includes all the words you'd find in a dictionary and all grammatical forms they can take, and set of rules to recognize the basic linguistic elements in the input language. For a seemingly simple sentence like, "The children eat the muffins," the program first parses its syntax, or grammatical structure, by identifying the children as the subject, and the rest of the sentence as the predicate consisting of a verb "eat," and a direct object "the muffins." It then needs to recognize English morphology, or how the language can be broken down into its smallest meaningful units, such as the word muffin and the suffix "s," used to indicate plural. Finally, it needs to understand the semantics, what the different parts of the sentence actually mean. To translate this sentence properly, the program would refer to a different set of vocabulary and rules for each element of the target language. But this is where it gets tricky. The syntax of some languages allows words to be arranged in any order, while in others, doing so could make the muffin eat the child. Morphology can also pose a problem. Slovene distinguishes between two children and three or more using a dual suffix absent in many other languages, while Russian's lack of definite articles might leave you wondering whether the children are eating some particular muffins, or just eat muffins in general. Finally, even when the semantics are technically correct, the program might miss their finer points, such as whether the children "mangiano" the muffins, or "divorano" them. Another method is statistical machine translation, which analyzes a database of books, articles, and documents that have already been translated by humans. By finding matches between source and translated text that are unlikely to occur by chance, the program can identify corresponding phrases and patterns, and use them for future translations. However, the quality of this type of translation depends on the size of the initial database and the availability of samples for certain languages or styles of writing. The difficulty that computers have with the exceptions, irregularities and shades of meaning that seem to come instinctively to humans has led some researchers to believe that our understanding of language is a unique product of our biological brain structure. In fact, one of the most famous fictional universal translators, the Babel fish from "The Hitchhiker's Guide to the Galaxy", is not a machine at all but a small creature that translates the brain waves and nerve signals of sentient species through a form of telepathy. For now, learning a language the old fashioned way will still give you better results than any currently available computer program. But this is no easy task, and the sheer number of languages in the world, as well as the increasing interaction between the people who speak them, will only continue to spur greater advances in automatic translation. Perhaps by the time we encounter intergalactic life forms, we'll be able to communicate with them through a tiny gizmo, or we might have to start compiling that dictionary, after all.

**P288 2015-10-14 Why do women have periods**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=288)

A handful of species on Earth share a seemingly mysterious trait: a menstrual cycle. We're one of the select few. Monkeys, apes, bats, humans, and possibly elephant shrews are the only mammals on Earth that menstruate. We also do it more than any other animal, even though its a waste of nutrients and can be a physical inconvenience. So where's the sense in this uncommon biological process? The answer begins with pregnancy. During this process, the body's resources are cleverly used to shape a suitable environment for a fetus, creating an internal haven for a mother to nurture her growing child. In this respect, pregnancy is awe-inspiring, but that's only half the story. The other half reveals that pregnancy places a mother and her child at odds. As for all living creatures, the human body evolved to promote the spread of its genes. For the mother, that means she should try to provide equally for all her offspring. But a mother and her fetus don't share exactly the same genes. The fetus inherits genes from its father, as well, and those genes can promote their own survival by extracting more than their fair share of resources from the mother. This evolutionary conflict of interests places a woman and her unborn child in a biological tug-of-war that plays out inside the womb. One factor contributing to this internal tussle is the placenta, the fetal organ that connects to the mother's blood supply and nourishes the fetus while it grows. In most mammals, the placenta is confined behind a barrier of maternal cells. This barrier lets the mother control the supply of nutrients to the fetus. But in humans and a few other species, the placenta actually penetrates right into the mother's circulatory system to directly access her blood stream. Through its placenta, the fetus pumps the mother's arteries with hormones that keep them open to provide a permanent flow of nutrient-rich blood. A fetus with such unrestricted access can manufacture hormones to increase the mother's blood sugar, dilate her arteries, and inflate her blood pressure. Most mammal mothers can expel or reabsorb embryos if required, but in humans, once the fetus is connected to the blood supply, severing that connection can result in hemorrhage. If the fetus develops poorly or dies, the mother's health is endangered. As it grows, a fetus's ongoing need for resources can cause intense fatigue, high blood pressure, and conditions like diabetes and preeclampsia. Because of these risks, pregnancy is always a huge, and sometimes dangerous, investment. So it makes sense that the body should screen embryos carefully to find out which ones are worth the challenge. This is where menstruation fits in. Pregnancy starts with a process called implantation, where the embryo embeds itself in the endometrium that lines the uterus. The endometrium evolved to make implantation difficult so that only the healthy embryos could survive. But in doing so, it also selected for the most vigorously invasive embryos, creating an evolutionary feedback loop. The embryo engages in a complex, exquisitely timed hormonal dialogue that transforms the endometrium to allow implantation. What happens when an embryo fails the test? It might still manage to attach, or even get partly through the endometrium. As it slowly dies, it could leave its mother vulnerable to infection, and all the time, it may be emitting hormonal signals that disrupt her tissues. The body avoids this problem by simply removing every possible risk. Each time ovulation doesn't result in a healthy pregnancy, the womb gets rid of its endometrial lining, along with any unfertilized eggs, sick, dying, or dead embryos. That protective process is known as menstruation, leading to the period. This biological trait, bizarre as it may be, sets us on course for the continuation of the human race.

**P289 2015-10-15 How stress affects your body - Sharon Horesh Bergquist**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=289)

Cramming for a test? Trying to get more done than you have time to do? Stress is a feeling we all experience when we are challenged or overwhelmed. But more than just an emotion, stress is a hardwired physical response that travels throughout your entire body. In the short term, stress can be advantageous, but when activated too often or too long, your primitive fight or flight stress response not only changes your brain but also damages many of the other organs and cells throughout your body. Your adrenal gland releases the stress hormones cortisol, epinephrine, also known as adrenaline, and norepinephrine. As these hormones travel through your blood stream, they easily reach your blood vessels and heart. Adrenaline causes your heart to beat faster and raises your blood pressure, over time causing hypertension. Cortisol can also cause the endothelium, or inner lining of blood vessels, to not function normally. Scientists now know that this is an early step in triggering the process of atherosclerosis or cholesterol plaque build up in your arteries. Together, these changes increase your chances of a heart attack or stroke. When your brain senses stress, it activates your autonomic nervous system. Through this network of nerve connections, your big brain communicates stress to your enteric, or intestinal nervous system. Besides causing butterflies in your stomach, this brain-gut connection can disturb the natural rhythmic contractions that move food through your gut, leading to irritable bowel syndrome, and can increase your gut sensitivity to acid, making you more likely to feel heartburn. Via the gut's nervous system, stress can also change the composition and function of your gut bacteria, which may affect your digestive and overall health. Speaking of digestion, does chronic stress affect your waistline? Well, yes. Cortisol can increase your appetite. It tells your body to replenish your energy stores with energy dense foods and carbs, causing you to crave comfort foods. High levels of cortisol can also cause you to put on those extra calories as visceral or deep belly fat. This type of fat doesn't just make it harder to button your pants. It is an organ that actively releases hormones and immune system chemicals called cytokines that can increase your risk of developing chronic diseases, such as heart disease and insulin resistance. Meanwhile, stress hormones affect immune cells in a variety of ways. Initially, they help prepare to fight invaders and heal after injury, but chronic stress can dampen function of some immune cells, make you more susceptible to infections, and slow the rate you heal. Want to live a long life? You may have to curb your chronic stress. That's because it has even been associated with shortened telomeres, the shoelace tip ends of chromosomes that measure a cell's age. Telomeres cap chromosomes to allow DNA to get copied every time a cell divides without damaging the cell's genetic code, and they shorten with each cell division. When telomeres become too short, a cell can no longer divide and it dies. As if all that weren't enough, chronic stress has even more ways it can sabotage your health, including acne, hair loss, sexual dysfunction, headaches, muscle tension, difficulty concentrating, fatigue, and irritability. So, what does all this mean for you? Your life will always be filled with stressful situations. But what matters to your brain and entire body is how you respond to that stress. If you can view those situations as challenges you can control and master, rather than as threats that are insurmountable, you will perform better in the short run and stay healthy in the long run.

**P290 2015-10-20 The science of snowflakes - Maruša Bradač**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=290)

If you ever find yourself gazing at falling snow, why not catch a few snowflakes on your glove and examine their shapes? You might notice that they look symmetrical, and if you look closely, you'll see they have six sides. You could say a snowflake is simply frozen water, but compare one with an ice cube from the freezer, and you'll realize they're very different things. Unlike ice cubes, formed when liquid freezes into a solid, snowflakes form when water vapor turns straight into ice. But that still doesn't explain why snowflakes have six sides. To understand that, we need to delve deeper into the physics of water. Water is made out of two hydrogen atoms and one oxygen atom. A single water molecule thus has ten protons and ten electrons, eight from oxygen and one from each hydrogen atom. The two electrons from oxygen's outer shell are shared with two electrons from both hydrogens as they bond together, and the remaining four outer shell electrons from oxygen form two pairs. We call the bonds between these atoms covalent bonds. The pairs of electrons are all negatively charged. Similar charges repel, so they tend to stay as far away from each other as possible. The pairs form four electron clouds, two of which are where the hydrogen and oxygen share electrons. The repulsion between the unbonded pairs is even stronger than repulsion between the shared pairs, so the two hydrogens get pushed a little further to an angle of 104.5 degrees. The water molecule as a whole is electrically neutral, but oxygen gets a larger share of electrons, making it slightly negative and the hydrogens slightly positive. Due to its negative charge, the oxygen in one molecule is attracted to the positive charge of the hydrogen in another molecule. And so a weak bond between the two molecules, called a hydrogen bond, is formed. When water freezes, this bonding occurs on repeat, ultimately forming a hexagonal structure due to the angle between hydrogens and oxygen within each molecule. This is the seed of a snowflake, and it retains a hexagonal shape as it grows. As the snowflake moves through the air, water vapor molecules stick to the six sharp edges and expand the snowflake outwards, bit by bit. A snowflake's developing shape depends on atmospheric conditions, like humidity and temperature. As a snowflake falls, changes in weather conditions can affect how it grows, and even small differences in the paths two snowflakes take will differentiate their shapes. However, since conditions at the six sharp edges of one snowflake are similar, a symmetric snowflake can grow. Weather conditions affect snow on the ground, as well. Warmer ground temperatures produce a wetter snow that is easier to pack because liquid water molecules help snowflakes stick to each other. Melted snow also plays a critical role in another wintry activity, skiing. Completely dry snow is very difficult to ski on because there's too much friction between the jagged snowflakes and the ski surface. So what's happening is that as skis move, they rub the surface of the snow and warm it up, creating a thin layer of water, which helps them slide along. So technically, it's not really snow skiing, but water skiing. But it is true that no matter how hard you look, you're almost definitely not going to find two identical snowflakes, and that's a mystery that scientists are still trying to solve, though we know that it has to do with the many possible branching points in snowflake formation, and the differences in temperature and humidity, and while we wait for the answer, we can enjoy watching these tiny fractals falling from the sky.

**P291 2015-10-23 How do hard drives work - Kanawat Senanan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=291)

Imagine an airplane flying one millimeter above the ground and circling the Earth once every 25 seconds while counting every blade of grass. Shrink all that down so that it fits in the palm of your hand, and you'd have something equivalent to a modern hard drive, an object that can likely hold more information than your local library. So how does it store so much information in such a small space? At the heart of every hard drive is a stack of high-speed spinning discs with a recording head flying over each surface. Each disc is coated with a film of microscopic magnetised metal grains, and your data doesn't live there in a form you can recognize. Instead, it is recorded as a magnetic pattern formed by groups of those tiny grains. In each group, also known as a bit, all of the grains have their magnetization's aligned in one of two possible states, which correspond to zeroes and ones. Data is written onto the disc by converting strings of bits into electrical current fed through an electromagnet. This magnet generates a field strong enough to change the direction of the metal grain's magnetization. Once this information is written onto the disc, the drive uses a magnetic reader to turn it back into a useful form, much like a phonograph needle translates a record's grooves into music. But how can you get so much information out of just zeroes and ones? Well, by putting lots of them together. For example, a letter is represented in one byte, or eight bits, and your average photo takes up several megabytes, each of which is 8 million bits. Because each bit must be written onto a physical area of the disc, we're always seeking to increase the disc's areal density, or how many bits can be squeezed into one square inch. The areal density of a modern hard drive is about 600 gigabits per square inch, 300 million times greater than that of IBM's first hard drive from 1957. This amazing advance in storage capacity wasn't just a matter of making everything smaller, but involved multiple innovations. A technique called the thin film lithography process allowed engineers to shrink the reader and writer. And despite its size, the reader became more sensitive by taking advantage of new discoveries in magnetic and quantum properties of matter. Bits could also be packed closer together thanks to mathematical algorithms that filter out noise from magnetic interference, and find the most likely bit sequences from each chunk of read-back signal. And thermal expansion control of the head, enabled by placing a heater under the magnetic writer, allowed it to fly less than five nanometers above the disc's surface, about the width of two strands of DNA. For the past several decades, the exponential growth in computer storage capacity and processing power has followed a pattern known as Moore's Law, which, in 1975, predicted that information density would double every two years. But at around 100 gigabits per square inch, shrinking the magnetic grains further or cramming them closer together posed a new risk called the superparamagnetic effect. When a magnetic grain volume is too small, its magnetization is easily disturbed by heat energy and can cause bits to switch unintentionally, leading to data loss. Scientists resolved this limitation in a remarkably simple way: by changing the direction of recording from longitudinal to perpendicular, allowing areal density to approach one terabit per square inch. Recently, the potential limit has been increased yet again through heat assisted magnetic recording. This uses an even more thermally stable recording medium, whose magnetic resistance is momentarily reduced by heating up a particular spot with a laser and allowing data to be written. And while those drives are currently in the prototype stage, scientists already have the next potential trick up their sleeves: bit-patterned media, where bit locations are arranged in separate, nano-sized structures, potentially allowing for areal densities of twenty terabits per square inch or more. So it's thanks to the combined efforts of generations of engineers, material scientists, and quantum physicists that this tool of incredible power and precision can spin in the palm of your hand.

**P292 2015-11-02 How mucus keeps us healthy - Katharina Ribbeck**

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If you've got a cold, mucus is hard to miss. But what is it, and what does it do besides making you miserable? Your body produces more than a liter of mucus every day, and all the wet surfaces of your body that are not covered by skin, like your eyes, nose, mouth, lungs, and stomach get a liberal coating. That's why they're known as mucus membranes. Mucus plays lots of roles in your body. It keeps delicate tissues from drying out and cracking, which would expose them to infection. It lubricates your eyes so you can blink. It protects your stomach lining from acid. It neutralizes threats by removing or trapping substances that could make you sick. And finally, it houses and keeps your body's trillions of bacterial inhabitants, your microbiota, under control. Mucus contains lots of different compounds, including proteins, fats, and salts. But a key component of mucus versatility is a set of proteins called mucins. Mucins are the primary large molecules in mucus and are essential for giving mucus its slippery feel. They belong to a class of proteins called glycoproteins which are built out of both amino acids and sugars. In mucin, long chains of sugars are attached to specific amino acids in the protein backbone. The hydrophilic sugar chains help mucin dissolve in your body's watery fluids. Mucus, which is up to 90% water, stays hydrated thanks to these sugar chains. Some of these mucins can interact with other mucin molecules to create a complex network that establishes a barrier against pathogens and other invaders. That's why mucus is the body's first line of defense against foreign objects, like bacteria and dust. It's continuously produced to clear them from the respiratory tract, like a slimy conveyor belt. This keeps bacteria from getting a solid purchase on delicate lung tissue, or making it to the blood stream, where they could cause a major infection. Many of those harmful bacteria also cause diseases when they cluster into slimy growths called biofilms. But mucus contains mucins, antimicrobial peptides, antibodies, and even bacteria-hungry viruses called bacteriophages that all work together to prevent biofilms from forming. If microbes do become harmful and you get sick, the body ramps up mucus production to try to quickly flush out the offenders, and the immune system floods your mucus with extra white blood cells. In fact, the greenish mucus often associated with infections gets its color from an enzyme produced by those white blood cells. This multi-pronged approach to bacterial management is one of the main reasons why we're not sick all the time. Even though mucus protects against the infectious bacteria, the vast majority of your body's bacterial tenants are not harmful, and many are actually beneficial. That's particularly true when they live in mucus, where they can perform important functions, like synthesizing vitamins, suppressing harmful inflammation, and controlling the growth of more harmful species. So even though you probably associate mucus with being ill, it's really helping you stay healthy. Sure, it might seem gross, but can you think of any other substance that can lubricate, keep your body clean, fight infection, and domesticate a teeming bacterial population? Nope, just mucus.

**P293 2015-11-02 What makes muscles grow - Jeffrey Siegel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=293)

Muscles. We have over 600 of them. They make up between 1/3 and 1/2 of our body weight, and along with connective tissue, they bind us together, hold us up, and help us move. And whether or not body building is your hobby, muscles need your constant attention because the way you treat them on a daily basis determines whether they will wither or grow. Say you're standing in front of a door, ready to pull it open. Your brain and muscles are perfectly poised to help you achieve this goal. First, your brain sends a signal to motor neurons inside your arm. When they receive this message, they fire, causing muscles to contract and relax, which pull on the bones in your arm and generate the needed movement. The bigger the challenge becomes, the bigger the brain's signal grows, and the more motor units it rallies to help you achieve your task. But what if the door is made of solid iron? At this point, your arm muscles alone won't be able to generate enough tension to pull it open, so your brain appeals to other muscles for help. You plant your feet, tighten your belly, and tense your back, generating enough force to yank it open. Your nervous system has just leveraged the resources you already have, other muscles, to meet the demand. While all this is happening, your muscle fibers undergo another kind of cellular change. As you expose them to stress, they experience microscopic damage, which, in this context, is a good thing. In response, the injured cells release inflammatory molecules called cytokines that activate the immune system to repair the injury. This is when the muscle-building magic happens. The greater the damage to the muscle tissue, the more your body will need to repair itself. The resulting cycle of damage and repair eventually makes muscles bigger and stronger as they adapt to progressively greater demands. Since our bodies have already adapted to most everyday activities, those generally don't produce enough stress to stimulate new muscle growth. So, to build new muscle, a process called hypertrophy, our cells need to be exposed to higher workloads than they are used to. In fact, if you don't continuously expose your muscles to some resistance, they will shrink, a process known as muscular atrophy. In contrast, exposing the muscle to a high-degree of tension, especially while the muscle is lengthening, also called an eccentric contraction, generates effective conditions for new growth. However, muscles rely on more than just activity to grow. Without proper nutrition, hormones, and rest, your body would never be able to repair damaged muscle fibers. Protein in our diet preserves muscle mass by providing the building blocks for new tissue in the form of amino acids. Adequate protein intake, along with naturally occurring hormones, like insulin-like growth factor and testosterone, help shift the body into a state where tissue is repaired and grown. This vital repair process mainly occurs when we're resting, especially at night while sleeping. Gender and age affect this repair mechanism, which is why young men with more testosterone have a leg up in the muscle building game. Genetic factors also play a role in one's ability to grow muscle. Some people have more robust immune reactions to muscle damage, and are better able to repair and replace damaged muscle fibers, increasing their muscle-building potential. The body responds to the demands you place on it. If you tear your muscles up, eat right, rest and repeat, you'll create the conditions to make your muscles as big and strong as possible. It is with muscles as it is with life: Meaningful growth requires challenge and stress.

**P294 2015-11-06 The science behind the myth - Homer's 'Odyssey' - Matt Kaplan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=294)

Homer's "Odyssey", one of the oldest works of Western literature, recounts the adventures of the Greek hero Odysseus during his ten-year journey home from the Trojan War. Though some parts may be based on real events, the encounters with strange monsters, terrifying giants and powerful magicians are considered to be complete fiction. But might there be more to these myths than meets the eye? Let's look at one famous episode from the poem. In the midst of their long voyage, Odysseus and his crew find themselves on the mysterious island of Aeaea. Starving and exhausted, some of the men stumble upon a palatial home where a stunning woman welcomes them inside for a sumptuous feast. Of course, this all turns out to be too good to be true. The woman, in fact, is the nefarious sorceress Circe, and as soon as the soldiers have eaten their fill at her table, she turns them all into animals with a wave of her wand. Fortunately, one of the men escapes, finds Odysseus and tells him of the crew's plight. But as Odysseus rushes to save his men, he meets the messenger god, Hermes, who advises him to first consume a magical herb. Odysseus follows this advice, and when he finally encounters Circe, her spells have no effect on him, allowing him to defeat her and rescue his crew. Naturally, this story of witchcraft and animal transformations was dismissed as nothing more than imagination for centuries. But in recent years, the many mentions of herbs and drugs throughout the passage have piqued the interest of scientists, leading some to suggest the myths might have been fictional expressions of real experiences. The earliest versions of Homer's text say that Circe mixed baneful drugs into the food such that the crew might utterly forget their native land. As it happens, one of the plants growing in the Mediterranean region is an innocent sounding herb known as Jimson weed, whose effects include pronounced amnesia. The plant is also loaded with compounds that disrupt the vital neurotransmitter called acetylcholine. Such disruption can cause vivid hallucinations, bizarre behaviors, and general difficulty distinguishing fantasy from reality, just the sorts of things which might make people believe they've been turned into animals, which also suggests that Circe was no sorceress, but in fact a chemist who knew how to use local plants to great effect. But Jimson weed is only half the story. Unlike a lot of material in the Odyssey, the text about the herb that Hermes gives to Odysseus is unusually specific. Called moly by the gods, it's described as being found in a forest glen, black at the root and with a flower as white as milk. Like the rest of the Circe episode, moly was dismissed as fictional invention for centuries. But in 1951, Russian pharmacologist Mikhail Mashkovsky discovered that villagers in the Ural Mountains used a plant with a milk-white flower and a black root to stave off paralysis in children suffering from polio. The plant, called snowdrop, turned out to contain a compound called galantamine that prevented the disruption of the neurotransmitter acetylcholine, making it effective in treating not only polio but other disease, such as Alzheimer's. At the 12th World Congress of Neurology, Doctors Andreas Plaitakis and Roger Duvoisin first proposed that snowdrop was, in fact, the plant Hermes gave to Odysseus. Although there is not much direct evidence that people in Homer's day would have known about its anti-hallucinatory effects, we do have a passage from 4th century Greek writer Theophrastus stating that moly is used as an antidote against poisons. So, does this all mean that Odysseus, Circe, and other characters in the Odyssey were real? Not necessarily. But it does suggest that ancient stories may have more elements of truth to them than we previously thought. And as we learn more about the world around us, we may uncover some of the same knowledge hidden within the myths and legends of ages passed.

**P295 2015-11-10 How to write descriptively - Nalo Hopkinson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=295)

We read fiction for many reasons. To be entertained, to find out who done it, to travel to strange, new planets, to be scared, to laugh, to cry, to think, to feel, to be so absorbed that for a while we forget where we are. So, how about writing fiction? How do you suck your readers into your stories? With an exciting plot? Maybe. Fascinating characters? Probably. Beautiful language? Perhaps. "Billie's legs are noodles. The ends of her hair are poison needles. Her tongue is a bristly sponge, and her eyes are bags of bleach." Did that description almost make you feel as queasy as Billie? We grasp that Billie's legs aren't actually noodles. To Billie, they feel as limp as cooked noodles. It's an implied comparison, a metaphor. So, why not simply write it like this? "Billie feels nauseated and weak." Chances are the second description wasn't as vivid to you as the first. The point of fiction is to cast a spell, a momentary illusion that you are living in the world of the story. Fiction engages the senses, helps us create vivid mental simulacra of the experiences the characters are having. Stage and screen engage some of our senses directly. We see and hear the interactions of the characters and the setting. But with prose fiction, all you have is static symbols on a contrasting background. If you describe the story in matter of fact, non-tactile language, the spell risks being a weak one. Your reader may not get much beyond interpreting the squiggles. She will understand what Billie feels like, but she won't feel what Billie feels. She'll be reading, not immersed in the world of the story, discovering the truths of Billie's life at the same time that Billie herself does. Fiction plays with our senses: taste, smell, touch, hearing, sight, and the sense of motion. It also plays with our ability to abstract and make complex associations. Look at the following sentence. "The world was ghost-quiet, except for the crack of sails and the burbling of water against hull." The words, "quiet," "crack," and "burbling," engage the sense of hearing. Notice that Buckell doesn't use the generic word sound. Each word he chooses evokes a particular quality of sound. Then, like an artist laying on washes of color to give the sense of texture to a painting, he adds anoter layer, motion, "the crack of sails," and touch, "the burbling of water against hull." Finally, he gives us an abstract connection by linking the word quiet with the word ghost. Not "quiet as a ghost," which would put a distancing layer of simile between the reader and the experience. Instead, Buckell creates the metaphor "ghost-quiet" for an implied, rather than overt, comparison. Writers are always told to avoid cliches because there's very little engagement for the reader in an overused image, such as "red as a rose." But give them, "Love...began on a beach. It began that day when Jacob saw Anette in her stewed-cherry dress," and their brains engage in the absorbing task of figuring out what a stewed-cherry dress is like. Suddenly, they're on a beach about to fall in love. They're experiencing the story at both a visceral and a conceptual level, meeting the writer halfway in the imaginative play of creating a dynamic world of the senses. So when you write, use well-chosen words to engage sound, sight, taste, touch, smell, and movement. Then create unexpected connotations among your story elements, and set your readers' brushfire imaginations alight.

**P296 2015-11-10 What would happen if you didn’t sleep - Claudia Aguirre**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=296)

In 1965, 17-year-old high school student, Randy Gardner stayed awake for 264 hours. That's 11 days to see how he'd cope without sleep. On the second day, his eyes stopped focusing. Next, he lost the ability to identify objects by touch. By day three, Gardner was moody and uncoordinated. At the end of the experiment, he was struggling to concentrate, had trouble with short-term memory, became paranoid, and started hallucinating. Although Gardner recovered without long-term psychological or physical damage, for others, losing shuteye can result in hormonal imbalance, illness, and, in extreme cases, death. We're only beginning to understand why we sleep to begin with, but we do know it's essential. Adults need seven to eight hours of sleep a night, and adolescents need about ten. We grow sleepy due to signals from our body telling our brain we are tired, and signals from the environment telling us it's dark outside. The rise in sleep-inducing chemicals, like adenosine and melatonin, send us into a light doze that grows deeper, making our breathing and heart rate slow down and our muscles relax. This non-REM sleep is when DNA is repaired and our bodies replenish themselves for the day ahead. In the United States, it's estimated that 30% of adults and 66% of adolescents are regularly sleep-deprived. This isn't just a minor inconvenience. Staying awake can cause serious bodily harm. When we lose sleep, learning, memory, mood, and reaction time are affected. Sleeplessness may also cause inflammation, halluciations, high blood pressure, and it's even been linked to diabetes and obesity. In 2014, a devoted soccer fan died after staying awake for 48 hours to watch the World Cup. While his untimely death was due to a stroke, studies show that chronically sleeping fewer than six hours a night increases stroke risk by four and half times compared to those getting a consistent seven to eight hours of shuteye. For a handful of people on the planet who carry a rare inherited genetic mutation, sleeplessness is a daily reality. This condition, known as Fatal Familial Insomnia, places the body in a nightmarish state of wakefulness, forbidding it from entering the sanctuary of sleep. Within months or years, this progressively worsening condition leads to dementia and death. How can sleep deprivation cause such immense suffering? Scientists think the answer lies with the accumulation of waste prducts in the brain. During our waking hours, our cells are busy using up our day's energy sources, which get broken down into various byproducts, including adenosine. As adenosine builds up, it increases the urge to sleep, also known as sleep pressure. In fact, caffeine works by blocking adenosine's receptor pathways. Other waste products also build up in the brain, and if they're not cleared away, they collectively overload the brain and are thought to lead to the many negative symptoms of sleep deprivation. So, what's happening in our brain when we sleep to prevent this? Scientists found something called the glymphatic system, a clean-up mechanism that removes this buildup and is much more active when we're asleep. It works by using cerebrospinal fluid to flush away toxic byproducts that accumulate between cells. Lymphatic vessels, which serve as pathways for immune cells, have recently been discovered in the brain, and they may also play a role in clearing out the brain's daily waste products. While scientists continue exploring the restorative mechanisms behind sleep, we can be sure that slipping into slumber is a necessity if we want to maintain our health and our sanity.

**P297 2015-11-11 Would you opt for a life with no pain - Hayley Levitt and Bethany Ric**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=297)

Imagine if you could plug your brain into a machine that would bring you ultimate pleasure for the rest of your life. If you were given the choice to sign up for that kind of existence, would you? That's the question philosopher Robert Nozick posed through a thought experiment he called the Experience Machine. The experiment asks us to consider a world in which scientists have developed a machine that would simulate real life while guaranteeing experiences of only pleasure and never pain. The catch? You have to permanently leave reality behind, but you'll hardly know the difference. Your experiences will be indistinguishable from reality. Life's natural ups and downs will just be replaced with an endless series of ups. Sounds great, right? It may seem like a tempting offer, but perhaps it's not as ideal as it sounds. The experiment was actually designed to refute a philosophical notion called hedonism. According to hedonists, maximizing net pleasure is the most important thing in life because pleasure is the greatest good that life has to offer. For hedonists, the best choice that a person could make for himself is one that brings him the greatest possible amount of pleasure while bringing him no pain. Limitless pleasure minus zero pain equals maximum net pleasure, or in other words, the exact scenario the Experience Machine offers. Therefore, if hedonism is your philosophy of choice, plugging in would be a no-brainer. But what if there's more to life than just pleasure? That's what Nozick believed he was demonstrating through his Experience Machine thought experiment. Despite the machine's promise of maximum net pleasure, he still found reason not to plug in, as do many other experimenters who consider the proposition. But what could possibly dissuade us from choosing a future of ultimate pleasure? Consider this scenario. Betsy and Xander are in a loving, committed relationship. Betsy is head over heels and has never felt happier. However, unbeknownst to Betsy, Xander has been romancing her sister, Angelica, with love letters and secret rendezvous for the duration of their relationship. If Betsy found out, it would destroy her relationships with both Xander and Angelica, and the experience would be so traumatic, she would never love again. Since Betsy is in blissful ignorance about Xander's infidelity, hedonists would say she's better off remaining in the dark and maintaining her high level of net pleasure. As long as Betsy never finds out about the relationship, her life is guaranteed to go on as happily as it is right now. So, is there value in Besty knowing the truth of her situation? Imagine if you were Betsy. Would you prefer to know the truth? If the answer is yes, you'd be choosing an option that sharply decreases your net pleasure. Perhaps, then, you believe that there are things in life with greater intrinsic value than pleasure. Truth, knowledge, authentic connection with other human beings. These are all things that might make the list. By never learning the truth, Betsy is essentially living life in her own personal Experience Machine, a world of happiness that's not based in reality. This love triangle is an extreme example, but it mirrors many of the decisions we make in day to day life. So whether you're making a choice for Betsy or for yourself, why might you feel reality should be a factor? Is there inherent value in real experiences, whether pleasurable or painful? Do you yourself have more value when you're experiencing real life's pleasures and pains? Nozick's experiment may not provide all the answers, but it forces us to consider whether real life, though imperfect, holds some intrinsic value beyond the pleasure of plugging in.

**P298 2015-11-17 What’s the difference between a scientific law and theory - Matt Anti**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=298)

Chat with a friend about an established scientific theory and she might reply, "Well, that's just a theory." But a conversation about an established scientific law rarely ends with, "Well, that's just a law." Why is that? What is the difference between a theory and a law, and is one better? Scientific laws and theories have different jobs to do. A scientific law predicts the results of certain initial conditions. It might predict your unborn child's possible hair colors, or how far a baseball travels when launched at a certain angle. In contrast, a theory tries to provide the most logical explanation about why things happen as they do. A theory might invoke dominant and recessive genes to explain how brown-haired parents ended up with a red-headed child, or use gravity to shed light on the parabolic trajectory of a baseball. In simplest terms, a law predicts what happens while a theory proposes why. A theory will never grow up into a law, though the development of one often triggers progress on the other. In the 17th century, Johannes Kepler theorized cosmic musical harmonies to explain the nature of planetary orbits. He developed three brilliant laws of planetary motion while he was studying decades of precise astronomical data in an effort to find support for his theory. While his three laws are still in use today, gravity replaced his theory of harmonics to explain the planets' motions. How did Kepler get part of it wrong? Well, we weren't handed a universal instruction manual. Instead, we continually propose, challenge, revise, or even replace our scientific ideas as a work in progress. Laws usually resist change since they wouldn't have been adopted if they didn't fit the data, though we occasionally revise laws in the face of new unexpected information. A theory's acceptance, however, is often gladiatorial. Multiple theories may compete to supply the best explanation of a new scientific discovery. Upon further research, scientists tend to favor the theory that can explain most of the data, though there may still be gaps in our understanding. Scientists also like when a new theory successfully predicts previously unobserved phenomena, like when Dmitri Mendeleev's theory about the periodic table predicted several undiscovered elements. The term scientific theory covers a broad swath. Some theories are new ideas with little experimental evidence that scientists eye with suspicion, or even ridicule. Other theories, like those involving the Big Bang, evolution, and climate change, have endured years of experimental confirmation before earning acceptance by the majority of the scientific community. You would need to learn more about a specific explanation before you'd know how well scientists perceive it. The word theory alone doesn't tell you. In full disclosure, the scientific community has bet on the wrong horse before: alchemy, the geocentric model, spontaneous generation, and the interstellar aether are just a few of many theories discarded in favor of better ones. But even incorrect theories have their value. Discredited alchemy was the birthplace of modern chemistry, and medicine made great strides long before we understood the roles of bacteria and viruses. That said, better theories often lead to exciting new discoveries that were unimaginable under the old way of thinking. Nor should we assume all of our current scientific theories will stand the test of time. A single unexpected result is enough to challenge the status quo. However, vulnerability to some potentially better explanation doesn't weaken a current scientific theory. Instead, it shields science from becoming unchallenged dogma. A good scientific law is a finely-tuned machine, accomplishing its task brilliantly but ignorant of why it works as well as it does. A good scientific theory is a bruised, but unbowed, fighter who risks defeat if unable to overpower or adapt to the next challenger. Though different, science needs both laws and theories to understand the whole picture. So next time someone comments that it's just a theory, challenge them to go nine rounds with the champ and see if they can do any better.

**P299 2015-11-19 How did clouds get their names - Richard Hamblyn**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=299)

The Naming of Clouds On a cold December evening in 1802, a nervous young man named Luke Howard stood before the assembled members of a London science club about to give a lecture that would change his life and go on to change humanity's understanding of the skies. Luke Howard was a pharmacist by profession, but he was a meteorologist by inclination, having been obsessed by clouds and weather since childhood. As a school boy, he spent hours staring out of the classroom window, gazing at the passing clouds. Like everyone else at the time, he had no idea how clouds formed, or how they stayed aloft. But he enjoyed observing their endless transformations. By his own admission, Luke paid little attention to his lessons, but fortunately for the future of meteorology, he managed to pick up a good knowledge of Latin. Compared to the other natural sciences, meteorology, the study of weather, was a late developer, mainly because weather is elusive. You can't snap off a piece of rainbow or a section of cloud for convenient study. You can, of course, collect rain water in calibrated containers, but all you really end up with are buckets of water. Understanding clouds required a different approach, which is where Luke Howard's idea came in. His simple insight based on years of observation was that clouds have many individual shapes but they have few basic forms. In fact, all clouds belong to one of three principle types to which Howard gave the names: cirrus, Latin for tendril or hair, cumulus, heap or pile, and stratus, layer or sheet. But that wasn't the clever part. Clouds are constantly changing, merging, rising, falling, and spreading throughout the atmosphere, rarely maintaining the same shapes for more than a few minutes. Any successful naming system had to accommodate this essential instability, as Howard realized. So, in addition to the three main cloud types, he introduced a series of intermediate and compound types as a way of including the regular transitions that occur among clouds. A high, whispy cirrus cloud that descended and spread into a sheet was named cirrostratus, while groups of fluffy cumulus clouds that joined up and spread were named stratocumulus. Howard identified seven cloud types, but these have since been expanded to ten, cloud nine being the towering cumulonimbus thunder cloud, which is probably why being on cloud nine means to be on top of the world. Howard's classification had an immediate international impact. The German poet and scientist J.W. von Goethe wrote a series of poems in praise of Howard's clouds, which ended with the memorable lines, "As clouds ascend, are folded, scatter, fall, Let the world think of thee who taught it all," while Percy Shelley also wrote a poem "The Cloud," in which each of Howard's seven cloud types was characterized in turn. But perhaps the most impressive response to the naming of clouds was by the painter John Constable, who spent two summers on Hampstead Heath painting clouds in the open air. Once they had been named and classified, clouds became easier to understand as the visible signs of otherwise invisible atmospheric processes. Clouds write a kind of journal on the sky that allows us to understand the circulating patterns of weather and climate. Perhaps the most important breakthrough in understanding clouds was realizing that they are subject to the same physical laws as everything else on Earth. Clouds, for example, do not float, but fall slowly under the influence of gravity. Some of them stay aloft due to upward convection from the sun-heated ground, but most are in a state of slow, balletic descent. "Clouds are the patron goddesses of idle fellows," as the Greek dramatist Aristophanes wrote in 420 B.C. and nephology, the study of clouds, remains a daydreamer's science, aptly founded by a thoughtful young man whose favorite activity was staring out of the window at the sky.

**P300 2015-11-19 Let's make history…by recording it - StoryCorps & TED Prize**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=300)

StoryCorps Founder & TED Prize winner Davey Isay has created an app that aims to bring people together in a project of listening, connection, and generosity. Here's why... This is the library of lost stories. It's where you'll find the true origins of the Sphinx and Stonehenge, the text lost in the fire of Alexandria, all of the great ideas that Einstein never thought to write down, the dream you can't quite remember from last night, your ancestor's first words, her last words. And it's the fastest growing library in the world. In the next year, 25 languages will be added to the collection, never to be heard aloud again, 50 million points of view never related, the last eyewitness account of an incredible act of athleticism, disobedience, courage, unread, unheard, unwatched. But this is the StoryCorps archive at the Library of Congress where everything recorded by StoryCorps is preserved for posterity. This is where, if you record your parents, your grandparents, your neighbors, your children, their stories will live on. What if Anne Frank hadn't kept her diary? What if no one could listen to Martin Luther King's Mountaintop speech? What if the camera hadn't been rolling during the first moon landing? But what if, this Thanksgiving, the youngest member of every family interviewed the oldest? "It's like the only thing on his mind was to tell the kids that he loved them." Or if on February 14th, you asked a person you love some questions you've never thought to ask. "Being married is like having a color television set, you never want to go back to black and white." History is all of these things, the testament to tragedy, the progress of civilization, the heroic triumphs, and the moments and stories that are our lives. It's also the act of actively listening to the voices of the past and the people who matter to us. "Grand Central Station, now, we know there's an architect, but who hung the iron? Who were the brick masons? Who swept the floor? Who kept the trains going? We shall begin celebrating the lives of the uncelebrated." So you can make history by recording it.

**P301 2015-11-23 Can you solve 'Einstein’s Riddle' - Dan Van der Vieren**

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Before he turned physics upside down, a young Albert Einstein supposedly showed off his genius by devising a complex riddle involving this list of clues. Can you resist tackling a brain teaser written by one of the smartest people in history? Let's give it a shot. The world's rarest fish has been stolen from the city aquarium. The police have followed the scent to a street with five identical looking houses. But they can't search all the houses at once, and if they pick the wrong one, the thief will know they're on his trail. It's up to you, the city's best detective, to solve the case. When you arrive on the scene, the police tell you what they know. One: each house's owner is of a different nationality, drinks a different beverage, and smokes a different type of cigar. Two: each house's interior walls are painted a different color. Three: each house contains a different animal, one of which is the fish. After a few hours of expert sleuthing, you gather some clues. It may look like a lot of information, but there's a clear logical path to the solution. Solving the puzzle will be a lot like Sudoku, so you may find it helpful to organize your information in a grid, like this. Pause the video on the following screen to examine your clues and solve the riddle. Answer in: 3 2 1 To start, you fill in the information from clues eight and nine. Immediately, you also realize that since the Norwegian is at the end of the street, there's only one house next to him, which must be the one with the blue walls in clue fourteen. Clue five says the green-walled house's owner drinks coffee. It can't be the center house since you already know its owner drinks milk, but it also can't be the second house, which you know has blue walls. And since clue four says the green-walled house must be directly to the left of the white-walled one, it can't be the first or fifth house either. The only place left for the green-walled house with the coffee drinker is the fourth spot, meaning the white-walled house is the fifth. Clue one gives you a nationality and a color. Since the only column missing both these values is the center one, this must be the Brit's red-walled home. Now that the only unassigned wall color is yellow, this must be applied to the first house, where clue seven says the Dunhill smoker lives. And clue eleven tells you that the owner of the horse is next door, which can only be the second house. The next step is to figure out what the Norwegian in the first house drinks. It can't be tea, clue three tells you that's the Dane. As per clue twelve, it can't be root beer since that person smokes Bluemaster, and since you already assigned milk and coffee, it must be water. From clue fifteen, you know that the Norwegian's neighbor, who can only be in the second house, smokes Blends. Now that the only spot in the grid without a cigar and a drink is in the fifth column, that must be the home of the person in clue twelve. And since this leaves only the second house without a drink, the tea-drinking Dane must live there. The fourth house is now the only one missing a nationality and a cigar brand, so the Prince-smoking German from clue thirteen must live there. Through elimination, you can conclude that the Brit smokes Pall Mall and the Swede lives in the fifth house, while clue six and clue two tell you that these two have a bird and a dog, respectively. Clue ten tells you that the cat owner lives next to the Blend-smoking Dane, putting him in the first house. Now with only one spot left on the grid, you know that the German in the green-walled house must be the culprit. You and the police burst into the house, catching the thief fish-handed. While that explanation was straightforward, solving puzzles like this often involves false starts and dead ends. Part of the trick is to use the process of elimination and lots of trial and error to hone in on the right pieces, and the more logic puzzles you solve, the better your intuition will be for when and where there's enough information to make your deductions. And did young Einstein really write this puzzle? Probably not. There's no evidence he did, and some of the brands mentioned are too recent. But the logic here is not so different from what you'd use to solve equations with multiple variables, even those describing the nature of the universe.

**P302 2015-12-02 How does anesthesia work - Steven Zheng**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=302)

If you've had surgery, you might remember starting to count backwards from ten, nine, eight, and then waking up with the surgery already over before you even got to five. And it might seem like you were asleep, but you weren't. You were under anesthesia, which is much more complicated. You were unconscious, but you also couldn't move, form memories, or, hopefully, feel pain. Without being able to block all those processes at once, many surgeries would be way too traumatic to perform. Ancient medical texts from Egypt, Asia and the Middle East all describe early anesthetics containing things like opium poppy, mandrake fruit, and alcohol. Today, anesthesiologists often combine regional, inhalational and intravenous agents to get the right balance for a surgery. Regional anesthesia blocks pain signals from a specific part of the body from getting to the brain. Pain and other messages travel through the nervous system as electrical impulses. Regional anesthetics work by setting up an electrical barricade. They bind to the proteins in neurons' cell membranes that let charged particles in and out, and lock out positively charged particles. One compound that does this is cocaine, whose painkilling effects were discovered by accident when an ophthalmology intern got some on his tongue. It's still occasionally used as an anesthetic, but many of the more common regional anesthetics have a similar chemical structure and work the same way. But for major surgeries where you need to be unconscious, you'll want something that acts on the entire nervous system, including the brain. That's what inhalational anesthetics do. In Western medicine, diethyl ether was the first common one. It was best known as a recreational drug until doctors started to realize that people sometimes didn't notice injuries they received under the influence. In the 1840s, they started sedating patients with ether during dental extractions and surgeries. Nitrous oxide became popular in the decades that followed and is still used today. although ether derivatives, like sevoflurane, are more common. Inhalational anesthesia is usually supplemented with intravenous anesthesia, which was developed in the 1870s. Common intravenous agents include sedatives, like propofol, which induce unconsciousness, and opioids, like fentanyl, which reduce pain. These general anesthetics also seem to work by affecting electrical signals in the nervous system. Normally, the brain's electrical signals are a chaotic chorus as different parts of the brain communicate with each other. That connectivity keeps you awake and aware. But as someone becomes anesthetized, those signals become calmer and more organized, suggesting that different parts of the brain aren't talking to each other anymore. There's a lot we still don't know about exactly how this happens. Several common anesthetics bind to the GABA-A receptor in the brain's neurons. They hold the gateway open, letting negatively charged particles flow into the cell. Negative charge builds up and acts like a log jam, keeping the neuron from transmitting electrical signals. The nervous system has lots of these gated channels, controlling pathways for movement, memory, and consciousness. Most anesthetics probably act on more than one, and they don't act on just the nervous system. Many anesthetics also affect the heart, lungs, and other vital organs. Just like early anesthetics, which included familiar poisons like hemlock and aconite, modern drugs can have serious side effects. So an anesthesiologist has to mix just the right balance of drugs to create all the features of anesthesia, while carefully monitoring the patient's vital signs, and adjusting the drug mixture as needed. Anesthesia is complicated, but figuring out how to use it allowed for the development of new and better surgical techniques. Surgeons could learn how to routinely and safely perform C-sections, reopen blocked arteries, replace damaged livers and kidneys, and many other life-saving operations. And each year, new anesthesia techniques are developed that will ensure more and more patients survive the trauma of surgery.

**P303 2015-12-02 Why the octopus brain is so extraordinary - Cláudio L. Guerra**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=303)

What could octopuses possibly have in common with us? After all, they don't have lungs, spines, or even a plural noun we can all agree on. But what they do have is the ability to solve puzzles, learn through observation, and even use tools, just like some other animals we know. And what makes octopus intelligence so amazing is that it comes from a biological structure completely different from ours. The 200 or so species of octopuses are mollusks belonging to the order cephalopoda, Greek for head-feet. Those heads contain impressively large brains, with a brain to body ratio similar to that of other intelligent animals, and a complex nervous system with about as many neurons as that of a dog. But instead of being centralized in the brain, these 500 million neurons are spread out in a network of interconnected ganglia organized into three basic structures. The central brain only contains about 10% of the neurons, while the two huge optic lobes contain about 30%. The other 60% are in the tentacles, which for humans would be like our arms having minds of their own. This is where things get even more interesting. Vertebrates like us have a rigid skeleton to support our bodies, with joints that allow us to move. But not all types of movement are allowed. You can't bend your knee backwards, or bend your forearm in the middle, for example. Cephalopods, on the other hand, have no bones at all, allowing them to bend their limbs at any point and in any direction. So shaping their tentacles into any one of the virtually limitless number of possible arrangements is unlike anything we are used to. Consider a simple task, like grabbing and eating an apple. The human brain contains a neurological map of our body. When you see the apple, your brain's motor center activates the appropriate muscles, allowing you to reach out with your arm, grab it with your hand, bend your elbow joint, and bring it to your mouth. For an octopus, the process is quite different. Rather than a body map, the cephalopod brain has a behavior library. So when an octopus sees food, its brain doesn't activate a specific body part, but rather a behavioral response to grab. As the signal travels through the network, the arm neurons pick up the message and jump into action to command the movement. As soon as the arm touches the food, a muscle activation wave travels all the way through the arm to its base, while the arm sends back another wave from the base to the tip. The signals meet halfway between the food and the base of the arm, letting it know to bend at that spot. What all this means is that each of an octopus's eight arms can essentially think for itself. This gives it amazing flexibility and creativity when facing a new situation or problem, whether its opening a bottle to reach food, escaping through a maze, moving around in a new environment, changing the texture and the color of its skin to blend into the scenery, or even mimicking other creatures to scare away enemies. Cephalopods may have evolved complex brains long before our vertebrate relatives. And octopus intelligence isn't just useful for octopuses. Their radically different nervous system and autonomously thinking appendages have inspired new research in developing flexible robots made of soft materials. And studying how intelligence can arise along such a divergent evolutionary path can help us understand more about intelligence and consciousness in general. Who knows what other forms of intelligent life are possible, or how they process the world around them.

**P304 2015-12-04 The ethical dilemma of self-driving cars - Patrick Lin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=304)

This is a thought experiment. Let's say at some point in the not so distant future, you're barreling down the highway in your self-driving car, and you find yourself boxed in on all sides by other cars. Suddenly, a large, heavy object falls off the truck in front of you. Your car can't stop in time to avoid the collision, so it needs to make a decision: go straight and hit the object, swerve left into an SUV, or swerve right into a motorcycle. Should it prioritize your safety by hitting the motorcycle, minimize danger to others by not swerving, even if it means hitting the large object and sacrificing your life, or take the middle ground by hitting the SUV, which has a high passenger safety rating? So what should the self-driving car do? If we were driving that boxed in car in manual mode, whichever way we'd react would be understood as just that, a reaction, not a deliberate decision. It would be an instinctual panicked move with no forethought or malice. But if a programmer were to instruct the car to make the same move, given conditions it may sense in the future, well, that looks more like premeditated homicide. Now, to be fair, self-driving cars are are predicted to dramatically reduce traffic accidents and fatalities by removing human error from the driving equation. Plus, there may be all sorts of other benefits: eased road congestion, decreased harmful emissions, and minimized unproductive and stressful driving time. But accidents can and will still happen, and when they do, their outcomes may be determined months or years in advance by programmers or policy makers. And they'll have some difficult decisions to make. It's tempting to offer up general decision-making principles, like minimize harm, but even that quickly leads to morally murky decisions. For example, let's say we have the same initial set up, but now there's a motorcyclist wearing a helmet to your left and another one without a helmet to your right. Which one should your robot car crash into? If you say the biker with the helmet because she's more likely to survive, then aren't you penalizing the responsible motorist? If, instead, you save the biker without the helmet because he's acting irresponsibly, then you've gone way beyond the initial design principle about minimizing harm, and the robot car is now meting out street justice. The ethical considerations get more complicated here. In both of our scenarios, the underlying design is functioning as a targeting algorithm of sorts. In other words, it's systematically favoring or discriminating against a certain type of object to crash into. And the owners of the target vehicles will suffer the negative consequences of this algorithm through no fault of their own. Our new technologies are opening up many other novel ethical dilemmas. For instance, if you had to choose between a car that would always save as many lives as possible in an accident, or one that would save you at any cost, which would you buy? What happens if the cars start analyzing and factoring in the passengers of the cars and the particulars of their lives? Could it be the case that a random decision is still better than a predetermined one designed to minimize harm? And who should be making all of these decisions anyhow? Programmers? Companies? Governments? Reality may not play out exactly like our thought experiments, but that's not the point. They're designed to isolate and stress test our intuitions on ethics, just like science experiments do for the physical world. Spotting these moral hairpin turns now will help us maneuver the unfamiliar road of technology ethics, and allow us to cruise confidently and conscientiously into our brave new future.

**P305 2015-12-10 History through the eyes of the potato - Leo Bear-McGuinness**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=305)

Baked or fried, boiled or roasted, as chips or fries. At some point in your life, you've probably eaten a potato. Delicious, for sure, but the fact is potatoes have played a much more significant role in our history than just that of the dietary staple we have come to know and love today. Without the potato, our modern civilization might not exist at all. 8,000 years ago in South America, high atop the Andes, ancient Peruvians were the first to cultivate the potato. Containing high levels of proteins and carbohydrates, as well as essential fats, vitamins and minerals, potatoes were the perfect food source to fuel a large Incan working class as they built and farmed their terraced fields, mined the Rocky Mountains, and created the sophisticated civilization of the great Incan Empire. But considering how vital they were to the Incan people, when Spanish sailors returning from the Andes first brought potatoes to Europe, the spuds were duds. Europeans simply didn't want to eat what they considered dull and tasteless oddities from a strange new land, too closely related to the deadly nightshade plant belladonna for comfort. So instead of consuming them, they used potatoes as decorative garden plants. More than 200 years would pass before the potato caught on as a major food source throughout Europe, though even then, it was predominantly eaten by the lower classes. However, beginning around 1750, and thanks at least in part to the wide availability of inexpensive and nutritious potatoes, European peasants with greater food security no longer found themselves at the mercy of the regularly occurring grain famines of the time, and so their populations steadily grew. As a result, the British, Dutch and German Empires rose on the backs of the growing groups of farmers, laborers, and soldiers, thus lifting the West to its place of world dominion. However, not all European countries sprouted empires. After the Irish adopted the potato, their population dramatically increased, as did their dependence on the tuber as a major food staple. But then disaster struck. From 1845 to 1852, potato blight disease ravaged the majority of Ireland's potato crop, leading to the Irish Potato Famine, one of the deadliest famines in world history. Over a million Irish citizens starved to death, and 2 million more left their homes behind. But of course, this wasn't the end for the potato. The crop eventually recovered, and Europe's population, especially the working classes, continued to increase. Aided by the influx of Irish migrants, Europe now had a large, sustainable, and well-fed population who were capable of manning the emerging factories that would bring about our modern world via the Industrial Revolution. So it's almost impossible to imagine a world without the potato. Would the Industrial Revolution ever have happened? Would World War II have been lost by the Allies without this easy-to-grow crop that fed the Allied troops? Would it even have started? When you think about it like this, many major milestones in world history can all be at least partially attributed to the simple spud from the Peruvian hilltops.

**P306 2015-12-11 What is depression - Helen M. Farrell**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=306)

Depression is the leading cause of disability in the world. In the United States, close to 10% of adults struggle with depression. But because it's a mental illness, it can be a lot harder to understand than, say, high cholesterol. One major source of confusion is the difference between having depression and just feeling depressed. Almost everyone feels down from time to time. Getting a bad grade, losing a job, having an argument, even a rainy day can bring on feelings of sadness. Sometimes there's no trigger at all. It just pops up out of the blue. Then circumstances change, and those sad feelings disappear. Clinical depression is different. It's a medical disorder, and it won't go away just because you want it to. It lingers for at least two consecutive weeks, and significantly interferes with one's ability to work, play, or love. Depression can have a lot of different symptoms: a low mood, loss of interest in things you'd normally enjoy, changes in appetite, feeling worthless or excessively guilty, sleeping either too much or too little, poor concentration, restlessness or slowness, loss of energy, or recurrent thoughts of suicide. If you have at least five of those symptoms, according to psychiatric guidelines, you qualify for a diagnosis of depression. And it's not just behavioral symptoms. Depression has physical manifestations inside the brain. First of all, there are changes that could be seen with the naked eye and X-ray vision. These include smaller frontal lobes and hippocampal volumes. On a more microscale, depression is associated with a few things: the abnormal transmission or depletion of certain neurotransmitters, especially serotonin, norepinephrine, and dopamine, blunted circadian rhythms, or specific changes in the REM and slow-wave parts of your sleep cycle, and hormone abnormalities, such as high cortisol and deregulation of thyroid hormones. But neuroscientists still don't have a complete picture of what causes depression. It seems to have to do with a complex interaction between genes and environment, but we don't have a diagnostic tool that can accurately predict where or when it will show up. And because depression symptoms are intangible, it's hard to know who might look fine but is actually struggling. According to the National Institute of Mental Health, it takes the average person suffering with a mental illness over ten years to ask for help. But there are very effective treatments. Medications and therapy complement each other to boost brain chemicals. In extreme cases, electroconvulsive therapy, which is like a controlled seizure in the patient's brain, is also very helpful. Other promising treatments, like transcranial magnetic stimulation, are being investigated, too. So, if you know someone struggling with depression, encourage them, gently, to seek out some of these options. You might even offer to help with specific tasks, like looking up therapists in the area, or making a list of questions to ask a doctor. To someone with depression, these first steps can seem insurmountable. If they feel guilty or ashamed, point out that depression is a medical condition, just like asthma or diabetes. It's not a weakness or a personality trait, and they shouldn't expect themselves to just get over it anymore than they could will themselves to get over a broken arm. If you haven't experienced depression yourself, avoid comparing it to times you've felt down. Comparing what they're experiencing to normal, temporary feelings of sadness can make them feel guilty for struggling. Even just talking about depression openly can help. For example, research shows that asking someone about suicidal thoughts actually reduces their suicide risk. Open conversations about mental illness help erode stigma and make it easier for people to ask for help. And the more patients seek treatment, the more scientists will learn about depression, and the better the treatments will get.

**P307 2015-12-12 Forget shopping. Soon you'll download your new clothes - Danit Peleg**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=307)

In the past few months, I've been traveling for weeks at a time with only one suitcase of clothes. One day, I was invited to an important event, and I wanted to wear something special and new for it. So I looked through my suitcase and I couldn't find anything to wear. I was lucky to be at the technology conference on that day, and I had access to 3D printers. So I quickly designed a skirt on my computer, and I loaded the file on the printer. It just printed the pieces overnight. The next morning, I just took all the pieces, assembled them together in my hotel room, and this is actually the skirt that I'm wearing right now. (Applause) So it wasn't the first time that I printed clothes. For my senior collection at fashion design school, I decided to try and 3D print an entire fashion collection from my home. The problem was that I barely knew anything about 3D printing, and I had only nine months to figure out how to print five fashionable looks. I always felt most creative when I worked from home. I loved experimenting with new materials, and I always tried to develop new techniques to make the most unique textiles for my fashion projects. I loved going to old factories and weird stores in search of leftovers of strange powders and weird materials, and then bring them home to experiment on. As you can probably imagine, my roommates didn't like that at all. (Laughter) So I decided to move on to working with big machines, ones that didn't fit in my living room. I love the exact and the custom work I can do with all kinds of fashion technologies, like knitting machines and laser cutting and silk printing. One summer break, I came here to New York for an internship at a fashion house in Chinatown. We worked on two incredible dresses that were 3D printed. They were amazing -- like you can see here. But I had a few issues with them. They were made from hard plastics and that's why they were very breakable. The models couldn't sit in them, and they even got scratched from the plastics under their arms. With 3D printing, the designers had so much freedom to make the dresses look exactly like they wanted, but still, they were very dependent on big and expensive industrial printers that were located in a lab far from their studio. Later that year, a friend gave me a 3D printed necklace, printed using a home printer. I knew that these printers were much cheaper and much more accessible than the ones we used at my internship. So I looked at the necklace, and then I thought, "If I can print a necklace from home, why not print my clothes from home, too?" I really liked the idea that I wouldn't have to go to the market and pick fabrics that someone else chose to sell -- I could just design them and print them directly from home. I found a small makerspace, where I learned everything I know about 3D printing. Right away, they literally gave me the key to the lab, so I could experiment into the night, every night. The main challenge was to find the right filament for printing clothes with. So what is a filament? Filament is the material you feed the printer with. And I spent a month or so experimenting with PLA, which is a hard and scratchy, breakable material. The breakthrough came when I was introduced to Filaflex, which is a new kind of filament. It's strong, yet very flexible. And with it, I was able to print the first garment, the red jacket that had the word "Liberté" -- "freedom" in French -- embedded into it. I chose this word because I felt so empowered and free when I could just design a garment from my home and then print it by myself. And actually, you can easily download this jacket, and easily change the word to something else. For example, your name or your sweetheart's name. (Laughter) So the printer plates are small, so I had to piece the garment together, just like a puzzle. And I wanted to solve another challenge. I wanted to print textiles that I would use just like regular fabrics. That's when I found an open-source file from an architect who designed a pattern that I love. And with it, I was able to print a beautiful textile that I would use just like a regular fabric. And it actually even looks a little bit like lace. So I took his file and I modified it, and changed it, played with it -- many kinds of versions out of it. And I needed to print another 1,500 more hours to complete printing my collection. So I brought six printers to my home and just printed 24-7. And this is actually a really slow process, but let's remember the Internet was significantly slower 20 years ago, so 3D printing will also accelerate and in no time you'll be able to print a T-Shirt in your home in just a couple of hours, or even minutes. So you guys, you want to see what it looks like? Audience: Yeah! (Applause) Danit Peleg: Rebecca is wearing one of my five outfits. Almost everything here she's wearing, I printed from my home. Even her shoes are printed. Audience: Wow! Audience: Cool! (Applause) Danit Peleg: Thank you, Rebecca. (To audience) Thank you, guys. So I think in the future, materials will evolve, and they will look and feel like fabrics we know today, like cotton or silk. Imagine personalized clothes that fit exactly to your measurements. Music was once a very physical thing. You would have to go to the record shop and buy CDs, but now you can just download the music -- digital music -- directly to your phone. Fashion is also a very physical thing. And I wonder what our world will look like when our clothes will be digital, just like this skirt is. Thank you so much. (Applause) [Thank You] (Applause)

**P308 2015-12-18 The Sun’s surprising movement across the sky - Gordon Williamson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=308)

Suppose you placed a camera at a fixed position, took a picture of the sky at the same time everyday for an entire year and overlayed all of the photos on top of each other. What would the sun look like in that combined image? A stationary dot? A circular path? Neither. Oddly enough, it makes this figure eight pattern, known as the Sun's analemma, but why? The Earth's movement creates a few cycles. First of all, it rotates on its axis about once every 24 hours, producing sunrises and sunsets. At the same time, it's making a much slower cycle, orbiting around the sun approximately every 365 days. But there's a twist. Relative to the plane of its orbit, the Earth doesn't spin with the North Pole pointing straight up. Instead, its axis has a constant tilt of 23.4 degrees. This is known as the Earth's axial tilt, or obliquity. A 23-degree tilt may not seem important, but it's the main reason that we experience different seasons. Because the axis remains tilted in the same direction while the Earth makes its annual orbit, there are long periods each year when the northern half of the planet remains tilted toward the Sun while the southern half is tilted away and vice versa, what we experience as summer and winter. During summer in a given hemisphere, the Sun appears higher in the sky, making the days longer and warmer. Once a year, the Sun's declination, the angle between the equator and the position on the Earth where the Sun appears directly overhead reaches its maximum. This day is known as the summer solstice, the longest day of the year, and the one day where the Sun appears highest in the sky. So the Earth's axial tilt partially explains why the Sun changes positions in the sky and the analemma's length represents the full 46.8 degrees of the sun's declination throughout the year. But why is it a figure eight and not just a straight line? This is due to another feature of the Earth's revolution, its orbital eccentricity. The Earth's orbit around the Sun is an ellipse, with its distance to the Sun changing at various points. The corresponding change in gravitational force causes the Earth to move fastest in January when it reaches its closest point to the Sun, the perihelion, and the slowest in July when it reaches its farthest point, the aphelion. The Earth's eccentricity means that solar noon, the time when the Sun is highest in the sky, doesn't always occur at the same point in the day. So a sundial may be as much as sixteen minutes ahead or fourteen minutes behind a regular clock. In fact, clock time and Sun time only match four times a year. The analemma's width represents the extent of this deviation. So how did people know the correct time years ago? For most of human history, going by the Sun's position was close enough. But during the modern era, the difference between sundials and mechanical clocks became important. The equation of time, introduced by Ptolemy and later refined based on the work of Johannes Kepler, converts between apparent solar time and the mean time we've all come to rely on. Globes even used to have the analemma printed on them to allow people to determine the difference between clock time and solar time based on the day of the year. Just how the analemma appears depends upon where you are. It will be tilted at an angle depending on your latitude or inverted if you're in the southern hemisphere. And if you're on another planet, you might find something completely different. Depending on that planet's orbital eccentricity and axial tilt, the analemma might appear as a tear drop, oval, or even a straight line.

**P309 2015-12-22 How do carbohydrates impact your health - Richard J. Wood**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=309)

Which of these has the least carbohydrates? This roll of bread? This bowl of rice? Or this can of soda? It's a trick question. Although they may differ in fats, vitamins, and other nutritional content, when it comes to carbs, they're pretty much the same. So what exactly does that mean for your diet? First of all, carbohydrate is the nutritional category for sugars and molecules that your body breaks down to make sugars. Carbohydrates can be simple or complex depending on their structure. This is a simple sugar, or monosaccharide. Glucose, fructose, and galactose are all simple sugars. Link two of them together, and you've got a disaccharide, lactose, maltose, or sucrose. Complex carbohydrates, on the other hand, have three or more simple sugars strung together. Complex carbohydrates with three to ten linked sugars are oligosaccharides. Those with more than ten are polysaccharides. During digestion, your body breaks down those complex carbohydrates into their monosaccharide building blocks, which your cells can use for energy. So when you eat any carbohydrate-rich food, the sugar level in your blood, normally about a teaspoon, goes up. But your digestive tract doesn't respond to all carbohydrates the same. Consider starch and fiber, both polysaccharides, both derived from plants, both composed of hundreds to thousands of monosaccharides joined together, but they're joined together differently, and that changes the effect they have on your body. In starches, which plants mostly store for energy in roots and seeds, glucose molecules are joined together by alpha linkages, most of which can be easily cleaved by enzymes in your digestive tract. But in fiber, the bonds between monosaccharide molecules are beta bonds, which your body can't break down. Fiber can also trap some starches, preventing them from being cleaved, resulting in something called resistant starch. So foods high in starch, like crackers and white bread, are digested easily, quickly releasing a whole bunch of glucose into your blood, exactly what would happen if you drank something high in glucose, like soda. These foods have a high glycemic index, the amount that a particular food raises the sugar level in your blood. Soda and white bread have a similar glycemic index because they have a similar effect on your blood sugar. But when you eat foods high in fiber, like vegetables, fruits, and whole grains, those indigestible beta bonds slow the release of glucose into the blood. Those foods have a lower glycemic index, and foods like eggs, cheese, and meats have the lowest glycemic index. When sugar moves from the digestive tract to the blood stream, your body kicks into action to transfer it into your tissues where it can be processed and used for energy. Insulin, a hormone synthesized in the pancreas, is one of the body's main tools for sugar management. When you eat and your blood sugar rises, insulin is secreted into the blood. It prompts your muscle and fat cells to let glucose in and jump starts the conversion of sugar to energy. The degree to which a unit of insulin lowers the blood sugar helps us understand something called insulin sensitivity. The more a given unit of insulin lowers blood sugar, the more sensitive you are to insulin. If insulin sensitivity goes down, that's known as insulin resistance. The pancreas still sends out insulin, but cells, especially muscle cells, are less and less responsive to it, so blood sugar fails to decrease, and blood insulin continues to rise. Chronically consuming a lot of carbohydrates may lead to insulin resistance, and many scientists believe that insulin resistance leads to a serious condition called metabolic syndrome. That involves a constellation of symptoms, including high blood sugar, increased waist circumference, and high blood pressure. It increases the risk of developing conditions, like cardiovascular disease and type II diabetes. And its prevalence is rapidly increasing all over the world. As much as 32% of the population in the U.S. has metabolic syndrome. So let's get back to your diet. Whether your food tastes sweet or not, sugar is sugar, and too many carbs can be a problem. So maybe you'll want to take a pass on that pasta sushi roll pita burrito donut burger sandwich.

**P310 2015-12-22 How do we know what color dinosaurs were - Len Bloch**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=310)

This is the microraptor, a carnivorous four-winged dinosaur that was almost two-feet long, ate fish, and lived about 120 million years ago. Most of what we know about it comes from fossils that look like this. So, is its coloration here just an artist's best guess? The answer is no. We know this shimmering black color is accurate because paleontologists have analyzed clues contained within the fossil. But making sense of the evidence requires careful examination of the fossil and a good understanding of the physics of light and color. First of all, here's what we actually see on the fossil: imprints of bones and feathers that have left telltale mineral deposits. And from those imprints, we can determine that these microraptor feathers were similar to modern dinosaur, as in bird, feathers. But what gives birds their signature diverse colorations? Most feathers contain just one or two dye-like pigments. The cardinal's bright red comes from carotenoids, the same pigments that make carrots orange, while the black of its face is from melanin, the pigment that colors our hair and skin. But in bird feathers, melanin isn't simply a dye. It forms hollow nanostructures called melanosomes which can shine in all the colors of the rainbow. To understand how that works, it helps to remember some things about light. Light is basically a tiny electromagnetic wave traveling through space. The top of a wave is called its crest and the distance between two crests is called the wavelength. The crests in red light are about 700 billionths of a meter apart and the wavelength of purple light is even shorter, about 400 billionths of a meter, or 400 nanometers. When light hits the thin front surface of a bird's hollow melanosome, some is reflected and some passes through. A portion of the transmitted light then reflects off the back surface. The two reflected waves interact. Usually they cancel each other out, but when the wavelength of the reflected light matches the distance between the two reflections, they reinforce each other. Green light has a wavelength of about 500 nanometers, so melanosomes that are about 500 nanometers across give off green light, thinner melanosomes give off purple light, and thicker ones give off red light. Of course, it's more complex than this. The melanosomes are packed together inside cells, and other factors, like how the melanosomes are arranged within the feather, also matter. Let's return to the microraptor fossil. When scientists examined its feather imprints under a powerful microscope, they found nanostructures that look like melanosomes. X-ray analysis of the melanosomes further supported that theory. They contained minerals that would result from the decay of melanin. The scientists then chose 20 feathers from one fossil and found that the melanosomes in all 20 looked alike, so they became pretty sure this dinosaur was one solid color. They compared these microraptor melanosomes to those of modern birds and found a close similarity, though not a perfect match, to the iridescent teal feathers found on duck wings. And by examining the exact size and arrangement of the melanosomes, scientists determined that the feathers were iridescent black. Now that we can determine a fossilized feather's color, paleontologists are looking for more fossils with well-preserved melanosomes. They've found that a lot of dinosaurs, including velociraptor, probably had feathers, meaning that certain films might not be so biologically accurate. Clever girls.

**P311 2016-01-06 The surprising (and invisible) signatures of sea creatures - Kakani K**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=311)

So my name is Kakani Katija, and I'm a bioengineer. I study marine organisms in their natural environment. And what I want to point out, and at least you can see this in this visualization, is that the ocean environment is a dynamic place. What you're seeing are the kinds of currents, as well as the whirls, that are left behind in the ocean because of tides or because of winds. And imagine a marine organism as living in this environment, and they're trying to undergo their entire lives while dealing with currents like these. But what I also want to point out is that small organisms also create small fluid motions, as well. And it's these fluid motions that I study. And we can think about them like being footprints. So this is my dog Kieran, and take a look at her footprints. Footprints provide a lot of information. Not only do they tell us what kind of organism left them, they might also tell us something about when that organism was there, but also what kind of behavior, were they running or were they walking? And so terrestrial organisms, like my cute dog Kieran, might be leaving footprints behind in dirt or in sand, but marine organisms leave footprints in the form of what we call wake structures, or hydrodynamic signatures, in fluid. Now imagine, it's really hard to see these kinds of structures because fluid is transparent. However, if we add something to the fluid, we get a completely different picture. And you can see that these footprints that marine organisms create are just dynamic. They are constantly changing. And marine organisms also have the ability to sense these signatures. They can also inform decisions, like whether or not they want to continue following a signature like this to find a mate or to find food, or maybe avoid these signatures to avoid being eaten. So imagine the ability to be able to not only see or visualize these kinds of signatures, but to also measure them. This is the engineering side of what I do. And so what I've done is I actually took a laboratory technique and miniaturized it and basically shrunk it down into the use of underwater housings to make a device that a single scuba diver can use. And so a single scuba diver can go anywhere from the surface to 40 meters, or 120 feet deep, to measure the hydrodynamic signatures that organisms create. Before I begin, I want to immerse you into what these kinds of measurements require. So in order to work, we actually dive at night, and this is because we're trying to minimize any interactions between the laser and sunlight and we're diving in complete darkness because we do not want to scare away the organisms we're trying to study. And then once we find the organisms we're interested in, we turn on a green laser. And this green laser is actually illuminating a sheet of fluid, and in that fluid, it's reflecting off of particles that are found everywhere in the ocean. And so as an animal swims through this laser sheet, you can see these particles are moving over time, and so we actually risk our lives to get this kind of data. What you're going to see is that on the left these two particles images that shows the displacement of fluid over time, and using that data, you can actually extract what the velocity of that fluid is, and that's indicated by the vector plots that you see in the middle. And then we can use that data to answer a variety of different questions, not only to understand the rotational sense of that fluid, which you see on the right, but also estimate something about energetics, or the kinds of forces that act on these organisms or on the fluid, and also evaluate swimming and feeding performance. We've used this technique on a variety of different organisms, but remember, there's an issue here. We're only able to study organisms that a scuba diver can reach. And so before I finish, I want to tell you what the next frontier is in terms of these kinds of measurements. And with collaborators at Monterey Bay Aquarium Research Institute, we're developing instrumentation to go on remotely opperated vehicles so we can study organisms anywhere from the surface down to 4000 meters, or two and a half miles. And so we can answer really interesting questions about this organism, this is a larvacean, that creates a feeding current and forces fluids through their mucus house and extracts nutrients. And then this animal, this is a siphonophore, and they can get to lengths about half the size of a football field. And they're able to swim vertically in the ocean by just creating jet propulsion. And then finally we can answer these questions about how swarming organisms, like krill, are able to affect mixing on larger scales. And this is actually one of the most interesting results so far that we've collected using the scuba diving device in that organisms, especially when they're moving in mass, are able to generate mixing at levels that are equivalent to some other physical processes that are associated with winds and tides. But before I finish, I want to leave you all with a question because I think it's important to keep in mind that technologies today that we take for granted started somewhere. It was inspired from something. So imagine scientists and engineers were inspired by birds to create airplanes. And something we take for granted, flying from San Francisco to New York, is something that was inspired by an organism. And as we're developing these new technologies to understand marine organisms, what we want to do is answer this question: how will marine organisms inspire us? Will they allow us to develop new underwater technologies, like underwater vehicles that look like a jellyfish? I think it's a really exciting time in ocean exploration because now we have the tools available to answer this kind of question, and with the help of you guys at some point, you can apply these tools to answer this kind of question and also develop technologies of the future. Thank you.

**P312 2016-01-08 How menstruation works - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=312)

This might seem hard to believe, but right now, 300 million women across the planet are experiencing the same thing: a period. The monthly menstrual cycle that leads to the period is a reality most women on Earth will go through in their lives. But why is this cycle so universal? And what makes it a cycle in the first place? Periods last anywhere between two and seven days, arising once within in a 28-day rotation. That whole system occurs on repeat, happening approximately 450 times during a woman's life. Behind the scenes are a series of hormonal controls that fine tune the body's internal workings to make menstruation start or stop during those 28 days. This inner machinery includes two ovaries stocked with thousands of tiny sacks called follicles that each contain one oocyte, an unfertilized egg cell. At puberty, ovaries hold over 400 thousand egg cells, but release only one each month, which results in pregnancy or a period. Here's how this cycle unfolds. Each month beginning around puberty, the hormone-producing pituitary gland in the brain starts releasing two substances into the blood: follicle stimulating hormone and luteinizing hormone. When they reach the ovaries, they encourage the internal egg cells to grow and mature. The follicles respond by pumping out estrogen. The egg cells grow and estrogen levels peak, inhibiting the production of FSH, and telling the pituitary to pump out more LH. That causes only the most mature egg cell from one of the ovaries to burst out of the follicle and through the ovary wall. This is called ovulation, and it usually happens ten to sixteen days before the start of a period. The tiny oocyte moves along the fallopian tube. A pregnancy can only occur if the egg is fertilized by a sperm cell within the next 24 hours. Otherwise, the egg's escapade ends, and the window for pregnancy closes for that month. Meanwhile, the now empty follicle begins to release progesterone, another hormone that tells the womb's lining to plump up with blood and nutrients in preparation for a fertilized egg that may embed there and grow. If it doesn't embed, a few days later, the body's progesterone and estrogen levels plummet, meaning the womb stops padding out and starts to degenerate, eventually falling away. Blood and tissue leave the body, forming the period. The womb can take up to a week to clear out its unused contents, after which, the cycle begins anew. Soon afterwards, the ovaries begin to secrete estrogen again, and the womb lining thickens, getting ready to accommodate a fertilized egg or be shed. Hormones continually control these activities by circulating in ideal amounts delivered at just the right time. The cycle keeps on turning, transforming each day and each week into a milestone along its course towards pregnancy or a period. Although this cycle appears to move by clockwork, there's room for variation. Women and their bodies are unique, after all. Menstrual cycles occur at diffferent times in the month, ovulation comes at various points in the cycle, and some periods last longer than others. Menstruation even begins and ends at different times in life for different women, too. In other words, variations between periods are normal. Appreciating these differences and learning about this monthly process can empower women, giving them the tools to understand and take charge of their own bodies. That way, they're able to factor this small cycle into a much larger cycle of life.

**P313 2016-01-08 How statistics can be misleading - Mark Liddell**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=313)

Statistics are persuasive. So much so that people, organizations, and whole countries base some of their most important decisions on organized data. But there's a problem with that. Any set of statistics might have something lurking inside it, something that can turn the results completely upside down. For example, imagine you need to choose between two hospitals for an elderly relative's surgery. Out of each hospital's last 1000 patient's, 900 survived at Hospital A, while only 800 survived at Hospital B. So it looks like Hospital A is the better choice. But before you make your decision, remember that not all patients arrive at the hospital with the same level of health. And if we divide each hospital's last 1000 patients into those who arrived in good health and those who arrived in poor health, the picture starts to look very different. Hospital A had only 100 patients who arrived in poor health, of which 30 survived. But Hospital B had 400, and they were able to save 210. So Hospital B is the better choice for patients who arrive at hospital in poor health, with a survival rate of 52.5%. And what if your relative's health is good when she arrives at the hospital? Strangely enough, Hospital B is still the better choice, with a survival rate of over 98%. So how can Hospital A have a better overall survival rate if Hospital B has better survival rates for patients in each of the two groups? What we've stumbled upon is a case of Simpson's paradox, where the same set of data can appear to show opposite trends depending on how it's grouped. This often occurs when aggregated data hides a conditional variable, sometimes known as a lurking variable, which is a hidden additional factor that significantly influences results. Here, the hidden factor is the relative proportion of patients who arrive in good or poor health. Simpson's paradox isn't just a hypothetical scenario. It pops up from time to time in the real world, sometimes in important contexts. One study in the UK appeared to show that smokers had a higher survival rate than nonsmokers over a twenty-year time period. That is, until dividing the participants by age group showed that the nonsmokers were significantly older on average, and thus, more likely to die during the trial period, precisely because they were living longer in general. Here, the age groups are the lurking variable, and are vital to correctly interpret the data. In another example, an analysis of Florida's death penalty cases seemed to reveal no racial disparity in sentencing between black and white defendants convicted of murder. But dividing the cases by the race of the victim told a different story. In either situation, black defendants were more likely to be sentenced to death. The slightly higher overall sentencing rate for white defendants was due to the fact that cases with white victims were more likely to elicit a death sentence than cases where the victim was black, and most murders occurred between people of the same race. So how do we avoid falling for the paradox? Unfortunately, there's no one-size-fits-all answer. Data can be grouped and divided in any number of ways, and overall numbers may sometimes give a more accurate picture than data divided into misleading or arbitrary categories. All we can do is carefully study the actual situations the statistics describe and consider whether lurking variables may be present. Otherwise, we leave ourselves vulnerable to those who would use data to manipulate others and promote their own agendas.

**P314 2016-01-15 The beneficial bacteria that make delicious food - Erez Garty**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=314)

Where does bread get its fluffiness? Swiss cheese its holes? And what makes vinegar so sour? These foods may taste completely different, but all of these phenomena come from tiny organisms chowing down on sugar and belching up some culinary byproducts. Let's start with yeast. Yeast are single-celled fungi used to make bread, beer, and wine, among other products. Yeast break down carbohydrates, like sugar, to get energy and the molecules they need to function. They have two different ways to do this: the oxygen-dependent, or aerobic, pathway, and the oxygen-independent, anaerobic pathway, which is also called fermentation. When you bake bread, yeast can use both pathways, but they normally prefer to start with the anaerobic process of fermentation. In this process, ethanol is produced in addition to CO2. No, bread isn't alcoholic. Small amounts of alcohol that are secreted evaporate during baking. In the aerobic, or oxygen-dependent pathway, the yeast consume some of the sugar and produce carbon dioxide gas, or CO2, and water. In both processes, the CO2 accumulates and creates tiny bubbles. These bubbles get trapped by gluten and create a sponge-like structure that gives the bread its soft texture. Wine also relies on yeast. But a wine-making set-up keeps the oxygen levels low so that yeast consume sugar using fermentation, the anaerobic pathway. The process often starts with wild yeasts already hanging out on the grapes. But to get consistent results, most winemakers also add carefully selected strains of yeast that can tolerate high levels of alcohol. The yeast consume the sugar in the grape juice, and as the sugar level drops, the alcohol level rises. This doesn't necessarily mean that sweeter wines have less alcohol. Different types of grapes start with different amounts of sugar, and sugar can also be added. What happens to the carbon dioxide? It just bubbles away through a vent. In carbonated alcoholic beverages, like champagne and beer, sealed containers are used in primary or secondary fermentation to keep the carbon dioxide in the bottle. Wine also introduces us to our second type of food-producing microorganism: bacteria. A special strain of bacteria turns a tart compound in grape juice into softer tasting ones that are responsible for some of the flavors in red wines and chardonnays. Another type of bacteria, called acetic acid bacteria, isn't so desirable in wine, but they have their function, too. If there's oxygen around, these bacteria convert the ethanol in wine into, well, acetic acid. Let this process continue and you'll eventually get vinegar. Bacteria are the key for cheese, too. To make cheese, milk is inoculated with bacteria. The bacteria gobble up the lactose, a kind of sugar, and produce lactic acid, along with many other chemicals. As the milk gets more and more acidic, its proteins start to aggregate and curdle. That's why spoiled milk is clumpy. Cheesemakers usually add an enzyme called rennet, naturally found inside of cows, goats, and some other mammals to help this process along. Eventually, those little curdles turn into bigger curds, which are pressed to squeeze out the water, and create a firm cheese. Different strains of bacteria make different kinds of cheese. For example, a species of bacteria that emits carbon dioxide is what gives swiss cheese its characteristic holes. Some cheeses, brie and camembert, use another kind of microorganism, too: mold. So your kitchen functions as a sort of biotechnology lab manned by microorganisms that culture your cuisine. Yogurt, soy sauce, sour cream, sauerkraut, kefir, kimchi, kombucha, cheddar, challah, pita, and naan. But maybe not all at the same dinner.

**P315 2016-01-20 When will the next mass extinction occur - Borths, D'Emic, and Pritch**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=315)

About 66 million years ago, something terrible happened to life on our planet. Ecosystems were hit with a double blow as massive volcanic eruptions filled the atmosphere with carbon dioxide and an asteroid roughly the size of Manhattan struck the Earth. The dust from the impact reduced or stopped photosynthesis from many plants, starving herbivores and the carnivores that preyed on them. Within a short time span, three-quarters of the world's species disappeared forever, and the giant dinosaurs, flying pterosaurs, shelled squids, and marine reptiles that had flourished for ages faded into prehistory. It may seem like the dinosaurs were especially unlucky, but extinctions of various severities have occurred throughout the Earth's history, and are still happening all around us today. Environments change, pushing some species out of their comfort zones while creating new opportunities for others. Invasive species arrive in new habitats, outcompeting the natives. And in some cases, entire species are wiped out as a result of activity by better adapted organisms. Sometimes, however, massive changes in the environment occur too quickly for most living creatures to adapt, causing thousands of species to die off in a geological instant. We call this a mass extinction event, and although such events may be rare, paleontologists have been able to identify several of them through dramatic changes in the fossil record, where lineages that persisted through several geological layers suddenly disappear. In fact, these mass extinctions are used to divide the Earth's history into distinct periods. Although the disappearance of the dinosaurs is the best known mass extinction event, the largest occurred long before dinosaurs ever existed. 252 million years ago, between the Permian and Triassic periods, the Earth's land masses gathered together into the single supercontinent Pangaea. As it coalesced, its interior was filled with deserts, while the single coastline eliminated many of the shallow tropical seas where biodiversity thrived. Huge volcanic eruptions occurred across Siberia, coinciding with very high temperatures, suggesting a massive greenhouse effect. These catastrophes contributed to the extinction of 95% of species in the ocean, and on land, the strange reptiles of the Permian gave way to the ancestors of the far more familiar dinosaurs we know today. But mass extinctions are not just a thing of the distant past. Over the last few million years, the fluctuation of massive ice sheets at our planet's poles has caused sea levels to rise and fall, changing weather patterns and ocean currents along the way. As the ice sheets spread, retreated, and returned, some animals were either able to adapt to the changes, or migrate to a more suitable environment. Others, however, such as giant ground sloths, giant hyenas, and mammoths went extinct. The extinction of these large mammals coincides with changes in the climate and ecosystem due to the melting ice caps. But there is also an uncomfortable overlap with the rise of a certain hominid species originating in Africa 150,000 years ago. In the course of their adaptation to the new environment, creating new tools and methods for gathering food and hunting prey, humans may not have single-handedly caused the extinction of these large animals, as some were able to coexist with us for thousands of years. But it's clear that today, our tools and methods have become so effective that humans are no longer reacting to the environment, but are actively changing it. The extinction of species is a normal occurrence in the background of ecosystems. But studies suggest that rates of extinction today for many organisms are hundreds to thousands of times higher than the normal background. But the same unique ability that makes humans capable of driving mass extinctions can also enable us to prevent them. By learning about past extinction events, recognizing what is happening today as environments change, and using this knowledge to lessen our effect on other species, we can transform humanity's impact on the world from something as destructive as a massive asteroid into a collaborative part of a biologically diverse future.

**P316 2016-01-20 Why are human bodies asymmetrical - Leo Q. Wan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=316)

Symmetry is everywhere in nature, and we usually associate it with beauty: a perfectly shaped leaf, or a butterfly with intricate patterns mirrored on each wing. But it turns out that asymmetry is pretty important, too, and more common than you might think, from crabs with one giant pincer claw to snail species whose shells' always coil in the same direction. Some species of beans only climb up their trellises clockwise, others, only counterclockwise, and even though the human body looks pretty symmetrical on the outside, it's a different story on the inside. Most of your vital organs are arranged asymmetrically. The heart, stomach, spleen, and pancreas lie towards the left. The gallbladder and most of your liver are on the right. Even your lungs are different. The left one has two lobes, and the right one has three. The two sides of your brain look similar, but function differently. Making sure this asymmetry is distributed the right way is critical. If all your internal organs are flipped, a condition called situs inversus, it's often harmless. But incomplete reversals can be fatal, especially if the heart is involved. But where does this asymmetry come from, since a brand-new embryo looks identical on the right and left. One theory focuses on a small pit on the embryo called a node. The node is lined with tiny hairs called cilia, while tilt away from the head and whirl around rapidly, all in the same direction. This synchronized rotation pushes fluid from the right side of the embryo to the left. On the node's left-hand rim, other cilia sense this fluid flow and activate specific genes on the embryo's left side. These genes direct the cells to make certain proteins, and in just a few hours, the right and left sides of the embryo are chemically different. Even though they still look the same, these chemical differences are eventually translated into asymmetric organs. Asymmetry shows up in the heart first. It begins as a straight tube along the center of the embryo, but when the embryo is around three weeks old, the tube starts to bend into a c-shape and rotate towards the right side of the body. It grows different structures on each side, eventually turning into the familiar asymmetric heart. Meanwhile, the other major organs emerge from a central tube and grow towards their ultimate positions. But some organisms, like pigs, don't have those embryonic cilia and still have asymmetric internal organs. Could all cells be intrinsically asymmetric? Probably. Bacterial colonies grow lacy branches that all curl in the same direction, and human cells cultured inside a ring-shaped boundary tend to line up like the ridges on a cruller. If we zoom in even more, we see that many of cells' basic building blocks, like nucleic acids, proteins, and sugars, are inherently asymmetric. Proteins have complex asymmetric shapes, and those proteins control which way cells migrate and which way embryonic cilia twirl. These biomolecules have a property called chirality, which means that a molecule and its mirror image aren't identical. Like your right and left hands, they look the same, but trying to put your right in your left glove proves they're not. This asymmetry at the molecular level is reflected in asymmetric cells, asymmetric embryos, and finally asymmetric organisms. So while symmetry may be beautiful, asymmetry holds an allure of its own, found in its graceful whirls, its organized complexity, and its striking imperfections.

**P317 2016-01-25 How science fiction can help predict the future - Roey Tzezana**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=317)

Would you like to know what's in our future? What's going to happen tomorrow, next year, or even a millennium from now? Well, you're not alone. Everyone from governments to militaries to industry leaders do, as well, and they all employ people called futurists who attempt to forecast the future. Some are able to do this with surprising accuracy. In the middle of the 20th century, a think tank known as the RAND Corporation consulted dozens of scientists and futurists who together forecast many of the technologies we take for granted today, including artificial organs, the use of birth control pills, and libraries able to look up research material for the reader. One way futurists arrive at their predictions is by analyzing movements and trends in society, and charting the paths they are likely to follow into the future with varying degrees of probability. Their work informs the decisions of policymakers and world leaders, enabling them to weigh options for the future that otherwise could not have been imagined in such depth or detail. Of course, there are obvious limits to how certain anyone can be about the future. There are always unimaginable discoveries that arise which would make no sense to anyone in the present. Imagine, for example, transporting a physicist from the middle of the 19th century into the 21st. You explain to him that a strange material exists, Uranium 235, that of its own accord can produce enough energy to power an entire city, or destroy it one fell swoop. "How can such energy come from nowhere?" he would demand to know. "That's not science, that's magic." And for all intents and purposes, he would be right. His 19th century grasp of science includes no knowledge of radioactivity or nuclear physics. In his day, no forecast of the future could have predicted X-rays, or the atom bomb, let alone the theory of relativity or quantum mechanics. As Arthur C. Clarke has said, "Any sufficiently advanced technology is indistinguishable from magic." How can we prepare, then, for a future that will be as magical to us as our present would appear to someone from the 19th century? We may think our modern technology and advanced data analysis techniques might allow us to predict the future with much more accuracy than our 19th century counterpart, and rightly so. However, it's also true that our technological progress has brought with it new increasingly complex and unpredictable challenges. The stakes for future generations to be able to imagine the unimaginable are higher than ever before. So the question remains: how do we do that? One promising answer has actually been with us since the 19th century and the Industrial Revolution that laid the foundation for our modern world. During this time of explosive development and invention, a new form of literature, science fiction, also emerged. Inspired by the innovations of the day, Jules Verne, H.G. Wells, and other prolific thinkers explored fantastic scenarios, depicting new frontiers of human endeavor. And throughout the 20th century and into the 21st, storytellers have continued to share their visions of the future and correctly predicted many aspects of the world we inhabit decades later. In "Brave New World," Aldous Huxley foretold the use of antidepressants in 1932, long before such medication became popular. In 1953, Ray Bradbury's "Fahrenheit 451," forecast earbuds, "thimble radios," in his words. And in "2001: A Space Odyssey," Arthur C. Clarke described a portable, flat-screen news pad in 1968. In works that often combine entertainment and social commentary, we are invited to suspend our disbelief and consider the consequences of radical shifts in familiar and deeply engrained institutions. In this sense, the best science fiction fulfills the words of philosopher Michel Foucault, "I'm no prophet. My job is making windows where there were once walls." Free from the constraints of the present and our assumptions of what's impossible, science fiction serves as a useful tool for thinking outside of the box. Many futurists recognize this, and some are beginning to employ science fictions writers in their teams. Just recently, a project called iKnow proposed scenarios that look much like science fiction stories. They include the discovery of an alien civilization, development of a way for humans and animals to communicate flawlessly, and radical life extension. So, what does the future hold? Of course, we can't know for certain, but science fiction shows us many possibilities. Ultimately, it is our responsibility to determine which we will work towards making a reality.

**P318 2016-01-26 How to make your writing funnier - Cheri Steinkellner**

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Did you ever notice how many jokes start with, "Did you ever notice?" And what's the deal with, "What's the deal?" There's a lot of funny to be found by simply noticing the ordinary, everyday things you don't ordinarily notice everyday. So if you'd like to add a little humor to that story, or speech, or screenplay you're writing, here are a few tips and tricks for finding the funny. All great storytelling, including comedy writing, consists of a handful of basic ingredients: who, what, when, where, why, and how. Writers have been asking these questions since at least the 1st century BC, yet none can be answered with a simple yes or no. They demand details, and the more specific the details, the funnier the story. Let's start with the who, the comedic character. Think about the books, TV shows, and movies that make you laugh. They're usually filled with funny types, or archetypes. The know-it-all, the loveable loser, the bad boss, the neurotic, the airhead. Incidentally, these are all stock characters found in Commedia Dell'Arte, or the artists comedy of late Renaissance Italy, and they have yet to get old. The Commedia rule for creating comic characters is find the flaw, then play it up. Or you can try playing with opposites. When the smartest guy in the room does the stupidest thing, or the doofus outwits the brainiac, we tend to laugh because we didn't see that coming. Ancient Greek funnyman Aristotle is said to have said, "The secret to humor is surprise." This surprise, or incongruity theory of humor, says we laugh at things that seem out of place or run up against our expectations, like a frog dating a pig, or a lizard selling insurance, a baby disco dancing, a nun disco dancing, a cat disco dancing. Actually, a baby, a nun, or a cat doing pretty much anything, especially involving disco. One fun way to find incongruities is by drawing connections. Actually drawing them with a mind map. Start small. Pick a word, I choose pickle. Jot it down, then quick as you can, try making connections. What do pickles make me think of? Who eats pickles? What treasured pickle memories do I have from childhood? Another great way to generate comedic material is to shift from observation to imagination. Try going from "what is" to "what if?" Like, what if instead of a horse, for example, you just had a pair of coconuts? Okay, let's think of some other memorable moments in history, literature, or film. Now, what if they featured coconuts? Get wild, let it go. Even if an idea seems overdone, or too obvious, or just plain dumb, try jotting it down, anyway. What's obvious to you may not be to the next person. And the opposite of the dumbest idea might just turn out to be the smartest. What about all that dumb stuff that happens in real life? Have you ever noticed how much comedy revolves around things that irritate, frustrate, and humiliate us? Will Rodgers said, "Everything's funny as long as it happens to somebody else." So if you're having a crummy morning, imagine it happening to a character you're writing about, and by afternoon, you may at least get a funny story out of it. Once you've got your characters and story, here are a few quick and easy comedy writing tricks to make them zing. The rule of three, or zig zig zag. Try setting up an expected pattern, zig zig, then flip it, zag. A rabbi, a priest, and a coconut walk into a bar. The punchline rule says put your punch at the end of the line. A rabbi, a priest, and a coconut walk into a disco. That brings up the rule of K. For some reason, words with a k-sound catch our ears and are considered comical. Coconut, disco, pickles, crickets? Okay, so we don't always get the laugh. Humor is subjective. Comedy is trial and error. Writing is rewriting. Just keep trying. Find the flaws, discover the details, insert incongruities, incorporate k-words, and remember the most important rule of writing funny: have fun. As Charles Dickins said, "There is nothing in the world so irresistibly contagious as laughter and good humor." And disco.

**P319 2016-01-29 Can you solve the temple riddle - Dennis E. Shasha**

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You've found the hidden switches, evaded the secret traps, and now your expedition finally stands at the heart of the ancient temple inside The Lost City. But as you study the inscriptions in the near total darkness, two of the eight graduate students accompanying you bump into the alter. Suddenly, two whisps of green smoke burst forth and the walls begin to shake. Fleeing for your lives, you come to a room you passed before with five hallways, including the one to the altar and the one leading back outside. The giant sandglass in the center is now flowing, with less than an hour before it empties, and the rumbling tells you that you don't want to be around when that happens. From what you recall of your way here, it would take about 20 minutes to reach the exit at a fast pace. You know this is the last junction before the exit, but your trail markings have been erased, and no one remembers the way. If nine of you split up, there should be just enough time for each group to explore one of the four halls ahead and report back to this room, with everyone then making a run down the correct path. There's just one problem; the inscriptions told of the altar's curse: the spirits of the city's King and Queen possessing intruders and leading them to their doom through deception. Remembering the green smoke, you realize two of the students have been cursed. At any time, one or both of them might lie, though they also might tell the truth. You know for sure that the curse didn't get you, but you don't know which students can't be trusted, and because the possessed students may lie only occasionally, there is no guaranteed way to test them to determine which are cursed. Can you figure out a way to ensure that you all escape? Don't worry about the possessed students attacking or otherwise harming the others. This curse only affects their communication. Pause the video now if you want to figure it out by yourself! Answer in: 3 Answer in: 2 Answer in: 1 The first thing to realize is that since you know you aren't possessed, you can explore one of the halls alone. This leaves eight students for the remaining three paths. Sending groups of four down just two of the paths won't work because if one group came back split two versus two, you'd have to guess who to trust. But splitting them into one pair and two trios would work every time, and here's why. The possessed students might lie, or they might not, but you know there are only two of them, while the other six will always tell the truth. When each group returns to the hall, all of its members will either give the same report or argue about whether they found the exit. If a trio returns in total agreement, then you know none of them are lying. With the pair, you can't be sure either way, but all you need is reliable evidence about three of the four paths. The fourth you can figure out using the process of elimination. Of course, none of this matters if you're lucky enough to find the exit yourself, but otherwise, putting everything together leaves you with three possibilities. If each group gives a consistent answer, either everyone is telling the truth, or the two possessed students are paired together. In either case, ignore the duo. If there's only one group arguing, both others must be telling the truth, and if there are two conflicts, then the possessed students are in separate groups and you can safely trust the majority in both trios since at least two people in each will be truthful. The temple collapses behind you as greenish vapors escape from two of the students. You're all safe and free from the curse. After that ordeal, you tell your group they all deserve a vacation, and you just happen to have another expedition coming up.

**P320 2016-02-02 History vs. Napoleon Bonaparte - Alex Gendler**

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After the French Revolution erupted in 1789, Europe was thrown into chaos. Neighboring countries' monarchs feared they would share the fate of Louis XVI, and attacked the New Republic, while at home, extremism and mistrust between factions lead to bloodshed. In the midst of all this conflict, a powerful figure emerged to take charge of France. But did he save the revolution or destroy it? "Order, order, who's the defendant today? I don't see anyone." "Your Honor, this is Napoléon Bonaparte, the tyrant who invaded nearly all of Europe to compensate for his personal stature-based insecurities." "Actually, Napoléon was at least average height for his time. The idea that he was short comes only from British wartime propaganda. And he was no tyrant. He was safeguarding the young Republic from being crushed by the European monarchies." "By overthrowing its government and seizing power himself?" "Your Honor, as a young and successful military officer, Napoléon fully supported the French Revolution, and its ideals of liberty, equality, and fraternity. But the revolutionaries were incapable of real leadership. Robespierre and the Jacobins who first came to power unleashed a reign of terror on the population, with their anti-Catholic extremism and nonstop executions of everyone who disagreed with them. And The Directory that replaced them was an unstable and incompetent oligarchy. They needed a strong leader who could govern wisely and justly." "So, France went through that whole revolution just to end up with another all-powerful ruler?" "Not quite. Napoléon's new powers were derived from the constitution that was approved by a popular vote in the Consulate." "Ha! The constitution was practically dictated at gunpoint in a military coup, and the public only accepted the tyrant because they were tired of constant civil war." "Be that as it may, Napoléon introduced a new constitution and a legal code that kept some of the most important achievements of the revolution in tact: freedom of religion abolition of hereditary privilege, and equality before the law for all men." "All men, indeed. He deprived women of the rights that the revolution had given them and even reinstated slavery in the French colonies. Haiti is still recovering from the consequences centuries later. What kind of equality is that?" "The only kind that could be stably maintained at the time, and still far ahead of France's neighbors." "Speaking of neighbors, what was with all the invasions?" "Great question, Your Honor." "Which invasions are we talking about? It was the neighboring empires who had invaded France trying to restore the monarchy, and prevent the spread of liberty across Europe, twice by the time Napoléon took charge. Having defended France as a soldier and a general in those wars, he knew that the best defense is a good offense." "An offense against the entire continent? Peace was secured by 1802, and other European powers recognized the new French Regime. But Bonaparte couldn't rest unless he had control of the whole continent, and all he knew was fighting. He tried to enforce a European-wide blockade of Britain, invaded any country that didn't comply, and launched more wars to hold onto his gains. And what was the result? Millions dead all over the continent, and the whole international order shattered." "You forgot the other result: the spread of democratic and liberal ideals across Europe. It was thanks to Napoléon that the continent was reshaped from a chaotic patchwork of fragmented feudal and religious territories into efficient, modern, and secular nation states where the people held more power and rights than ever before." "Should we also thank him for the rise of nationalism and the massive increase in army sizes? You can see how well that turned out a century later." "So what would European history have been like if it weren't for Napoléon?" "Unimaginably better/worse." Napoléon seemingly unstoppable momentum would die in the Russian winter snows, along with most of his army. But even after being deposed and exiled, he refused to give up, escaping from his prison and launching a bold attempt at restoring his empire before being defeated for the second and final time. Bonaparte was a ruler full of contradictions, defending a popular revolution by imposing absolute dictatorship, and spreading liberal ideals through imperial wars, and though he never achieved his dream of conquering Europe, he undoubtedly left his mark on it, for better or for worse.

**P321 2016-02-02 The origins of ballet - Jennifer Tortorello and Adrienne Westwood**

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Can you imagine a party where every movement, from the slightest gesture to walking across the room, and every visual detail, from furniture to hemline length, were governed by a complex system of rules and procedures? For centuries, such rituals were commonplace for European nobility. And while they've gone out of fashion, we recognize the components under a familiar label: ballet. Ballet, from Italian "balletto," or little dance, originated in Renaissance Italy as a combination of social dance and choreographed display at aristocratic gatherings. In many aspects, it was a way of controlling people in court with acceptable forms of behavior, such as the manner in which people stepped, bowed, or took someone's hand. It also involved rules governing everything from attire to where one could walk or sit in relation to the King. Over time, the study of ballet became a central element of court life, and proper grasp of the etiquette could make or break one's success as a courtier. Many of these court gestures can still be seen in modern ballet techniques. Ballet was brought to France in the 16th century by Catherine de' Medici, the Italian wife of King Henry II. As celebrations became more lavish, so did the dance, with dancing masters teaching elaborate steps to young nobles and story elements providing a unifying theme. The focus shifted from participation to performance, and the form acquired more theatrical trappings, such as professionally designed sets and a slightly raised platform or stage with curtains and wings. But it was in the 17th century court of Louis XIV that ballet was refined into the art we know today. Louis himself had been trained in ballet from childhood. His early role as the sun god Apollo at age fifteen cemented the central role ballet would play during his reign. It also earned him the title of Sun King, with his splendid golden costume and choreography that promoted the idea of the king as a divinely ordained ruler. Louis would go on to perform 80 roles in 40 major ballets, either as a majestic lead, or sometimes playing minor or comedic parts before emerging in the lead role as the end. He trained daily in ballet, as well as fencing and riding, and through his example, dancing became an essential skill for all gentlemen of the era. But Louis XIV's main contribution to ballet was not as a performer. His founding of the Royal Academy of Dance in 1661 shifted control of ballet from local guilds to the royal court. As director, he appointed his personal ballet master and frequent performance partner Pierre Beauchamp, who codified the five main positions of the body still used today. Through is collaborations with Jean-Baptiste Lully, the director of the Royal Music Academy, and famed playwright Molière, Beauchamp helped establish ballet as a grand spectacle. And in 1669, a separate ballet academy was founded. The Paris Opera Ballet survives today as the oldest ballet company in the world. Ballet moved away from the royal court to the theater and survived the democratic revolutions and reforms that followed over the next century. With the advent of the romantic movement, fantasy and folklore themes became common motifs. And though the influence of ballet in France would decline, other countries, such as Russia, would play a major role in its further development. Fortunately, today most of us don't have to learn a complicated set of steps just to socialize at a wedding. Instead, we can go to the theater to see professionals who spend their lives training rigorously to perform feats that would have been unimagineable in Louis XIV's day.

**P322 2016-02-04 The immortal cells of Henrietta Lacks - Robin Bulleri**

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Imagine something small enough to float on a particle of dust that holds the keys to understanding cancer, virology, and genetics. Luckily for us, such a thing exists in the form of trillions upon trillions of human lab-grown cells called HeLa. Let's take a step back for a second. Scientists grow human cells in the lab to study how they function, understand how diseases develop, and test new treatments without endangering patients. To make sure that they can repeat these experiments over and over, and compare the results with other scientists, they need huge populations of identical cells that can duplicate themselves faithfully for years, but until 1951, all human cell lines that researchers tried to grow had died after a few days. Then a John Hopkins scientist named George Gey received a sample of a strange looking tumor: dark purple, shiny, jelly-like. This sample was special. Some of its cells just kept dividing, and dividing, and dividing. When individual cells died, generations of copies took their place and thrived. The result was an endless source of identical cells that's still around today. The very first immortal human cell line. Gey labeled it "HeLa" after the patient with the unusual tumor, Henrietta Lacks. Born on a tobacco farm in Virginia, she lived in Baltimore with her husband and five children. She died of aggressive cervical cancer a few months after her tumorous cells were harvested, and she never knew about them. So what's so special about the cells from Henrietta Lacks that lets them survive when other cell lines die? The short answer is we don't entirely know. Normal human cells have built-in control mechanisms. They can divide about 50 times before they self destruct in a process called apoptosis. This prevents the propagation of genetic errors that creep in after repeated rounds of division. But cancer cells ignore these signals, dividing indefinitely and crowding out normal cells. Still, most cell lines eventually die off, especially outside the human body. Not HeLa, though, and that's the part we can't yet explain. Regardless, when Dr. Gey realized he had the first immortal line of human cells, he sent samples to labs all over the world. Soon the world's first cell production facility was churning out 6 trillion HeLa cells a week, and scientists put them to work in an ethically problematic way, building careers and fortunes off of Henrietta's cells without her or her family's consent, or even knowledge until decades later. The polio epidemic was at its peak in the early 50s. HeLa cells, which easily took up and replicated the virus, allowed Jonas Salk to test his vaccine. They've been used to study diseases, including measles, mumps, HIV, and ebola. We know that human cells have 46 chromosomes because a scientist working with HeLa discovered a chemcial that makes chromosomes visible. HeLa cells themselves actually have around 80 highly mutated chromosomes. HeLa cells were the first to be cloned. They've traveled to outer space. Telomerase, an enzyme that helps cancer cells evade destruction by repairing their DNA, was discovered first in HeLa cells. In an interesting turn of fate, thanks to HeLa, we know that cervical cancer can be caused by a virus called HPV and now there's a vaccine. HeLa-fueled discoveries have filled thousands of scientific papers, and that number is probably even higher than anyone knows. HeLa cells are so resilient that they can travel on almost any surface: a lab worker's hand, a piece of dust, invading cultures of other cells and taking over like weeds, countless cures, patents and discoveries all made thanks to Henrieta Lacks.

**P323 2016-02-08 How miscommunication happens (and how to avoid it) - Katherine Hampst**

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Have you ever talked with a friend about a problem only to realize that he just doesn't seem to grasp why the issue is so important to you? Have you ever presented an idea to a group and it's met with utter confusion? Or maybe you've been in an argument when the other person suddenly accuses you of not listening to what they're saying at all? What's going on here? The answer is miscommunication, and in some form or another, we've all experienced it. It can lead to confusion, animosity, misunderstanding, or even crashing a multimillion dollar probe into the surface of Mars. The fact is even when face-to-face with another person, in the very same room, and speaking the same language, human communication is incredibly complex. But the good news is that a basic understanding of what happens when we communicate can help us prevent miscommunication. For decades, researchers have asked, "What happens when we communicate?" One interpretation, called the transmission model, views communication as a message that moves directly from one person to another, similar to someone tossing a ball and walking away. But in reality, this simplistic model doesn't account for communication's complexity. Enter the transactional model, which acknowledges the many added challenges of communicating. With this model, it's more accurate to think of communication between people as a game of catch. As we communicate our message, we receive feedback from the other party. Through the transaction, we create meaning together. But from this exchange, further complications arise. It's not like the Star Trek universe, where some characters can Vulcan mind meld, fully sharing thoughts and feelings. As humans, we can't help but send and receive messages through our own subjective lenses. When communicating, one person expresses her interpretation of a message, and the person she's communicating with hears his own interpretation of that message. Our perceptual filters continually shift meanings and interpretations. Remember that game of catch? Imagine it with a lump of clay. As each person touches it, they shape it to fit their own unique perceptions based on any number of variables, like knowledge or past experience, age, race, gender, ethnicity, religion, or family background. Simultaneously, every person interprets the message they receive based on their relationship with the other person, and their unique understanding of the semantics and connotations of the exact words being used. They could also be distracted by other stimuli, such as traffic or a growling stomach. Even emotion might cloud their understanding, and by adding more people into a conversation, each with their own subjectivities, the complexity of communication grows exponentially. So as the lump of clay goes back and forth from one person to another, reworked, reshaped, and always changing, it's no wonder our messages sometimes turn into a mush of miscommunication. But, luckily, there are some simple practices that can help us all navigate our daily interactions for better communication. One: recognize that passive hearing and active listening are not the same. Engage actively with the verbal and nonverbal feedback of others, and adjust your message to facilitate greater understanding. Two: listen with your eyes and ears, as well as with your gut. Remember that communication is more than just words. Three: take time to understand as you try to be understood. In the rush to express ourselves, it's easy to forget that communication is a two-way street. Be open to what the other person might say. And finally, four: Be aware of your personal perceptual filters. Elements of your experience, including your culture, community, and family, influence how you see the world. Say, "This is how I see the problem, but how do you see it?" Don't assume that your perception is the objective truth. That'll help you work toward sharing a dialogue with others to reach a common understanding together.

**P324 2016-02-10 The science of skin color - Angela Koine Flynn**

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When ultraviolet sunlight hits our skin, it affects each of us a little differently. Depending on skin color, it will take only minutes of exposure to turn one person beetroot-pink, while another requires hours to experience the slightest change. So what's to account for that difference and how did our skin come to take on so many different hues to begin with? Whatever the color, our skin tells an epic tale of human intrepidness and adaptability, revealing its variance to be a function of biology. It all centers around melanin, the pigment that gives skin and hair its color. This ingredient comes from skin cells called melanocytes and takes two basic forms. There's eumelanin, which gives rise to a range of brown skin tones, as well as black, brown, and blond hair, and pheomelanin, which causes the reddish browns of freckles and red hair. But humans weren't always like this. Our varying skin tones were formed by an evolutionary process driven by the Sun. In began some 50,000 years ago when our ancestors migrated north from Africa and into Europe and Asia. These ancient humans lived between the Equator and the Tropic of Capricorn, a region saturated by the Sun's UV-carrying rays. When skin is exposed to UV for long periods of time, the UV light damages the DNA within our cells, and skin starts to burn. If that damage is severe enough, the cells mutations can lead to melanoma, a deadly cancer that forms in the skin's melanocytes. Sunscreen as we know it today didn't exist 50,000 years ago. So how did our ancestors cope with this onslaught of UV? The key to survival lay in their own personal sunscreen manufactured beneath the skin: melanin. The type and amount of melanin in your skin determines whether you'll be more or less protected from the sun. This comes down to the skin's response as sunlight strikes it. When it's exposed to UV light, that triggers special light-sensitive receptors called rhodopsin, which stimulate the production of melanin to shield cells from damage. For light-skin people, that extra melanin darkens their skin and produces a tan. Over the course of generations, humans living at the Sun-saturated latitudes in Africa adapted to have a higher melanin production threshold and more eumelanin, giving skin a darker tone. This built-in sun shield helped protect them from melanoma, likely making them evolutionarily fitter and capable of passing this useful trait on to new generations. But soon, some of our Sun-adapted ancestors migrated northward out of the tropical zone, spreading far and wide across the Earth. The further north they traveled, the less direct sunshine they saw. This was a problem because although UV light can damage skin, it also has an important parallel benefit. UV helps our bodies produce vitamin D, an ingredient that strengthens bones and lets us absorb vital minerals, like calcium, iron, magnesium, phosphate, and zinc. Without it, humans experience serious fatigue and weakened bones that can cause a condition known as rickets. For humans whose dark skin effectively blocked whatever sunlight there was, vitamin D deficiency would have posed a serious threat in the north. But some of them happened to produce less melanin. They were exposed to small enough amounts of light that melanoma was less likely, and their lighter skin better absorbed the UV light. So they benefited from vitamin D, developed strong bones, and survived well enough to produce healthy offspring. Over many generations of selection, skin color in those regions gradually lightened. As a result of our ancestor's adaptability, today the planet is full of people with a vast palette of skin colors, typically, darker eumelanin-rich skin in the hot, sunny band around the Equator, and increasingly lighter pheomelanin-rich skin shades fanning outwards as the sunshine dwindles. Therefore, skin color is little more than an adaptive trait for living on a rock that orbits the Sun. It may absorb light, but it certainly does not reflect character.

**P325 2016-02-11 Why do we love A philosophical inquiry - Skye C. Cleary**

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Ah, romantic love - beautiful and intoxicating, heartbreaking and soul-crushing, often all at the same time. Why do we choose to put ourselves through its emotional wringer? Does love make our lives meaningful, or is it an escape from our loneliness and suffering? Is love a disguise for our sexual desire, or a trick of biology to make us procreate? Is it all we need? Do we need it at all? If romantic love has a purpose, neither science nor psychology has discovered it yet. But over the course of history, some of our most respected philosophers have put forward some intriguing theories. Love makes us whole, again. The ancient Greek philosopher Plato explored the idea that we love in order to become complete. In his "Symposium", he wrote about a dinner party, at which Aristophanes, a comic playwright, regales the guests with the following story: humans were once creatures with four arms, four legs, and two faces. One day, they angered the gods, and Zeus sliced them all in two. Since then, every person has been missing half of him or herself. Love is the longing to find a soulmate who'll make us feel whole again, or, at least, that's what Plato believed a drunken comedian would say at a party. Love tricks us into having babies. Much, much later, German philosopher Arthur Schopenhauer maintained that love based in sexual desire was a voluptuous illusion. He suggested that we love because our desires lead us to believe that another person will make us happy, but we are sorely mistaken. Nature is tricking us into procreating, and the loving fusion we seek is consummated in our children. When our sexual desires are satisfied, we are thrown back into our tormented existences, and we succeed only in maintaining the species and perpetuating the cycle of human drudgery. Sounds like somebody needs a hug. Love is escape from our loneliness. According to the Nobel Prize-winning British philosopher Bertrand Russell, we love in order to quench our physical and psychological desires. Humans are designed to procreate, but without the ecstasy of passionate love, sex is unsatisfying. Our fear of the cold, cruel world tempts us to build hard shells to protect and isolate ourselves. Love's delight, intimacy, and warmth helps us overcome our fear of the world, escape our lonely shells, and engage more abundantly in life. Love enriches our whole being, making it the best thing in life. Love is a misleading affliction. Siddhārtha Gautama, who became known as the Buddha, or the Enlightened One, probably would have had some interesting arguments with Russell. Buddha proposed that we love because we are trying to satisfy our base desires. Yet, our passionate cravings are defects, and attachments, even romantic love, are a great source of suffering. Luckily, Buddha discovered the eight-fold path, a sort of program for extinguishing the fires of desire so that we can reach Nirvana, an enlightened state of peace, clarity, wisdom, and compassion. The novelist Cao Xueqin illustrated this Buddhist sentiment that romantic love is folly in one of China's greatest classical novels, "Dream of the Red Chamber." In a subplot, Jia Rui falls in love with Xi-feng who tricks and humiliates him. Conflicting emotions of love and hate tear him apart, so a Taoist gives him a magic mirror that can cure him as long as he doesn't look at the front of it. But of course, he looks at the front of it. He sees Xi-feng. His soul enters the mirror and he is dragged away in iron chains to die. Not all Buddhists think this way about romantic and erotic love, but the moral of this story is that such attachments spell tragedy, and should, along with magic mirrors, be avoided. Love lets us reach beyond ourselves. Let's end on a slightly more positive note. The French philosopher Simone de Beauvoir proposed that love is the desire to integrate with another and that it infuses our lives with meaning. However, she was less concerned with why we love and more interested in how we can love better. She saw that the problem with traditional romantic love is it can be so captivating, that we are tempted to make it our only reason for being. Yet, dependence on another to justify our existence easily leads to boredom and power games. To avoid this trap, Beauvoir advised loving authentically, which is more like a great friendship. Lovers support each other in discovering themselves, reaching beyond themselves, and enriching their lives and the world together. Though we might never know why we fall in love, we can be certain that it will be an emotional rollercoaster ride. It's scary and exhilarating. It makes us suffer and makes us soar. Maybe we lose ourselves. Maybe we find ourselves. It might be heartbreaking, or it might just be the best thing in life. Will you dare to find out?

**P326 2016-02-12 The controversial origins of the Encyclopedia - Addison Anderson**

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Denis Diderot left a dungeon outside Paris on November 3, 1749. He'd had his writing burned in public before, but this time, he'd gotten locked up under royal order for an essay about a philosopher's death bed rejection of God. To free himself, Denis promised never to write things like that again. So he got back to work on something a little like that, only way worse, and much bigger. In 1745, publisher André le Breton had hired Diderot to adapt the English cyclopedia, or a universal dictionary of arts and sciences for French subscribers. A broke writer, Diderot survived by translating, tutoring, and authoring sermons for priests, and a pornographic novel once. Le Breton paired him with co-editor Jean le Rond d'Alembert, a math genius found on a church doorstep as a baby. Technical dictionaries, like the cyclopedia, weren't new, but no one had attempted one publication covering all knowledge, so they did. The two men organized the French Enlightenment's brightest stars to produce the first encyclopedia, or rational dictionary of the arts, sciences, and crafts. Assembling every essential fact and principle in, as it turned out, over 70,000 entries, 20,000,000 words in 35 volumes of text and illustrations created over three decades of researching, writing, arguging, smuggling, backstabbing, law-breaking, and alphabetizing. To organize the work, Diderot adapted Francis Bacon's "Classification of Knowledge" into a three-part system based on the mind's approaches to reality: memory, reason, and imagination. He also emphasized the importance of commerce, technology, and crafts, poking around shops to study the tools and techniques of Parisian laborers. To spotlight a few of the nearly 150 philosoph contributers, Jean Jacques Rousseau, Diderot's close friend, wrote much of the music section in three months, and was never reimbursed for copy fees. His entry on political economy holds ideas he'd later develop further in "The Social Contract." D'Alembert wrote the famous preliminary discourse, a key statement of the French Enlightenment, championing independent investigative reasoning as the path to progress. Louis de Jaucourt wrote a quarter of the encyclopedia, 18,000 articles, 5,000,000 words, unpaid. Louis once spent 20 years writing a book on anatomy, shipped it to Amsterdam to be published uncensored, and the ship sank. Voltaire contributed entries, among them history, elegance, and fire. Diderot's entries sometimes exhibit slight bias. In "political authority," he dismantled the divine right of kings. Under "citizen," he argued a state was strongest without great disparity in wealth. Not surprising from the guy who wrote poetry about mankind strangling its kings with the entrails of a priest. So Diderot's masterpiece wasn't a hit with the king or highest priest. Upon release of the first two volumes, Louie XV banned the whole thing but enjoyed his own copy. Pope Clement XIII ordered it burned. It was "dangerous," "reprehensible," as well as "written in French," and in "the most seductive style." He declared readers excommunicated and wanted Diderot arrested on sight. But Diderot kept a step ahead of being shut down, smuggling proofs outside France for publication, and getting help from allies in the French Regime, including the King's mistress, Madame de Pompadour, and the royal librarian and censor, Malesherbes, who tipped Diderot off to impending raids, and even hid Diderot's papers at his dad's house. Still, he faced years of difficulty. D'Alembert dropped out. Rousseau broke off his friendship over a line in a play. Worse yet, his publisher secretly edited some proofs to read less radically. The uncensored pages reappeared in Russia in 1933, long after Diderot had considered the work finished and died at lunch. The encyclopedia he left behind is many things: a cornerstone of the Enlightenment, a testament to France's crisis of authority, evidence of popular opinions migration from pulpit and pew to cafe, salon, and press. It even has recipes. It's also irrepressibly human, as you can tell from Diderot's entry about a plant named aguaxima. Read it yourself, preferably out loud in a French accent.

**P327 2016-02-16 Why are there so many insects - Murry Gans**

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If insects suddenly morphed into large beings, and decided to wage war on us, there's no doubt that humans would lose. We'd simply be crushed by their sheer numbers. There are an estimated 10 quintillion individual insects on Earth. That's a one followed by 19 zeroes. So, compared with our population of about 7 billion, these invertebrates outnumber us by more than a billion to one. Their astounding numbers exist at the species level, as well. There are more than 60,000 vertebrate species on the planet. But the class of insects contains a million known species, and many others that haven't been classified. In fact, these critters make up approximately 75% of all animals on Earth. So, what's their secret to success? Insect abundance comes down to many things that together make them some of the most adaptable and resilient creatures, beginning with their impressive ability to breed. Many species can produce hundreds of offspring within their lifetimes. Most offspring will die, but more than enough will survive into adulthood to reproduce. Offspring also mature very rapidly, so the cycle of reproduction resumes quickly, and can occur over and over again in a short time. These numbers mean that as a class, insects harbor a tremendous amount of genetic diversity. The different species contain a wealth of genetic data that give them the necessary adaptations they need to thrive in a range of environments across the planet. Even some of the most extreme environments are in bounds; Flat bark beetles can live at -40 degrees Fahrenheit, Sahara Desert ants can venture out when surface temperatures exceed 155 degrees, and some bumblebees can survive 18,000 feet above sea level. Insect exoskeletons also work like body armor, protecting insects against the outside world and helping them cope with habitats that other creatures can't. Even their small size, which we might see as a disadvantage, is something they use to their benefit. Because most species are so tiny, millions of insects can inhabit a small space and make use of all the available resources within it. This means they can occupy hundreds of different niches across ecosystems. Some insects survive by eating the roots, stems, leaves, seeds, pollen, and nectar of specific plants. Others, like wasps, make use of live insects by paralyzing the victims and laying their eggs inside so that when the hatchlings emerge, they can eat their way out and get nourishment. Mosquitos and biting flies feed on blood, taking advantage of this unusual resource to ensure their survival. And a whole bunch of other insects have built a niche around feces. Flies lay their eggs there, and some beetles even build large balls out of animal dung, which they eat and use as accommodation for their eggs. And then there's the insects' mighty power of metamorphosis. This trait not only transforms insects, but also helps them maximize the available resources in an ecosystem. Take butterflies. In their larval caterpillar form, they chomp hungrily through leaves at a rapid rate to help them grow and spin cocoons. But when they emerge as butterflies, these insects feed only on flower nectar. Metamorphosis means the larvae and adults of one species will never compete for the same resource, so they successfully share an ecological niche without limiting their own success. This process is so efficient that an incredible 86% of insect species undergo complete metamorphosis. We're big and they're small, so it's easy to forget that these critters are moving in their millions all around us, all the time. But examine almost any patch of ground, and you're sure to find them there. Their numbers are immense, and their success is unmatched. We may have to accept that it's insects, not us, that are the true conquerors of the planet.

**P328 2016-02-24 How ancient art influenced modern art - Felipe Galindo**

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The term modern art sounds like it means art that is popular at the moment, but in fact, modern art is a style that originated over 150 years ago, and includes artists that by now have attained classic status, such as Picasso, Matisse, and Gauguin. And what's even more ironic is that the movement they pioneered, considered revolutionary and even scandalous at the time, was inspired largely by an object of a traditional and ancient design. As far back as the Renaissance, the primary European art movements emphasized conventional representation and adherence to classical forms. But that began to change in the late 19th century as artists like Van Gogh and Cézanne expanded the boundaries of painting. Soon, a movement arose that sought to create an entirely new style of art, and one way of doing so was to look beyond Western civilization. For example, Paul Gauguin moved to the island of Tahiti in the 1890s. There, he found inspiration in the island's inhabitants, landscape, and culture to create artwork that intertwined European themes and Polynesian lore. Others looked the cultures of the Islamic world, but the most influential inspiration would come from Sub-Saharan Africa. As European empires expanded deeper into the African continent, its artifacts and artworks made their way into the hands of museums and collectors. One such collector was Henri Matisse, who showed his friend Picasso a mask he had acquired made by the Dan tribe of the Ivory Coast. The mask awoke Picasso's curiosity, leading him to visit the Trocadéro Ethnographic Museum in Paris in 1907. Founded to house acquisitions from colonial conquests, the museum boasted a collection of African art, with stylized figures and masks made of wood and decorated with simple colors and materials. The visit was a revelation for Picasso, who proclaimed that African masks were what painting was all about. At this time, Picasso had been working on a painting of five nude women in a style that would later come to be known as Cubism. And while three of these ladies show facial features found in ancient Iberian art, a nod to Picasso's Spanish heritage, the faces of the two on the right closely resemble African masks. Created in 1907 after hundreds of sketches and studies, "Les Demoiselles d'Avignon" has been considered the first truly 20th century masterpiece, breaking with many previously held notions in art. It was at once aggressive and abstract, distorted yet primal in its raw geometry, a new artistic language with new forms, colors, and meanings. And these avant-garde qualities caused a sensation when the painting was first exhibited almost ten years later. The public was shocked, critics denounced it as immoral, and even Picasso's own friends were simultaneously surprised, offended, and mesmerized at his audacity. More artists soon followed in Picasso's footsteps. Constantin Brâncuși and Amedeo Modigliani in Paris, as well as the German Expressionists, all drew on the aesthetics of African sculptures in their work. Others looked to a different continent for their inspiration. British sculptor Henry Moore based many of his semi-abstract bronze sculptures on a replica of a chacmool, a distinctive reclining statue from the Toltec-Maya culture. Pre-Columbian art was also a major influence for Josef Albers. He created a series of compositions, such as the geometrical series Homage to the Square, that were inspired by pyramids and local art he encountered on his frequent visits to Mexico. Inspiration from ancient cultures initiated one of the most revolutionary movements in art history, but were these artists playing the role of explorers or conquistadors, appropriating ideas and profiting from cultures they considered primitive? Questions like this deserve scrutiny, as artists continue to redefine standards. Perhaps not too long from now, the bold innovations of modern art will seem like stale orthodoxies, ready to be overturned by a new set of radical trailblazers drawing inspiration from another unlikely source.

**P329 2016-02-25 Can wildlife adapt to climate change - Erin Eastwood**

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Rising temperatures and seas, massive droughts, changing landscapes. Successfully adapting to climate change is growing increasingly important. For humans, this means using our technological advancement to find solutions, like smarter cities and better water management. But for some plants and animals, adapting to these global changes involves the most ancient solution of all: evolution. Evolutionary adaptation usually occurs along time scales of thousands to hundreds of thousands of years. But in cases where species are under especially strong selective conditions, like those caused by rapidly changing climates, adaptive evolution can happen more quickly. In recent decades, we've seen many plants, animals, and insects relocating themselves and undergoing changes to their body sizes, and the dates they flower or breed. But many of these are plastic, or nonheritable changes to an individual's physical traits. And there are limits to how much an organism can change its own physiology to meet environmental requirements. That's why scientists are seeking examples of evolutionary changes coded in species' DNA that are heritable, long-lasting, and may provide a key to their future. Take the tawny owl. If you were walking through a wintry forest in northern Europe 30 years ago, chances are you'd have heard, rather than seen, this elusive bird. Against the snowy backdrop, its plumage would have been near impossible to spot. Today, the landscape is vastly different. Since the 1980s, climate change has led to significantly less snowfall, but you'd still struggle to spot a tawny owl because nowadays, they're brown. The brown color variant is the genetically dominant form of plumage in this species, but historically, the recessive pale gray variant triumphed because of its selective advantage in helping these predators blend in. However, less snow cover reduces opportunities for camouflage, so lately, this gray color variant has been losing the battle against natural selection. The offspring of the brown color morphs, on the other hand, have an advantage in exposed forests, so brown tawny owls are flourishing today. Several other species have undergone similar climate-change-adaptive genetic changes in recent decades. Pitcher plant mosquitoes have rapidly evolved to take advantage of the warmer temperatures, entering dormancy later and later in the year. Two spot ladybug populations, once comprised of equal numbers of melanic and non-melanic morphs, have now shifted almost entirely to the non-melanic color combination. Scientists think that keeps them from overheating. Meanwhile, pink salmon have adapted to warmer waters by spawning earlier in the season to protect their sensitive eggs. And wild thyme plants in Europe are producing more repellent oils to protect themselves against the herbivores that become more common when it's warm. These plants and animals belong to a group of about 20 identified species with evolutionary adaptations to rapid climate change, including snapping turtles, wood frogs, knotweed, and silver spotted skipper butterflies. However, scientists hope to discover more species evolving in response to climate change out of 8.7 million species on the planet. For most of our planet's astounding and precious biodiversity, evolution won't be the answer. Instead, many of those species will have to rely on us to help them survive a changing world or face extinction. The good news is we already have the tools. Across the planet, we're making on-the-ground decisions that will help entire ecosystems adapt. Critical climate refuges are being identified and set aside, and projects are underway to help mobile species move to more suitable climates. Existing parks and protected areas are also doing climate change check-ups to help their wildlife cope. Fortunately, it's still within our power to preserve much of the wondrous biodiversity of this planet, which, after all, sustains us in so many ways.

**P330 2016-02-25 Can you solve the frog riddle - Derek Abbott**

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So you're stranded in a huge rainforest, and you've eaten a poisonous mushroom. To save your life, you need the antidote excreted by a certain species of frog. Unfortunately, only the female of the species produces the antidote, and to make matters worse, the male and female occur in equal numbers and look identical, with no way for you to tell them apart, except that the male has a distinctive croak. And it may just be your lucky day. To your left, you've spotted a frog on a tree stump, but before you start running to it, you're startled by the croak of a male frog coming from a clearing in the opposite direction. There, you see two frogs, but you can't tell which one made the sound. You feel yourself starting to lose consciousness, and realize you only have time to go in one direction before you collapse. What are your chances of survival if you head for the clearing and lick both of the frogs there? What about if you go to the tree stump? Which way should you go? Press pause now to calculate odds yourself. 3 2 1 If you chose to go to the clearing, you're right, but the hard part is correctly calculating your odds. There are two common incorrect ways of solving this problem. Wrong answer number one: Assuming there's a roughly equal number of males and females, the probability of any one frog being either sex is one in two, which is 0.5, or 50%. And since all frogs are independent of each other, the chance of any one of them being female should still be 50% each time you choose. This logic actually is correct for the tree stump, but not for the clearing. Wrong answer two: First, you saw two frogs in the clearing. Now you've learned that at least one of them is male, but what are the chances that both are? If the probability of each individual frog being male is 0.5, then multiplying the two together will give you 0.25, which is one in four, or 25%. So, you have a 75% chance of getting at least one female and receiving the antidote. So here's the right answer. Going for the clearing gives you a two in three chance of survival, or about 67%. If you're wondering how this could possibly be right, it's because of something called conditional probability. Let's see how it unfolds. When we first see the two frogs, there are several possible combinations of male and female. If we write out the full list, we have what mathematicians call the sample space, and as we can see, out of the four possible combinations, only one has two males. So why was the answer of 75% wrong? Because the croak gives us additional information. As soon as we know that one of the frogs is male, that tells us there can't be a pair of females, which means we can eliminate that possibility from the sample space, leaving us with three possible combinations. Of them, one still has two males, giving us our two in three, or 67% chance of getting a female. This is how conditional probability works. You start off with a large sample space that includes every possibility. But every additional piece of information allows you to eliminate possibilities, shrinking the sample space and increasing the probability of getting a particular combination. The point is that information affects probability. And conditional probability isn't just the stuff of abstract mathematical games. It pops up in the real world, as well. Computers and other devices use conditional probability to detect likely errors in the strings of 1's and 0's that all our data consists of. And in many of our own life decisions, we use information gained from past experience and our surroundings to narrow down our choices to the best options so that maybe next time, we can avoid eating that poisonous mushroom in the first place.

**P331 2016-03-01 This is Sparta - Fierce warriors of the ancient world - Craig Zimmer**

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In ancient Greece, violent internal conflict between bordering neighbors and war with foreign invaders was a way of life, and Greeks were considered premier warriors. Most Greek city-states surrounded themselves with massive defensive walls for added protection. Sparta in its prime was a different story, finding walls unnecessary when it had an army of the most feared warriors in the ancient world. So what was Sparta doing differently than everyone else to produce such fierce soldiers? To answer that question, we turn to the written accounts of that time. There are no surviving written accounts from Spartans themselves, as it was forbidden for Spartans to keep records, so we have to rely on those of non-Spartan ancient historians, like Herodotus, Thucydides, and Plutarch. These stories may be embellished and depict Sparta at the apex of its power, so take them with a grain of salt. For Spartans, the purpose for their existence was simple: to serve Sparta. On the day of their birth, elder Spartan leaders examined every newborn. The strong healthy babies were considered capable of fulfilling this purpose, and the others may have been left on Mount Taygetus to die. Every Spartan, boy or girl, was expected to be physically strong, mentally sharp, and emotionally resilient. And it was their absolute duty to defend and promote Sparta at all costs. So in the first years of their lives, children were raised to understand that their loyalty belonged first to Sparta, and then to family. This mindset probably made it easier for the Spartan boys, who upon turning seven, were sent to the agoge, a place with one main purpose: to turn a boy into a Spartan warrior through thirteen years of relentless, harsh, and often brutal training. The Spartans prized physical perfection above all else, and so the students spent a great deal of their time learning how to fight. To ensure resilience in battle, boys were encouraged to fight among themselves, and bullying, unlike today, was acceptable. In order to better prepare the boys for the conditions of war, the boys were poorly fed, sometimes even going days without eating. They also were given little in the way of clothing so that they could learn to deal with different temperatures. Spartan boys were encouraged to steal in order to survive, but if they were caught, they would be disciplined, not because they stole, but because they were caught in the act. During the annual contest of endurance in a religious ritual known as the diamastigosis, teenage boys were whipped in front of an altar at the Sanctuary of Artemis Orthia. It was common for boys to die on the altar of the goddess. Fortunately, not everything was as brutal as that. Young Spartans were also taught how to read, write, and dance, which taught them graceful control of their movements and helped them in combat. While the responsibilities for the girls of Sparta were different, the high standards of excellence and expectation to serve Sparta with their lives remained the same. Spartan girls lived at home with their mothers as they attended school. Their curriculum included the arts, music, dance, reading, and writing. And to stay in peak physical condition, they learned a variety of sports, such as discus, javelin, and horseback riding. In Sparta, it was believed that only strong and capable women could bear children that would one day become strong and capable warriors. To all Spartans, men and women, perhaps the most important lesson from Spartan school was allegiance to Sparta. To die for their city-state was seen as the completion of one's duty to Sparta. Upon their death, only men who died in battle and women who died in childbirth were given tombstones. In the eyes of their countrymen, both died so that Sparta could live.

**P332 2016-03-02 What is metallic glass - Ashwini Bharathula**

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Steel and plastic. These two materials are essential to so much of our infrastructure and technology, and they have a complementary set of strengths and weaknesses. Steel is strong and hard, but difficult to shape intricately. While plastic can take on just about any form, it's weak and soft. So wouldn't it be nice if there were one material as strong as the strongest steel and as shapeable as plastic? Well, a lot of scientists and technologists are getting excited about a relatively recent invention called metallic glass with both of those properties, and more. Metallic glasses look shiny and opaque, like metals, and also like metals, they conduct heat and electricity. But they're way stronger than most metals, which means they can withstand a lot of force without getting bent or dented, making ultrasharp scalpels, and ultrastrong electronics cases, hinges, screws; the list goes on. Metallic glasses also have an incredible ability to store and release elastic energy, which makes them perfect for sports equipment, like tennis racquets, golf clubs, and skis. They're resistant to corrosion, and can be cast into complex shapes with mirror-like surfaces in a single molding step. Despite their strength at room temperature, if you go up a few hundred degrees Celsius, they soften significantly, and can be deformed into any shape you like. Cool them back down, and they regain the strength. So where do all of these wondrous attributes come from? In essence, they have to do with metallic glass' unique atomic structure. Most metals are crystalline as solids. That means that if you zoomed in close enough to see the individual atoms, they'd be neatly lined up in an orderly, repeating pattern that extends throughout the whole material. Ice is crystalline, and so are diamonds, and salt. If you heat these materials up enough and melt them, the atoms can jiggle freely and move randomly, but when you cool them back down, the atoms reorganize themselves, reestablishing the crystal. But what if you could cool a molten metal so fast that the atoms couldn't find their places again, so that the material was solid, but with the chaotic, amorphous internal structure of a liquid? That's metallic glass. This structure has the added benefit of lacking the grain boundaries that most metals have. Those are weak spots where the material is more susceptible to scratches or corrosion. The first metallic glass was made in 1960 from gold and silicon. It wasn't easy to make. Because metal atoms crystallize so rapidly, scientists had to cool the alloy down incredibly fast, a million degrees Kelvin per second, by shooting tiny droplets at cold copper plates, or spinning ultrathin ribbons. At that time, metallic glasses could only be tens or hundreds of microns thick, which was too thin for most practical applications. But since then, scientists have figured out that if you blend several metals that mix with each other freely, but can't easily crystallize together, usually because they have very different atomic sizes, the mixture crystallizes much more slowly. That means you don't have to cool it down as fast, so the material can be thicker, centimeters instead of micrometers. These materials are called bulk metallic glasses, or BMGs. Now there are hundreds of different BMGs, so why aren't all of our bridges and cars made out of them? Many of the BMGs currently available are made from expensive metals, like palladium and zirconium, and they have to be really pure because any impurities can cause crystallization. So a BMG skyscraper or space shuttle would be astronomically expensive. And despite their strength, they're not yet tough enough for load-bearing applications. When the stresses get high, they can fracture without warning, which isn't ideal for, say, a bridge. But when engineers figure out how to make BMGs from cheaper metals, and how to make them even tougher, for these super materials, the sky's the limit.

**P333 2016-03-03 Why is this painting so captivating - James Earle and Christina Bozsi**

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On first glance, this painting might not seem terribly special, but it's actually one of the most analyzed paintings in the history of art. It's called "Las Meninas," or "The Maids of Honor," painted by Diego Velázquez in 1656, and it depicts a scene in the life of the Spanish Royal Court. A well-dressed child princess refuses a glass of water from a handmaid, while a dwarf teases a dog. A second dwarf stands next to them, while the artist himself pauses at his canvas. Two more people whisper in the background, while a third appears to be exiting the room, and why wouldn't he when there seems to be so little going on? Even the dog looks bored. But look more closely. The two people reflected in the blurry mirror at the back, easily missed at first glance, are none other than King Philip IV and Queen Mariana, seemingly changing the scene from a simple depiction of court life to that of a royal portrait. And with this piece of information, we can begin to understand far more about the painting and why it has captivated viewers for centuries. First, there's the historical context. When "Las Meninas" was painted at the end of Philip's reign, the Spanish Empire was in a period of decline, having suffered defeat in The Thirty Years War, as well as economic and political difficulties. The King himself had also suffered misfortune, losing both his first wife and his only heir to the throne before remarrying. But the painting obscures their struggle to provide food for their household. Even the monarch's advanced age is concealed through the blurring of the mirror. What we do see in the geometric center of the canvas, brightly illuminated by the light from the window, in the Infanta Margarita Teresa, the King's only living legitimate child at the time. Her glowing and healthy appearance is an idealized view of the struggling empire's future. However, the Infanta is not the only center of the painting. Through the clever use of perspective, as well as painting the work life-sized, on a 10.5 x 9 foot canvas, Velázquez blurs the boundary between art and reality, creating the sense of a three-dimensional picture that we can walk into. The line between the ceiling and the wall converges to the open door, further creating the perception of the painting as a physical space seen from the viewer's perspective. In this sense, the audience and the real world are the focus, underlined by the three figures looking straight at the viewer. But there is still another focal point. The line formed by the light fixtures leads to the center of the back wall to the mirror reflecting the royal couple. And its positioning relative to the viewer has led to radically different interpretations of the entire work. The mirror could be reflecting the King and Queen posing for their portrait, or is it reflecting the canvas? And what do we make of the fact that Velázquez never painted the royal portrait implied here? Could the painting actually be depicting its own creation instead? With the incorporation of the mirror into his work, Velázquez elevated the art of painting from its perception as a simple craft to an intellectual endeavor. With its three competing center points, "Las Meninas" captures the contrast between the ideal, the real, and the reflected worlds, maintaining an unresolved tension between them to tell a more complex story than any mirror can provide.

**P334 2016-03-04 5 tips to improve your critical thinking - Samantha Agoos**

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Every day, a sea of decisions stretches before us. Some are small and unimportant, but others have a larger impact on our lives. For example, which politician should I vote for? Should I try the latest diet craze? Or will email make me a millionaire? We're bombarded with so many decisions that it's impossible to make a perfect choice every time. But there are many ways to improve our chances, and one particularly effective technique is critical thinking. This is a way of approaching a question that allows us to carefully deconstruct a situation, reveal its hidden issues, such as bias and manipulation, and make the best decision. If the critical part sounds negative that's because in a way it is. Rather than choosing an answer because it feels right, a person who uses critical thinking subjects all available options to scrutiny and skepticism. Using the tools at their disposal, they'll eliminate everything but the most useful and reliable information. There are many different ways of approaching critical thinking, but here's one five-step process that may help you solve any number of problems. One: formulate your question. In other words, know what you're looking for. This isn't always as straightforward as it sounds. For example, if you're deciding whether to try out the newest diet craze, your reasons for doing so may be obscured by other factors, like claims that you'll see results in just two weeks. But if you approach the situation with a clear view of what you're actually trying to accomplish by dieting, whether that's weight loss, better nutrition, or having more energy, that'll equip you to sift through this information critically, find what you're looking for, and decide whether the new fad really suits your needs. Two: gather your information. There's lots of it out there, so having a clear idea of your question will help you determine what's relevant. If you're trying to decide on a diet to improve your nutrition, you may ask an expert for their advice, or seek other people's testimonies. Information gathering helps you weigh different options, moving you closer to a decision that meets your goal. Three: apply the information, something you do by asking critical questions. Facing a decision, ask yourself, "What concepts are at work?" "What assumptions exist?" "Is my interpretation of the information logically sound?" For example, in an email that promises you millions, you should consider, "What is shaping my approach to this situation?" "Do I assume the sender is telling the truth?" "Based on the evidence, is it logical to assume I'll win any money?" Four: consider the implications. Imagine it's election time, and you've selected a political candidate based on their promise to make it cheaper for drivers to fill up on gas. At first glance, that seems great. But what about the long-term environmental effects? If gasoline use is less restricted by cost, this could also cause a huge surge in air pollution, an unintended consequence that's important to think about. Five: explore other points of view. Ask yourself why so many people are drawn to the policies of the opposing political candidate. Even if you disagree with everything that candidate says, exploring the full spectrum of viewpoints might explain why some policies that don't seem valid to you appeal to others. This will allow you to explore alternatives, evaluate your own choices, and ultimately help you make more informed decisions. This five-step process is just one tool, and it certainly won't eradicate difficult decisions from our lives. But it can help us increase the number of positive choices we make. Critical thinking can give us the tools to sift through a sea of information and find what we're looking for. And if enough of us use it, it has the power to make the world a more reasonable place.

**P335 2016-03-04 Is radiation dangerous - Matt Anticole**

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When we hear the word radiation, it's tempting to picture huge explosions and frightening mutations, but that's not the full story. Radiation also applies to rainbows and a doctor examining an x-ray. So what is radiation really, and how much should we worry about its effects? The answer begins with understanding that the word radiation describes two very different scientific phenomena: electromagnetic radiation and nuclear radiation. Electromagnetic radiation is pure energy consisting of interacting electrical and magnetic waves oscillating through space. As these waves oscillate faster, they scale up in energy. At the lower end of the spectrum, there's radio, infrared, and visible light. At the higher end are ultraviolet, X-ray, and gamma rays. Modern society is shaped by sending and detecting electromagnetic radiation. We might download an email to our phone via radio waves to open an image of an X-ray print, which we can see because our screen emits visible light. Nuclear radiation, on the other hand, originates in the atomic nucleus, where protons repel each other due to their mutually positive charges. A phenomenon known as the strong nuclear force struggles to overcome this repulsion and keep the nucleus intact. However, some combinations of protons and neutrons, known as isotopes, remain unstable, or radioactive. They will randomly eject matter and/or energy, known as nuclear radiation, to achieve greater stability. Nuclear radiation comes from natural sources, like radon, a gas which seeps up from the ground. We also refine naturally occurring radioactive ores to fuel nuclear power plants. Even bananas contain trace amounts of a radioactive potassium isotope. So if we live in a world of radiation, how can we escape its dangerous effects? To start, not all radiation is hazardous. Radiation becomes risky when it rips atoms' electrons away upon impact, a process that can damage DNA. This is known as ionizing radiation because an atom that has lost or gained electrons is called an ion. All nuclear radiation is ionizing, while only the highest energy electromagnetic radiation is. That includes gamma rays, X-rays, and the high-energy end of ultraviolet. That's why as an extra precaution during X-rays, doctors shield body parts they don't need to examine, and why beach-goers use sunscreen. In comparison, cell phones and microwaves operate at the lower end of the spectrum, so there is no risk of ionizing radiation from their use. The biggest health risk occurs when lots of ionizing radiation hits us in a short time period, also known as an acute exposure. Acute exposures overwhelm the body's natural ability to repair the damage. This can trigger cancers, cellular dysfunction, and potentially even death. Fortunately, acute exposures are rare, but we are exposed daily to lower levels of ionizing radiation from both natural and man-made sources. Scientists have a harder time quantifying these risks. Your body often repairs damage from small amounts ionizing radiation, and if it can't, the results of damage may not manifest for a decade or more. One way scientists compare ionizing radiation exposure is a unit called the sievert. An acute exposure to one sievert will probably cause nausea within hours, and four sieverts could be fatal. However, our normal daily exposures are far lower. The average person receives 6.2 millisieverts of radiation from all sources annually, around a third due to radon. At only five microsieverts each, you'd need to get more than 1200 dental X-rays to rack up your annual dosage. And remember that banana? If you could absorb all the banana's radiation, you'd need around 170 a day to hit your annual dosage. We live in a world of radiation. However, much of that radiation is non-ionizing. For the remainder that is ionizing, our exposures are usually low, and choices like getting your home tested for radon and wearing sunscreen can help reduce the associated health risks. Marie Curie, one of the early radiation pioneers, summed up the challenge as follows: "Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less."

**P336 2016-03-17 The physics of the 'hardest move' in ballet - Arleen Sugano**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=336)

In the third act of "Swan Lake," the Black Swan pulls off a seemingly endless series of turns, bobbing up and down on one pointed foot and spinning around, and around, and around 32 times. It's one of the toughest sequences in ballet, and for those thirty seconds or so, she's like a human top in perpetual motion. Those spectacular turns are called fouettés, which means "whipped" in French, describing the dancer's incredible ability to whip around without stopping. But while we're marveling at the fouetté, can we unravel its physics? The dancer starts the fouetté by pushing off with her foot to generate torque. But the hard part is maintaining the rotation. As she turns, friction between her pointe shoe and the floor, and somewhat between her body and the air, reduces her momentum. So how does she keep turning? Between each turn, the dancer pauses for a split second and faces the audience. Her supporting foot flattens, and then twists as it rises back onto pointe, pushing against the floor to generate a tiny amount of new torque. At the same time, her arms sweep open to help her keep her balance. The turns are most effective if her center of gravity stays constant, and a skilled dancer will be able to keep her turning axis vertical. The extended arms and torque-generating foot both help drive the fouetté. But the real secret and the reason you hardly notice the pause is that her other leg never stops moving. During her momentary pause, the dancer's elevated leg straightens and moves from the front to the side, before it folds back into her knee. By staying in motion, that leg is storing some of the momentum of the turn. When the leg comes back in towards the body, that stored momentum gets transferred back to the dancer's body, propelling her around as she rises back onto pointe. As the ballerina extends and retracts her leg with each turn, momentum travels back and forth between leg and body, keeping her in motion. A really good ballerina can get more than one turn out of every leg extension in one of two ways. First, she can extend her leg sooner. The longer the leg is extended, the more momentum it stores, and the more momentum it can return to the body when it's pulled back in. More angular momentum means she can make more turns before needing to replenish what was lost to friction. The other option is for the dancer to bring her arms or leg in closer to her body once she returns to pointe. Why does this work? Like every other turn in ballet, the fouetté is governed by angular momentum, which is equal to the dancer's angular velocity times her rotational inertia. And except for what's lost to friction, that angular momentum has to stay constant while the dancer is on pointe. That's called conservation of angular momentum. Now, rotational inertia can be thought of as a body's resistance to rotational motion. It increases when more mass is distributed further from the axis of rotation, and decreases when the mass is distributed closer to the axis of rotation. So as she brings her arms closer to her body, her rotational inertia shrinks. In order to conserve angular momentum, her angular velocity, the speed of her turn, has to increase, allowing the same amount of stored momentum to carry her through multiple turns. You've probably seen ice skaters do the same thing, spinning faster and faster by drawing in their arms and legs. In Tchaikovsky's ballet, the Black Swan is a sorceress, and her 32 captivating fouettés do seem almost supernatural. But it's not magic that makes them possible. It's physics.

**P337 2016-03-18 The invisible motion of still objects - Ran Tivony**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=337)

Many of the inanimate objects around you probably seem perfectly still. But look deep into the atomic structure of any of them, and you'll see a world in constant flux. Stretching, contracting, springing, jittering, drifting atoms everywhere. And though that movement may seem chaotic, it's not random. Atoms that are bonded together, and that describes almost all substances, move according to a set of principles. For example, take molecules, atoms held together by covalent bonds. There are three basic ways molecules can move: rotation, translation, and vibration. Rotation and translation move a molecule in space while its atoms stay the same distance apart. Vibration, on the other hand, changes those distances, actually altering the molecule's shape. For any molecule, you can count up the number of different ways it can move. That corresponds to its degrees of freedom, which in the context of mechanics basically means the number of variables we need to take into account to understand the full system. Three-dimensional space is defined by x, y, and z axes. Translation allows the molecule to move in the direction of any of them. That's three degrees of freedom. It can also rotate around any of these three axes. That's three more, unless it's a linear molecule, like carbon dioxide. There, one of the rotations just spins the molecule around its own axis, which doesn't count because it doesn't change the position of the atoms. Vibration is where it gets a bit tricky. Let's take a simple molecule, like hydrogen. The length of the bond that holds the two atoms together is constantly changing as if the atoms were connected by a spring. That change in distance is tiny, less than a billionth of a meter. The more atoms and bonds a molecule has, the more vibrational modes. For example, a water molecule has three atoms: one oxygen and two hydrogens, and two bonds. That gives it three modes of vibration: symmetric stretching, asymmetric stretching, and bending. More complicated molecules have even fancier vibrational modes, like rocking, wagging, and twisting. If you know how many atoms a molecule has, you can count its vibrational modes. Start with the total degrees of freedom, which is three times the number of atoms in the molecule. That's because each atom can move in three different directions. Three of the total correspond to translation when all the atoms are going in the same direction. And three, or two for linear molecules, correspond to rotations. All the rest, 3N-6 or 3N-5 for linear molecules, are vibrations. So what's causing all this motion? Molecules move because they absorb energy from their surroundings, mainly in the form of heat or electromagnetic radiation. When this energy gets transferred to the molecules, they vibrate, rotate, or translate faster. Faster motion increases the kinetic energy of the molecules and atoms. We define this as an increase in temperature and thermal energy. This is the phenomenon your microwave oven uses to heat your food. The oven emits microwave radiation, which is absorbed by the molecules, especially those of water. They move around faster and faster, bumping into each other and increasing the food's temperature and thermal energy. The greenhouse effect is another example. Some of the solar radiation that hits the Earth's surface is reflected back to the atmosphere. Greenhouse gases, like water vapor and carbon dioxide absorb this radiation and speed up. These hotter, faster-moving molecules emit infrared radiation in all directions, including back to Earth, warming it. Does all this molecular motion ever stop? You might think that would happen at absolute zero, the coldest possible temperature. No one's ever managed to cool anything down that much, but even if we could, molecules would still move due to a quantum mechanical principle called zero-point energy. In other words, everything has been moving since the universe's very first moments, and will keep going long, long after we're gone.

**P338 2016-03-21 What would happen if you didn’t drink water - Mia Nacamulli**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=338)

Water is virtually everywhere, from soil moisture and ice caps, to the cells inside our own bodies. Depending on factors like location, fat index, age, and sex, the average human is between 55-60% water. At birth, human babies are even wetter. Being 75% water, they are swimmingly similar to fish. But their water composition drops to 65% by their first birthday. So what role does water play in our bodies, and how much do we actually need to drink to stay healthy? The H20 in our bodies works to cushion and lubricate joints, regulate temperature, and to nourish the brain and spinal cord. Water isn't only in our blood. An adult's brain and heart are almost three quarters water. That's roughly equivalent to the amount of moisture in a banana. Lungs are more similar to an apple at 83%. And even seemingly dry human bones are 31% water. If we are essentially made of water, and surrounded by water, why do we still need to drink so much? Well, each day we lose two to three liters through our sweat, urine, and bowel movements, and even just from breathing. While these functions are essential to our survival, we need to compensate for the fluid loss. Maintaining a balanced water level is essential to avoid dehydration or over-hydration, both of which can have devastating effects on overall health. At first detection of low water levels, sensory receptors in the brain's hypothalamus signal the release of antidiuretic hormone. When it reached the kidneys, it creates aquaporins, special channels that enable blood to absorb and retain more water, leading to concentrated, dark urine. Increased dehydration can cause notable drops in energy, mood, skin moisture, and blood pressure, as well as signs of cognitive impairment. A dehydrated brain works harder to accomplish the same amount as a normal brain, and it even temporarily shrinks because of its lack of water. Over-hydration, or hyponatremia, is usually caused by overconsumption of water in a short amount of time. Athletes are often the victims of over-hydration because of complications in regulating water levels in extreme physical conditions. Whereas the dehydrated brain amps up the production of antidiuretic hormone, the over-hydrated brain slows, or even stops, releasing it into the blood. Sodium electrolytes in the body become diluted, causing cells to swell. In severe cases, the kidneys can't keep up with the resulting volumes of dilute urine. Water intoxication then occurs, possibly causing headache, vomiting, and, in rare instances, seizures or death. But that's a pretty extreme situation. On a normal, day-to-day basis, maintaining a well-hydrated system is easy to manage for those of us fortunate enough to have access to clean drinking water. For a long time, conventional wisdom said that we should drink eight glasses a day. That estimate has since been fine-tuned. Now, the consensus is that the amount of water we need to imbibe depends largely on our weight and environment. The recommended daily intake varies from between 2.5-3.7 liters of water for men, and about 2-2.7 liters for women, a range that is pushed up or down if we are healthy, active, old, or overheating. While water is the healthiest hydrator, other beverages, even those with caffeine like coffee or tea, replenish fluids as well. And water within food makes up about a fifth of our daily H20 intake. Fruits and vegetables like strawberries, cucumbers, and even broccoli are over 90% water, and can supplement liquid intake while providing valuable nutrients and fiber. Drinking well might also have various long-term benefits. Studies have shown that optimal hydration can lower the chance of stroke, help manage diabetes, and potentially reduce the risk of certain types of cancer. No matter what, getting the right amount of liquid makes a world of difference in how you'll feel, think, and function day to day.

**P339 2016-03-30 How do glasses help us see - Andrew Bastawrous and Clare Gilbert**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=339)

Almost 2000 years ago, the Roman philosopher Seneca peered at his book through a glass of water. Suddenly, the text below was transformed. The words magically became clear. But it wasn't until a millennium later that that same principle would be used to create the earliest glasses. Today, glasses can help millions of people with poor vision due to uncorrected refractive errors. The key to understanding what that means lies with the term refraction, the ability of a transparent medium, like glass, water, or the eye to change the direction of light passing through it. The eye has two main refractive surfaces: the cornea and the lens. Ideally, these surfaces work together to refract light in a way that accurately focuses light onto the retina, the layer of light-sensitive tissue at the back of the eye that works with the brain to give rise to vision. But many people develop refractive errors, either during childhood as their eyes are growing, or in later life as their eyes age. Imperfections in the cornea and lens cause refracted light to be focused in front of or behind the retina, making images appear blurry. People with refractive errors can still see color, movement, and light, but the details of what they're looking at are out of focus. People experience refractive errors in different ways, owing to differences in their eyes. In some, light refracts too much, and in others, too little. Eyes with a focal point in front of the retina are called myopic, or short-sighted. They can see close objects clearly, but those far away are out of focus. But when the focus point is behind the retina, people are hyperopic, or long-sighted. For them, objects close up are unfocused, but distant objects are crystal clear. Finally, some people have a cornea with a non-spherical shape that causes astigmatism, a form of out-of-focus vision that makes all objects seem blurred, whether close or far. As we age, our eyes face new challenges. When we're young, the lens of the eye is flexible and can change shape to bring images into focus, something called accommodation. This keeps objects in focus when we shift our gaze from far to near. But as we get older, the lens becomes less flexible, and can't change shape when we want to look at near objects. This is called presbyopia, and it affects adults starting around the age of 40 years. Myopia, hyperopia, astigmatism, and presbyopia. Each of these is a refractive error. Nowadays we can fix them all with glasses or contact lenses, which work by refocusing light so it strikes the retina precisely. It's even possible to correct vision with surgery using lasers that change the shape of the cornea and alter its refractive properties. But glasses remain the most popular. By using carefully crafted lenses to steer light to exactly the right spot on the retina, a person's clear vision can be restored. We've come a long way since Seneca's discovery and the crude glasses of yesteryear. In 1727, a British optician named Edward Scarlett developed the modern style of glasses which are kept in place with arms which hook over each ear. Today's glasses take their inspiration from that design, but they're also much more precise and personal. Each pair is tailored for an individual to bring out their unique powers of sight. So if you're one of the 500 million people with a problem with close or far vision, or both, there's a pair of glasses out there waiting to reveal a whole new world that's hiding in plain view.

**P340 2016-03-30 How do schools of fish swim in harmony - Nathan S. Jacobs**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=340)

How do schools of fish swim in harmony? And how do the tiny cells in your brain give rise to the complex thoughts, memories, and consciousness that are you? Oddly enough, those questions have the same general answer: emergence, or the spontaneous creation of sophisticated behaviors and functions from large groups of simple elements. Like many animals, fish stick together in groups, but that's not just because they enjoy each other's company. It's a matter of survival. Schools of fish exhibit complex swarming behaviors that help them evade hungry predators, while a lone fish is quickly singled out as easy prey. So which brilliant fish leader is the one in charge? Actually, no one is, and everyone is. So what does that mean? While the school of fish is elegantly twisting, turning, and dodging sharks in what looks like deliberate coordination, each individual fish is actually just following two basic rules that have nothing to do with the shark: one, stay close, but not too close to your neighbor, and two, keep swimmming. As individuals, the fish are focused on the minutiae of these local interactions, but if enough fish join the group, something remarkable happens. The movement of individual fish is eclipsed by an entirely new entity: the school, which has its own unique set of behaviors. The school isn't controlled by any single fish. It simply emerges if you have enough fish following the right set of local rules. It's like an accident that happens over and over again, allowing fish all across the ocean to reliably avoid predation. And it's not just fish. Emergence is a basic property of many complex systems of interacting elements. For example, the specific way in which millions of grains of sand collide and tumble over each other almost always produces the same basic pattern of ripples. And when moisture freezes in the atmosphere, the specific binding properties of water molecules reliably produce radiating lattices that form into beautiful snowflakes. What makes emergence so complex is that you can't understand it by simply taking it apart, like the engine of a car. Taking things apart is a good first step to understanding a complex system. But if you reduce a school of fish to individuals, it loses the ability to evade predators, and there's nothing left to study. And if you reduce the brain to individual neurons, you're left with something that is notoriously unreliable, and nothing like how we think and behave, at least most of the time. Regardless, whatever you're thinking about right now isn't reliant on a single neuron lodged in the corner of your brain. Rather, the mind emerges from the collective activities of many, many neurons. There are billions of neurons in the human brain, and trillions of connections between all those neurons. When you turn such a complicated system like that on, it could behave in all sorts of weird ways, but it doesn't. The neurons in our brain follow simple rules, just like the fish, so that as a group, their activity self-organizes into reliable patterns that let you do things like recognize faces, successfully repeat the same task over and over again, and keep all those silly little habits that everyone likes about you. So, what are the simple rules when it comes to the brain? The basic function of each neuron in the brain is to either excite or inhibit other neurons. If you connect a few neurons together into a simple circuit, you can generate rhythmic patterns of activity, feedback loops that ramp up or shut down a signal, coincidence detectors, and disinhibition, where two inhibitory neurons can actually activate another neuron by removing inhibitory brakes. As more and more neurons are connected, increasingly complex patterns of activity emerge from the network. Soon, so many neurons are interacting in so many different ways at once that the system becomes chaotic. The trajectory of the network's activity cannot be easily explained by the simple local circuits described earlier. And yet, from this chaos, patterns can emerge, and then emerge again and again in a reproducible manner. At some point, these emergent patterns of activity become sufficiently complex, and curious to begin studying their own biological origins, not to mention emergence. And what we found in emergent phenomena at vastly different scales is that same remarkable characteristic as the fish displayed: That emergence doesn't require someone or something to be in charge. If the right rules are in place, and some basic conditions are met, a complex system will fall into the same habits over and over again, turning chaos into order. That's true in the molecular pandemonium that lets your cells function, the tangled thicket of neurons that produces your thoughts and identity, your network of friends and family, all the way up to the structures and economies of our cities across the planet.

**P341 2016-03-31 Why is Mount Everest so tall - Michele Koppes**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=341)

Every spring, hundreds of adventure-seekers dream of climbing Qomolangma, also known as Mount Everest. At base camp, they hunker down for months waiting for the chance to scale the mountain's lofty, lethal peak. But why do people risk life and limb to climb Everest? Is it the challenge? The view? The chance to touch the sky? For many, the draw is Everest's status as the highest mountain on Earth. There's an important distinction to make here. Mauna Kea is actually the tallest from base to summit, but at 8850 meters above sea level, Everest has the highest altitude on the planet. To understand how this towering formation was born, we have to peer deep into our planet's crust, where continental plates collide. The Earth's surface is like an armadillo's armor. Pieces of crust constantly move over, under, and around each other. For such huge continental plates, the motion is relatively quick. They move two to four centimeters per year, about as fast as fingernails grow. When two plates collide, one pushes into or underneath the other, buckling at the margins, and causing what's known as uplift to accomodate the extra crust. That's how Everest came about. 50 million years ago, the Earth's Indian Plate drifted north, bumped into the bigger Eurasian Plate, and the crust crumpled, creating huge uplift. Mountain Everest lies at the heart of this action, on the edge of the Indian-Eurasian collision zone. But mountains are shaped by forces other than uplift. As the land is pushed up, air masses are forced to rise as well. Rising air cools, causing any water vapor within it to condense and form rain or snow. As that falls, it wears down the landscape, dissolving rocks or breaking them down in a process known as weathering. Water moving downhill carries the weathered material and erodes the landscape, carving out deep valleys and jagged peaks. This balance between uplift and erosion gives a mountain its shape. But compare the celestial peaks of the Himalayas to the comforting hills of Appalachia. Clearly, all mountains are not alike. That's because time comes into the equation, too. When continental plates first collide, uplift happens fast. The peaks grow tall with steep slopes. Over time, however, gravity and water wear them down. Eventually, erosion overtakes uplift, wearing down peaks faster than they're pushed up. A third factor shapes mountains: climate. In subzero temperatures, some snowfall doesn't completely melt away, instead slowly compacting until it becomes ice. That forms the snowline, which occurs at different heights around the planet depending on climate. At the freezing poles, the snowline is at sea level. Near the equator, you have to climb five kilometers before it gets cold enough for ice to form. Gathered ice starts flowing under its own immense weight forming a slow-moving frozen river known as a glacier, which grinds the rocks below. The steeper the mountains, the faster ice flows, and the quicker it carves the underlying rock. Glaciers can erode landscapes swifter than rain and rivers. Where glaciers cling to mountain peaks, they sand them down so fast, they lop the tops off like giant snowy buzzsaws. So then, how did the icy Mount Everest come to be so tall? The cataclysmic continental clash from which it arose made it huge to begin with. Secondly, the mountain lies near the tropics, so the snowline is high, and the glaciers relatively small, barely big enough to widdle it down. The mountain exists in a perfect storm of conditions that maintain its impressive stature. But that won't always be the case. We live in a changing world where the continental plates, Earth's climate, and the planet's erosive power might one day conspire to cut Mount Everest down to size. For now, at least, it remains legendary in the minds of hikers, adventurers, and dreamers alike.

**P342 2016-04-04 How to spot a fad diet - Mia Nacamulli**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=342)

Conventional wisdom about diets, including government health recommendations, seems to change all the time. And yet, ads routinely come about claiming to have the answer about what we should eat. So how do we distinguish what's actually healthy from what advertisers just want us to believe is good for us? Marketing takes advantage of the desire to drop weight fast, and be stronger, slimmer, and brighter. And in the big picture, diet plans promising dramatic results, known as fad diets, are just what they seem: too good to be true. So where do diet fads even come from? While the Ancient Greeks and Romans rallied behind large-scale health regimens centuries earlier, this phenomenon began in earnest in the Victorian Era with crazes like the vinegar diet and the Banting Diet. Since then, diets have advised us all sorts of things: to excessively chew, to not chew at all, to swallow a grapefruit per meal, non-stop cabbage soup, even consumption of arsenic, or tapeworms. If the idea of diet crazes has withstood history, could this mean that they work? In the short term, the answer is often yes. Low-carbohydrate plans, like the popular Atkins or South Beach Diets, have an initial diuretic effect. Sodium is lost until the body can balance itself out, and temporary fluid weight loss may occur. With other high-protein diets, you might lose weight at first since by restricting your food choices, you are dropping your overall calorie intake. But your body then lowers its metabolic rate to adjust to the shift, lessening the diet's effect over time and resulting in a quick reversal if the diet is abandoned. So while these diets may be alluring early on, they don't guarantee long-term benefits for your health and weight. A few simple guidelines, though, can help differentiate between a diet that is beneficial in maintaining long-term health, and one that only offers temporary weight changes. Here's the first tipoff: If a diet focuses on intensely cutting back calories or on cutting out entire food groups, like fat, sugar, or carbohydrates, chances are it's a fad diet. And another red flag is ritual, when the diet in question instructs you to only eat specific foods, prescribed combinations, or to opt for particular food substitutes, like drinks, bars, or powders. The truth is shedding pounds in the long run simply doesn't have a quick-fix solution. Not all diet crazes tout weight loss. What about claims of superfoods, cleanses, and other body-boosting solutions? Marketing emphasizes the allure of products associated with ancient and remote cultures to create a sense of mysticism for consumers. While so-called superfoods, like blueberries or açaí, do add a powerful punch of nutrients, their super transformative qualities are largely exaggeration. They are healthy additions to a balanced diet, yet often, they're marketed as part of sugary drinks or cereals, in which case the negative properties outweight the benefits. Cleanses, too, may be great in moderation since they can assist with jumpstarting weight loss and can increase the number of fresh fruits and vegetables consumed daily. Scientifically speaking, though, they've not yet been shown to have either a long-term benefit or to detox the body any better than the natural mechanisms already in place. Everywhere we look, we're offered solutions to how we can look better, feel fitter, and generally get ahead. Food is no exception, but advice on what we should eat is best left to the doctors and nutritionists who are aware of our individual circumstances. Diets and food fads aren't inherently wrong. Circumstantially, they might even be right, just not for everyone all of the time.

**P343 2016-04-05 The surprising reason you feel awful when you're sick - Marco A. Soto**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=343)

It starts with a tickle in your throat that becomes a cough. Your muscles begin to ache, you grow irritable, and you lose your appetite. It's official: you've got the flu. It's logical to assume that this miserable medley of symptoms is the result of the infection coursing through your body, but is that really the case? What's actually making you feel sick? What if your body itself was driving this vicious onslaught? You first get ill when a pathogen like the flu virus gets into your system, infecting and killing your cells. But this unwelcome intrusion has another effect: it alerts your body's immune system to your plight. As soon as it becomes aware of infection, your body leaps to your defense. Cells called macrophages charge in as the first line of attack, searching for and destroying the viruses and infected cells. Afterwards, the macrophages release protein molecules called cytokines whose job is to recruit and organize more virus-busting cells from your immune system. If this coordinated effort is strong enough, it'll wipe out the infection before you even notice it. But that's just your body setting the scene for some real action. In some cases, viruses spread further, even into the blood and vital organs. To avoid this sometimes dangerous fate, your immune system must launch a stronger attack, coordinating its activity with the brain. That's where those unpleasant symptoms come in, starting with the surging temperature, aches and pains, and sleepiness. So why do we experience this? When the immune system is under serious attack, it secretes more cytokines, which trigger two responses. First, the vagus nerve, which runs through the body into the brain, quickly transmits the information to the brain stem, passing near an important area of pain processing. Second, cytokines travel through the body to the hypothalamus, the part of the brain responsible for controlling temperature, thirst, hunger, and sleep, among other things. When it receives this message, the hypothalamus produces another molecule called prostaglandin E2, which gears it up for war. The hypothalamus sends signals that instruct your muscles to contract and causes a rise in body temperature. It also makes you sleepy, and you lose your appetite and thirst. But what's the point of all of these unpleasant symptoms? Well, we're not yet sure, but some theorize that they aid in recovery. The rise in temperature can slow bacteria and help your immune system destroy pathogens. Sleep lets your body channel more energy towards fighting infection. When you stop eating, your liver can take up much of the iron in your blood, and since iron is essential for bacterial survival, that effectively starves them. Your reduced thirst makes you mildly dehydrated, diminishing transmission through sneezes, coughs, vomit, or diarrhea. Though it's worth noting that if you don't drink enough water, that dehydration can become dangerous. Even the body's aches make you more sensitive, drawing attention to infected cuts that might be worsening, or even causing your condition. In addition to physical symptoms, sickness can also make you irritable, sad, and confused. That's because cytokines and prostaglandin can reach even higher structures in your brain, disrupting the activity of neurotransmitters, like glutamate, endorphins, serotonin, and dopamine. This affects areas like the limbic system, which oversees emotions, and your cerebral cortex, which is involved in reasoning. So it's actually the body's own immune response that causes much of the discomfort you feel every time you get ill. Unfortunately, it doesn't always work perfectly. Most notably, millions of people worldwide suffer from autoimmune diseases, in which the immune system treats normal bodily cues as threats, so the body attacks itself. But for the majority of the human race, millions of years of evolution have fine-tuned the immune system so that it works for, rather than against us. The symptoms of our illnesses are annoying, but collectively, they signify an ancient process that will continue barricading our bodies against the outside world for centuries to come.

**P344 2016-04-06 Does grammar matter - Andreea S. Calude**

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You're telling a friend an amazing story, and you just get to the best part when suddenly he interrupts, "The alien and I," not "Me and the alien." Most of us would probably be annoyed, but aside from the rude interruption, does your friend have a point? Was your sentence actually grammatically incorrect? And if he still understood it, why does it even matter? From the point of view of linguistics, grammar is a set of patterns for how words are put together to form phrases or clauses, whether spoken or in writing. Different languages have different patterns. In English, the subject normally comes first, followed by the verb, and then the object, while in Japanese and many other languages, the order is subject, object, verb. Some scholars have tried to identify patterns common to all languages, but apart from some basic features, like having nouns or verbs, few of these so-called linguistic universals have been found. And while any language needs consistent patterns to function, the study of these patterns opens up an ongoing debate between two positions known as prescriptivism and descriptivism. Grossly simplified, prescriptivists think a given language should follow consistent rules, while descriptivists see variation and adaptation as a natural and necessary part of language. For much of history, the vast majority of language was spoken. But as people became more interconnected and writing gained importance, written language was standardized to allow broader communication and ensure that people in different parts of a realm could understand each other. In many languages, this standard form came to be considered the only proper one, despite being derived from just one of many spoken varieties, usually that of the people in power. Language purists worked to establish and propagate this standard by detailing a set of rules that reflected the established grammar of their times. And rules for written grammar were applied to spoken language, as well. Speech patterns that deviated from the written rules were considered corruptions, or signs of low social status, and many people who had grown up speaking in these ways were forced to adopt the standardized form. More recently, however, linguists have understood that speech is a separate phenomenon from writing with its own regularities and patterns. Most of us learn to speak at such an early age that we don't even remember it. We form our spoken repertoire through unconscious habits, not memorized rules. And because speech also uses mood and intonation for meaning, its structure is often more flexible, adapting to the needs of speakers and listeners. This could mean avoiding complex clauses that are hard to parse in real time, making changes to avoid awkward pronounciation, or removing sounds to make speech faster. The linguistic approach that tries to understand and map such differences without dictating correct ones is known as descriptivism. Rather than deciding how language should be used, it describes how people actually use it, and tracks the innovations they come up with in the process. But while the debate between prescriptivism and descriptivism continues, the two are not mutually exclusive. At its best, prescriptivism is useful for informing people about the most common established patterns at a given point in time. This is important, not only for formal contexts, but it also makes communication easier between non-native speakers from different backgrounds. Descriptivism, on the other hand, gives us insight into how our minds work and the instinctive ways in which we structure our view of the world. Ultimately, grammar is best thought of as a set of linguistic habits that are constantly being negotiated and reinvented by the entire group of language users. Like language itself, it's a wonderful and complex fabric woven through the contributions of speakers and listeners, writers and readers, prescriptivists and descriptivists, from both near and far.

**P345 2016-04-15 Why is being scared so fun - Margee Kerr**

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Somewhere right now, people are lining up to scare themselves, maybe with a thrill ride or horror movie. In fact, in October of 2015 alone, about 28 million people visited a haunted house in the U.S. But many consider this behavior perplexing, asking the question, "What could possibly be fun about being scared?" Fear has a bad rap, but it's not all bad. For starters, fear can actually feel pretty good. When a threat triggers our fight or flight response, our bodies prepare for danger by releasing chemicals that change how our brains and bodies function. This automatic response jumpstarts systems that can aid in survival. They do this by making sure we have enough energy and are protected from feeling pain, while shutting down nonessential systems, like critical thought. Feeling pain-free and energized, while not getting caught up in worrisome thoughts that normally occupy our brains, that all sounds great, and it can be because this response is similar, though not exactly the same to what we experience in positive, high-arousal states, like excitement, happiness, and even during sex. The difference lays in the context. If we're in real danger, we're focused on survival, not fun. But when we trigger this high arousal response in a safe place, we can switch over to enjoying the natural high of being scared. It's why people on roller coasters can go from screaming to laughing within moments. Your body is already in a euphoric state. You're just relabeling the experience. And though the threat response is universal, research shows differences between individuals in how the chemicals associated with the threat response work. This explains why some are more prone to thrill-seeking than others. Other normal physical differences explain why some may love the dizziness associated with a loop-de-loop, while loathing the stomach-drop sensation of a steep roller coaster, or why some squeal with delight inside a haunted house, but retreat in terror if taken to an actual cemetery. Fear brings more than just a fun, natural high. Doing things that we're afraid of can give us a nice boost of self-esteem. Like any personal challenge, whether it's running a race or finishing a long book, when we make it through to the end, we feel a sense of accomplishment. This is true even if we know we're not really in any danger. Our thinking brains may know the zombies aren't real, but our bodies tell us otherwise. The fear feels real, so when we make it through alive, the satisfaction and sense of accomplishment also feel real. This is a great evolutionary adaptation. Those who had the right balance of bravery and wit to know when to push through the fear and when to retreat were rewarded with survival, new food, and new lands. Finally, fear can bring people together. Emotions can be contagious, and when you see your friend scream and laugh, you feel compelled to do the same. This is because we make sense of what our friends are experiencing by recreating the experience ourselves. In fact, the parts of the brain that are active when our friend screams are active in us when we watch them. This not only intensifies our own emotional experience, but makes us feel closer to those we're with. The feeling of closeness during times of fear is aided by the hormone oxytocin released during fight or flight. Fear is a powerful emotional experience, and anything that triggers a strong reaction is going to be stored in our memory really well. You don't want to forget what can hurt you. So if your memory of watching a horror film with your friends is positive and left you with a sense of satisfaction, then you'll want to do it over and over again.

**P346 2016-04-21 The Turing test - Can a computer pass for a human - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=346)

What is consciousness? Can an artificial machine really think? Does the mind just consist of neurons in the brain, or is there some intangible spark at its core? For many, these have been vital considerations for the future of artificial intelligence. But British computer scientist Alan Turing decided to disregard all these questions in favor of a much simpler one: can a computer talk like a human? This question led to an idea for measuring aritificial intelligence that would famously come to be known as the Turing test. In the 1950 paper, "Computing Machinery and Intelligence," Turing proposed the following game. A human judge has a text conversation with unseen players and evaluates their responses. To pass the test, a computer must be able to replace one of the players without substantially changing the results. In other words, a computer would be considered intelligent if its conversation couldn't be easily distinguished from a human's. Turing predicted that by the year 2000, machines with 100 megabytes of memory would be able to easily pass his test. But he may have jumped the gun. Even though today's computers have far more memory than that, few have succeeded, and those that have done well focused more on finding clever ways to fool judges than using overwhelming computing power. Though it was never subjected to a real test, the first program with some claim to success was called ELIZA. With only a fairly short and simple script, it managed to mislead many people by mimicking a psychologist, encouraging them to talk more and reflecting their own questions back at them. Another early script PARRY took the opposite approach by imitating a paranoid schizophrenic who kept steering the conversation back to his own preprogrammed obsessions. Their success in fooling people highlighted one weakness of the test. Humans regularly attribute intelligence to a whole range of things that are not actually intelligent. Nonetheless, annual competitions like the Loebner Prize, have made the test more formal with judges knowing ahead of time that some of their conversation partners are machines. But while the quality has improved, many chatbot programmers have used similar strategies to ELIZA and PARRY. 1997's winner Catherine could carry on amazingly focused and intelligent conversation, but mostly if the judge wanted to talk about Bill Clinton. And the more recent winner Eugene Goostman was given the persona of a 13-year-old Ukrainian boy, so judges interpreted its nonsequiturs and awkward grammar as language and culture barriers. Meanwhile, other programs like Cleverbot have taken a different approach by statistically analyzing huge databases of real conversations to determine the best responses. Some also store memories of previous conversations in order to improve over time. But while Cleverbot's individual responses can sound incredibly human, its lack of a consistent personality and inability to deal with brand new topics are a dead giveaway. Who in Turing's day could have predicted that today's computers would be able to pilot spacecraft, perform delicate surgeries, and solve massive equations, but still struggle with the most basic small talk? Human language turns out to be an amazingly complex phenomenon that can't be captured by even the largest dictionary. Chatbots can be baffled by simple pauses, like "umm..." or questions with no correct answer. And a simple conversational sentence, like, "I took the juice out of the fridge and gave it to him, but forgot to check the date," requires a wealth of underlying knowledge and intuition to parse. It turns out that simulating a human conversation takes more than just increasing memory and processing power, and as we get closer to Turing's goal, we may have to deal with all those big questions about consciousness after all.

**P347 2016-04-22 Why do cats act so weird - Tony Buffington**

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Why do cats do that? They're cute, they're lovable, and judging by the 26 billions views of over 2 million YouTube videos of them pouncing, bouncing, climbing, cramming, stalking, clawing, chattering, and purring, one thing is certain: cats are very entertaining. These somewhat strange feline behaviors, both amusing and baffling, leave many of us asking, "Why do cats do that?" Throughout time, cats were simultaneously solitary predators of smaller animals and prey for larger carnivores. As both predator and prey, survival of their species depended on crucial instinctual behaviors which we still observe in wild and domestic cats today. While the feline actions of your house cat Grizmo might seem perplexing, in the wild, these same behaviors, naturally bred into cats for millions of years, would make Grizmo a super cat. Enabled by their unique muscular structure and keen balancing abilities, cats climbed to high vantage points to survey their territory and spot prey in the wild. Grizmo doesn't need these particular skills to find and hunt down dinner in her food bowl today, but instinctually, viewing the living room from the top of the bookcase is exactly what she has evolved to do. As wild predators, cats are opportunistic and hunt whenever prey is available. Since most cat prey are small, cats in the wild needed to eat many times each day, and use a stalk, pounce, kill, eat strategy to stay fed. This is why Grizmo prefers to chase and pounce on little toys and eat small meals over the course of the day and night. Also, small prey tend to hide in tiny spaces in their natural environments, so one explanation for Grizmo's propensity to reach into containers and openings is that she is compelled by the same curiosity that helped ensure the continuation of her species for millions of years before. In the wild, cats needed sharp claws for climbing, hunting, and self-defense. Sharpening their claws on nearby surfaces kept them conditioned and ready, helped stretch their back and leg muscles, and relieve some stress, too. So, it's not that Grizmo hates your couch, chair, ottoman, pillows, curtains, and everything else you put in her environment. She's ripping these things to shreds and keeping her claws in tip-top shape because this is exactly what her ancestors did in order to survive. As animals that were preyed upon, cats evolved to not get caught, and in the wild, the cats that were the best at avoiding predators thrived. So at your house today, Grizmo is an expert at squeezing into small spaces and seeking out and hiding in unconventional spots. It also explains why she prefers a clean and odor-free litter box. That's less likely to give away her location to any predators that may be sniffing around nearby. Considering everything we do know about cats, it seems that one of their most predominate behaviors is still one of the most mysterious. Cats may purr for any number of reasons, such as happiness, stress, and hunger. But curiously, the frequency of their purrs, between 25 and 150 hertz, is within a range that can promote tissue regeneration. So while her purring makes Grizmo an excellent nap companion, it is also possible that her purr is healing her muscles and bones, and maybe even yours, too. They developed through time as both solitary predators that hunted and killed to eat, and stealthy prey that hid and escaped to survive. So cats today retain many of the same instincts that allowed them to thrive in the wild for millions of years. This explains some of their seemingly strange behaviors. To them, our homes are their jungles. But if this is the case, in our own cat's eyes, who are we? Big, dumb, hairless cats competing with them for resources? Terribly stupid predators they're able to outsmart every day? Or maybe they think we're the prey.

**P348 2016-04-28 The threat of invasive species - Jennifer Klos**

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Massive vines that blanket the southern United States, climbing as high as 100 feet as they uproot trees and swallow buildings. A ravenous snake that is capable of devouring an alligator. Rabbit populations that eat themselves into starvation. These aren't horror movie concepts. They're real stories, but how could such situations exist in nature? All three are examples of invasive species, organisms harmful not because of what they are, but where they happen to be. The kudzu vine, for example, had grown quality in its native east Asia, eaten by various insects and dying off during the cold winters. But its fortunes changed when it was imported into the southeastern United States for porch decoration and cattle feed. Its planting was even subsidized by the government to fight soil erosion. With sunny fields, a mild climate, and no natural predators in its new home, the vine grew uncontrollably until it became known as the plant that ate the South. Meanwhile in Florida's Everglades, Burmese pythons, thought to have been released by pet owners, are the cause of decreasing populations of organisms. They're successfully outcompeting top predators, such as the alligator and panther, causing a significant reduction in their food sources. They're not a problem in their native Asia because diseases, parasites, and predators help to control their population size. And in Australia, European rabbits eat so many plants that they wipe out the food supply for themselves and other herbivores. They're a pretty recent addition, intentionally introduced to the continent because one man enjoyed hunting them. Like the Burmese pythons, various factors in their native habitat keep their numbers in control. But in Australia, the lack of predators and a climate perfect for year-long reproduction allows their populations to skyrocket. So why does this keep happening? Most of the world's ecosystems are the result of millennia of coevolution by organisms, adapting to their environment and each other until a stable balance is reached. Healthy ecosystems maintain this balance via limiting factors, environmental conditions that restrict the size or range of a species. These include things like natural geography and climate, food availability, and the presence or absence of predators. For example, plant growth depends on levels of sunlight and soil nutrients. The amount of edible plants affects the population of herbivores, which in turn impacts the carnivores that feed on them. And a healthy predator population keeps the herbivores from becoming too numerous and devouring all the plants. But even minor changes in one factor can upset this balance, and the sudden introduction of non-native organisms can be a pretty major change. A species that is evolved in a separate habitat will be susceptible to different limiting factors, different predators, different energy sources, and different climates. If the new habitat's limiting factors fail to restrict the species growth, it will continue to multiply, out-competing native organisms for resources and disrupting the entire ecosystem. Species are sometimes introduced into new habitats through natural factors, like storms, ocean currents, or climate shifts. The majority of invasive species, though, are introduced by humans. Often this happens unintentionally, as when the zebra mussel was accidentally brought to Lake Erie by cargo ships. But as people migrate around the world, we have also deliberately brought our plants and animals along, rarely considering the consequences. But now that we're learning more about the effects of invasive species on ecosystems, many governments closely monitor the transport of plants and animals, and ban the imports of certain organisms. But could the species with the most drastic environmental impact be a group of primates who emerged from Africa to cover most of the world? Are we an invasive species?

**P349 2016-04-29 Can plants talk to each other - Richard Karban**

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Can plants talk to each other? It certainly doesn't seem that way. Plants don't have complex sensory or nervous systems like animals do, and they look pretty passive, basking in the sun, and responding instinctively to inputs like light and water. But odd as it sounds, plants can communicate with each other. Just like animals, plants produce all kinds of chemical signals in response to their environments, and they can share those signals with each other, especially when they're under attack. These signals take two routes: through the air, and through the soil. When plant leaves get damaged, whether by hungry insects or an invading lawn mower, they release plumes of volatile chemicals. They're what's responsible for the smell of freshly cut grass. Certain kinds of plants, like sagebrush and lima beans, are able to pick up on those airborne messages and adjust their own internal chemistry accordingly. In one experiment, sagebrush leaves were deliberately damaged by insects or scissor-wielding scientists. Throughout the summer, other branches on the same sagebrush plant got eaten less by insects wandering through, and so did branches on neighboring bushes, suggesting that they had beefed up their anti-insect defenses. Even moving the air from above a clipped plant to another one made the second plant more insect-resistant. These airborne cues increase the likelihood of seedling survival, and made adult plants produce more new branches and flowers. But why would a plant warn its neighbors of danger, especially if they're competing for resources? Well, it might be an accidental consequence of a self-defense mechanism. Plants can't move information through their bodies as easily as we can, especially if water is scarce. So plants may rely on those airborne chemicals to get messages from one part of a plant to another. Nearby plants can eavesdrop on those signals, like overhearing your neighbor sneeze and stocking up on cold medicine. Different plants convey those warnings using different chemical languages. Individual sagebrush plants in the same meadow release slightly different sets of alarm chemicals. The makeup of that cocktail influences the effectiveness of communication. The more similar two plants' chemical fingerprints are, the more fluently they can communicate. A plant will be most sensitive to the cues emitted by its own leaves. But because these chemicals seem to be inherited, like human blood types, sagebrush plants communicate more effectively with relatives than with strangers. But sometimes, even other species can benefit. Tomato and tobacco plants can both decipher sagebrush warning signals. Plants don't have to rely solely on those airborne broadcasts. Signals can travel below the soil surface, too. Most plants have a symbiotic relationship with fungi, which colonize the plants' roots and help them absorb water and nutrients. These fungal filaments form extensive networks that can connect separate plants, creating an underground super highway for chemical messages. When a tomato plant responds to blight by acitvating disease-fighting genes and enzymes, signaling molecules produced by its immune system can travel to a healthy plant and prompt it to turn on its immune system, too. These advance warnings increase the plants chance of survival. Bean plants also eavesdrop on each other's health through these fungal conduits. An aphid investation in one plant triggers its neighbor to ramp up production of compounds that repel aphids and attract aphid-eating wasps. If you think of communication as an exchange of information, then plants seem to be active communicators. They're sending, receiving, and responding to signals without making a sound, and without brains, noses, dictionaries, or the Internet. And if we can learn to speak to them on their terms, we may gain a powerful new tool to protect crops and other valuable species. It all makes you wonder what else are we missing?

**P350 2016-05-04 How do we separate the seemingly inseparable - Iddo Magen**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=350)

Your cell phone is mainly made of plastics and metals. It's easy to appreciate the inventive process by which those elements are made to add up to something so useful and entertaining. But there's another story we don't hear about as much. How did we get our raw ingredients in the first place from the chaotic tangle of materials that is nature? The answer is a group of clever hacks known as separation techniques. They work by taking advantage of the fundamental properties of things to disentangle them from each other. Simple separation techniques apply to many physical scenarios, like separating cream from milk, extracting water from soil, or even sifting out flecks of gold from river sand. But not all mixtures are so easy to unravel. In some of those cases, we can exploit the differences between physical properties within a mixture, like particle size, density, or boiling point to extract what's required. Take petroleum, a mixture of different types of hydrocarbons. Some of these are valuable as fuels, and others make good raw materials for generating electric power. To separate them, experts rely on one important feature: different hydrocarbons boil at different temperatures. During the boiling process, each type vaporizes at a precise point, then gets separately funneled into a container and collected as a liquid as it cools. Separation techniques also take us to the sea. In some drought-stricken countries, the ocean is the only available water source. But of course, humans can't drink salt water. One way to get around this problem is to remove salt from sea water with reverse osmosis, a process that separates water's ingredients by size. A membrane with pores bigger than water particles, but smaller than salt particles, only lets fresh water pass through, transforming what was once undrinkable into a life saver. Meanwhile in the medical world, blood tests are a vital tool for evaluating a person's health, but doctors typically can't examine blood samples until they've separated the solid blood cells from the liquid plasma they're dissolved in. To do that, a powerful rotational force is exerted on the test tube, causing heavier substances with higher density, like blood cells, to move away from the rotational axis. Meanwhile, lighter substances with lower density, like plasma, move to its center. The tube's contents divide clearly, and the blood cells and liquid plasma can be tested independently. But sometimes, unlike oil, seawater, and blood, the parts of mixtures that we want to separate share the same physical properties. In these cases, the only way to isolate ingredients is by chemical separation, a complex process that relies on unique interactions between components within a mixture and another material. One of these methods is chromatography, a tool forensic scientists use to examine crime scenes. They dissolve gathered evidence in a gas, and can monitor and analyze the ingredients as they separate and move at varying speeds due to their unique chemical properties. That information then tells scientists precisely what was present at the scene, often helping to identify the culprit. Separation techniques are not just about industry, infrastructure, medicine, and justice. One of the most technically ambitious projects in human history is a separation technique aimed at answering the fundamental question, "What is the Universe made of?" By accelerating particles to extremely high speeds and smashing them into each other, we can break them into their constituent parts ever so briefly. And if we succeed at that, what's next? Is there a most elementary particle? And if so, what's it made of?

**P351 2016-05-04 Who IS Sherlock Holmes - Neil McCaw**

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More than a century after first emerging into the fog-bound, gas-lit streets of Victorian London, Sherlock Holmes is universally recognizable. Even his wardrobe and accessories are iconic: the Inverness cape, deerstalker hat, and calabash pipe, and figures such as his best friend and housemate Doctor Watson, arch-nemesis Moriarty, and housekeeper Mrs. Hudson have become part of the popular consciousness, as have his extraordinary, infallible powers of deduction utilized in the name of the law, his notorious drug use, and his popular catchphrase, "Elementary, my dear Watson." And yet many of these most recognizable features of Holmes don't appear in Arthur Conan Doyle's original stories. Doyle's great detective solves crimes in all sorts of ways, not just using deduction. He speculates, and at times even guesses, and regularly makes false assumptions. Furthermore, Mrs. Hudson is barely mentioned, no one says, "Elementary, my dear Watson," and the detective and his sidekick live apart for much of the time. Moriarty, the grand villain, only appears in two stories, the detective's drug use is infrequent after the first two novels, and Holmes is rarely enthralled to the English legal system; He much prefers enacting his own form of natural justice to sticking to the letter of the law. Finally, many of the most iconic elements of the Holmesian legend aren't Doyle's either. The deerstalker cap and cape were first imagined by Sidney Paget, the story's initial illustrator. the curved pipe was chosen by American actor William Gillette so that audiences could more clearly see his face on stage, and the phrase, "Elementary, my dear Watson," was coined by author and humorist P.G. Wodehouse. So who exactly is Sherlock Holmes? Who's the real great detective, and where do we find him? Purists might answer that the original Sherlock inspired by Arthur Conan Doyle's university mentor Dr. Joseph Bell is the real one. But the fact remains that that version of Sherlock has been largely eclipsed by the sheer volume of interpretation, leaving Doyle's detective largely unrecognizable. So there's another, more complex, but perhaps more satisfying answer to the question, but to get there, we must first consider the vast body of interpretations of the great detective. Since Conan Doyle's first story in 1887, there have been thousands of adaptations of Holmes, making him perhaps the most adapted fictional character in the world. That process began with Victorian stage adaptations, and accelerated with the emergence of film. There were more than 100 film adaptations of Holmes in the first two decades of the 20th century alone. And since then, there have many thousands more in print, and on film, television, stage, and radio. Holmes has been reinterpreted by people everywhere, in remarkably different, and often contradictory ways. These adaptations demonstrate both Holmes's popularity and his malleability. For instance, he featured in a number of allied anti-Nazi propaganda films during World War II. And both Winston Churchill and Franklin Delano Roosevelt were avid enthusiasts, the latter even joining the Baker Street Irregulars, a Holmesian appreciation society, and nicknaming one secret service hideout Baker Street. And yet, at the very same time, Holmes also appeared in various German-language film adaptations, some of which were said to have been much-loved favorites of Adolf Hitler. So let's return to our question. Would the real Sherlock Holmes please stand up? The truth is that this world of adaptation has made him into a palimpsest. Sherlock is a cultural text, repeatedly altered over time as each new interpretation becomes superimposed over those that proceed it. This means that Sherlock continually evolves, embodying ideas and values often far removed from those found in Conan Doyle. And after each particular story ends, Sherlock rises again, a little changed, perhaps, with a new face and fresh mannerisms or turns of phrase, but still essentially Sherlock, our Sherlock.

**P352 2016-05-05 Why is the US Constitution so hard to amend - Peter Paccone**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=352)

When it was ratified in 1789, the U.S. Constitution didn't just institute a government by the people. It provided a way for the people to alter the constitution itself. And yet, of the nearly 11,000 amendments proposed in the centuries since, only 27 have succeeded as of 2016. So what is it that makes the Constitution so hard to change? In short, its creators. The founders of the United States were trying to create a unified country from thirteen different colonies, which needed assurance that their agreements couldn't be easily undone. So here's what they decided. For an amendment to even be proposed, it must receive a two-thirds vote of approval in both houses of Congress, or a request from two-thirds of state legislatures to call a national convention, and that's just the first step. To actually change the Constitution, the amendment must be ratified by three-quarters of all states. To do this, each state can either have its legislature vote on the amendment, or it can hold a separate ratification convention with delegates elected by voters. The result of such high thresholds is that, today, the American Constitution is quite static. Most other democracies pass amendments every couple of years. The U.S., on the other hand, hasn't passed one since 1992. At this point, you may wonder how any amendments managed to pass at all. The first ten, known as the Bill of Rights, includes some of America's most well-known freedoms, such as the freedom of speech, and the right to a fair trial. These were passed all at once to resolve some conflicts from the original Constitutional Convention. Years later, the Thirteenth Amendment, which abolished slavery, as well as the Fourteenth and Fifteenth Amendments, only passed after a bloody civil war. Ratifying amendments has also become harder as the country has grown larger and more diverse. The first ever proposed amendment, a formula to assign congressional representatives, was on the verge of ratification in the 1790s. However, as more and more states joined the union, the number needed to reach the three-quarter mark increased as well, leaving it unratified to this day. Today, there are many suggested amendments, including outlawing the burning of the flag, limiting congressional terms, or even repealing the Second Amendment. While many enjoy strong support, their likelihood of passing is slim. Americans today are the most politically polarized since the Civil War, making it nearly impossible to reach a broad consensus. In fact, the late Supreme Court Justice Antonin Scalia once calculated that due to America's representative system of government, it could take as little as 2% of the total population to block an amendment. Of course, the simplest solution would be to make the Constitution easier to amend by lowering the thresholds required for proposal and ratification. That, however, would require its own amendment. Instead, historical progress has mainly come from the U.S. Supreme Court, which has expanded its interpretation of existing constitutional laws to keep up with the times. Considering that Supreme Court justices are unelected and serve for life once appointed, this is far from the most democratic option. Interestingly, the founders themselves may have foreseen this problem early on. In a letter to James Madison, Thomas Jefferson wrote that laws should expire every 19 years rather than having to be changed or repealed since every political process is full of obstacles that distort the will of the people. Although he believed that the basic principles of the Constitution would endure, he stressed that the Earth belongs to the living, and not to the dead.

**P353 2016-05-06 How computer memory works - Kanawat Senanan**

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In many ways, our memories make us who we are, helping us remember our past, learn and retain skills, and plan for the future. And for the computers that often act as extensions of ourselves, memory plays much the same role, whether it's a two-hour movie, a two-word text file, or the instructions for opening either, everything in a computer's memory takes the form of basic units called bits, or binary digits. Each of these is stored in a memory cell that can switch between two states for two possible values, 0 and 1. Files and programs consist of millions of these bits, all processed in the central processing unit, or CPU, that acts as the computer's brain. And as the number of bits needing to be processed grows exponentially, computer designers face a constant struggle between size, cost, and speed. Like us, computers have short-term memory for immediate tasks, and long-term memory for more permanent storage. When you run a program, your operating system allocates area within the short-term memory for performing those instructions. For example, when you press a key in a word processor, the CPU will access one of these locations to retrieve bits of data. It could also modify them, or create new ones. The time this takes is known as the memory's latency. And because program instructions must be processed quickly and continuously, all locations within the short-term memory can be accessed in any order, hence the name random access memory. The most common type of RAM is dynamic RAM, or DRAM. There, each memory cell consists of a tiny transistor and a capacitor that store electrical charges, a 0 when there's no charge, or a 1 when charged. Such memory is called dynamic because it only holds charges briefly before they leak away, requiring periodic recharging to retain data. But even its low latency of 100 nanoseconds is too long for modern CPUs, so there's also a small, high-speed internal memory cache made from static RAM. That's usually made up of six interlocked transistors which don't need refreshing. SRAM is the fastest memory in a computer system, but also the most expensive, and takes up three times more space than DRAM. But RAM and cache can only hold data as long as they're powered. For data to remain once the device is turned off, it must be transferred into a long-term storage device, which comes in three major types. In magnetic storage, which is the cheapest, data is stored as a magnetic pattern on a spinning disc coated with magnetic film. But because the disc must rotate to where the data is located in order to be read, the latency for such drives is 100,000 times slower than that of DRAM. On the other hand, optical-based storage like DVD and Blu-ray also uses spinning discs, but with a reflective coating. Bits are encoded as light and dark spots using a dye that can be read by a laser. While optical storage media are cheap and removable, they have even slower latencies than magnetic storage and lower capacity as well. Finally, the newest and fastest types of long-term storage are solid-state drives, like flash sticks. These have no moving parts, instead using floating gate transistors that store bits by trapping or removing electrical charges within their specially designed internal structures. So how reliable are these billions of bits? We tend to think of computer memory as stable and permanent, but it actually degrades fairly quickly. The heat generated from a device and its environment will eventually demagnetize hard drives, degrade the dye in optical media, and cause charge leakage in floating gates. Solid-state drives also have an additional weakness. Repeatedly writing to floating gate transistors corrodes them, eventually rendering them useless. With data on most current storage media having less than a ten-year life expectancy, scientists are working to exploit the physical properties of materials down to the quantum level in the hopes of making memory devices faster, smaller, and more durable. For now, immortality remains out of reach, for humans and computers alike.

**P354 2016-05-10 The psychology behind irrational decisions - Sara Garofalo**

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Let's say you're on a game show. You've already earned $1000 in the first round when you land on the bonus space. Now, you have a choice. You can either take a $500 bonus guaranteed or you can flip a coin. If it's heads, you win $1000 bonus. If it's tails, you get no bonus at all. In the second round, you've earned $2000 when you land on the penalty space. Now you have another choice. You can either take a $500 loss, or try your luck at the coin flip. If it's heads, you lose nothing, but if it's tails, you lose $1000 instead. If you're like most people, you probably chose to take the guaranteed bonus in the first round and flip the coin in the second round. But if you think about it, this makes no sense. The odds and outcomes in both rounds are exactly the same. So why does the second round seem much scarier? The answer lies in a phenomenon known as loss aversion. Under rational economic theory, our decisions should follow a simple mathematical equation that weighs the level of risk against the amount at stake. But studies have found that for many people, the negative psychological impact we feel from losing something is about twice as strong as the positive impact of gaining the same thing. Loss aversion is one cognitive bias that arises from heuristics, problem-solving approaches based on previous experience and intuition rather than careful analysis. And these mental shortcuts can lead to irrational decisions, not like falling in love or bungee jumping off a cliff, but logical fallacies that can easily be proven wrong. Situations involving probability are notoriously bad for applying heuristics. For instance, say you were to roll a die with four green faces and two red faces twenty times. You can choose one of the following sequences of rolls, and if it shows up, you'll win $25. Which would you pick? In one study, 65% of the participants who were all college students chose sequence B even though A is shorter and contained within B, in other words, more likely. This is what's called a conjunction fallacy. Here, we expect to see more green rolls, so our brains can trick us into picking the less likely option. Heuristics are also terrible at dealing with numbers in general. In one example, students were split into two groups. The first group was asked whether Mahatma Gandhi died before or after age 9, while the second was asked whether he died before or after age 140. Both numbers were obviously way off, but when the students were then asked to guess the actual age at which he died, the first group's answers averaged to 50 while the second group's averaged to 67. Even though the clearly wrong information in the initial questions should have been irrelevant, it still affected the students' estimates. This is an example of the anchoring effect, and it's often used in marketing and negotiations to raise the prices that people are willing to pay. So, if heuristics lead to all these wrong decisions, why do we even have them? Well, because they can be quite effective. For most of human history, survival depended on making quick decisions with limited information. When there's no time to logically analyze all the possibilities, heuristics can sometimes save our lives. But today's environment requires far more complex decision-making, and these decisions are more biased by unconscious factors than we think, affecting everything from health and education to finance and criminal justice. We can't just shut off our brain's heuristics, but we can learn to be aware of them. When you come to a situation involving numbers, probability, or multiple details, pause for a second and consider that the intuitive answer might not be the right one after all.

**P355 2016-05-16 The microbial jungles all over the place (and you) - Scott Chimileski**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=355)

As we walk through our daily environments, we're surrounded by exotic creatures that are too small to see with the naked eye. We usually imagine these microscopic organisms, or microbes, as asocial cells that float around by themselves. But in reality, microbes gather by the millions to form vast communities known as biofilms. Natural biofilms are like miniature jungles filled with many kinds of microbes from across the web of life. Bacteria and archaea mingle with other microbes like algae, fungi, and protozoa, forming dense, organized structures that grow on almost any surface. When you pad across a river bottom, touch the rind of an aged cheese, tend your garden soil, or brush your teeth, you're coming into contact with these invisible ecosystems. To see how biofilms come about, let's watch one as it develops on a submerged river rock. This type of biofilm might begin with a few bacteria swimming through their liquid environment. The cells use rotating flagella to propel towards the surface of the rock, which they attach to with the help of sticky appendages. Then, they start producing an extracellular matrix that holds them together as they divide and reproduce. Before long, microcolonies arise, clusters of cells sheathed in this slimy, glue-like material. Microcolonies grow to become towers, while water channels flow around them, functioning like a basic circulatory system. But why do microbes build such complex communities when they could live alone? For one thing, microbes living in a biofilm are rooted in a relatively stable microenvironment where they may have access to a nutrient source. There's also safety in numbers. Out in the deep, dark wilderness of the microbial world, isolated microbes face serious risks. Predators want to eat them, immune systems seek to destroy them, and there are physical dangers, too, like running out of water and drying up. However, in a biofilm, the extracellular matrix shields microbes from external threats. Biofilms also enable interactions between individual cells. When microbes are packed against each other in close proximity, they can communicate, exchange genetic information, and engage in cooperative and competitive social behaviors. Take the soil in your garden, home to thousands of bacterial species. As one species colonizes a plant root, its individual cells might differentiate into various subpopulations, each carrying out a specific task. Matrix producers pump out the extracellular goo, swimmers assemble flagella and are free to move about or migrate, and spore-formers produce dormant, tough endospores that survive starvation, temperature extremes, and harmful radiation. This phenomenon is called division of labor. Ultimately, it gives rise to a sophisticated system of cooperation that's somewhat like a multicellular organism in itself. But because biofilms often contain many different microbes that aren't closely related to each other, interactions can also be competitive. Bacteria launch vicious attacks on their competitors by secreting chemicals into the environment, or by deploying molecular spears to inject nearby cells with toxins that literally blow them up. In the end, competition is all about resources. If one species eliminates another, it keeps more space and food for itself. Although this dramatic life cycle occurs beyond the limits of our vision, microbial communities provide humans and other species with tangible, and sometimes even delicious, benefits. Microbes make up a major fraction of the biomass on Earth and play a critical role within the global ecosystem that supports all larger organisms, including us. They produce much of the oxygen we breath, and are recruited to clean up environmental pollution, like oil spills, or to treat our waste water. Not to mention, biofilms are normal and flavor enhancing parts of many of the foods we enjoy, including cheese, salami, and kombucha. So the next time you brush your teeth, bite into that cheese rind, sift through garden soil, or skip a river stone, look as close as you can. Imagine the microbial jungles all around you waiting to be discovered and explored.

**P356 2016-05-17 Making sense of irrational numbers - Ganesh Pai**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=356)

Like many heroes of Greek myths, the philosopher Hippasus was rumored to have been mortally punished by the gods. But what was his crime? Did he murder guests, or disrupt a sacred ritual? No, Hippasus's transgression was a mathematical proof: the discovery of irrational numbers. Hippasus belonged to a group called the Pythagorean mathematicians who had a religious reverence for numbers. Their dictum of, "All is number," suggested that numbers were the building blocks of the Universe and part of this belief was that everything from cosmology and metaphysics to music and morals followed eternal rules describable as ratios of numbers. Thus, any number could be written as such a ratio. 5 as 5/1, 0.5 as 1/2 and so on. Even an infinitely extending decimal like this could be expressed exactly as 34/45. All of these are what we now call rational numbers. But Hippasus found one number that violated this harmonious rule, one that was not supposed to exist. The problem began with a simple shape, a square with each side measuring one unit. According to Pythagoras Theorem, the diagonal length would be square root of two, but try as he might, Hippasus could not express this as a ratio of two integers. And instead of giving up, he decided to prove it couldn't be done. Hippasus began by assuming that the Pythagorean worldview was true, that root 2 could be expressed as a ratio of two integers. He labeled these hypothetical integers p and q. Assuming the ratio was reduced to its simplest form, p and q could not have any common factors. To prove that root 2 was not rational, Hippasus just had to prove that p/q cannot exist. So he multiplied both sides of the equation by q and squared both sides. which gave him this equation. Multiplying any number by 2 results in an even number, so p^2 had to be even. That couldn't be true if p was odd because an odd number times itself is always odd, so p was even as well. Thus, p could be expressed as 2a, where a is an integer. Substituting this into the equation and simplifying gave q^2 = 2a^2 Once again, two times any number produces an even number, so q^2 must have been even, and q must have been even as well, making both p and q even. But if that was true, then they had a common factor of two, which contradicted the initial statement, and that's how Hippasus concluded that no such ratio exists. That's called a proof by contradiction, and according to the legend, the gods did not appreciate being contradicted. Interestingly, even though we can't express irrational numbers as ratios of integers, it is possible to precisely plot some of them on the number line. Take root 2. All we need to do is form a right triangle with two sides each measuring one unit. The hypotenuse has a length of root 2, which can be extended along the line. We can then form another right triangle with a base of that length and a one unit height, and its hypotenuse would equal root three, which can be extended along the line, as well. The key here is that decimals and ratios are only ways to express numbers. Root 2 simply is the hypotenuse of a right triangle with sides of a length one. Similarly, the famous irrational number pi is always equal to exactly what it represents, the ratio of a circle's circumference to its diameter. Approximations like 22/7, or 355/113 will never precisely equal pi. We'll never know what really happened to Hippasus, but what we do know is that his discovery revolutionized mathematics. So whatever the myths may say, don't be afraid to explore the impossible.

**P357 2016-05-19 The otherworldly creatures in the ocean's deepest depths - Lidia Lins**

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It's easy to forget how vast and deep the ocean really is. About 60% of it is actually a cold and dark region known as the deep ocean. And it reaches down to 11,000 meters. Yet, this remote zone is also one of the greatest habitats on Earth, harboring a huge diversity of life, from giant squids and goblin sharks to minuscule animals smaller than a millimeter. How do so many species thrive in this underwater world? Over the decades, intrepid scientists have ventured there to find out. Traveling down through the water column, pressure increases and light begins to wane. At 200 meters, photosynthesis stops and temperature decreases from surface temperatures by up to 20 degrees Celsius. By 1000 meters, normal sunlight has disappeared altogether. Without light, life as we know it seems impossible. That's why in 1844, the naturalist Edward Forbes wrote his Azoic Theory, Azoic, meaning without animals. Forbes was sure that nothing could survive below 600 meters on account of the lack of light. Of course, the discovery of deep-sea species proved him wrong. What Forbes failed to take into account is something called marine snow, which sounds much nicer than it is. Marine snow is basically organic matter, things like particles of dead algae, plants, and animals, drifting down into the depths and acting as food for deep-sea animals. Largely thanks to that, abundant life forms exist in the darkness, adapting to a harsh reality where only the weird and wonderful can survive. Fish with cavernous mouths, spiky teeth jutting from their jaws, and lamp-like structures protruding from their heads, like the anglerfish which entices prey with its misleading glow. Several sea creatures have perfected this lightning technique known as bioluminescence, using it to lure prey, distract predators, or attract mates. Some creatures use it for camoflauge. In parts of the water column where only faint blue light filters through, animals bioluminesce to match the glow. Predators or prey looking up from below are deceived by this camoflauge, unable to see the creatures silhouette. Such otherworldly adaptations also arise from the need to locate and snatch up food before it drifts away. Some sea animals, like jellyfish, comb jellies and salps can migrate between depths partially because their 90% water consistency allows them to withstand immense pressure. But they're the exception. Most deep-sea creatures are confined to a narrow range in the water column where nutrients are scarce since the food drifting downwards from the surface rapidly sinks to the sea floor. Plunging all the way down, we find more exotic creatures. Some take on dwarfism, a trait that transforms them into miniature versions of animals we see closer to the surface. It's thought that reduced food availability causes the shrinkage. Only a tiny fraction of the food produced at the surface reaches the sea floor, so being small gives animals a low energy requirement and an adaptive advantage. And yet, the sea is also the land of giants. Here, gargantuan squids can reach 18 meters long. Isopods scuttle around the sea floor like enormous wood lice. There are long-limbed Japanese spider crabs, and oarfish, whose bodies stretch to 15 meters. This trait is known as gigantism, and it's something of a mystery. It's thought that high oxygen levels may drive extreme growth in some species, while the colder temperatures promote longer life spans, giving animals the opportunity to grow massive. Many of these exotic sea beasts will never experience sunlight. Some will venture up through the water column to feed, and a few will actually break the waves, reminding us at the surface about the incredible survival skills of the ocean's deepest inhabitants. Humans still have an astounding 95% of the ocean left to explore. So those depths remain a great mystery. What other untold wonders lie far below, and which ones will we discover next?

**P358 2016-05-25 Can you solve the control room riddle - Dennis Shasha**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=358)

As your country's top spy, you must infiltrate the headquarters of the evil syndicate, find the secret control panel, and deactivate their death ray. But all you have to go on is the following information picked up by your surveillance team. The headquarters is a massive pyramid with a single room at the top level, two rooms on the next, and so on. The control panel is hidden behind a painting on the highest floor that can satisfy the following conditions: Each room has exactly three doors to other rooms on that floor, except the control panel room, which connects to only one, there are no hallways, and you can ignore stairs. Unfortunately, you don't have a floor plan, and you'll only have enough time to search a single floor before the alarm system reactivates. Can you figure out which floor the control room is on? Pause now to solve the riddle yourself. Answer in: 3 Answer in: 2 Answer in: 1 To solve this problem, we need to visualize it. For starters, we know that on the correct floor there's one room, let's call it room A, with one door to the control panel room, plus one door to room B, and one to C. So there must be at least four rooms, which we can represent as circles, drawing lines between them for the doorways. But once we connect rooms B and C, there are no other connections possible, so the fourth floor down from the top is out. We know the control panel has to be as high up as possible, so let's make our way down the pyramid. The fifth highest floor doesn't work either. We can figure that out by drawing it, but to be sure we haven't missed any possibilities, here's another way. Every door corresponds to a line in our graph that makes two rooms into neighbors. So in the end, there have to be an even number of neighbors no matter how many connections we make. On the fifth highest floor, to fulfill our starting conditions, we'd need four rooms with three neighbors each, plus the control panel room with one neighbor, which makes 13 total neighbors. Since that's an odd number, it's not possible, and, in fact, this also rules out every floor that has an odd number of rooms. So let's go one more floor down. When we draw out the rooms, low and behold, we can find an arrangement that works like this. Incidentally, the study of such visual models that show the connections and relationships between different objects is known as graph theory. In a basic graph, the circles representing the objects are known as nodes, while the connecting lines are called edges. Researchers studying such graphs ask questions like, "How far is this node from that one?" "How many edges does the most popular node have?" "Is there a route between these two nodes, and if so, how long is it?" Graphs like this are often used to map communication networks, but they can represent almost any kind of network, from transport connections within a city and social relationships among people, to chemical interactions between proteins or the spread of an epidemic through different locations. So, armed with these techniques, back to the pyramid. You avoid the guards and security cameras, infiltrate the sixth floor from the top, find the hidden panel, pull some conspicuous levers, and send the death ray crashing into the ocean. Now, time to solve the mystery of why your surveillance team always gives you cryptic information. Hi everybody. If you liked this riddle, try solving these two.

**P359 2016-05-25 Why do people have seasonal allergies - Eleanor Nelsen**

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Ah, spring. Grass growing, flowers blooming, trees growing new leaves, but if you get allergies, this explosion of new life probably inspires more dread than joy. Step outside, and within minutes, you're sneezing and congested. Your nose is running, your eyes are swollen and watery, your throat is itchy. For you and millions of others, it's seasonal allergy time. So what's behind this onslaught of mucus? The answer lies within you. It's your immune system. Seasonal allergies, also called hay fever, or allergic rhinitis, are a hypersensitive immune response to something that's not actually harmful. Pollen from trees and grass, and mold spores from tiny fungi find their way into your mucous membranes and your body attacks these innocuous travelers the same way it would infectious bacteria. The immune system has a memory. When a foreign substance gets tagged as threatening, white blood cells produce customized antibodies that will recognize the offender the next time around. They then promptly recruit the body's defense team. But sometimes, the immune system accidentally discriminates against harmless substances, like pollen. When it wafts in again, antibodies on the surface of white blood cells recognize it and latch on. This triggers the cell to release inflammatory chemicals, like histamine, which stimulate nerve cells, and cause blood vessels in the mucous membranes to swell and leak fluid. In other words, itchiness, sneezing, congestion, and a runny nose. Allergies usually, but not always, show up for the first time during childhood. But why do some people get allergies and others don't? Allergies tend to run in families, so genetics may be one culprit. In fact, errors in a gene that helps regulate the immune system are associated with higher rates of allergies. The environment you grow up in matters, too. Being exposed to an allergen as a baby makes you less likely to actually develop an allergy to it. People who grow up on farms, in big families, and in the developing world also tend to have fewer allergies, although there are plenty of exceptions, partly thanks to genetics. One theory is that as children, they encounter more of the microbes and parasites that co-evolved with traditional hunter-gatherer societies. Called the hygiene hypothesis, the idea is that when the immune system isn't exposed to the familiar cast of microbes, it'll keep itself busy mounting defenses against harmless substances, like pollen. Another theory is that an immune system toughened up by a barrage of pathogens is less likely to overreact to allergens. Pollen is a common offender, just because we encounter so much of it, but there's a long list of substances: dust, animal dander, insect venom, medications, certain foods, that can send your immune system into overdrive. Some of these reactions can be scary. An allergy can develop into full-blown anaphylaxis, which typically brings on severe swelling, shortness of breath, and very low blood pressure. It can be deadly. The body can even have an allergic reaction to itself causing auto-immune disorders, like multiple sclerosis, lupus, and type 1 diabetes. But even non-life threatening allergy symptoms can make you miserable, so what can you do about it? Medications can help reduce the symptoms. The most common ones keep histamines from binding to your cells. These antihistamines stop the inflammation response. Steroids can help dial down the immune system. Another more permanent option is immunotherapy. Deliberate, controlled exposure to gradually increasing amounts of an allergen can teach the immune system that it isn't dangerous after all. And if you're really adventurous, there's a less traditional option: intestinal parasites. When hookworms sink their teeth into the intestinal wall, they secrete chemicals that blunt the immune system. Some studies suggest that hookworms can treat allergies, which may be another reason allergies are more common in industrialized countries where hookworms are few and far between. Of course, you can always just wait your seasonal allergies out. The spring pollen onslaught dwindles by mid-summer, just in time for ragweed season.

**P360 2016-05-28 The pleasure of poetic pattern - David Silverstein**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=360)

Just for a moment, focus on your breath. In slowly. Out slowly. In slowly. Out. The same pattern repeats within every one of us and consider your pulse. The beat is built into the very fabric of our being. Simply put, we're creatures of rhythm and repetition. It's central to our experience, rhythm and repetition, rhythm and repetition. On, and in, and on, and out. And we delight in those aspects everyday, in the rhythm of a song, the beat of the drum, the nod of your head, or in the repetition of soup cans, the rows of an orchard, the artistry of petals. Pattern can be pleasure. In language, rhythm and repetition are often used as the building blocks for poetry. There's the rhythm of language, created by syllables and their emphasis, such as, "So long as men can breathe or eyes can see." And there's the repetition of language at multiple levels: the repetition of letters, "So long lives this and this gives life to thee," of sounds, "breathe," "see," "thee," and of words. With so many uses, repetition is one of the poet's most malleable and reliable tools. It can lift or lull the listener, amplify or diminish the line, unify or diversify ideas. In fact, even rhythm itself, a repeated pattern of stressed syllables, is a form of repetition. Yet for all its varied uses, too much repetition can backfire. Imagine writing the same sentence on the blackboard twenty times, again, and again, and again, and again, or imagine a young child clamoring for her mother's attention, "Mom, mom, mommy, mom, mom." Not exactly what we might call poetry. So what is poetic repetition, and why does it work? Possibly most familiar is rhyme, the repetition of like sounds in word endings. As with Shakespeare's example, we often encounter rhyme at the ends of lines. Repetition in this way creates an expectation. We begin to listen for the repetition of those similar sounds. When we hear them, the found pattern is pleasurable. Like finding Waldo in the visual chaos, we hear the echo in the oral chatter. Yet, rhyme need not surface solely at a line's end. Notice the strong "i" sound in, "So long lives this and this gives life to thee." This repetition of vowel sounds is called assonance and can also be heard in Eminem's "Lose Yourself." Notice how the "e" and "o" sounds repeat both within in and at the end of each line: "Oh, there goes gravity, Oh, there goes rabbit, he choked, he so mad but he won't give up that easy, no, he won't have it, he knows his whole back's to these ropes." The alternating assonance creates its own rhythm, and invites us to try our own voices in echoing it. Similarly, consonance is the repetition of like consonant sounds, such as the "l" and "th" in, "So long lives this and this gives life to thee." In fact, this type of specific consonance, which occurs at the beginning of words may be familiar to you already. It's called alliteration, or front rhyme. Great examples include tongue twisters. Betty bought some butter but the butter was bitter so Betty bought some better butter to make the bitter butter better. Here, the pleasure in pattern is apparent as we trip over the consonance both within words and at their start. Yet tongue twisters also reflect the need for variation in poetic repetition. While challenging to say, they're seen by some as lesser imitations of poetry, or gimmicky because they hammer so heavily on the same sounds, closer to that blackboard-style of repetition. Ultimately, this is the poet's balancing act, learning when to repeat and when to riff, when to satisfy expectations, and when to thwart them, and in that balance, it may be enough to remember we all live in a world of wild variation and carry with us our own breath and beat, our own repetition wherever we go.

**P361 2016-06-01 How transistors work - Gokul J. Krishnan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=361)

Modern computers are revolutionizing our lives, performing tasks unimaginable only decades ago. This was made possible by a long series of innovations, but there's one foundational invention that almost everything else relies upon: the transistor. So what is that, and how does such a device enable all the amazing things computers can do? Well, at their core, all computers are just what the name implies, machines that perform mathematical operations. The earliest computers were manual counting devices, like the abacus, while later ones used mechanical parts. What made them computers was having a way to represent numbers and a system for manipulating them. Electronic computers work the same way, but instead of physical arrangements, the numbers are represented by electric voltages. Most such computers use a type of math called Boolean logic that has only two possible values, the logical conditions true and false, denoted by binary digits one and zero. They are represented by high and low voltages. Equations are implemented via logic gate circuits that produce an output of one or zero based on whether the inputs satisfy a certain logical statement. These circuits perform three fundamental logical operations, conjunction, disjunction, and negation. The way conjunction works is an "and gate" provides a high-voltage output only if it receives two high-voltage inputs, and the other gates work by similar principles. Circuits can be combined to perform complex operations, like addition and subtraction. And computer programs consist of instructions for electronically performing these operations. This kind of system needs a reliable and accurate method for controlling electric current. Early electronic computers, like the ENIAC, used a device called the vacuum tube. Its early form, the diode, consisted of two electrodes in an evacuated glass container. Applying a voltage to the cathode makes it heat up and release electrons. If the anode is at a slightly higher positive potential, the electrons are attracted to it, completing the circuit. This unidirectional current flow could be controlled by varying the voltage to the cathode, which makes it release more or less electrons. The next stage was the triode, which uses a third electrode called the grid. This is a wire screen between the cathode and anode through which electrons could pass. Varying its voltage makes it either repel or attract the electrons emitted by the cathode, thus, enabling fast current-switching. The ability to amplify signals also made the triode crucial for radio and long distance communication. But despite these advancements, vacuum tubes were unreliable and bulky. With 18,000 triodes, ENIAC was nearly the size of a tennis court and weighed 30 tons. Tubes failed every other day, and in one hour, it consumed the amount of electricity used by 15 homes in a day. The solution was the transistor. Instead of electrodes, it uses a semiconductor, like silicon treated with different elements to create an electron-emitting N-type, and an electron absorbing P-type. These are arranged in three alternating layers with a terminal at each. The emitter, the base, and the collector. In this typical NPN transistor, due to certain phenomena at the P-N interface, a special region called a P-N junction forms between the emitter and base. It only conducts electricity when a voltage exceeding a certain threshold is applied. Otherwise, it remains switched off. In this way, small variations in the input voltage can be used to quickly switch between high and low-output currents. The advantage of the transistor lies in its efficiency and compactness. Because they don't require heating, they're more durable and use less power. ENIAC's functionality can now be surpassed by a single fingernail-sized microchip containing billions of transistors. At trillions of calculations per second, today's computers may seem like they're performing miracles, but underneath it all, each individual operation is still as simple as the flick of a switch.

**P362 2016-06-03 How interpreters juggle two languages at once - Ewandro Magalhaes**

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In 1956, during a diplomatic reception in Moscow, Soviet leader Nikita Khrushchev told Western Bloc ambassadors, "My vas pokhoronim!" His interpreter rendered that into English as, "We will bury you!" This statement sent shockwaves through the Western world, heightening the tension between the Soviet Union and the US who were in the thick of the Cold War. Some believe this incident alone set East/West relations back a decade. As it turns out, Khrushchev's remark was translated a bit too literally. Given the context, his words should have been rendered as, "We will live to see you buried," meaning that Communism would outlast Capitalism, a less threatening comment. Though the intended meaning was eventually clarified, the initial impact of Khrushchev's apparent words put the world on a path that could have led to nuclear armageddon. So now, given the complexities of language and cultural exchange, how does this sort of thing not happen all the time? Much of the answer lies with the skill and training of interpreters to overcome language barriers. For most of history, interpretation was mainly done consecutively, with speakers and interpreters making pauses to allow each other to speak. But after the advent of radio technology, a new simultaneous interpretations system was developed in the wake of World War II. In the simultaneous mode interpreters instantaneously translate a speaker's words into a microphone while he speaks. Without pauses, those in the audience can choose the language in which they want to follow. On the surface, it all looks seamless, but behind the scenes, human interpreters work incessantly to ensure every idea gets across as intended. And that is no easy task. It takes about two years of training for already fluent bilingual professionals to expand their vocabulary and master the skills necessary to become a conference interpreter. To get used to the unnatural task of speaking while they listen, students shadow speakers and repeat their every word exactly as heard in the same language. In time, they begin to paraphrase what is said, making stylistic adjustments as they go. At some point, a second language is introduced. Practicing in this way creates new neural pathways in the interpreter's brain, and the constant effort of reformulation gradually becomes second nature. Over time and through much hard work, the interpreter masters a vast array of tricks to keep up with speed, deal with challenging terminology, and handle a multitude of foreign accents. They may resort to acronyms to shorten long names, choose generic terms over specific, or refer to slides and other visual aides. They can even leave a term in the original language, while they search for the most accurate equivalent. Interpreters are also skilled at keeping aplomb in the face of chaos. Remember, they have no control over who is going to say what, or how articulate the speaker will sound. A curveball can be thrown at any time. Also, they often perform to thousands of people and in very intimidating settings, like the UN General Assembly. To keep their emotions in check, they carefully prepare for an assignment, building glossaries in advance, reading voraciously about the subject matter, and reviewing previous talks on the topic. Finally, interpreters work in pairs. While one colleague is busy translating incoming speeches in real time, the other gives support by locating documents, looking up words, and tracking down pertinent information. Because simultaneous interpretation requires intense concentration, every 30 minutes, the pair switches roles. Success is heavily dependent on skillful collaboration. Language is complex, and when abstract or nuanced concepts get lost in translation, the consequences may be catastrophic. As Margaret Atwood famously noted, "War is what happens when language fails." Conference interpreters of all people are aware of that and work diligently behind the scenes to make sure it never does.

**P363 2016-06-06 Why do our bodies age - Monica Menesini**

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In 1997, a French woman named Jeanne Calment passed away after 122 years and 164 days on this Earth, making her the oldest known person in history. Her age was so astounding that a millionaire pledged $1 million to anyone who could break her record. But in reality, living to this age or beyond is a feat that very few, maybe even no humans, are likely to accomplish. Human bodies just aren't built for extreme aging. Our capacity is set at about 90 years. But what does aging really mean and how does it counteract the body's efforts to stay alive? We know intuitively what it means to age. For some, it means growing up, while for others, it's growing old. Yet finding a strict scientific definition of aging is a challenge. What we can say is that aging occurs when intrinsic processes and interactions with the environment, like sunlight, and toxins in the air, water, and our diets, cause changes in the structure and function of the body's molecules and cells. Those changes in turn drive their decline, and subsequently, the failure of the whole organism. The exact mechanisms of aging are poorly understood. But recently, scientists have identified nine physiological traits, ranging from genetic changes to alterations in a cell's regenerative ability that play a central role. Firstly, as the years pass, our bodies accumulate genetic damage in the form of DNA lesions. These occur naturally when the body's DNA replicates, but also in non-dividing cells. Organelles called mitochondria are especially prone to this damage. Mitochondria produce adenosine triphosphate, or ATP, the main energy source for all cellular processes, plus mitochondria regulate many different cell activities and play an important role in programmed cell death. If mitochondrial function declines, then cells and, later on, whole organs, deteriorate, too. Other changes are known to occur in the expression patterns of genes, also known as epigenetic alterations, that affect the body's tissues and cells. Genes silenced or expressed only at low levels in newborns become prominent in older people, leading to the development of degenerative diseases, like Alzheimer's, which accelerate aging. Even if we could avoid all these harmful genetic alterations, not even our own cells could save us. The fact remains that cellular regeneration, the very stuff of life, declines as we age. The DNA in our cells is packaged within chromosomes, each of which has two protective regions at the extremities called telomeres. Those shorten every time cells replicate. When telomeres become too short, cells stop replicating and die, slowing the body's ability to renew itself. With age, cells increasingly grow senescent, too, a process that halts the cell cycle in times of risk, like when cancer cells are proliferating. But the response also kicks in more as we age, halting cell growth and cutting short their ability to replicate. Aging also involves stem cells that reside in many tissues and have the property of dividing without limits to replenish other cells. As we get older, stem cells decrease in number and tend to lose their regenerative potential, affecting tissue renewal and maintenance of our organs original functions. Other changes revolve around cells' ability to function properly. As they age, they stop being able to do quality control on proteins, causing the accumulation of damaged and potentially toxic nutrients, leading to excessive metabolic activity that could be fatal for them. Intercellular communication also slows, ultimately undermining the body's functional ability. There's a lot we don't yet understand about aging. Ultimately, does longer life as we know it come down to diet, exercise, medicine, or something else? Will future technologies, like cell-repairing nanobots, or gene therapy, artificially extend our years? And do we want to live longer than we already do? Starting with 122 years as inspiration, there's no telling where our curiosity might take us.

**P364 2016-06-07 The evolution of the book - Julie Dreyfuss**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=364)

What makes a book a book? Is it just anything that stores and communicates information? Or does it have to do with paper, binding, font, ink, its weight in your hands, the smell of the pages? Is this a book? Probably not. But is this? To answer these questions, we need to go back to the start of the book as we know it and understand how these elements came together to make something more than the sum of their parts. The earliest object that we think of as a book is the codex, a stack of pages bound along one edge. But the real turning point in book history was Johannes Gutenberg's printing press in the mid-15th century. The concept of moveable type had been invented much earlier in Eastern culture, but the introduction of Gutenberg's press had a profound effect. Suddenly, an elite class of monks and the ruling class no longer controlled the production of texts. Messages could spread more easily, and copies could constantly be produced, so printing houses popped up all over Europe. The product of this bibliographic boom is familiar to us in some respects, but markedly different in others. The skeleton of the book is paper, type, and cover. More than 2000 years ago, China invented paper as a writing surface, which was itself predated by Egyptian papyrus. However, until the 16th century, Europeans mainly wrote on thin sheets of wood and durable parchment made of stretched animal skins. Eventually, the popularity of paper spread throughout Europe, replacing parchment for most printings because it was less expensive in bulk. Inks had been made by combining organic plant and animal dyes with water or wine, but since water doesn't stick to metal type, use of the printing press required a change to oil-based ink. Printers used black ink made of a mixture of lamp soot, turpentine, and walnut oil. And what about font size and type? The earliest movable type pieces consisted of reversed letters cast in relief on the ends of lead alloy stocks. They were handmade and expensive, and the designs were as different as the people who carved their molds. Standardization was not really possible until mass manufacturing and the creation of an accessible word processing system. As for style, we can thank Nicolas Jenson for developing two types of Roman font that led to thousands of others, including the familiar Times Roman. Something had to hold all this together, and until the late 15th century, covers consisted of either wood, or sheets of paper pasted together. These would eventually be replaced by rope fiber millboard, originally intended for high quality bindings in the late 17th century, but later as a less expensive option. And while today's mass produced cover illustrations are marketing tools, the cover designs of early books were made to order. Even spines have a history. Initially, they were not considered aesthetically important, and the earliest ones were flat, rather than rounded. The flat form made the books easier to read by allowing the book to rest easily on a table. But those spines were damaged easily from the stresses of normal use. A rounded form solved that issue, although new problems arose, like having the book close in on itself. But flexibility was more important, especially for the on-the-go reader. As the book evolves and we replace bound texts with flat screens and electronic ink, are these objects and files really books? Does the feel of the cover or the smell of the paper add something crucial to the experience? Or does the magic live only within the words, no matter what their presentation?

**P365 2016-06-08 Why wasn’t the Bill of Rights originally in the US Constitution - Jam**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=365)

Take a moment to think about the US Constitution. What's the first thing that comes to mind? Freedom of speech? Protection from illegal searches? The right to keep and bear arms? These passages are cited so often that we can hardly imagine the document without them, but that's exactly what the writers of the Constitution did. The list of individual freedoms known as the Bill of Rights was not in the original text and wasn't added for another three years. So does this mean the founders didn't consider them? The answer goes back to the very origins of the Constitution itself. Even prior to the first shots of the American Revolution, the Thirteen Colonies worked together through a provisional government called the Continental Congress. During the war in 1781, the Articles of Confederation were ratified as the first truly national government. But establishing a new nation would prove easier than running it. Congress had no power to make the states comply with their laws. When the national government proved unable to raise funds, enforce foreign treaties, or suppress rebellions, it was clear reform was needed. So in May 1787, all the states but Rhode Island sent delegates to Philidelphia for a constitutional convention. A majority of these delegates favored introducing a new national constitution to create a stronger federal government. Thanks to compromises on issues like state representation, taxation power, and how to elect the president, their proposal gradually gained support. But the final text drafted in September still had to be approved by conventions held in the states. So over the next few months, ratification would be debated across the young nation. Among those who championed the new document were leading statesmen Alexander Hamilton, James Madison, and John Jay. Together, they laid out eloquent philosophical arguments for their positions in a series of 85 essays now known as the Federalist Papers. But others felt the Constitution was overreaching and that more centralized authority would return the states to the sort of tyranny they had just escaped. These Anti-Federalists were especially worried by the text's apparent lack of protections for individual liberties. As the conventions proceeded, many of these critics shifted from opposing the Constitution entirely to insisting on adding an explicit declaration of rights. So what was the Federalists problem with this idea? While their opponents accused them of despotism, wanting to maintain absolute power in the central government, their real motives were mostly practical. Changing the constitution when it had already been ratified by some states could complicate the entire process. More importantly, Madison felt that people's rights were already guaranteed through the democratic process, while adding extra provisions risked misinterpretation. And some feared that creating an explicit list of things the government can't do would imply that it can do everything else. After the first five states ratified the Constitution quickly, the debate grew more intense. Massachusetts and several other states would only ratify if they could propose their own amendments for consideration. Leading Federalists recognized the need to compromise and promised to give them due regard. Once ratification by nine states finally brought the Constitution into legal force, they made good on their promise. During a meeting of the first United States Congress, representative James Madison stood on the House floor to propose the very amendments he had previously believed to be unnecessary. After much debate and revision, first in the Congress, and then in the states, ten amendments were ratified on December 15, 1791, over three years after the US Constitution had become law. Today, every sentence, word, and punctuation mark in the Bill of RIghts is still considered fundamental to the freedoms Americans enjoy, even though the original framers left them out.

**P366 2016-06-14 How the food you eat affects your brain - Mia Nacamulli**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=366)

Your Brain on Food If you sucked all of the moisture out of your brain and broke it down to its constituent nutritional content, what would it look like? Most of the weight of your dehydrated brain would come from fats, also known as lipids. In the remaining brain matter, you would find proteins and amino acids, traces of micronutrients, and glucose. The brain is, of course, more than just the sum of its nutritional parts, but each component does have a distinct impact on functioning, development, mood, and energy. So that post-lunch apathy, or late-night alertness you might be feeling, well, that could simply be the effects of food on your brain. Of the fats in your brain, the superstars are omegas 3 and 6. These essential fatty acids, which have been linked to preventing degenerative brain conditions, must come from our diets. So eating omega-rich foods, like nuts, seeds, and fatty fish, is crucial to the creation and maintenance of cell membranes. And while omegas are good fats for your brain, long-term consumption of other fats, like trans and saturated fats, may compromise brain health. Meanwhile, proteins and amino acids, the building block nutrients of growth and development, manipulate how we feel and behave. Amino acids contain the precursors to neurotransmitters, the chemical messengers that carry signals between neurons, affecting things like mood, sleep, attentiveness, and weight. They're one of the reasons we might feel calm after eating a large plate of pasta, or more alert after a protein-rich meal. The complex combinations of compounds in food can stimulate brain cells to release mood-altering norepinephrine, dopamine, and serotonin. But getting to your brain cells is tricky, and amino acids have to compete for limited access. A diet with a range of foods helps maintain a balanced combination of brain messengers, and keeps your mood from getting skewed in one direction or the other. Like the other organs in our bodies, our brains also benefit from a steady supply of micronutrients. Antioxidants in fruits and vegetables strengthen the brain to fight off free radicals that destroy brain cells, enabling your brain to work well for a longer period of time. And without powerful micronutrients, like the vitamins B6, B12, and folic acid, our brains would be susceptible to brain disease and mental decline. Trace amounts of the minerals iron, copper, zinc, and sodium are also fundamental to brain health and early cognitive development. In order for the brain to efficiently transform and synthesize these valuable nutrients, it needs fuel, and lots of it. While the human brain only makes up about 2% of our body weight, it uses up to 20% of our energy resources. Most of this energy comes from carbohydrates that our body digests into glucose, or blood sugar. The frontal lobes are so sensitive to drops in glucose, in fact, that a change in mental function is one of the primary signals of nutrient deficiency. Assuming that we are getting glucose regularly, how does the specific type of carbohydrates we eat affect our brains? Carbs come in three forms: starch, sugar, and fiber. While on most nutrition labels, they are all lumped into one total carb count, the ratio of the sugar and fiber subgroups to the whole amount affect how the body and brain respond. A high glycemic food, like white bread, causes a rapid release of glucose into the blood, and then comes the dip. Blood sugar shoots down, and with it, our attention span and mood. On the other hand, oats, grains, and legumes have slower glucose release, enabling a steadier level of attentiveness. For sustained brain power, opting for a varied diet of nutrient-rich foods is critical. When it comes to what you bite, chew, and swallow, your choices have a direct and long-lasting effect on the most powerful organ in your body.

**P367 2016-06-15 What does it mean to be a refugee - Benedetta Berti and Evelien Borgm**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=367)

Around the globe, there are approximately 60 million people who have been forced to leave their homes to escape war, violence, and persecution. The majority of them have become internally displaced persons, which means they have fled their homes but are still within their own countries. Others have crossed a border and sought shelter outside of their own countries. They are commonly referred to as refugees. But what exactly does that term mean? The world has known refugees for millennia, but the modern definition was drafted in the UN's 1951 Convention relating to the status of refugees in response to mass persecutions and displacements of the Second World War. It defines a refugee as someone who is outside their country of nationality, and is unable to return to their home country because of well-founded fears of being persecuted. That persecution may be due to their race, religion, nationality, membership in a particular social group, or political opinion, and is often related to war and violence. Today, roughly half the world's refugees are children, some of them unaccompanied by an adult, a situation that makes them especially vulnerable to child labor or sexual exploitation. Each refugee's story is different, and many must undergo dangerous journeys with uncertain outcomes. But before we get to what their journeys involve, let's clear one thing up. There's a lot of confusion regarding the difference between the terms "migrant" and "refugee." "Migrants" usually refers to people who leave their country for reasons not related to persecution, such as searching for better economic opportunities or leaving drought-stricken areas in search of better circumstances. There are many people around the world who have been displaced because of natural disasters, food insecurities, and other hardships, but international law, rightly or wrongly, only recognizes those fleeing conflict and violence as refugees. So what happens when someone flees their country? Most refugee journeys are long and perilous with limited access to shelter, water, or food. Since the departure can be sudden and unexpected, belongings might be left behind, and people who are evading conflict often do not have the required documents, like visas, to board airplanes and legally enter other countries. Financial and political factors can also prevent them from traveling by standard routes. This means they can usually only travel by land or sea, and may need to entrust their lives to smugglers to help them cross borders. Whereas some people seek safety with their families, others attempt passage alone and leave their loved ones behind with the hopes of being reunited later. This separation can be traumatic and unbearably long. While more than half the world's refugees are in cities, sometimes the first stop for a person fleeing conflict is a refugee camp, usually run by the United Nations Refugee Agency or local governments. Refugee camps are intended to be temporary structures, offering short-term shelter until inhabitants can safely return home, be integrated to the host country, or resettle in another country. But resettlement and long-term integration options are often limited. So many refugees are left with no choice but to remain in camps for years and sometimes even decades. Once in a new country, the first legal step for a displaced person is to apply for asylum. At this point, they are an asylum seeker and not officially recognized as a refugee until the application has been accepted. While countries by and large agree on one definition of refugee, every host country is responsible for examining all requests for asylum and deciding whether applicants can be granted the status of refugee. Different countries guidelines can vary substantially. Host countries have several duties towards people they have recognized as refugees, like the guarantee of a minimum standard of treatment and non-discrimination. The most basic obligation towards refugees is non-refoulement, a principle preventing a nation from sending an individual to a country where their life and freedom are threatened. In reality, however, refugees are frequently the victims of inconsistent and discriminatory treatment. They're increasingly obliged to rebuild their lives in the face of xenophobia and racism. And all too often, they aren't permitted to enter the work force and are fully dependent on humanitarian aid. In addition, far too many refugee children are out of school due to lack of funding for education programs. If you go back in your own family history, chances are you will discover that at a certain point, your ancestors were forced from their homes, either escaping a war or fleeing discrimination and persecution. It would be good of us to remember their stories when we hear of refugees currently displaced, searching for a new home.

**P368 2016-06-17 What makes something 'Kafkaesque' - Noah Tavlin**

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"Someone must have been telling lies about Josef K. He knew he had done nothing wrong, but one morning, he was arrested." Thus begins "The Trial," one of author Franz Kafka's most well-known novels. K, the protagonist, is arrested out of nowhere and made to go through a bewildering process where neither the cause of his arrest, nor the nature of the judicial proceedings are made clear to him. This sort of scenario is considered so characteristic of Kafka's work that scholars came up with a new word for it. Kafkaesque has entered the vernacular to describe unnecessarily complicated and frustrating experiences, like being forced to navigate labyrinths of bureaucracy. But does standing in a long line to fill out confusing paperwork really capture the richness of Kafka's vision? Beyond the word's casual use, what makes something Kafkaesque? Franz Kafka's stories do indeed deal with many mundane and absurd aspects of modern bureaucracy, drawn in part from his experience of working as an insurance clerk in early 20th century Prague. Many of his protagonists are office workers compelled to struggle through a web of obstacles in order to achieve their goals, and often the whole ordeal turns out to be so disorienting and illogical that success becomes pointless in the first place. For example, in the short story, "Poseidon," the Ancient Greek god is an executive so swamped with paperwork that he's never had time to explore his underwater domain. The joke here is that not even a god can handle the amount of paperwork demanded by the modern workplace. But the reason why is telling. He's unwilling to delegate any of the work because he deems everyone else unworthy of the task. Kafka's Poseidon is a prisoner of his own ego. This simple story contains all of the elements that make for a truly Kafkaesque scenario. It's not the absurdity of bureaucracy alone, but the irony of the character's circular reasoning in reaction to it that is emblematic of Kafka's writing. His tragicomic stories act as a form of mythology for the modern industrial age, employing dream logic to explore the relationships between systems of arbitrary power and the individuals caught up in them. Take, for example, Kafka's most famous story, "Metamorphosis." When Gregor Samsa awaken's one morning to find himself transformed into a giant insect, his greatest worry is that he gets to work on time. Of course, this proves impossible. It was not only the authoritarian realm of the workplace that inspired Kafka. Some of his protagonists' struggles come from within. The short story, "A Hunger Artist," describes a circus performer whose act consists of extended fasts. He's upset that the circus master limits these to 40 days, believing this prevents him from achieving greatness in his art. But when his act loses popularity, he is left free to starve himself to death. The twist comes when he lays dying in anonymity, regretfully admitting that his art has always been a fraud. He fasted not through strength of will, but simply because he never found a food he liked. Even in "The Trial," which seems to focus directly on bureaucracy, the vague laws and bewildering procedures point to something far more sinister: the terrible momentum of the legal system proves unstoppable, even by supposedly powerful officials. This is a system that doesn't serve justice, but whose sole function is to perpetuate itself. What political theorist Hannah Arendt, writing years after Kafka's death, would call "tyranny without a tyrant." Yet accompanying the bleakness of Kafka's stories, there's a great deal of humor rooted in the nonsensical logic of the situations described. So on the one hand, it's easy to recognize the Kafkaesque in today's world. We rely on increasingly convoluted systems of administration that have real consequences on every aspect of our lives. And we find our every word judged by people we can't see according to rules we don't know. On the other hand, by fine-tuning our attention to the absurd, Kafka also reflects our shortcomings back at ourselves. In doing so, he reminds us that the world we live in is one we create, and have the power to change for the better.

**P369 2016-06-20 Is there a disease that makes us love cats - Jaap de Roode**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=369)

Is there a disease that makes us love cats, and do you have it? Maybe, and it's more likely than you'd think. We're talking about toxoplasmosis, a disease caused by toxoplasma gondii. Like all parasites, toxoplasma lives at the expense of its host, and needs its host to produce offspring. To do that, toxo orchestrates a brain manipulation scheme involving cats, their rodent prey, and virtually all other birds and mammals, including humans. Documented human infections go as far back as ancient Egypt. We found samples in mummies. Today, about a third of the world's population is infected, and most of them never even know it. In healthy people, symptoms often don't show up at all. When they do, they're mild and flu-like. But those are just the physical symptoms. Toxoplasma also nestles into our brains and meddles with our behavior behind the scenes. To understand why, let's take a look at the parasite's life cycle. While the parasite can multiply in practically any host, it can only reproduce sexually in the intestines of cats. The offspring, called oocysts, are shed in the cat's feces. A single cat can shed up to a hundred million oocysts. If another animal, like a mouse, accidentally ingests them, they'll invade the mouse's tissues and mature to form tissue cysts. If the mouse gets eaten by a cat, the tissue cysts become active and release offspring that mate to form new oocysts, completing the cycle. But there's a problem. A mouse's natural desire to avoid a cat makes it tough to close this loop. Toxoplasma has a solution for that. The parasites invade white blood cells to hitch a ride to the brain where they seem to override the innate fear of predators. Infected rodents are more reckless and have slower reaction times. Strangest of all, they're actually attracted to feline urine, which probably makes them more likely to cross paths with a cat and help the parasite complete its life cycle. How does the parasite pull this off? Although the exact mechanism isn't known, toxo appears to increase dopamine, a brain neurotransmitter that is involved in novelty-seeking behavior. Thus, one idea is that toxo tinkers with neurotransmitters, the chemical signals that modulate emotions. The result? Fatal attraction. But mice aren't the only animals that end up with these parasites, and that's where humans, and all of toxo's other hosts, come in. We can accidentally ingest oocysts in contaminated water, or unwashed produce, or from playing in sandboxes, or cleaning out litter boxes. This is behind the common recommendation that pregnant women not change cat litter. Toxo can cause serious birth defects. We can also get toxo from eating undercooked meat from other animals that picked up some oocysts. And it turns out that toxo can mess with our brains, too. Studies have found connections between toxo and schizophrenia, biopolar disorder, obsessive compulsive disorder, and aggression. It also slows reactions and decreases concentration, which may be why one study found that people involved in traffic accidents were almost three times more likely to have toxoplasma. So is toxo manipulating our brains as an evolutionary strategy to get predatory cats to eat us? Or are our brains just similar enough to a rodent's that the same neurological tricks that lure them in catch us in the net, too? And is toxo the reason so many people love cats and keep them as pets? Well, the jury's still out on that one. Some recent studies even contradict the idea. Regardless, toxoplasma has definitely benefited from humans to become one of the world's most successful parasites. It's not just our willingness to let cats on our dining room tables or in our beds. Raising livestock and building cities which attract rodents has provided billions of new hosts, and you and your cat may be two of them.

**P370 2016-06-23 Can you solve the prisoner boxes riddle - Yossi Elran**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=370)

Your favorite band is great at playing music, but not so great at being organized. They keep misplacing their instruments on tour, and it's driving their manager mad. On the day of the big concert, the band wakes up to find themselves tied up in a windowless, soundproof practice room. Their manager explains what's happening. Outside, there are ten large boxes. Each contains one of your instruments, but don't be fooled by the pictures - they've been randomly placed. I'm going to let you out one at a time. While you're outside, you can look inside any five boxes before security takes you back to the tour bus. You can't touch the instruments or in any way communicate what you find to the others. No marking the boxes, shouting, nothing. If each one of you can find your own instrument, then you can play tonight. Otherwise, the label is dropping you. You have three minutes to think about it before we start. The band is in despair. After all, each musician only has a 50% chance of finding their instrument by picking five random boxes. And the chances that all ten will succeed are even lower - just 1 in 1024. But suddenly, the drummer comes up with a valid strategy that has a better than 35% chance of working. Can you figure out what it was? Pause the video on the next screen if you want to figure it out for yourself! Answer in: 3 Answer in: 2 Answer in: 1 Here's what the drummer said: Everyone first open the box with the picture of your instrument. If your instrument is inside, you're done. Otherwise, look at whatever's in there, and then open the box with that picture on it. Keep going that way until you find your instrument. The bandmates are skeptical, but amazingly enough, they all find what they need. And a few hours later, they're playing to thousands of adoring fans. So why did the drummer's strategy work? Each musician follows a linked sequence that starts with the box whose outside matches their instrument and ends with the box actually containing it. Note that if they kept going, that would lead them back to the start, so this is a loop. For example, if the boxes are arranged like so, the singer would open the first box to find the drums, go to the eighth box to find the bass, and find her microphone in the third box, which would point back to the first. This works much better than random guessing because by starting with the box with the picture of their instrument, each musician restricts their search to the loop that contains their instrument, and there are decent odds, about 35%, that all of the loops will be of length five or less. How do we calculate those odds? For the sake of simplicity, we'll demonstrate with a simplified case, four instruments and no more than two guesses allowed for each musician. Let's start by finding the odds of failure, the chance that someone will need to open three or four boxes before they find their instrument. There are six distinct four-box loops. One fun way to count them is to make a square, put an instrument at each corner, and draw the diagonals. See how many unique loops you can find, and keep in mind that these two are considered the same, they just start at different points. These two, however, are different. We can visualize the eight distinct three-box loops using triangles. You'll find four possible triangles depending on which instrument you leave out, and two distinct paths on each. So of the 24 possible combinations of boxes, there are 14 that lead to faliure, and ten that result in success. That computational strategy works for any even number of musicians, but if you want a shortcut, it generalizes to a handy equation. Plug in ten musicians, and we get odds of about 35%. What if there were 1,000 musicians? 1,000,000? As n increases, the odds approach about 30%. Not a guarantee, but with a bit of musician's luck, it's far from hopeless. Hi everybody, if you liked this riddle, try solving these two.

**P371 2016-06-23 How North America got its shape - Peter J. Haproff**

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The geography of our planet is in flux. Each continent has ricocheted around the globe on one or more tectonic plates, changing quite dramatically with time. Today, we'll focus on North America and how its familiar landscape and features emerged over hundreds of millions of years. Our story begins about 750 million years ago. As the super continent Rodinia becomes unstable, it rifts along what's now the west coast of North America to create the Panthalassa Ocean. You're seeing an ancestral continent called Laurentia, which grows over the next few hundred million years as island chains collide with it and add land mass. We're now at 400 million years ago. Off today's east coast, the massive African plate inches westward, closing the ancient Iapetus Ocean. It finally collides with Laurentia at 250 million years to form another supercontinent Pangea. The immense pressure causes faulting and folding, stacking up rock to form the Appalachian Mountains. Let's fast forward a bit. About 100 million years later, Pangea breaks apart, opening the Southern Atlantic Ocean between the new North American Plate and the African Plate. We forge ahead, and now the eastward-moving Farallon Plate converges with the present-day west coast. The Farallon Plate's greater density makes it sink beneath North America. This is called subduction, and it diffuses water into the magma-filled mantle. That lowers the magma's melting point and makes it rise into the overlying North American plate. From a subterranean chamber, the magma travels upwards and erupts along a chain of volcanos. Magma still deep underground slowly cools, crystallizing to form solid rock, including the granite now found in Yosemite National Park and the Sierra Nevada Mountains. We'll come back to that later. Now, it's 85 million years ago. The Farallon Plate becomes less steep, causing volcanism to stretch eastward and eventually cease. As the Farallon Plate subducts, it compresses North America, thrusting up mountain ranges like the Rockies, which extend over 3,000 miles. Soon after, the Eurasian Plate rifts from North America, opening the North Atlantic Ocean. We'll fast forward again. The Colorado Plateau now uplifts, likely due to a combination of upward mantle flow and a thickened North American Plate. In future millennia, the Colorado River will eventually sculpt the plateau into the epic Grand Canyon. 30 million years ago, the majority of the Farallon Plate sinks into the mantle, leaving behind only small corners still subducting. The Pacific and North American plates converge and a new boundary called the San Andreas Fault forms. Here, North America moves to the south, sliding against the Pacific Plate, which shifts to the north. This plate boundary still exists today, and moves about 30 millimeters per year capable of causing devastating earthquakes. The San Andreas also pulls apart western North America across a wide rift zone. This extensional region is called the Basin and Range Province, and through uplift and erosion, is responsible for exposing the once deep granite of Yosemite and the Sierra Nevada. Another 15 million years off the clock, and magma from the mantle burns a giant hole into western North America, periodically erupting onto the surface. Today, this hotspot feeds an active supervolcano beneath Yellowstone National Park. It hasn't erupted in the last 174,000 years, but if it did, its sheer force could blanket most of the continent with ash that would blacken the skies and threaten humanity. The Yellowstone supervolcano is just one reminder that the Earth continues to seethe below our feet. Its mobile plates put the planet in a state of constant flux. In another few hundred million years, who knows how the landscape of North America will have changed. As the continent slowly morphs into something unfamiliar, only geological time will tell.

**P372 2016-06-23 What is obesity - Mia Nacamulli**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=372)

The most basic function of bodily fat is self-storage of food reserves. In prehistoric times, natural selection favored genotypes that could endure harsh conditions by stocking the most fat. With chronic malnutrition being the norm for most of human history, genetics evolved to favor fat storage. So when did body fat become problematic? The negative impacts of being overweight were not even noted in medical literature until as late as the 18th century. Then, technological advances coupled with public health measures resulted in the betterment of the quantity, quality, and variety of food. Sustained abundance of good food enabled a healthier population to boom economically. Output increased, and with it, leisure time and waistlines. By the mid 19th century, being excessively overweight, or obese, was recognized as a cause of ill health, and another century later, declared deadly. What is the distinction between being overweight and being obese? A calculation called the BMI breaks it down for us. For example, if someone weighs 65 kilgorams and is 1.5 meters tall, they have a BMI of about 29. Obesity is a condition of excess body fat that occurs when a person's BMI is above 30, just over the overweight range of 25 to 29.9. While BMI can be a helpful estimate of healthy weight, actual body fat percentage can only really be determined by also considering information like waist circumference and muscle mass. Athletes, for instance, have a naturally higher BMI. So how does a person become obese? At its most basic, obesity is caused by energy imbalance. If the energy input from calories is greater than the energy output from physical activity, the body stores the extra calories as fat. In most cases, this imbalance comes from a combination of circumstances and choices. Adults should be getting at least 2.5 hours of exercise each week, and children a whole hour per day. But globally, one in four adults and eight out of ten adolescents aren't active enough. Calorie-dense processed foods and growing portion sizes coupled with pervasive marketing lead to passive overeating. And scarce resources, and a lack of access to healthy, affordable foods creates an even greater risk in disadvantaged communities. Yet, our genetic makeup also plays a part. Studies on families and on separated twins have shown a clear causal hereditary relationship to weight gain. Recent studies have also found a link between obesity and variations in the bacteria species that live in our digestive systems. No matter the cause, obesity is an escalating global epidemic. It substantially raises the probability of diseases, like diabetes, heart disease, stroke, high blood pressure, and cancer. It affects virtually all ages, genders, and socioeconomic groups in both developed and developing countries. With a 60% rise in child obesity globally over just two decades, the problem is too significant to ignore. Once a person is obese, the climb to recovery becomes progressively steeper. Hormonal and metabolic changes reduce the body's response to overeating. After losing weight, a formerly overweight person burns less calories doing the same exercises as a person who is naturally the same weight, making it much more difficult to shed the excess fat. And as people gain weight, damage to signaling pathways makes it increasingly difficult for the brain to measure food intake and fat storage. There is, however, some evidence that well-monitored, long-term changes in behavior can lead to improvements in obesity-related health issues. And weight loss from sustained lifestyle changes, or invasive treatments like bariatric surgery, can improve insulin resistance and decrease inflammation. What was once an advantage for survival is now working against us. As the world's population continues to slow down and get bigger, moving and consciously eating our way towards a healthier weight is essential to our overall well-being. And with the epidemic affecting every country in the world for different socioeconomic reasons, obesity cannot be seen as an isolated issue. More global measures for prevention are essential to manage the weight of the world.

**P373 2016-06-24 How playing sports benefits your body ... and your brain - Leah Lagos**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=373)

The victory of the underdog over the favored team. The last minute penalty shot that wins the tournament. The high-energy training montages. Many people love to glorify victory on the playing field, cheer for favorite teams, and play sports. But here's a question: Should we be so obsessed with sports? Is playing sports actually as good for us as we make it out to be, or just a fun and entertaining pastime? What does science have to say? First of all, it's well accepted that exercise is good for our bodies and minds, and that's definitely true. Exercising, especially when we're young, has all sorts of health benefits, like strengthening our bones, clearing out bad cholesterol from our arteries, and decreasing the risk of stroke, high blood pressure, and diabetes. Our brains also release a number of chemicals when we workout, including endorphins. These natural hormones, which control pain and pleasure responses in the cental nervous system, can lead to feelings of euphoria, or, what's often called, a runner's high. Increased endorphins and consistent physical activity in general can sharpen your focus and improve your mood and memory. So does that mean we get just as much benefit going to the gym five days a week as we would joining a team and competing? Well, here's where it gets interesting: because it turns out that if you can find a sport and a team you like, studies show that there are all sorts of benefits that go beyond the physical and mental benefits of exercise alone. Some of the most significant are psychological benefits, both in the short and long term. Some of those come from the communal experience of being on a team, for instance, learning to trust and depend on others, to accept help, to give help, and to work together towards a common goal. In addition, commitment to a team and doing something fun can also make it easier to establish a regular habit of exercise. School sport participation has also been shown to reduce the risk of suffering from depression for up to four years. Meanwhile, your self-esteem and confidence can get a big boost. There are a few reasons for that. One is found in training. Just by working and working at skills, especially with a good coach, you reinforce a growth mindset within yourself. That's when you say, "Even if I can't do something today, I can improve myself through practice and achieve it eventually." That mindset is useful in all walks of life. And then there's learning through failure, one of the most transformative, long-term benefits of playing sports. The experience of coming to terms with defeat can build the resilience and self-awareness necessary to manage academic, social, and physical hurdles. So even if your team isn't winning all the time, or at all, there's a real benefit to your experience. Now, not everyone will enjoy every sport. Perhaps one team is too competitive, or not competitive enough. It can also take time to find a sport that plays to your strengths. That's completely okay. But if you spend some time looking, you'll be able to find a sport that fits your individual needs, and if you do, there are so many benefits. You'll be a part of a supportive community, you'll be building your confidence, you'll be exercising your body, and you'll be nurturing your mind, not to mention having fun.

**P374 2016-07-13 How coffee got quicker \_ Moments of Vision 2 - Jessica Oreck**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=374)

In a Moment of Vision... It's 1849. William H. Bovee leaves his job at a coffee producer in New York City to seek his fortune in gold-fevered California. But leaving behind the luxuries of the city, Bovee leaves behind a more expedient cup of joe. Out west, folks are still buying their coffee beans green, roasting the beans at home, then grinding them with a hand crank, all before actually brewing them. Bovee builds California's first coffee mill, packaging and selling pre-roasted beans. And in a moment of vision, he takes the process one step farther making his mill the world's first to grind the already roasted beans on a large scale, then pack them conveniently into small, consumer-friendly tins. Only a few years later, however, Bovee tires of the coffee business and sells his shares of the company to a young employee: James Folger. Folger changes the name and grows the company to a nationwide brand, jumpstarting a race to find the quickest, easiest way to that morning caffeine fix. For the 64% of Americans that drink coffee daily, an expedient cup is practically essential.

**P375 2016-07-13 Why the metric system matters - Matt Anticole**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=375)

What does the French Revolution have to do with the time NASA accidentally crashed a $200 million orbiter into the surface of Mars? Actually, everything. That crash happened due to an error in converting between two measurement systems, U.S. customary units and their S.I, or metric, equivalence. So what's the connection to the French Revolution? Let's explain. For the majority of recorded human history, units like the weight of a grain or the length of a hand weren't exact and varied from place to place. And different regions didn't just use varying measurements. They had completely different number systems as well. By the late Middle Ages, the Hindu-Arabic decimal system mostly replaced Roman numerals and fractions in Europe, but efforts by scholars like John Wilkins to promote standard decimal-based measures were less successful. With a quarter million different units in France alone, any widespread change would require massive disruption. And in 1789, that disruption came. The leaders of the French Revolution didn't just overthrow the monarchy. They sought to completely transform society according to the rational principles of the Enlightenment. When the new government took power, the Academy of Sciences convened to reform the system of measurements. Old standards based on arbitrary authority or local traditions were replaced with mathematical and natural relationships. For example, the meter, from the Greek word for measure, was defined as 1/10,000,000 between the Equator and North Pole. And the new metric system was, in the words of the Marquis de Condorcet, "For all people, for all time." Standardizing measurements had political advantages for the Revolutionaries as well. Nobles could no longer manipulate local units to extract more rent from commoners, while the government could collect taxes more efficiently. And switching to a new Republican Calendar with ten-day weeks reduced church power by eliminating Sundays. Adoption of this new system wasn't easy. In fact, it was a bit of a mess. At first, people used new units alongside old ones, and the Republican Calendar was eventually abandoned. When Napoléon Bonaparte took power, he allowed small businesses to use traditional measurements redefined in metric terms. But the metric system remained standard for formal use, and it spread across the continent, along with France's borders. While Napoléon's empire lasted eight years, its legacy endured far longer. Some European countries reverted to old measurements upon independence. Others realized the value of standardization in an age of international trade. After Portugal and the Netherlands switched to metric voluntarily, other nations followed, with colonial empires spreading the system around the world. As France's main rival, Britain had resisted revolutionary ideas and retained its traditional units. But over the next two centuries, the British Empire slowly transitioned, first approving the metric system as an optional alternative before gradually making it offical. However, this switch came too late for thirteen former colonies that had already gained independence. The United States of America stuck with the English units of its colonial past and today remains one of only three countries which haven't fully embraced the metric system. Despite constant initiatives for metrication, many Americans consider units like feet and pounds more intuitive. And ironically, some regard the once revolutionary metric system as a symbol of global conformity. Nevertheless, the metric system is almost universally used in science and medicine, and it continues to evolve according to its original principles. For a long time, standard units were actually defined by carefully maintained physical prototypes. But thanks to improving technology and precision, these objects with limited access and unreliable longevity are now being replaced with standards based on universal constants, like the speed of light. Consistent measurements are such an integral part of our daily lives that it's hard to appreciate what a major accomplishment for humanity they've been. And just as it arose from a political revolution, the metric system remains crucial for the scientific revolutions to come.

**P376 2016-07-14 Why do we hiccup - John Cameron**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=376)

Charles Osborne began to hiccup in 1922 after a hog fell on top of him. He wasn't cured until 68 years later and is now listed by Guinness as the world record holder for hiccup longevity. Meanwhile, Florida teen Jennifer Mee may hold the record for the most frequent hiccups, 50 times per minute for more than four weeks in 2007. So what causes hiccups? Doctors point out that a round of hiccups often follows from stimuli that stretch the stomach, like swallowing air or too rapid eating or drinking. Others associate hiccups with intense emotions or a response to them: laughing, sobbing, anxiety, and excitement. Let's look at what happens when we hiccup. It begins with an involuntary spasm or sudden contraction of the diaphragm, the large dome-shaped muscle below our lungs that we use to inhale air. This is followed almost immediately by the sudden closure of the vocal chords and the opening between them, which is called the glottis. The movement of the diaphragm initiates a sudden intake of air, but the closure of the vocal chords stops it from entering the wind pipe and reaching the lungs. It also creates the characteristic sound: "hic." To date, there is no known function for hiccups. They don't seem to provide any medical or physiological advantage. Why begin to inhale air only to suddenly stop it from actually entering the lungs? Anatomical structures, or physiological mechanisms, with no apparent purpose present challenges to evolutionary biologists. Do such structures serve some hidden function that hasn't yet been discovered? Or are they relics of our evolutionary past, having once served some important purpose only to persist into the present as vestigial remnants? One idea is that hiccups began many millions of years before the appearance of humans. The lung is thought to have evolved as a structure to allow early fish, many of which lived in warm, stagnant water with little oxygen, to take advantage of the abundant oxygen in the air overhead. When descendants of these animals later moved onto land, they moved from gill-based ventilation to air-breathing with lungs. That's similar to the much more rapid changes faced by frogs today as they transition from tadpoles with gills to adults with lungs. This hypothesis suggests that the hiccup is a relic of the ancient transition from water to land. An inhalation that could move water over gills followed by a rapid closure of the glottis preventing water from entering the lungs. That's supported by evidence which suggests that the neural patterning involved in generating a hiccup is almost identical to that responsible for respiration in amphibians. Another group of scientists believe that the reflex is retained in us today because it actually provides an important advantage. They point out that true hiccups are found only in mammals and that they're not retained in birds, lizards, turtles, or any other exclusively air-breathing animals. Further, hiccups appear in human babies long before birth and are far more common in infants that adults. Their explanation for this involves the uniquely mammalian activity of nursing. The ancient hiccup reflex may have been adapted by mammals to help remove air from the stomach as a sort of glorified burp. The sudden expansion of the diaphragm would raise air from the stomach, while a closure of the glottis would prevent milk from entering the lungs. Sometimes, a bout of hiccups will go on and on, and we try home remedies: sipping continuously from a glass of cold water, holding one's breath, a mouthful of honey or peanut butter, breathing into a paper bag, or being suddenly frightened. Unfortunately, scientists have yet to verify that any one cure works better or more consistently than others. However, we do know one thing that definitely doesn't work.

**P377 2016-07-18 Should we be looking for life elsewhere in the universe - Aomawa Shie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=377)

Astronomers have discovered thousands of planets orbiting stars other than the Sun. They come in all sizes, at different orbital distances from their stars. The closest of them are trillions of miles away, and even the largest are just fuzzy patches in the fields of high-powered telescopes. But if one of these planets is close in size to the Earth and orbits not too close and too far away from its parent star, it could be rocky and warm enough to have oceans and perhaps life. Astronomers discover these potentially habitable planets, and their eyes get big and wide. Could one of these distant worlds carry the building blocks of life? Or even a living, breathing, civilization? Is the question, "Are we alone in the universe?" about to be answered? But wait. Maybe we should ask a different question first. Should we try to find out if we're alone in the universe? If we do find the atmospheric fingerprints of life on one of these small, distant worlds, should we try to contact any beings who may live there? Is that wise? Three decades ago, NASA decided the answer was yes. Voyager 1 and 2 were launched in 1977 to explore the giant planets in the solar system. Each spacecraft carried a golden phonograph record, a time capsule of sorts that included clues and messages meant to convey the story of human civilization. The contents of these gold-plated copper disks were chosen by a committee chaired by American astronomer and author Carl Sagan. They included over 100 images, and a range of sounds from the natural world: ocean waves, thunder, the sounds of birds and whales. The records also included music from many different time periods and cultures, greetings in 55 languages, and messages from the President of the United States, and the UN Secretary General. They also included a map. Each golden record displays the location of our solar system with respect to fourteen pulsars. Their precise, unique frequencies were indicated so that intelligent, extraterrestrial lifeforms could use them to find the Earth. Many years later, renowned physicist Stephen Hawking said that it was a mistake to give an alien species a roadmap to our planet. Hawking suspected that any extraterrestrial life probably wasn't any more complex than microbes, but he warned that if an advanced alien species did visit Earth, it could be as catastrophic as Christopher Columbus's arrival was for the Native Americans. Meanwhile, the golden records continue their journeys. In 1990, both Voyager spacecraft passed beyond the orbit of Pluto. Voyager 1 entered interstellar space in 2012, and will reach the nearest stellar system in 40,000 years. If either spacecraft is discovered by extraterrestrial life, there's a possibility that they could decipher the clues from the golden record and one day reach our planet. That's particularly true if theirs is a much more technologically advanced civilization. That life could be benevolent, as we would hope to be if humans are one day able to achieve interstellar travel. Or it could be hostile. Searching for planets that might have life means staring into a great abyss. We'll likely have no clear knowledge of the evolutionary stage, sentience, character, or intentions of the first form of life we discover. So it's a risk to turn our eyes outwards. We risk our very way of life. But it may be a greater risk not to look, to deny the very pioneering spirits that help shape our own species. We are all born curious about the world and the universe. Pursuing that curiosity is one of humankind's greatest achievements. Perhaps there is room to push the frontiers of science, provided that we cradle alongside our fervor another of humankind's greatest assets: hope.

**P378 2016-07-26 Real life sunken cities - Peter Campbell**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=378)

While touring the remains of ancient Alexandria, Egypt, there are a few things that present-day explorers should look for. First, as you travel along the Great Harbor, keep your eyes open for large columns and statues. Across the bay to your left is the island where the Great Lighthouse once stood. And as you make your way through the palaces of the Royal Quarter and reach the area where the Library of Alexandria once stood, keep your eyes open for sharks. Because if you visit this section of Alexandria, you'll be fifteen feet deep in the Mediterranean Sea. Though people are most familiar with Plato's fictional Atlantis, many real underwater cities actually exist. Places like Alexandria, Port Royal, Jamaica, and Pavlopetri, Greece. Sunken cities are studied by scientists to help us understand the lives of our ancestors, the dynamic nature of our planet, and the impact of each on the other. Water is essential for life, food sources, and transport, so many cities have been built along coast lines and river banks. However, these benefits also come with risks because natural forces that can sink a city are at their doorstep. Take, for instance, an earthquake. June 7, 1692 seemed like a normal morning in Port Royal, Jamaica, then one of the richest ports in the world, but when a massive earthquake struck, two-thirds of Port Royal immediately sank to its rooftops. Today, many buildings and elements of everyday life remain surprisingly intact on the sea floor, frozen in time. That includes a 300-year-old pocket watch that stopped at 11:43, the moment Port Royal slipped beneath the Carribean. And during the winter of 373 BCE, the Greek city of Helike was struck by an earthquake so strong that it liquefied the sandy ground upon which the city was built. Minutes later, a tsunami struck the city, and Helike and its inhabitants sunk downwards into the Mediterranean Sea. Centuries later, Roman tourists would sail on the lagoon that formed and peer down at the city's remains. Earthquakes are sudden, unpredictable disasters that have drowned cities in an instant. Luckily, however, throughout history, the majority of sunken cities were not submerged by a single cataclysmic event, but by a combination of more gradual processes. For instance, Pavlopetri, the oldest known sunken city, was built on the southern coastline of Greece 5,000 years ago. It's an example of a city that was submerged due to what is called isostatic sea level change. 18,000 years ago when the Ice Age ended, glaciers began melting and the sea level rose globally until about 5,000 years ago. Isostatic sea level change isn't caused by that melt water, but rather the Earth's crust slowly springing back from the released weight of the glaciers, making some places rise, and others sink. The ground around Pavlopetri is still sinking at an average rate of a millimeter per year. But the ancient inhabitants were able to move gradually inland over several generations before they finally abandoned the city about 3,000 years ago. Today, divers swim over the streets of Pavlopetri and peer through ancient door jams into the foundations of houses and community buildings. They learn about the people who lived there by observing what they left behind. Natural geological events, such as earthquakes and tsunamis, will continue to shape our continents, just as they have for millions of years. As increased global warming melts our polar ice caps at accelerated rates and sea levels rise, we will be forced to adapt, like Pavlopetri's inhabitants. Undoubtedly, over the coming centuries, some of the coastal areas that we live in today will eventually be claimed by the water, too - cities like Venice, New Orleans, Amsterdam, Miami, and Tokyo. Imagine what future civilizations will learn about us as they swim around the ancient ruins of the cities that we live in today.

**P379 2016-07-26 Which sunscreen should you choose - Mary Poffenroth**

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Sunscreen comes in many forms, each with its own impacts on your body and the environment. With so many options, how do you choose which sunscreen is best for you? To answer that question, we first have to understand how sunscreens work. Sunlight is composed of electromagnetic waves and is our primary source of ultraviolet radiation, which has a shorter wavelength than visible light and carries more energy. UVA, UVB, and UVC are classified according to their wavelengths. Short wavelength UVC never reaches the Earth's surface, but UVB and UVA do. Medium wavelength UVB rays can enter the skin's superficial layers and long length UVA rays can penetrate into the deeper layers. UVB in small amounts actually helps us make vitamin D, which enables our bodies to build and maintain strong bones. However, prolonged exposure to UVA and UVB can damage DNA, age your skin, and promote the development of potentially deadly skin cancer. Sunscreen protects your skin either physically by deflecting UV rays with an inorganic blocker like zinc oxide or titanium dioxide, or chemically by using carbon-based compounds to absorb UV photons that are then harmlessly dissipated as heat. So, what differentiates one sunscreen from another? When we choose a sunscreen, we can compare application method, the SPF, and the active ingredients. Sprays can be convenient to put on, especially when you're wet, but a recent study found that most people don't apply a thick enough layer to get full protection. And the possible health risks of inhaling sunscreen compounds from a spray cloud might make you consider reaching for that bottle of lotion instead. Opt for a sunscreen with an SPF of at least 15, although 30 is better. SPF is a nonlinear scale of how much UVB radiation is needed to give protected skin a sunburn. SPF 15 does a pretty good job by blocking 93% of UVB rays. You get a slight increase as SPF goes up, with SPF 30 blocking 97%, and 50 blocking 98%. SPF is based on the quantity of solar exposure. So how much time you have before you start to burn really depends on a long list of factors, including your genetics, and when, where, and how you spend your time in the sun. Even though US marketed sunscreens have been deemed safe by the FDA, scientists are still researching the effects of many active ingredients on the human body. So if you're worried about potential irritants, look for mineral-based formulas with zinc oxide or titanium dioxide. Even though they may go on a bit thick at first, they're less irritating than carbon-based chemical sunscreens. These mineral-based sunscreens are preferential for the environment, too. If you plan on catching rays while splashing in a river or the ocean, keep in mind that carbon-based chemical sunscreens can harm marine life. Take coral reefs, for example. Although they cover less than 1% of the Earth's underwater surface, they're home to nearly 25% of all fish species, making them the most diverse and productive marine ecosystems. Research shows that carbon-based chemical sunscreen ingredients, like oxybenzone, butylparaben, octinoxate, and 4MBC contribute to a stress condition called coral bleaching in corals, which are living creatures. Exposure to these organic compounds results in the death of the coral's symbiotic algae. In addition to providing a reliable food source, these algae give coral their brilliant rainbow of colors. Without them, corals turn a bleached white and are susceptible to disease and possibly death. And once the coral dies, the entire reef ecosystem is not far behind. So you're now ready to make an informed choice when picking out your next sunscreen. SPF is clearly labeled on the front. On the back under "active ingredients," you can find whether zinc oxide, titanium dioxide, and those coral-harming components are present. Taking a bit more time to check can be well worth it for both you and the environment.

**P380 2016-08-02 How smart are orangutans - Lu Gao**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=380)

Fu Manchu was one of the most notorious escape artists at the Omaha Zoo in the 1960s. But he wasn't a performer, he was an orangutan. The keepers who locked his enclosure every night were baffled to find him outside the next day hanging out with friends in a tree, or sunning on the roof. Only after installing cameras did they realize Fu Manchu had been picking the lock with a metal wire that he kept hidden under his cheek pouch. The keepers shouldn't have been surprised at Fu Manchu's cunningness. Along with our other great ape cousins, the gorillas, chimps, and bonobos, they belong to our Hominidae family tree, which stretches back 14 million years. But it's not just their striking red hair that makes orangutans unique among our cousins. As the only great apes from Asia, orangutans have adapted to a life high in the rain forest canopies. Many of the skills they learn are transmitted through the special bond they have with their mothers, the most extended in the animal kingdom next to humans. Orangutan mothers usually give birth to one baby at a time, waiting up to eight years before having another. This gives the young, who begin as fully dependent infants, plenty of time to learn how to climb and distinguish the hundreds of plants and fruits that make up their diet. Female orangutans even stay with their mothers into their teen years to learn child-rearing. As they grow up, orangutans also develop a complex set of cooperative social skills by interacting with their peers and siblings. Much like ourselves, young orangutans involuntarily mimic the facial expressions and emotions of their playmates, with behaviors that closely parallel human smiling and laughter. Once they finally venture out on their own, orangutans continue to develop their resourcefulness, putting the skills they've learned into practice. Adults build a new nest each night by carefully weaving twigs together, topping them with soft leaves, pillows, and blankets. This process requires dexterity, coordination, and an eye for design. Orangutans also use a variety of tools to make their lives in the jungle easier. They turn branches into fly swatters and back scratchers, construct umbrellas when it rains, make gloves from leafy pads, and even use leaves as bandages to dress their wounds. But orangutan intelligence goes far beyond jungle survival. Research in controlled environments has shown that orangutans are self-aware, being one of the few species to recognize their own reflections. They also display remarkable foresight, planning, and cognition. In one experiment, researchers taught an orangutan to use a straw to extract his favorite fruit soup from a box. That orangutan was later given the choice between the straw or a grape that could be eaten right away, and he chose the straw just in case he was given another box of soup. In another experiment, orangutans figured out how to reach peanuts at the bottom of long tubes by spitting water into them. While orangutans are able to pass cognitive tests with flying colors, there are certain problems that they need our help to solve. Indonesia has the world's highest rate of deforestation, and millions of acres of rain forest are burned annually to support the logging and palm oil industries. Deforestation exposes the 30,000 orangutans remaining in the wild to poachers. They kill mothers so that baby orangutans can be sold as exotic pets. But fortunately, the story often doesn't end here. Orphans can be confiscated and given a second chance. At special forest schools, they recover from emotional trauma and continue to develop essential life skills. Against all odds, these orphans demonstrate incredible resilience and readiness to learn. In Malay, the word orangutan translates literally to "the person of the forest," a reminder of our common lineage. And despite orangutans being some of the smartest animals on Earth, outsmarting their extinction requires the creativity, empathy, and foresight that our species share.

**P381 2016-08-09 One of the most difficult words to translate... - Krystian Aparta**

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Which is the hardest word to translate in this sentence? "Know" is easy to translate. "Pep rally" doesn't have a direct analog in a lot of languages and cultures, but can be approximated. But the hardest word there is actually one of the smallest: "you." As simple as it seems, it's often impossible to accurately translate "you" without knowing a lot more about the situation where it's being said. To start with, how familiar are you with the person you're talking to? Many cultures have different levels of formality. A close friend, someone much older or much younger, a stranger, a boss. These all may be slightly different "you's." In many languages, the pronoun reflects these differences through what's known as the T–V distinction. In French, for example, you would say "tu" when talking to your friend at school, but "vous" when addressing your teacher. Even English once had something similar. Remember the old-timey "thou?" Ironically, it was actually the informal pronoun for people you're close with, while "you" was the formal and polite version. That distinction was lost when the English decided to just be polite all the time. But the difficulty in translating "you" doesn't end there. In languages like Hausa or Korana, the "you" form depends on the listener's gender. In many more, it depends on whether they are one or many, such as with German "Du" or "ihr." Even in English, some dialects use words like "y'all" or "youse" the same way. Some plural forms, like the French "vous" and Russian "Вы" are also used for a single person to show that the addressee is that much more important, much like the royal "we." And a few languages even have a specific form for addressing exactly two people, like Slovenian "vidva." If that wasn't complicated enough, formality, number, and gender can all come into play at the same time. In Spanish, "tú" is unisex informal singular, "usted" is unisex formal singular, "vosotros" is masculine informal plural, "vosotras" is feminine informal plural, and "ustedes" is the unisex formal plural. Phew! After all that, it may come as a relief that some languages often leave out the second person pronoun. In languages like Romanian and Portuguese, the pronoun can be dropped from sentences because it's clearly implied by the way the verbs are conjugated. And in languages like Korean, Thai, and Chinese, pronouns can be dropped without any grammatical hints. Speakers often would rather have the listener guess the pronoun from context than use the wrong one and risk being seen as rude. So if you're ever working as a translator and come across this sentence without any context: "You and you, no, not you, you, your job is to translate 'you' for yourselves" ... Well, good luck. And to the volunteer community who will be translating this video into multiple languages: Sorry about that!

**P382 2016-08-11 How to visualize one part per million - Kim Preshoff + The TED-Ed Com**

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What does it mean to be one in a million? Not in the greeting card sense, in the scientific sense, where one part per million is a unit of measurement. Parts per million counts the number of units of one substance per one million units of another. It can measure concentrations when a small amount makes a big difference. For example, a concentration of just 35 ppm of carbon monoxide in the air is poisonous to us. We encounter measurements like this pretty often, but because it's hard to conceptualize really large numbers, it's difficult to wrap our brain around what one part per million really means. So here are nine helpful ways to visualize it. If you had 11,363 pianos-worth of piano keys, one of those keys would be about one part per million. So would a single granule of sugar among 273 sugar cubes, one second in eleven and a half days, or four dots in the painting, "A Sunday Afternoon on the Island of La Grande Jatte." Your bath tub's capacity is about 60 gallons, so seven drops of ink would be one part per million. The English version of the Harry Potter series has 1,084,170 words, which makes "hippogriff" on page 221 of "The Prisoner of Azkaban" a little less than one part per million. A million kernels of corn is about 1,250 ears, so one kernel in that truckload would be one part per million. There are 10 million bricks in the Empire State Building, so one part per million would be a pile of just ten. And finally, 100 people worked together to animate this video. Collectively, they have about 10 million hairs on their heads. Pluck ten of those hairs, and you have one in a million.

**P383 2016-08-12 How the Königsberg bridge problem changed mathematics - Dan Van der V**

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You'd have a hard time finding Königsberg on any modern maps, but one particular quirk in its geography has made it one of the most famous cities in mathematics. The medieval German city lay on both sides of the Pregel River. At the center were two large islands. The two islands were connected to each other and to the river banks by seven bridges. Carl Gottlieb Ehler, a mathematician who later became the mayor of a nearby town, grew obsessed with these islands and bridges. He kept coming back to a single question: Which route would allow someone to cross all seven bridges without crossing any of them more than once? Think about it for a moment. 7 6 5 4 3 2 1 Give up? You should. It's not possible. But attempting to explain why led famous mathematician Leonhard Euler to invent a new field of mathematics. Carl wrote to Euler for help with the problem. Euler first dismissed the question as having nothing to do with math. But the more he wrestled with it, the more it seemed there might be something there after all. The answer he came up with had to do with a type of geometry that did not quite exist yet, what he called the Geometry of Position, now known as Graph Theory. Euler's first insight was that the route taken between entering an island or a riverbank and leaving it didn't actually matter. Thus, the map could be simplified with each of the four landmasses represented as a single point, what we now call a node, with lines, or edges, between them to represent the bridges. And this simplified graph allows us to easily count the degrees of each node. That's the number of bridges each land mass touches. Why do the degrees matter? Well, according to the rules of the challenge, once travelers arrive onto a landmass by one bridge, they would have to leave it via a different bridge. In other words, the bridges leading to and from each node on any route must occur in distinct pairs, meaning that the number of bridges touching each landmass visited must be even. The only possible exceptions would be the locations of the beginning and end of the walk. Looking at the graph, it becomes apparent that all four nodes have an odd degree. So no matter which path is chosen, at some point, a bridge will have to be crossed twice. Euler used this proof to formulate a general theory that applies to all graphs with two or more nodes. A Eulerian path that visits each edge only once is only possible in one of two scenarios. The first is when there are exactly two nodes of odd degree, meaning all the rest are even. There, the starting point is one of the odd nodes, and the end point is the other. The second is when all the nodes are of even degree. Then, the Eulerian path will start and stop in the same location, which also makes it something called a Eulerian circuit. So how might you create a Eulerian path in Königsberg? It's simple. Just remove any one bridge. And it turns out, history created a Eulerian path of its own. During World War II, the Soviet Air Force destroyed two of the city's bridges, making a Eulerian path easily possible. Though, to be fair, that probably wasn't their intention. These bombings pretty much wiped Königsberg off the map, and it was later rebuilt as the Russian city of Kaliningrad. So while Königsberg and her seven bridges may not be around anymore, they will be remembered throughout history by the seemingly trivial riddle which led to the emergence of a whole new field of mathematics.

**P384 2016-08-15 What is a vector - David Huynh**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=384)

Physicists, air traffic controllers, and video game creators all have at least one thing in common: vectors. What exactly are they, and why do they matter? To answer, we first need to understand scalars. A scalar is a quantity with magnitude. It tells us how much of something there is. The distance between you and a bench, and the volume and temperature of the beverage in your cup are all described by scalars. Vector quantities also have a magnitude plus an extra piece of information, direction. To navigate to your bench, you need to know how far away it is and in what direction, not just the distance, but the displacement. What makes vectors special and useful in all sorts of fields is that they don't change based on perspective but remain invariant to the coordinate system. What does that mean? Let's say you and a friend are moving your tent. You stand on opposite sides so you're facing in opposite directions. Your friend moves two steps to the right and three steps forward while you move two steps to the left and three steps back. But even though it seems like you're moving differently, you both end up moving the same distance in the same direction following the same vector. No matter which way you face, or what coordinate system you place over the camp ground, the vector doesn't change. Let's use the familiar Cartesian coordinate system with its x and y axes. We call these two directions our coordinate basis because they're used to describe everything we graph. Let's say the tent starts at the origin and ends up over here at point B. The straight arrow connecting the two points is the vector from the origin to B. When your friend thinks about where he has to move, it can be written mathematically as 2x + 3y, or, like this, which is called an array. Since you're facing the other way, your coordinate basis points in opposite directions, which we can call x prime and y prime, and your movement can be written like this, or with this array. If we look at the two arrays, they're clearly not the same, but an array alone doesn't completely describe a vector. Each needs a basis to give it context, and when we properly assign them, we see that they are in fact describing the same vector. You can think of elements in the array as individual letters. Just as a sequence of letters only becomes a word in the context of a particular language, an array acquires meaning as a vector when assigned a coordinate basis. And just as different words in two languages can convey the same idea, different representations from two bases can describe the same vector. The vector is the essence of what's being communicated, regardless of the language used to describe it. It turns out that scalars also share this coordinate invariance property. In fact, all quantities with this property are members of a group called tensors. Various types of tensors contain different amounts of information. Does that mean there's something that can convey more information than vectors? Absolutely. Say you're designing a video game, and you want to realistically model how water behaves. Even if you have forces acting in the same direction with the same magnitude, depending on how they're oriented, you might see waves or whirls. When force, a vector, is combined with another vector that provides orientation, we have the physical quantity called stress, which is an example of a second order tensor. These tensors are also used outside of video games for all sorts of purposes, including scientific simulations, car designs, and brain imaging. Scalars, vectors, and the tensor family present us with a relatively simple way of making sense of complex ideas and interactions, and as such, they're a prime example of the elegance, beauty, and fundamental usefulness of mathematics.

**P385 2016-08-18 Are spotty fruits and vegetables safe to eat - Elizabeth Brauer**

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In 2010, $30 billion worth of fruits and vegetables were wasted by American retailers and shoppers in part because of cosmetic problems and perceived spoilage. That's a poor use of about 30% of the produce on the market, not to mention the water and energy required to grow and transport it, and the landfill space getting used up by rotting fruit. So what are those cosmetic problems? You've probably passed over a spotty apple in the grocery store, or accidentally sunk your thumb into a mushy patch on a tomato. These blemishes can doom produce to the trash can. But what are they anyway, and are they actually bad for you? Those spots are evidence of an epic battle between plants and microbes. Like humans, plants coexist with billions of fungi and bacteria. Some of these microbes are beneficial to the plant, suppressing disease and helping it extract nutrients. Others are pathogens, attacking the produce, still alive as it sits in a store display or your refrigerator and siphoning off molecules they can use themselves. The good news is they're almost never bad for you. These fungi and bacteria have spent millions of years developing strategies to overcome a plant's immune system. But healthy human immune systems are different enough that those strategies just don't work on us. So in a plant, what does this process look like? Microbes can reach plants in a number of ways, like getting splashed onto it during watering or fertilization. Under the right conditions, the microbes grow into large enough colonies to attack the waxy outer layer of fruit or leaves. Their target: the delicious sugars and nutrients inside. This type of pathogen often makes spots like this. A clump of bacteria drains the nutrients and color from the fruit's cells making that yellow halo. It then moves outward, leaving a black spot of dead cells in its wake. Each spot, which could contain hundreds of thousands of microbes is actually caused by a combination of microbial attack and the host defending itself. For example, this is the bacterial pathogen Pseudomonas syringae. Once on a tomato, it enters the fruit and leaves, multiplies in the space between the cells, and produces toxins and proteins that allow it to disrupt the plant's immune response. One toxin coronatine makes plants' stomata open up, allowing bacteria to enter more freely. Coronatine also activates pathways leading to chlorophyll degradation, which you can see as yellow spots. As the bacteria continue to feed and multiply, they start to kill off the plant cells. That explains spots, but what about mushy blemishes? Those are usually caused when the fruit is attacked by microbes after it's detached from the plant. If the plant is wounded during transport, necrotic fungi can infiltrate through the wound, kill the cells, absorb their nutrients, and leave your food looking mushy or brown. Those spots in particular can taste pretty bad. You're eating dead and decomposing tissue, after all. But you can usually salvage the rest of the fruit. The non-mushy spots, like the ones you typically see on apples or tomatoes, are just on the surface and don't usually affect flavor. Of course, microbes that do make us sick, like E. coli and salmonella, can hitch a ride on vegetables, too. But because they're not plant pathogens, they don't typically cause spots. They just hang out invisibly on the surface. So it's washing fruit and veggies, not avoiding the spotty ones, that will help you avoid getting sick. So the next time you're at the grocery store, don't be afraid to pick up funky-looking fruit. Some stores will even give you a discount. Wash them well and store them properly, as some produce like apples and cabbages will keep in the fridge for weeks. The spotty ones may not be eye candy, but they're safe and just as delicious.

**P386 2016-08-18 Is graffiti art Or vandalism - Kelly Wall**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=386)

Spray-painted subway cars, tagged bridges, mural-covered walls. Graffiti pops up boldly throughout our cities. It can make statements about identity, art, empowerment, and politics, while simultaneously being associated with destruction. And, it turns out, it's nothing new. Graffiti, or the act of writing or scribbling on public property, has been around for thousands of years. And across that span of time, it's raised the same questions we debate now: Is it art? Is it vandalism? In the 1st century BCE, Romans regularly inscribed messages on public walls, while oceans away, Mayans were prolifically scratching drawings onto their surfaces. And it wasn't always a subversive act. In Pompeii, ordinary citizens regularly marked public walls with magic spells, prose about unrequited love, political campaign slogans, and even messages to champion their favorite gladiators. Some, including the Greek philosopher Plutarch, pushed back, deeming graffiti ridiculous and pointless. But it wasn't until the 5th century that the roots of the modern concept of vandalism were planted. At that time, a barbaric tribe known as the Vandals swept through Rome, pillaging and destroying the city. But it wasn't until centuries later that the term vandalism was actually coined in an outcry against the defacing of art during the French Revolution. And as graffiti became increasingly associated with deliberate rebellion and provocativeness, it took on its vandalist label. That's part of the reason why, today, many graffiti artists stay underground. Some assume alternate identities to avoid retribution, while others do so to establish comradery and make claim to territory. Beginning with the tags of the 1960s, a novel overlap of celebrity and anonymity hit the streets of New York City and Philadelphia. Taggers used coded labels to trace their movements around cities while often alluding to their origins. And the very illegality of graffiti-making that forced it into the shadows also added to its intrigue and growing base of followers. The question of space and ownership is central to graffiti's history. Its contemporary evolution has gone hand in hand with counterculture scenes. While these movements raised their anti-establishment voices, graffiti artists likewise challenged established boundaries of public property. They reclaimed subway cars, billboards, and even once went so far as to paint an elephant in the city zoo. Political movements, too, have used wall writing to visually spread their messages. During World War II, both the Nazi Party and resistance groups covered walls with propaganda. And the Berlin Wall's one-sided graffiti can be seen as a striking symbol of repression versus relatively unrestricted public access. As the counterculture movements associated with graffiti become mainstream, does graffiti, too, become accepted? Since the creation of so-called graffiti unions in the 1970s and the admission of select graffiti artists into art galleries a decade later, graffiti has straddled the line between being outside and inside the mainstream. And the appropriation of graffiti styles by marketers and typographers has made this definition even more unclear. The once unlikely partnerships of graffiti artists with traditional museums and brands, have brought these artists out of the underground and into the spotlight. Although graffiti is linked to destruction, it's also a medium of unrestricted artistic expression. Today, the debate about the boundary between defacing and beautifying continues. Meanwhile, graffiti artists challenge common consensus about the value of art and the degree to which any space can be owned. Whether spraying, scrawling, or scratching, graffiti brings these questions of ownership, art, and acceptability to the surface.

**P387 2016-08-21 How do animals see in the dark - Anna Stöckl**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=387)

To human eyes, the world at night is a formless canvas of grey. Many nocturnal animals, on the other hand, experience a rich and varied world bursting with details, shapes, and colors. What is it, then, that separates moths from men? Moths and many other nocturnal animals see at night because their eyes are adapted to compensate for the lack of light. All eyes, whether nocturnal or not, depend on photoreceptors in the retina to detect light particles, known as photons. Photoreceptors then report information about these photons to other cells in the retina and brain. The brain sifts through that information and uses it to build up an image of the environment the eye perceives. The brighter the light is, the more photons hit the eye. On a sunny day, upwards of 100 million times more photons are available to the eye than on a cloudy, moonless night. Photons aren't just less numerous in darkness, but they also hit the eye in a less reliable way. This means the information that photoreceptors collect will vary over time, as will the quality of the image. In darkness, trying to detect the sparse scattering of randomly arriving photons is too difficult for the eyes of most daytime animals. But for night creatures, it's just a matter of adaptation. One of these adaptations is size. Take the tarsier, whose eyeballs are each as big as its brain, giving it the biggest eyes compared to head size of all mammals. If humans had the same brain to eye ratio, our eyes would be the size of grapefruits. The tarsier's enlarged orbs haven't evolved to make it cuter, however, but to gather as much light as possible. Bigger eyes can have larger openings, called pupils, and larger lenses, allowing for more light to be focused on the receptors. While tarsiers scan the nocturnal scene with their enormous peepers, cats use gleaming eyes to do the same. Cats' eyes get their shine from a structure called the tapetum lucidum that sits behind the photoreceptors. This structure is made from layers of mirror-like cells containing crystals that send incoming light bouncing back towards the photoreceptors and out of the eye. This results in an eerie glow, and it also gives the photoreceptors a second chance to detect photons. In fact, this system has inspired the artificial cats' eyes we use on our roads. Toads, on the other hand, have adapted to take it slow. They can form an image even when just a single photon hits each photoreceptor per second. They accomplish this with photoreceptors that are more than 25 times slower than human ones. This means toads can collect photons for up to four seconds, allowing them to gather many more than our eyes do at each visual time interval. The downside is that this causes toads to react very slowly because they're only receiving an updated image every four seconds. Fortunately, they're accustomed to targeting sluggish prey. Meanwhile, the night is also buzzing with insects, such as hawk moths, which can see their favorite flowers in color, even on a starlit night. They achieve this by a surprising move - getting rid of details in their visual perception. Information from neighboring photoreceptors is grouped in their brains, so the photon catch of each group is higher compared to individual receptors. However, grouping photoreceptors loses details in the image, as fine details require a fine grid of photoreceptors, each detecting photons from one small point in space. The trick is to balance the need for photons with the loss of detail to still find their flowers. Whether eyes are slow, enormous, shiny, or coarse, it's the combination of these biological adaptations that gives nocturnal animals their unique visual powers. Imagine what it might be like to witness through their eyes the world that wakes up when the Sun goes down.

**P388 2016-08-24 How do contraceptives work - NWHunter**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=388)

Here's what has to happen for pregnancy to occur after sexual intercourse. Sperm must swim up the vagina, through the cervical opening, upwards through the uterus, and into one of the two fallopian tubes. If an egg, released during that month's ovulation, is in the tube, one sperm has a chance to fertilize it. Contraceptives are designed to prevent this process, and they work in three basic ways. They block the sperm, disable sperm before they reach the uterus, or suppress ovulation. Block is the simplest. Male and female condoms prevent sperm from coming into contact with the vaginal space. That barrier is also why they, unlike other contraceptive methods, are able to prevent transmission of certain sexually transmitted diseases. Meanwhile, the diaphragm, cervical cap, and sponge work by being placed over the cervix, barricading the entrance to the uterus. These contraceptives are sometimes called barrier methods and can be used with spermicides, an example of the second category, disable. A spermicide is a chemical that immobilizes and destroys sperm. Today's spermicides come as foam, cream, jelly, suppositories, and even a thin piece of translucent film that dissolves in the vagina. These products can be inserted directly into the vagina before intercourse, or can be combined with block methods, like a diaphragm or condom, for added proection. The third category for preventing pregnancy works by suppressing the action of an egg maturing in the ovary. If there isn't an egg available in the fallopian tube, there's nothing for sperm to fertilize. Hormonal contraceptives, including the pill, the patch, the Depo shot, and the vaginal ring all release synthetic versions of various combinations of progesterone and estrogen. This hormone cocktail suppresses ovulation, keeping the immature egg safely sequestered in the ovary. Synthetic progesterone also has a block trick up its sleeve. It makes cervical mucus too thick and sticky for sperm to swim through easily. There are other contraceptives that use multiple approaches at the same time. For example, many IUDs, or intrauterine devices, contain synthetic hormones which suppress ovulation. Some also contain copper, which disable sperm while also making egg implantation in the uterus difficult. Block, disable, or suppress: is one strategy better than the other? There are differences, but a lot of it has to do with how convenient and easy it is to use each contraceptive correctly. For example, male condoms would be about 98% effective if everyone used them perfectly. That 98% means if 100 couples correctly used condoms for a year, two women would get pregnant. But not everyone uses them correctly, so they're only 82% effective in practice. Other methods, like the patch and pill, are 99% effective when they're used perfectly. But in practice, that's 91%. Spermicide is only 85% effective, even with perfect usage, and just 71% effective with typical usage. Another important consideration in the choice of contraceptives are side effects, which almost exclusively affect women rather than men. Hormonal methods in particular can cause symptoms like headaches, nausea, and high blood pressure, but they vary from woman to woman. That's why these methods require a prescription from a doctor. The choice of contraceptive method is a personal one, and what works best for you now may change later. Scientists also continue to research new methods, such as a male pill that would prevent sperm production. In the meantime, there are quite a few options to block sperm, disable them, or suppress eggs and keep them out of reach.

**P389 2016-09-07 Could we survive prolonged space travel - Lisa Nip**

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Prolonged space travel takes a severe toll on the human body. Microgravity impairs muscle and bone growth, and high doses of radiation cause irreversible mutations. As we seriously consider the human species becoming space-faring, a big question stands. Even if we break free from Earth's orbit and embark on long-duration journeys among the stars, can we adapt to the extreme environments of space? This won't be the first time that humans have adapted to harsh environments and evolved superhuman capabilities. Not fantastical powers like laser vision or invisibility, but physiological adaptations for survival in tough conditions. For example, on the Himalayan mountains where the highest elevation is nine kilometers above sea level, an unacclimated lowland human will experience symptoms of hypoxia, commonly known as mountain sickness. At these altitudes, the body usually produces extra red blood cells, thickening the blood and impeding its flow. But Himalayans who have lived on these mountains for thousands of years permanently evolved mechanisms to circumvent this process and maintain normal blood flow. Cases like that prove that humans can develop permanent lifesaving traits. But natural adaptation for entire human populations could take tens of thousands of years. Recent scientific advances may help us accelerate human adaptation to single generations. To thrive as a species during space travel, we could potentially develop methods to quickly program protective abilities into ourselves. A beta version of these methods is gene therapy, which we can currently use to correct genetic diseases. Gene editing technology, which is improving rapidly, allows scientists to directly change the human genome to stop undesirable processes or make helpful substances. An example of an unwanted process is what happens when our bodies are exposed to ionizing radiation. Without an atmospheric barrier and a magnetic field like Earth's, most planets and moons are bombarded with these dangerous subatomic particles. They can pass through nearly anything and would cause potentially cancerous DNA damage to space explorers. But what if we could turn the tables on radiation? Human skin produces a pigment called melanin that protects us from the filtered radiation on Earth. Melanin exists in many forms across species, and some melanin-expressing fungi use the pigment to convert radiation into chemical energy. Instead of trying to shield the human body, or rapidly repair damage, we could potentially engineer humans to adopt and express these fungal, melanin-based energy-harvesting systems. They'd then convert radiation into useful energy while protecting our DNA. This sounds pretty sci-fi, but may actually be achievable with current technology. But technology isn't the only obstacle. There are ongoing debates on the consequences and ethics of such radical alterations to our genetic fabric. Besides radiation, variation in gravitational strength is another challenge for space travelers. Until we develop artificial gravity in a space ship or on another planet, we should assume that astronauts will spend time living in microgravity. On Earth, human bone and muscle custodial cells respond to the stress of gravity's incessant tugging by renewing old cells in processes known as remodeling and regeneration. But in a microgravity environment like Mars, human bone and muscle cells won't get these cues, resulting in osteoporosis and muscle atrophy. So, how could we provide an artificial signal for cells to counteract bone and muscle loss? Again, this is speculative, but biochemically engineered microbes inside our bodies could churn out bone and muscle remodeling signaling factors. Or humans could be genetically engineered to produce more of these signals in the absence of gravity. Radiation exposure and microgravity are only two of the many challenges we will encounter in the hostile conditions of space. But if we're ethically prepared to use them, gene editing and microbial engineering are two flexible tools that could be adapted to many scenarios. In the near future, we may decide to further develop and tune these genetic tools for the harsh realities of space living.

**P390 2016-09-09 The history of the Cuban Missile Crisis - Matthew A. Jordan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=390)

It's not hard to imagine a world where at any given moment, you and everyone you know could be wiped out without warning at the push of a button. This was the reality for millions of people during the 45-year period after World War II, now known as the Cold War. As the United States and Soviet Union faced off across the globe, each knew that the other had nuclear weapons capable of destroying it. And destruction never loomed closer than during the 13 days of the Cuban Missile Crisis. In 1961, the U.S. unsuccessfully tried to overthrow Cuba's new communist government. That failed attempt was known as the Bay of Pigs, and it convinced Cuba to seek help from the U.S.S.R. Soviet premier Nikita Khrushchev was happy to comply by secretly deploying nuclear missiles to Cuba, not only to protect the island, but to counteract the threat from U.S. missiles in Italy and Turkey. By the time U.S. intelligence discovered the plan, the materials to create the missiles were already in place. At an emergency meeting on October 16, 1962, military advisors urged an airstrike on missile sites and invasion of the island. But President John F. Kennedy chose a more careful approach. On October 22, he announced that the the U.S. Navy would intercept all shipments to Cuba. There was just one problem: a naval blockade was considered an act of war. Although the President called it a quarantine that did not block basic necessities, the Soviets didn't appreciate the distinction. In an outraged letter to Kennedy, Khrushchev wrote, "The violation of freedom to use international waters and international airspace is an act of aggression which pushes mankind toward the abyss of world nuclear missile war." Thus ensued the most intense six days of the Cold War. While the U.S. demanded the removal of the missiles, Cuba and the U.S.S.R insisted they were only defensive. And as the weapons continued to be armed, the U.S. prepared for a possible invasion. On October 27, a spy plane piloted by Major Rudolph Anderson was shot down by a Soviet missile. The same day, a nuclear-armed Soviet submarine was hit by a small-depth charge from a U.S. Navy vessel trying to signal it to come up. The commanders on the sub, too deep to communicate with the surface, thought war had begun and prepared to launch a nuclear torpedo. That decision had to be made unanimously by three officers. The captain and political officer both authorized the launch, but Vasili Arkhipov, second in command, refused. His decision saved the day and perhaps the world. But the crisis wasn't over. For the first time in history, the U.S. Military set itself to DEFCON 2, the defense readiness one step away from nuclear war. With hundreds of nuclear missiles ready to launch, the metaphorical Doomsday Clock stood at one minute to midnight. But diplomacy carried on. In Washington, D.C., Attorney General Robert Kennedy secretly met with Soviet Ambassador Anatoly Dobrynin. After intense negotiation, they reached the following proposal. The U.S. would remove their missiles from Turkey and Italy and promise to never invade Cuba in exchange for the Soviet withdrawal from Cuba under U.N. inspection. Once the meeting had concluded, Dobrynin cabled Moscow saying time is of the essence and we shouldn't miss the chance. And at 9 a.m. the next day, a message arrived from Khrushchev announcing the Soviet missiles would be removed from Cuba. The crisis was now over. While criticized at the time by their respective governments for bargaining with the enemy, contemporary historical analysis shows great admiration for Kennedy's and Khrushchev's ability to diplomatically solve the crisis. But the disturbing lesson was that a slight communication error, or split-second decision by a commander, could have thwarted all their efforts, as it nearly did if not for Vasili Arkhipov's courageous choice. The Cuban Missile Crisis revealed just how fragile human politics are compared to the terrifying power they can unleash.

**P391 2016-09-13 Aphasia - The disorder that makes you lose your words - Susan Wortman**

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Language is an essential part of our lives that we often take for granted. With it, we can communicate our thoughts and feelings, lose ourselves in novels, send text messages, and greet friends. It's hard to imagine being unable to turn thoughts into words. But if the delicate web of language networks in your brain became disrupted by stroke, illness, or trauma, you could find yourself truly at a loss for words. This disorder, called aphasia, can impair all aspects of communication. People who have aphasia remain as intelligent as ever. They know what they want to say, but can't always get their words to come out correctly. They may unintentionally use substitutions called paraphasias, switching related words, like saying "dog" for "cat," or words that sound similar, such as "house" for "horse." Sometimes, their words may even be unrecognizable. There are several types of aphasia grouped into two categories: fluent, or receptive, aphasia and non-fluent, or expressive, aphasia. People with fluent aphasia may have normal vocal inflection but use words that lack meaning. They have difficulty comprehending the speech of others and are frequently unable to recognize their own speech errors. People with non-fluent aphasia, on the other hand, may have good comprehension but will experience long hesitations between words and make grammatical errors. We all have that tip-of-the-tongue feeling from time to time when we can't think of a word, but having aphasia can make it hard to name simple, everyday objects. Even reading and writing can be difficult and frustrating. So how does this language loss happen? The human brain has two hemispheres. In most people, the left hemisphere governs language. We know this because in 1861, the physician Paul Broca studied a patient who lost the ability to use all but a single word, "tan." During a postmortem study of that patient's brain, Broca discovered a large lesion in the left hemisphere now known as Broca's area. Scientists today believe that Broca's area is responsible in part for naming objects and coordinating the muscles involved in speech. Behind Broca's area is Wernicke's area near the auditory cortex. That's where the brain attaches meaning to speech sounds. Damage to Wernicke's area impairs the brain's ability to comprehend language. Aphasia is caused by injury to one or both of these specialized language areas. Fortunately, there are other areas of the brain which support these language centers and can assist with communication. Even brain areas that control movement are connected to language. FMRI studies found that when we hear action words, like "run" or "dance," parts of the brain responsible for movement light up as if the body was actually running or dancing. Our other hemisphere contributes to language, too, enhancing the rhythm and intonation of our speech. These non-language areas sometimes assist people with aphasia when communication is difficult. So how common is aphasia? Approximately 1 million people in the U.S. alone have it, with an estimated 80,000 new cases per year. About one-third of stroke survivors suffer from aphasia making it more prevalent than Parkinson's disease or multiple sclerosis, yet less widely known. There is one rare form of aphasia called primary progressive aphasia, or PPA, which is not caused by stroke or brain injury, but is actually a form of dementia in which language loss is the first symptom. The goal in treating PPA is to maintain language function for as long as possible before other symptoms of dementia eventually occur. However, when aphasia is acquired from a stroke or brain trauma, language improvement may be achieved through speech therapy. Our brain's ability to repair itself, known as brain plasticity, permits areas surrounding a brain lesion to take over some functions during the recovery process. Scientists have been conducting experiments using new forms of technology, which they believe may encourage brain plasticity in people with aphasia. Meanwhile, many people with aphasia remain isolated, afraid that others won't understand them or give them extra time to speak. By offering them the time and flexibility to communicate in whatever way they can, you can help open the door to language again, moving beyond the limitations of aphasia.

**P392 2016-09-13 Why are there so many types of apples - Theresa Doud**

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Have you ever walked into a grocery store and wondered where all those variety of apples came from? You might find SnapDragon, Pixie Crunch, Cosmic Crisp, Jazz, or Ambrosia next to the more familiar Red Delicious and Granny Smith. These delightfully descriptive names belong to just a handful of the over 7,500 apple varieties in the world. This huge diversity exists largely because of humanity's efforts to bear new fruit. Fruit breeding is a way to fulfill the expectations of farmers and consumers who seek specific qualities in an apple. On the one hand, farmers may want them to be disease-resistant and to store well. On the other, consumers are swayed by appearance, taste, and novelty. So, breeders have to consider everything from how well apples grow in certain climates to their color, taste, and size. And sometimes finding the perfect fit means breeding something new. To create apples with desirable characteristics, breeders first need to find parent apples that carry those characteristics. Once the parents have been selected, they have to wait until the trees bloom in the spring. The breeder takes the pollen from one bloom, called the father, and transfers it by hand to the other parent bloom, called the mother, through a process called cross-pollination. Once the mother bloom turns into an apple, the seeds are collected and then planted. It takes about five years for these seeds to grow into trees that produce apples, but because of the way traits are inherited, all of the seedlings produced will have different sets of genes and characteristics. This means that to achieve a desired quality, it takes a lot of offspring, not to mention patience on the breeder's part. When a seedling does bear fruit with the desired qualities, it's selected for further evaluation. Of the original crossed seedlings, about one in every 5,000 makes it to this prestigious stage. They're then sent to new farms where breeders can assess how various climates and soil types affect the plant's growth. The fruit of the seedling and its many clones must then be collected and sampled to ensure consistency. Breeders study about 45 traits in an apple, like the texture and firmness of the flesh, when it ripens, how sugary its juice is, and how long it stays fresh. Over several years, they weed out all the bad apples, selecting only those whose fruits are the best. These exclusive plants officially form the cultivar, or new apple variety. To ensure an exact copy of this cultivar, all apple trees must be grafted from the original seedling. Branches, called scion wood, are cut from the original tree and grown to generate more scion wood. Segments of these trees are then grafted onto root stalk - that's the lower section of another tree that's been chosen from a different cultivar for its superior roots and growing ability. Finally, this fusion creates a new apple tree with the desired qualities. Each new plant takes up to four years before it starts producing the fruit we eat. Apple breeding may be a difficult art, but it's accessible to all: universities, companies, and even individuals can create new cultivars. But to fully own an apple, the breeder faces a final challenge - naming the fruit. After a cultivar is patented, a breeder chooses a name for its trademark. That final step grants them long-lasting rights over the apple and its clones. That name must be completely original, and the catchier, the better, of course. With over 7,500 varieties and counting, that's why we have apples called Pink Lady, Sweet Tango, Kiku, and EverCrisp. The more we work with nature's bounty to breed new cultivars, the more creative and delectable these names will become.

**P393 2016-09-17 Is it bad to hold your pee - Heba Shaheed**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=393)

It begins with a bit of discomfort and soon becomes a pressing sensation that's impossible to ignore. Finally, it's all you can think about, and out of sheer desperation, you go on a hunt for a bathroom until "ahh." Humans should urinate at least four to six times a day, but occasionally, the pressures of modern life forces us to clench and hold it in. How bad is this habit, and how long can our bodies withstand it? The answers lie in the workings of the bladder, an oval pouch that sits inside the pelvis. Surrounding this structure are several other organs that together make up the whole urinary system. Two kidneys, two ureters, two urethral sphincters, and a urethra. Constantly trickling down from the kidneys is the yellowish liquid known as urine. The kidneys make urine from a mix of water and the body's waste products, funneling the unwanted fluid into two muscular tubes called ureters. These carry it downward into the hollow organ known as the bladder. This organ's muscular wall is made of tissue called detrusor muscle which relaxes as the bladder fills allowing it to inflate like a balloon. As the bladder gets full, the detrusor contracts. The internal urethral sphincter automatically and involuntarily opens, and the urine is released. Whooshing downwards, the fluid enters the urethra and stops short at the external urethral sphincter. This works like a tap. When you want to delay urinating, you keep the sphincter closed. When you want to release it, you can voluntarily open the flood gates. But how do you sense your bladder's fullness so you know when to pee? Inside the layers of detrusor muscles are millions of stretch receptors that get triggered as the bladder fills. They send signals along your nerves to the sacral region in your spinal cord. A reflex signal travels back to your bladder, making the detrusor muscle contract slightly and increasing the bladder's pressure so you're aware that it's filling up. Simultaneously, the internal urethral sphincter opens. This is called the micturition reflex. The brain can counter it if it's not a good time to urinate by sending another signal to contract the external urethral sphincter. With about 150 to 200 milliliters of urine inside of it, the bladder's muscular wall is stretched enough for you to sense that there's urine within. At about 400 to 500 milliliters, the pressure becomes uncomfortable. The bladder can go on stretching, but only to a point. Above 1,000 milliliters, it may burst. Most people would lose bladder control before this happens, but in very rare cases, such as when as a person can't sense the need to urinate, the pouch can rupture painfully requiring surgery to fix. But under normal circumstances, your decision to urinate stops the brain's signal to the external urethral sphincter, causing it to relax and the bladder to empty. The external urethral sphincter is one of the muscles of the pelvic floor, and it provides support to the urethra and bladder neck. It's lucky we have these pelvic floor muscles because placing pressure on the system by coughing, sneezing, laughing, or jumping could cause bladder leakage. Instead, the pelvic floor muscles keep the region sealed until you're ready to go. But holding it in for too long, forcing out your urine too fast, or urinating without proper physical support may over time weaken or overwork that muscular sling. That can lead to an overactive pelvic floor, bladder pain, urgency, or urinary incontinence. So in the interest of long-term health, it's not a great habit to hold your pee. But in the short term, at least, your body and brain have got you covered, so you can conveniently choose your moment of sweet release.

**P394 2016-09-20 The history of African-American social dance - Camille A. Brown**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=394)

This is the Bop. The Bop is a type of social dance. Dance is a language, and social dance is an expression that emerges from a community. A social dance isn't choreographed by any one person. It can't be traced to any one moment. Each dance has steps that everyone can agree on, but it's about the individual and their creative identity. Because of that, social dances bubble up, they change, and they spread like wildfire. They are as old as our remembered history. In African-American social dances, we see over 200 years of how African and African-American traditions influenced our history. The present always contains the past. And the past shapes who we are and who we will be. (Clapping) The Juba dance was born from enslaved Africans' experience on the plantation. Brought to the Americas, stripped of a common spoken language, this dance was a way for enslaved Africans to remember where they're from. It may have looked something like this. Slapping thighs, shuffling feet and patting hands: this was how they got around the slave owners' ban on drumming, improvising complex rhythms just like ancestors did with drums in Haiti or in the Yoruba communities of West Africa. It was about keeping cultural traditions alive and retaining a sense of inner freedom under captivity. It was the same subversive spirit that created this dance: the Cakewalk, a dance that parodied the mannerisms of Southern high society -- a way for the enslaved to throw shade at the masters. The crazy thing about this dance is that the Cakewalk was performed for the masters, who never suspected they were being made fun of. Now you might recognize this one. 1920s -- the Charleston. The Charleston was all about improvisation and musicality, making its way into Lindy Hop, swing dancing and even the Kid n Play, originally called the Funky Charleston. Started by a tight-knit Black community near Charleston, South Carolina, the Charleston permeated dance halls where young women suddenly had the freedom to kick their heels and move their legs. Now, social dance is about community and connection; if you knew the steps, it meant you belonged to a group. But what if it becomes a worldwide craze? Enter the Twist. It's no surprise that the Twist can be traced back to the 19th century, brought to America from the Congo during slavery. But in the late '50s, right before the Civil Rights Movement, the Twist is popularized by Chubby Checker and Dick Clark. Suddenly, everybody's doing the Twist: white teenagers, kids in Latin America, making its way into songs and movies. Through social dance, the boundaries between groups become blurred. The story continues in the 1980s and '90s. Along with the emergence of hip-hop, African-American social dance took on even more visibility, borrowing from its long past, shaping culture and being shaped by it. Today, these dances continue to evolve, grow and spread. Why do we dance? To move, to let loose, to express. Why do we dance together? To heal, to remember, to say: "We speak a common language. We exist and we are free."

**P395 2016-09-29 Could human civilization spread across the whole galaxy - Roey Tzezan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=395)

Translator: Jessica Ruby Reviewer: Brian Greene Could human civilization eventually spread across the whole Milky Way galaxy? Could we move beyond our small blue planet to establish colonies in the multitude of star systems out there? This question's a pretty daunting one. There are around 300 billion stars in the galaxy, which is about 160,000 light-years across. So far we've sent a single spacecraft outside our solar system, trudging along at 0.006% of the speed of light. At that rate, it would take over 2.5 billion years just to get from one end of the galaxy to the other. And then there's the question of human survival. The gulf between stars is simply enormous. We couldn't live sustainably on most planets, and we require a lot of resources to stay alive. And yet, decades ago, scholars found that it's theoretically possible to not just spread human civilization across the galaxy, but to do so quite quickly, without breaking any known laws of physics. Their idea is based on the work of a mathematician named John von Neumann, who designed on paper machines that could self-replicate and create new generations of themselves. These would later come to be known as von Neumann machines. In the context of space exploration, von Neumann machines could be built on Earth and launched into space. There, the self-sufficient machines would land on distant planets. They would then mine the available resources and harvest energy, build replicas of themselves, launch those to the nearest planets, and continue the cycle. The result is the creation of millions of probes spreading outwards into the universe like a drop of ink in a fishbowl. Scholars crunched the numbers and found that a single von Neumann machine traveling at 5% of the speed of light should be able to replicate throughout our galaxy in 4 million years or less. That may sound like a long time, but when you consider that our universe is 14 billion years old, on a cosmic scale, it's incredibly fast - the equivalent of about 2.5 hours in an entire year. Creating von Neumann machines would require a few technologies we don't have yet, including advanced artificial intelligence, miniaturization, and better propulsion systems. If we wanted to use them to spread actual humans throughout the galaxy, we would need yet another technological leap - the ability to artificially grow biological organisms and bodies using raw elements and genetic information. Regardless, if in the last billion years an alien civilization created such a machine and set it multiplying its way toward us, our galaxy would be swarming with them by now. So then where are all these machines? Some astronomers, like Carl Sagan, say that intelligent aliens wouldn't build self-replicating machines at all. They might hurtle out of control, scavenging planets to their cores in order to keep replicating. Others take the machines absence as proof that intelligent alien civilizations don't exist, or that they go extinct before they can develop the necessary technologies. But all this hasn't stopped people from imagining what it would be like if they were out there. Science fiction author David Brin writes about a universe in which many different von Neumann machines exist and proliferate simultaneously. Some are designed to greet young civilizations, others to locate and destroy them before they become a threat. In fact, in Brin's story "Lungfish," some von Neumann machines are keeping a close watch over the Earth right now, waiting for us to reach a certain level of sophistication before they make their move. For now, all we have is curiosity and theory. But the next time you look at the night sky, consider that billions of self-replicating machines could be advancing between stars in our galaxy right now. If they exist, one of them will eventually land on Earth, or maybe, just maybe, they're already here.

**P396 2016-09-29 How the rubber glove was invented \_ Moments of Vision 4 - Jessica Ore**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=396)

In a Moment of Vision... It's the winter of 1890. Dr. William Halsted is the chief surgeon at Johns Hopkins Hospital. The scrub nurse under Halsted, a woman named Caroline Hampton, begins to develop a severe reaction to the strong disinfectants used to scour her hands and arms before surgery. Halsted takes an interest in her plight. In a moment of vision, he asks Goodyear rubber company to experiment with the production of a pair of thin rubber gloves. They fit Caroline, well, like gloves, and her hands begin to recover. In fact, the gloves are such a success that the good doctor orders more for his team and for himself. From these early experiments, a multibillion dollar rubber glove industry is born. And it turns out the doctor didn't just want to protect the nurse's hands. He also wanted to take them in holy matrimony. Halsted and Caroline were married just a few months after he gave her that first pair of gloves.

**P397 2016-10-04 How does the Nobel Peace Prize work - Adeline Cuvelier and Toril Roks**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=397)

What do a seventeen-year-old Pakistani, a Norwegian explorer, a Tibetan monk, and an American pastor have in common? They were all awarded the Nobel Peace Prize. Among the top prestigious awards in the world, this prize has honored some of the most celebrated and revered international figures and organizations in history. To understand how it all got started, we have to go back to the 1800s. Swedish chemist Alfred Nobel was then mostly known for the invention of dynamite, a breakthrough which launched his career as a successful inventor and businessman. 30 years later, he had become extremely wealthy, but never married, and had no children. When his will was opened after his death, it came as a surprise that his fortune was to be used for five prizes in physics, chemistry, medicine, literature, and peace. These prizes illustrated his lifelong commitment to sciences and his passion for literature. But what about peace? Because Nobel's name was tied to inventions used in the war industry, many have assumed that he created the peace prize out of regret. However, this is all speculation as he never expressed any such sentiments, and his inventions were also used for constructive purposes. Instead, many historians connect Alfred Nobel's interest for the peace cause to his decade-long friendship and correspondence with an Austrian pacifist named Bertha Von Suttner. Von Suttner was one of the leaders of the international peace movement, and in 1905, after Nobel's death, she became the first woman to be awarded the Nobel Peace Prize. Nobel's will outlined three criteria for the Peace Prize, which unlike the other Sweden-based prizes, would be administered in Norway. Disarmament, peace congresses, and brotherhood between nations. These standards have since been expanded to include other ways of promoting peace, such as human rights and negotiations. And the prize doesn't just have to go to one person. About a third of Noble Peace Prizes have been shared by two or three laureates. So how do nominations for the prize work? According to the Nobel Foundation, a valid nomination can come from a member of a national assembly, state government, or an international court. Eligible nominators also include university rectors, professors of the social sciences, history, philosophy, law, and theology, and previous recipients of the Peace Prize. But if you want to know more about who was recently nominated, you'll have to be patient. All information about nominations remains secret for 50 years. Take Martin Luther King Jr. We didn't actually know who nominated him until 2014. His nominators turned out to be the Quakers, who had won the prize previously, and eight members of the Swedish Parliament. There's no limit to the number of times a person or organization can be nominated. In fact, Jane Addams, recognized as the founder of social work in the United States, was nominated 91 times before finally being awarded the prize. The absence of a laureate can also be symbolic. The 1948 decision not to award the prize following the death of Mahatma Gandhi has been interpreted as an attempt to respectfully honor the so-called missing laureate. As with the other Nobel Prizes, the Peace Prize can't be awarded posthumously. The secret selection process takes almost a year, and is carried out by the five appointed members of the Norwegian Nobel Committee who are forbidden from having any official political function in Norway. Starting with a large pool of nominations, exceeding 300 in recent years, they access each candidate's work and create a short list. Finally, the chairman of the Nobel Committee publicly announces the laureate in October. The awards ceremony takes place on December 10th, the anniversary of Alfred Nobel's death. The prize itself includes a gold medal inscribed with the Latin words, "Pro pace et fraternitate gentium," or "For the peace and brotherhood of men," as well as a diploma and a large cash prize. Recently, it's been 8 million Swedish kronor, or roughly a million US dollars, which is split in the case of multiple laureates. And while laureates can use the prize money as they choose, in recent years, many have donated it to humanitarian or social causes. For many years, the Nobel Peace Prize was predominately awarded to European and North American men. But in recent years, significant changes have been taking place, making the prize more global than ever. 23 organizations and 103 individuals, that's 87 men and 16 women, have made up the 126 Nobel Peace Prize laureates in history. They include Desmond Tutu for his nonviolent campaign against apartheid in South Africa, Jody Williams for her campaign to ban and clear anti-personnel mines, Rigoberta Menchú Tum for her work for social justice and reconciliation based on respect for the rights of indigenous peoples, Martti Ahtisaari for his efforts to resolve international conflicts in Namibia, Kosovo, and Indonesia, and Aung San Suu Kyi for her nonviolent struggle for democracy and human rights in Myanmar. They're just a few examples of the people who have inspired us, challenged us, and demonstrated through their actions that there are many paths to peace.

**P398 2016-10-04 What happens to our bodies after we die - Farnaz Khatibi Jafari**

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Since the dawn of humanity, an estimated 100.8 billion people have lived and died, a number that increases by about .8% of the world's population each year. What happens to all of those people's bodies after they die and will the planet eventually run out of burial space? When a person's heart stops beating, the body passes through several stages before it begins decomposing. Within minutes after death, the blood begins settling in the lower-most parts of the body. Usually eight to twelve hours later, the skin in those areas is discolored by livor mortis, or post-mortem stain. And while at the moment of death the body's muscles relax completely in a condition called primary flaccidity, they stiffen about two to six hours later in what's known as rigor mortis. This stiffening spreads through the muscles, and its speed can be affected by age, gender, and the surrounding environment. The body also changes temperature, usually cooling off to match its environment. Next comes decomposition, the process by which bacteria and insects break apart the body. Many factors affect the rate of decomposition. There is, however, a basic guide of the effect of the environment on decompositon called Casper's Law. It says that if all other factors are equal, a body exposed to air decomposes twice as fast as one immersed in water and eight times as fast as one buried in earth. Soil acidity also greatly affects bone preservation. High-acidity soils with a pH of less than 5.3 will rapidly decompose bone, whereas in a neutral or basic soil with a pH of 7 or more, a skeleton can remain in relatively good condition for centuries. Different cultures throughout history have developed unique approaches to burials. As far back as the first Neanderthal burials, death was accompanied by rituals, like the positioning, coloring, or decorating of corpses. Traditional Christian burials decorate the body in dress, while in traditional Islam, a body is wrapped in a piece of ritual fabric with the face oriented toward Mecca. Traditional Hindus ceremonially burn the body, and Zoroastrians, followers of one of the oldest monotheistic religions, traditionally place bodies atop a tower to expose them to the Sun and scavenging birds.` Before the Industrial Revolution, burials were simple and accessible. These days, with suitable burial land running out in high-population areas, purchasing private gravesites can be costly, and many people can't afford simple burials. Even cremation, the second most common burial practice in the world, comes with a high cost. As for the question of running out of space, the issue isn't so much about total land in the world as it is that large populations cluster together within cities. Most of the big cities in the world may run out of suitable burial grounds within a century. For London, it's even sooner. That may happen by 2035. So are there alternatives to traditional burials that might help with the space issue? In some countries, skyscraper cemeteries enable vertical burials. Some options focus on the body's relationship with the environment. Promession, for example, freeze-dries and pulverizes the body, creating a powder that can turn into compost when mixed with oxygen and water. There are also green burials that use special materials, such as biodegradable caskets, urns that sprout trees, and burial suits that grow mushrooms. Eternal reefs take that concept to the depths of the ocean using a mixture of ashes and cement to create marine habitats for sea life. Death is an inevitable part of the human condition, but how we treat bodies and burials continues to evolve. We may each have different spiritual, religious, or practical approaches to dying, but the ever-increasing demand for burial space might give us a push to be creative about where our bodies go after the final stages of life.

**P399 2016-10-05 How much of human history is on the bottom of the ocean - Peter Campb**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=399)

Sunken relics, ghostly shipwrecks, and lost cities. These aren't just wonders found in fictional adventures. Beneath the ocean's surface, there are ruins where people once roamed and shipwrecks loaded with artifacts from another time. This is the domain of underwater archaeology, where researchers discover and study human artifacts that slipped into the sea. They're not on a treasure hunt. Underwater archaeology reveals important information about ancient climates and coastlines, it tells us how humans sailed the seas, and what life was like millennia ago. So what exactly can we find? At shallow depths mingled in with modern-day items, we've discovered all sorts of ancient artifacts. This zone contains evidence of how our ancestors fished, how they repaired their ships, disposed of their trash, and even their convicted pirates, who were buried below the tide line. And it's not just our recent history. 800,000-year old footprints were found along the shore in Norfolk, Britain. In these shallow depths, the remains of sunken cities also loom up from the sea floor, deposited there by earthquakes, tsunamis, and Earth's sinking plates. Almost every sunken city can be found at these shallow depths because the sea level has changed little in the several thousand years that city-building civilizations have existed. For instance, in shallow waters off the coast of Italy lies Baia, a Roman seaside town over 2,000 years old. There, it's possible to swim among the ruins of structures built by Rome's great families, senators, and emperors. And then there are shipwrecks. As ships grow too old for use, they're usually abandoned near shore in out-of-the-way places like estuaries, rivers, and shallow bays. Archaeologists use these like a timeline to map a harbor's peaks and declines, and to get clues about the historic art of shipbuiding. At Roskilde in Denmark, for example, five purposefully sunken vessels reveal how Vikings crafted their fearsome long ships 1,000 years ago. When we descend a bit further, we reach the zone where the deepest human structures lie, like ancient harbor walls and quays. We also see more shipwrecks sunk by storms, war, and collisions. We're still excavating many of these wrecks today, like Blackbeard's ship, which is revealing secrets about life as an 18th century pirate. But past 50 feet, there are even deeper, better preserved shipwrecks, like the wreck at Antikythera, which sank during the 1st century BC. When it was discovered, it contained statues, trade cargo, and also the earliest known computer, a mysterious device called the Antikythera mechanism that kept track of astronomical changes and eclipses. Today, it gives archaeologists vital information about the knowledge possessed by the Ancient Greeks. It is in this zone that we also begin to find aircraft and submarines, such as those from the World Wars. Plunging as deep as 200 feet, we can find some of the earliest and rarest signs of human history. Prior to 5,000 years ago, there was a lot more dry land because glaciers trapped much of the water that now forms the sea. Our ancestors spread across these lands, and so on the sea floor, we find their camps, stone tools, and the bones of animals they hunted. These sites give us invaluable knowledge about our ancestor's migration patterns, hunting methods, and technologies. In the deepest zone, no human has ever walked. This area has been submerged since well before mankind evolved. The only artifacts we find are those that have drifted down from above, like NASA's Saturn V rocket engines at 14,000 feet, and the deepest shipwrecks. The ocean is like a huge underwater museum that constantly adds to our knowledge about humanity. With only a fraction of it explored, discoveries are sure to continue long into the future.

**P400 2016-10-05 The Egyptian Book of the Dead - A guidebook for the underworld - Teja**

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Ani stands before a large golden scale where the jackal-headed god Anubis is weighing his heart against a pure ostrich feather. Ani was a real person, a scribe from the Egyptian city of Thebes who lived in the 13th century BCE. And depicted here is a scene from his Book of the Dead, a 78-foot papyrus scroll designed to help him attain immortality. Such funerary texts were originally written only for Pharaohs, but with time, the Egyptians came to believe regular people could also reach the afterlife if they succeeded in the passage. Ani's epic journey begins with his death. His body is mummified by a team of priests who remove every organ except the heart, the seat of emotion, memory, and intelligence. It's then stuffed with a salt called natron and wrapped in resin-soaked linen. In addition, the wrappings are woven with charms for protection and topped with a heart scarab amulet that will prove important later on. The goal of the two-month process is to preserve Ani's body as an ideal form with which his spirit can eventually reunite. But first, that spirit must pass through the duat, or underworld. This is a realm of vast caverns, lakes of fire, and magical gates, all guarded by fearsome beasts - snakes, crocodiles, and half-human monstrosities with names like "he who dances in blood." To make things worse, Apep, the serpent god of destruction, lurks in the shadows waiting to swallow Ani's soul. Fortunately, Ani is prepared with the magic contained within his book of the dead. Like other Egyptians who could afford it, Ani customized his scroll to include the particular spells, prayers, and codes he thought his spirit might need. Equipped with this arsenal, our hero traverses the obstacles, repels the monsters' acts, and stealthily avoids Apep to reach the Hall of Ma'at, goddess of truth and justice. Here, Ani faces his final challenge. He is judged by 42 assessor gods who must be convinced that he has lived a righteous life. Ani approaches each one, addressing them by name, and declaring a sin he has not committed. Among these negative confessions, or declarations of innocence, he proclaims that he has not made anyone cry, is not an eavesdropper, and has not polluted the water. But did Ani really live such a perfect life? Not quite, but that's where the heart scarab amulet comes in. It's inscribed with the words, "Do not stand as a witness against me," precisely so Ani's heart doesn't betray him by recalling the time he listened to his neighbors fight or washed his feet in the Nile. Now, it's Ani's moment of truth, the weighing of the heart. If his heart is heavier than the feather, weighed down by Ani's wrongdoings, it'll be devoured by the monstrous Ammit, part crocodile, part leopard, part hippopotamus, and Ani will cease to exist forever. But Ani is in luck. His heart is judged pure. Ra, the sun god, takes him to Osiris, god of the underworld, who gives him final approval to enter the afterlife. In the endless and lush field of reeds, Ani meets his deceased parents. Here, there is no sadness, pain, or anger, but there is work to be done. Like everyone else, Ani must cultivate a plot of land, which he does with the help of a Shabti doll that had been placed in his tomb. Today, the Papyrus of Ani resides in the British Museum, where it has been since 1888. Only Ani, if anyone, knows what really happened after his death. But thanks to his Book of the Dead, we can imagine him happily tending his crops for all eternity.

**P401 2016-10-06 Plato’s best (and worst) ideas - Wisecrack**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=401)

Few individuals have influenced the world and many of today's thinkers like Plato. One 20th century philosopher even went so far as to describe all of Western philosophy as a series of footnotes to Plato. He created the first Western university and was teacher to Ancient Greece's greatest minds, including Aristotle. But even one of the founders of philosophy wasn't perfect. Along with his great ideas, Plato had a few that haven't exactly stood the test of time. So here are brief rundowns of a few of his best and worst ideas. Plato argued that beyond our imperfect world was a perfect unchanging world of Forms. Forms are the ideal versions of the things and concepts we see around us. They serve as a sort of instruction manual to our own world. Floating around the world of Forms is the ideal tree, and the ideal YouTube channel, and even the ideal justice, or ideal love. Our own reality is comprised of imperfect copies of ideal Forms. Plato argued that philosophers should strive to contemplate and understand these perfect Forms so that they may better navigate our misleading reality. While it may seem silly, the disconnect between the world as it appears and the greater truth behind it is one of philosophy's most vexing problems. It's been the subject of thousands of pages by theologians, philosophers, and screenwriters alike. It raises questions like should we trust our senses to come to the truth or our own reason? For Plato, the answer is reason. It alone provides us with at least the potential to contemplate the Forms. But reason didn't always pan out for Plato himself. When he sought to situate humankind amongst the animals, he lumped us in with birds. "Featherless bipeds" was his official designation. Diogenes the Cynic, annoyed by this definition, stormed into Plato's class with a plucked chicken, announcing, "Behold. Plato's man." But back to a few good ideas. Plato is one of the earliest political theorists on record, and with Aristotle, is seen as one of the founders of political science. He reasoned that being a ruler was no different than any other craft, whether a potter or doctor, and that only those who had mastered the craft were fit to lead. Ruling was the craft of contemplating the Forms. In his Republic, Plato imagined a utopia where justice is the ultimate goal. Plato's ideal city seeks a harmonious balance between its individual parts and should be lead by a philosopher king. Millennia before his time, Plato also reasoned that women were equally able to rule in this model city. Unfortunately, Plato was inconsistent with women, elsewhere likening them to children. He also believed that a woman's womb was a live animal that could wander around in her body and cause illness. This bad idea, also espoused by other contemporaries of Plato, was sadly influential for hundreds of years in European medicine. Furthermore, he thought that society should be divided into three groups: producers, the military, and the rulers, and that a great noble lie should convince everyone to follow this structure. The noble lie he proposed was that we're all born with gold, silver, or a mixture of brass and iron in our souls, which determine our roles in life. Some thinkers have gone on to credit the idea of the noble lie as a prototype for 20th century propaganda, and the philosopher king as inspiration for the dictators that used them. Should a few bad ideas tarnish Plato's status as one of the greatest philosophers in history? No! Plato gave the leaders and thinkers who came after him a place to start. Through the centuries, we've had the chance to test those ideas through writing and experience, and have accepted some while rejecting others. We are continuing to refine, amend, and edit his ideas which have become foundations of the modern world.

**P402 2016-10-11 Are food preservatives bad for you - Eleanor Nelsen**

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Food doesn't last. In days, sometimes hours, bread goes moldy, apple slices turn brown, and bacteria multiply in mayonnaise. But you can find all of these foods out on the shelf at the grocery store, hopefully unspoiled, thanks to preservatives. But what exactly are preservatives? How do they help keep food edible and are they safe? There are two major factors that cause food to go bad: microbes and oxidation. Microbes like bacteria and fungi invade food and feed off its nutrients. Some of these can cause diseases, like listeria and botulism. Others just turn edibles into a smelly, slimy, moldy mess. Meanwhile, oxidation is a chemical change in the food's molecules caused by enzymes or free radicals which turn fats rancid and brown produce, like apples and potatoes. Preservatives can prevent both types of deterioration. Before the invention of artificial refrigeration, fungi and bacteria could run rampant in food. So we found ways to create an inhospitable environment for microbes. For example, making the food more acidic unravels enzymes that microbes need to survive. And some types of bacteria can actually help. For thousands of years, people preserved food using bacteria that produce lactic acid. The acid turns perishable vegetables and milk into longer lasting foods, like sauerkraut in Europe, kimchi in Korea, and yogurt in the Middle East. These cultured foods also populate your digestive track with beneficial microbes. Many synthetic preservatives are also acids. Benzoic acid in salad dressing, sorbic acid in cheese, and propionic acid in baked goods. Are they safe? Some studies suggest that benzoates, related to benzoic acid, contribute to hyperactive behavior. But the results aren't conclusive. Otherwise, these acids seem to be perfectly safe. Another antimicrobial strategy is to add a lot of sugar, like in jam, or salt, like in salted meats. Sugar and salt hold on to water that microbes need to grow and actually suck moisture out of any cells that may be hanging around, thus destroying them. Of course, too much sugar and salt can increase your risk of heart disease, diabetes, and high blood pressure, so these preservatives are best in moderation. Antimicrobial nitrates and nitrites, often found in cured meats, ward off the bacteria that cause botulism, but they may cause other health problems. Some studies linking cured meats to cancer have suggested that these preservatives may be the culprit. Meanwhile, antioxidant preservatives prevent the chemical changes that can give food an off-flavor or color. Smoke has been used to preserve food for millennia because some of the aromatic compounds in wood smoke are antioxidants. Combining smoking with salting was an effective way of preserving meat before refrigeration. For antioxidant activity without a smoky flavor, there are compounds like BHT and tocopherol, better known as vitamin E. Like the compounds in smoke, these sop up free radicals and stave off rancid flavors that can develop in foods like oils, cheese, and cereal. Other antioxidants like citric acid and ascorbic acid help cut produce keep its color by thwarting the enzyme that causes browning. Some compounds like sulfites can multitask. They're both antimicrobials and antioxidants. Sulfites may cause allergy symptoms in some people, but most antioxidant preservatives are generally recognized as safe. So should you be worried about preservatives? Well, they're usually near the end of the ingredients list because they're used in very small amounts determined by the FDA to be safe. Nevertheless, some consumers and companies are trying to find alternatives. Packaging tricks, like reducing the oxygen around the food can help, but without some kind of chemical assistance, there are very few foods that can stay shelf stable for long.

**P403 2016-10-13 What causes cavities - Mel Rosenberg**

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When a team of archaeologists recently came across some 15,000 year-old human remains, they made an interesting discovery. The teeth of those ancient humans were riddled with holes. Their cavities were caused by the same thing that still plagues us today, specific tiny microbes that live in our mouths. These microbes are with us soon after birth. We typically pick them up as babies from our mothers' mouths. And as our teeth erupt, they naturally begin to accumulate communities of bacteria. Depending on what we eat, and specifically how much sugar we consume, certain microbes can overpopulate and cause cavities. Diets high in sugary foods cause an explosion of bacteria called mutans streptococci in our mouths. Like humans, these microorganisms love sugar, using it as a molecular building block and energy source. As they consume it, the bacteria generate byproducts in the form of acids, such as lactic acid. Mutans streptococci are resistant to this acid, but unfortunately, our teeth aren't. While each human tooth is coated in a hardy, protective layer of enamel, it's no match for acid. That degrades the armor over time, leaching away its calcium minerals. Gradually, acid wears down a pathway for bacteria into the tooth's secondary layer called the dentin. Since blood vessels and nerves in our teeth are enclosed deep within, at this stage, the expanding cavity doesn't hurt. But if the damage extends beyond the dentin, the bacterial invasion progresses causing excruciating pain as the nerves become exposed. Without treatment, the whole tooth may become infected and require removal all due to those sugar-loving bacteria. The more sugar our food contains, the more our teeth are put at risk. Those cavemen would hardly have indulged in sugary treats, however, so what caused their cavities? In meat-heavy diets, there would have been a low-risk of cavities developing because lean meat contains very little sugar, but that's not all our early human ancestors ate. Cavemen would also have consumed root vegetables, nuts, and grains, all of which contain carbohydrates. When exposed to enzymes in the saliva, carbohydrates get broken down into simpler sugars, which can become the fodder for those ravenous mouth bacteria. So while ancient humans did eat less sugar compared to us, their teeth were still exposed to sugars. That doesn't mean they were unable to treat their cavities, though. Archaeological remains show that about 14,000 years ago, humans were already using sharpened flint to remove bits of rotten teeth. Ancient humans even made rudimentary drills to smooth out the rough holes left behind and beeswax to plug cavities, like modern-day fillings. Today, we have much more sophisticated techniques and tools, which is fortunate because we also need to contend with our more damaging, sugar-guzzling ways. After the Industrial Revolution, the human incidence of cavities surged because suddenly we had technological advances that made refined sugar cheaper and accessible. Today, an incredible 92% of American adults have had cavities in their teeth. Some people are more susceptible to cavities due to genes that may cause certain weaknesses, like softer enamel, but for most, high sugar consumption is to blame. However, we have developed other ways of minimizing cavities besides reducing our intake of sugar and starch. In most toothpastes and many water supplies, we use tiny amounts of fluoride. That strengthens teeth and encourages the growth of enamel crystals that build up a tooth's defenses against acid. When cavities do develop, we use tooth fillings to fill and close off the infected area, preventing them from getting worse. The best way to avoid a cavity is still cutting down on sugar intake and practicing good oral hygiene to get rid of the bacteria and their food sources. That includes regular tooth brushing, flossing, and avoiding sugary, starchy, and sticky foods that cling to your teeth between meals. Gradually, the population of sugar-loving microbes in your mouth will decline. Unlike the cavemen of yesteryear, today we have the knowledge required to avert a cavity calamity. We just need to use it.

**P404 2016-10-19 What caused the French Revolution - Tom Mullaney**

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What rights do people have, and where do they come from? Who gets to make decisions for others and on what authority? And how can we organize society to meet people's needs? These questions challenged an entire nation during the upheaval of the French Revolution. By the end of the 18th century, Europe had undergone a profound intellectual and cultural shift known as the Enlightenment. Philosophers and artists promoted reason and human freedom over tradition and religion. The rise of a middle class and printed materials encouraged political awareness, and the American Revolution had turned a former English colony into an independent republic. Yet France, one of the largest and richest countries in Europe was still governed by an ancient regime of three rigid social classes called Estates. The monarch King Louis XVI based his authority on divine right and granted special privileges to the First and Second Estates, the Catholic clergy, and the nobles. The Third Estate, middle class merchants and craftsmen, as well as over 20 million peasants, had far less power and they were the only ones who paid taxes, not just to the king, but to the other Estates as well. In bad harvest years, taxation could leave peasants with almost nothing while the king and nobles lived lavishly on their extracted wealth. But as France sank into debt due to its support of the American Revolution and its long-running war with England, change was needed. King Louis appointed finance minister Jacques Necker, who pushed for tax reforms and won public support by openly publishing the government's finances. But the king's advisors strongly opposed these initiatives. Desperate for a solution, the king called a meeting of the Estates-General, an assembly of representatives from the Three Estates, for the first time in 175 years. Although the Third Estate represented 98% of the French population, its vote was equal to each of the other Estates. And unsurprisingly, both of the upper classes favored keeping their privileges. Realizing they couldn't get fair representation, the Third Estate broke off, declared themselves the National Assembly, and pledged to draft a new constitution with or without the other Estates. King Louis ordered the First and Second Estates to meet with the National Assembly, but he also dismissed Necker, his popular finance minister. In response, thousands of outraged Parisians joined with sympathetic soldiers to storm the Bastille prison, a symbol of royal power and a large storehouse of weapons. The Revolution had begun. As rebellion spread throughout the country, the feudal system was abolished. The Assembly's Declaration of the Rights of Man and Citizen proclaimed a radical idea for the time -- that individual rights and freedoms were fundamental to human nature and government existed only to protect them. Their privileges gone, many nobles fled abroad, begging foreign rulers to invade France and restore order. And while Louis remained as the figurehead of the constitutional monarchy, he feared for his future. In 1791, he tried to flee the country but was caught. The attempted escape shattered people's faith in the king. The royal family was arrested and the king charged with treason. After a trial, the once-revered king was publicly beheaded, signaling the end of one thousand years of monarchy and finalizing the September 21st declaration of the first French republic, governed by the motto "liberté, égalité, fraternité." Nine months later, Queen Marie Antoinette, a foreigner long-mocked as "Madame Déficit" for her extravagant reputation, was executed as well. But the Revolution would not end there. Some leaders, not content with just changing the government, sought to completely transform French society -- its religion, its street names, even its calendar. As multiple factions formed, the extremist Jacobins lead by Maximilien Robespierre launched a Reign of Terror to suppress the slightest dissent, executing over 20,000 people before the Jacobin's own downfall. Meanwhile, France found itself at war with neighboring monarchs seeking to strangle the Revolution before it spread. Amidst the chaos, a general named Napoleon Bonaparte took charge, becoming Emperor as he claimed to defend the Revolution's democratic values. All in all, the Revolution saw three constitutions and five governments within ten years, followed by decades alternating between monarchy and revolt before the next Republic formed in 1871. And while we celebrate the French Revolution's ideals, we still struggle with many of the same basic questions raised over two centuries ago.

**P405 2016-10-21 Can you solve the river crossing riddle - Lisa Winer**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=405)

As a wildfire rages through the grasslands, three lions and three wildebeest flee for their lives. To escape the inferno, they must cross over to the left bank of a crocodile-infested river. Fortunately, there happens to be a raft nearby. It can carry up to two animals at a time, and needs as least one lion or wildebeest on board to row it across the river. There's just one problem. If the lions ever outnumber the wildebeest on either side of the river, even for a moment, their instincts will kick in, and the results won't be pretty. That includes the animals in the boat when it's on a given side of the river. What's the fastest way for all six animals to get across without the lions stopping for dinner? Pause here if you want to figure it out for yourself. Answer in: 3 Answer in: 2 Answer in: 1 If you feel stuck on a problem like this, try listing all the decisions you can make at each point, and the consequences each choice leads to. For instance, there are five options for who goes across first: one wildebeest, one lion, two wildebeest, two lions, or one of each. If one animal goes alone, it'll just have to come straight back. And if two wildebeest cross first, the remaining one will immediately get eaten. So those options are all out. Sending two lions, or one of each animal, can actually both lead to solutions in the same number of moves. For the sake of time, we'll focus on the second one. One of each animal crosses. Now, if the wildebeest stays and the lion returns, there will be three lions on the right bank. Bad news for the two remaining wildebeest. So we need to have the lion stay on the left bank and the wildebeest go back to the right. Now we have the same five options, but with one lion already on the left bank. If two wildebeest go, the one that stays will get eaten, and if one of each animal goes, the wildebeest on the raft will be outnumbered as soon as it reaches the other side. So that's a dead end, which means that at the third crossing, only the two lions can go. One gets dropped off, leaving two lions on the left bank. The third lion takes the raft back to the right bank where the wildebeest are waiting. What now? Well, since we've got two lions waiting on the left bank, the only option is for two wildebeest to cross. Next, there's no sense in two wildebeest going back, since that just reverses the last step. And if two lions go back, they'll outnumber the wildebeest on the right bank. So one lion and one wildebeest take the raft back leaving us with one of each animal on the left bank and two of each on the right. Again, there's no point in sending the lion-wildebeest pair back, so the next trip should be either a pair of lions or a pair of wildebeest. If the lions go, they'd eat the wildebeest on the left, so they stay, and the two wildebeest cross instead. Now we're quite close because the wildebeest are all where they need to be with safety in numbers. All that's left is for that one lion to raft back and bring his fellow lions over one by one. That makes eleven trips total, the smallest number needed to get everyone across safely. The solution that involves sending both lions on the first step works similarly, and also takes eleven crossings. The six animals escape unharmed from the fire just in time and begin their new lives across the river. Of course, now that the danger's passed, it remains to be seen how long their unlikely alliance will last.

**P406 2016-10-21 Why should you listen to Vivaldi's 'Four Seasons' - Betsy Schwarm**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=406)

Light, bright, and cheerful. It's some of the most familiar of all early 18th century music. It's been featured in uncounted films and television commercials, but what is it and why does it sound that way? This is the opening of "Spring" from "The Four Seasons," by Italian composer Antonio Vivaldi. "The Four Seasons" are famous in part because they are a delight to the ear. However, even more notable is the fact that they have stories to tell. At the time of their publication in Amsterdam in 1725, they were accompanied by poems describing exactly what feature of that season Vivaldi intended to capture in musical terms. In providing specific plot content for instrumental music, Vivaldi was generations ahead of his time. If one were to read the poems simultaneously to hearing the music, one would find the poetic scenes synchronizing nicely with the musical imagery. We are told that the birds welcome spring with happy song, and here they are doing exactly that. Soon, however, a thunderstorm breaks out. Not only is there musical thunder and lightning, there are also more birds, wet, frightened, and unhappy. In "Summer," the turtle dove sings her name "tortorella" in Italian, before a hail storm flattens the fields. "Autumn" brings eager hunters dashing out in pursuit of their prey. The "Winter" concerto begins with teeth chattering in the cold before one takes refuge by a crackling fire. Then it's back out into the storm where there'll be slips and falls on the ice. In these first weeks of winter, the old year is coming to a close, and so does Vivaldi's musical exploration of the seasons. Not until the early 19th century would such expressive instrumental program music, as it was known, become popular. By then, larger, more varied ensembles were the rule with woodwinds, brass, and percussion to help tell the tale. But Vivaldi pulled it off with just one violin, strings, and a harpsichord. Unlike his contemporary Bach, Vivaldi wasn't much interested in complicated fugues. He preferred to offer readily accessible entertainment to his listeners with melodies that pop back up later in a piece to remind us of where we've been. So the first movement of the "Spring" concerto begins with a theme for spring and ends with it, too, slightly varied from when it was last heard. It was an inspired way to attract listeners, and Vivaldi, considered one of the most electrifying violinists of the early 18th century, understood the value of attracting audiences. Such concerts might feature himself as the star violinist. Others presented the young musicians of the Pietà, a Venetian girls' school where Vivaldi was Director of Music. Most of the students were orphans. Music training was intended not only as social skills suitable for young ladies but also as potential careers for those who might fail to make good marriages. Even in the composer's own time, Vivaldi's music served as diversion for all, not just for the wealthy aristocrats. 300 years later, it's an approach that still works, and Vivaldi's music still sounds like trotting horses on the move.

**P407 2016-10-24 Why do whales sing - Stephanie Sardelis**

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Communicating underwater is challenging. Light and odors don't travel well, so it's hard for animals to see or smell. But sound moves about four times faster in water than in air, so in this dark environment, marine mammals often rely on vocalization to communicate. That's why a chorus of sounds fills the ocean. Clicks, pulses, whistles, groans, boings, cries, and trills, to name a few. But the most famous parts of this underwater symphony are the evocative melodies, or songs, composed by the world's largest mammals, whales. Whale songs are one of the most sophisticated communication systems in the animal kingdom. Only a few species are known to sing. Blue, fin, bowhead minke whales, and of course humpback whales. These are all baleen whales which use hairy baleen plates instead of teeth to trap their prey. Meanwhile, toothed whales do use echolocation, and they and other species of baleen whales make social sounds, such as cries and whistles, to communicate. But those vocalizations lack the complexity of songs. So how do they do it? Land mammals like us generate sound by moving air over our vocal cords when we exhale, causing them to vibrate. Baleen whales have a U-shaped fold of tissue between their lungs and their large inflatable organs called laryngeal sacs. We don't know this for sure because it's essentially impossible to observe the internal organs of a living, singing whale, but we think that when a whale sings, muscular contractions in the throat and chest move air from the lungs across the U-fold and into the laryngeal sacs, causing the U-fold to vibrate. The resulting sound resonates in the sacs like a choir singing in a cathedral making songs loud enough to propagate up to thousands of kilometers away. Whales don't have to exhale to sing. Instead, the air is recycled back into the lungs, creating sound once more. One reason whale songs are so fascinating is their pattern. Units, like moans, cries, and chirps are arranged in phrases. Repeated phrases are assembled into themes. Multiple themes repeated in a predictable pattern create a song. This hierarchical structure is a kind of grammar. Whale songs are extremely variable in duration, and whales can repeat them over and over. In one recorded session, a humpback whale sang for 22 hours. And why do they do it? We don't yet know the exact purpose, but we can speculate. Given that the singers are males and they mostly sing during the mating season, songs might be used to attract females. Or perhaps they're territorial, used to deter other males. Whales return to the same feeding and breeding grounds annually, and each discrete population has a different song. Songs evolve over time as units or phrases are added, changed, or dropped. And when males from different populations are feeding within earshot, phrases are often exchanged, maybe because new songs make them more attractive to breeding females. This is one of the fastest examples of cultural transmission, where learned behaviors are passed between unrelated individuals of the same species. We can eavesdrop on these songs using underwater microphones called hydrophones. These help us track species when sightings or genetic samples are rare. For example, scientists have been able to differentiate the elusive blue whale's populations worldwide based on their songs. But the oceans are getting noisier as a result of human activity. Boating, military sonar, underwater construction, and seismic surveys for oil are occurring more often which may interfere with whale's communication. Some whales will avoid key feeding or breeding grounds if human noise is too loud. And humpback whales have been observed to reduce their singing in response to noise 200 kilometers away. Limiting human activity along migratory routes and in other critical habitats, and reducing noise pollution throughout the ocean would help ensure whales continued survival. If the whales can keep singing and we can keep listening, maybe one day we'll truly understand what they're saying.

**P408 2016-11-08 Do we really need pesticides - Fernan Pérez-Gálvez**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=408)

In 1845, Ireland's vast potato fields were struck by an invasive fungal disease that rapidly infested this staple crop. The effect was devastating. One million people died of famine, and over a million more were forced to leave Ireland. Nowadays, we avoid such agricultural catastrophes with the help of pesticides. Those are a range of manmade chemicals that control insects, unwanted weeds, funguses, rodents, and bacteria that may threaten our food supply. They've become an essential part of our food system. As populations have grown, monoculture, single crop farming, has helped us feed people efficiently. But it's also left our food vulnerable to extensive attack by pests. In turn, we've become more dependent on pesticides. Today, we annually shower over 5 billion pounds of pesticides across the Earth to control these unwanted visitors. The battle against pests, especially insects, has marked agriculture's long history. Records from thousands of years ago suggest that humans actively burned some of their crops after harvest to rid them of pests. There's even evidence from ancient times that we recruited other insects to help. In 300 A.D., Chinese farmers specially bred ferocious predatory ants in orange orchards to protect the trees from other bugs. Later, as large-scale farming spread, we began sprinkling arsenic, lead, and copper treatments on crops. But these were incredibly toxic to humans as well. As our demand for more, safer produce increased, so did the need for effective chemicals that could control pests on a grander scale. This ushered in the era of chemical pesticides. In 1948, a Swiss chemist named Paul Hermann Müller was awarded a Nobel Prize for his discovery of dichlorodiphenyltrichloroethane, also known as DDT. This new molecule had unparalleled power to control many insect species until the 1950s, when insects became resistant to it. Worse, the chemical actually drove dramatic declines in bird populations, poisoned water sources, and was eventually found to cause long-term health problems in humans. By 1972, DDT had been banned in the United States, and yet traces still linger in the environment today. Since then, chemists have been searching for alternatives. With each new wave of inventions, they've encountered the same obstacle - rapid species evolution. As pesticides destroy pest populations, they leave behind only the most resistant individuals. They then pass on their pesticide-resisting genes to the next generation. That's lead to the rise of super bugs, such as the Colorado potato beetle, which is resistant to over 50 different insecticides. Another downside is that other bugs get caught in the crossfire. Some of these are helpful predators of plant pests or vital pollinators, so erasing them from agriculture wipes out their benefits, too. Pesticides have improved over time and are currently regulated by strict safety standards, but they still have the potential to pollute soil and water, impact wildlife, and even harm us. So considering all these risks, why do we continue using pesticides? Although they're imperfect, they currently may be our best bet against major agricultural disasters, not to mention mosquito-born diseases. Today, scientists are on a quest for alternative pest control strategies that balance the demands of food production with environmental concerns. Nature has become a major source of inspiration, from natural plant and fungal chemicals that can repel or attract insects, to recruiting other insects as crop bodyguards. We're also turning to high-tech solutions, like drones. Programmed to fly over crops, these machines can use their sensors and GPS to carry out more targeted sprays that limit a pesticide's wider environmental impact. With a combination of biological understanding, environmental awareness, and improved technologies, we have a better chance of finding a holistic solution to pests. Chemical pesticides may never shake their controversial reputation, but with their help, we can ensure that agricultural catastrophes stay firmly in our past.

**P409 2016-11-10 How do US Supreme Court justices get appointed - Peter Paccone**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=409)

There's a job out there with a great deal of power, pay, prestige, and near-perfect job security. And there's only one way to be hired: get appointed to the US Supreme Court. If you want to become a justice on the Supreme Court, the highest federal court in the United States, three things have to happen. You have to be nominated by the president of the United States, your nomination needs to be approved by the Senate, and finally, the president must formally appoint you to the court. Because the Constitution doesn't specify any qualifications, in other words, that there's no age, education, profession, or even native-born citizenship requirement, a president can nominate any individual to serve. So far, six justices have been foreign-born, at least one never graduated from high school, and another was only 32 years old when he joined the bench. Most presidents nominate individuals who broadly share their ideological view, so a president with a liberal ideology will tend to appoint liberals to the court. Of course, a justice's leanings are not always so predictable. For example, when President Eisenhower, a Republican, nominated Earl Warren for Chief Justice, Eisenhower expected him to make conservative decisions. Instead, Warren's judgements have gone down as some of the most liberal in the Court's history. Eisenhower later remarked on that appointment as "the biggest damned-fool mistake" he ever made. Many other factors come up for consideration, as well, including experience, personal loyalties, ethnicity, and gender. The candidates are then thoroughly vetted down to their tax records and payments to domestic help. Once the president interviews the candidate and makes a formal nomination announcement, the Senate leadership traditionally turns the nomination over to hearings by the Senate Judiciary Committee. Depending on the contentiousness of the choice, that can stretch over many days. Since the Nixon administration, these hearings have averaged 60 days. The nominee is interviewed about their law record, if applicable, and where they stand on key issues to discern how they might vote. And especially in more recent history, the committee tries to unearth any dark secrets or past indiscretions. The Judiciary Committee votes to send the nomination to the full Senate with a positive or negative recommendation, often reflective of political leanings, or no recommendation at all. Most rejections have happened when the Senate majority has been a different political party than the president. When the Senate does approve, it's by a simple majority vote, with ties broken by the vice president. With the Senate's consent, the president issues a written appointment, allowing the nominee to complete the final steps to take the constitutional and judicial oaths. In doing so, they solemnly swear to administer justice without respect to persons and do equal right to the poor and the rich and faithfully and impartially discharge and perform all the duties incumbent upon a US Supreme Court justice. This job is for life, barring resignation, retirement, or removal from the court by impeachment. And of the 112 justices who have held the position, not one has yet been removed from office as a result of an impeachment. One of their roles is to protect the fundamental rights of all Americans, even as different parties take power. With the tremendous impact of this responsibility, it's no wonder that a US Supreme Court justice is expected to be, in the words of Irving R. Kaufman, "a paragon of virtue, an intellectual Titan, and an administrative wizard." Of course, not every member of the Court turns out to be an exemplar of justice. Each leaves behind a legacy of decisions and opinions to be debated and dissected by the ultimate judges, time and history.

**P410 2016-11-15 How to recognize a dystopia - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=410)

Have you ever tried to picture an ideal world? One without war, poverty, or crime? If so, you're not alone. Plato imagined an enlightened republic ruled by philosopher kings, many religions promise bliss in the afterlife, and throughout history, various groups have tried to build paradise on Earth. Thomas More's 1516 book "Utopia" gave this concept a name, Greek for "no place." Though the name suggested impossibility, modern scientific and political progress raised hopes of these dreams finally becoming reality. But time and time again, they instead turned into nightmares of war, famine, and oppression. And as artists began to question utopian thinking, the genre of dystopia, the not good place, was born. One of the earliest dystopian works is Jonathan Swift's "Gulliver's Travels." Throughout his journey, Gulliver encounters fictional societies, some of which at first seem impressive, but turn out to be seriously flawed. On the flying island of Laputa, scientists and social planners pursue extravagant and useless schemes while neglecting the practical needs of the people below. And the Houyhnhnm who live in perfectly logical harmony have no tolerance for the imperfections of actual human beings. With his novel, Swift established a blueprint for dystopia, imagining a world where certain trends in contemporary society are taken to extremes, exposing their underlying flaws. And the next few centuries would provide plenty of material. Industrial technology that promised to free laborers imprisoned them in slums and factories, instead, while tycoons grew richer than kings. By the late 1800's, many feared where such conditions might lead. H. G. Wells's "The Time Machine" imagined upper classes and workers evolving into separate species, while Jack London's "The Iron Heel" portrayed a tyrannical oligarchy ruling over impoverished masses. The new century brought more exciting and terrifying changes. Medical advances made it possible to transcend biological limits while mass media allowed instant communication between leaders and the public. In Aldous Huxley's "Brave New World", citizens are genetically engineered and conditioned to perform their social roles. While propaganda and drugs keep the society happy, it's clear some crucial human element is lost. But the best known dystopias were not imaginary at all. As Europe suffered unprecedented industrial warfare, new political movements took power. Some promised to erase all social distinctions, while others sought to unite people around a mythical heritage. The results were real-world dystopias where life passed under the watchful eye of the State and death came with ruthless efficiency to any who didn't belong. Many writers of the time didn't just observe these horrors, but lived through them. In his novel "We", Soviet writer Yevgeny Zamyatin described a future where free will and individuality were eliminated. Banned in the U.S.S.R., the book inspired authors like George Orwell who fought on the front lines against both fascism and communism. While his novel "Animal Farm" directly mocked the Soviet regime, the classic "1984" was a broader critique of totalitarianism, media, and language. And in the U.S.A., Sinclair Lewis's "It Can't Happen Here" envisioned how easily democracy gave way to fascism. In the decades after World War II, writers wondered what new technologies like atomic energy, artificial intelligence, and space travel meant for humanity's future. Contrasting with popular visions of shining progress, dystopian science fiction expanded to films, comics, and games. Robots turned against their creators while TV screens broadcast deadly mass entertainment. Workers toiled in space colonies above an Earth of depleted resources and overpopulated, crime-plagued cities. Yet politics was never far away. Works like "Dr. Strangelove" and "Watchmen" explored the real threat of nuclear war, while "V for Vendetta" and "The Handmaid's Tale" warned how easily our rights could disappear in a crisis. And today's dystopian fiction continues to reflect modern anxieties about inequality, climate change, government power, and global epidemics. So why bother with all this pessimism? Because at their heart, dystopias are cautionary tales, not about some particular government or technology, but the very idea that humanity can be molded into an ideal shape. Think back to the perfect world you imagined. Did you also imagine what it would take to achieve? How would you make people cooperate? And how would you make sure it lasted? Now take another look. Does that world still seem perfect?

**P411 2016-11-16 Can you solve the airplane riddle - Judd A. Schorr**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=411)

Professor Fukanō, the famous eccentric scientist and adventurer, has embarked on a new challenge: flying around the world nonstop in a plane of his own design. Able to travel consistently at the incredible speed of one degree longitude around the equator per minute, the plane would take six hours to circle the world. There's just one problem: the plane can only hold 180 kiloliters of fuel, only enough for exactly half the journey. Let's be honest. The professor probably could have designed the plane to hold more fuel, but where's the fun in that? Instead, he's devised a slightly more elaborate solution: building three identical planes for the mission. In addition to their speed, the professor's equipped them with a few other incredible features. Each of the planes can turn on a dime and instantly transfer any amount of its fuel to any of the others in midair without slowing down, provided they're next to each other. The professor will pilot the first plane, while his two assistants Fugōri and Orokana will pilot each of the others. However, only one airport, located on the equator, has granted permission for the experiment, making it the starting point, the finish line, and the only spot where the planes can land, takeoff, or refuel on the ground. How should the three planes coordinate so the professor can fly continuously for the whole trip and achieve his dream without anyone running out of fuel and crashing? Pause here if you want to figure it out for yourself. Answer in: 3 Answer in: 2 Answer in: 1 According to the professor's calculations, they should be able to pull it off by a hair. The key is to maximize the support each assistant provides, not wasting a single kiloliter of fuel. It also helps us to think symmetrically so they can make shorter trips in either direction while setting the professor up for a long unsupported stretch in the middle. Here's his solution. All three planes take off at noon flying west, each fully loaded with 180 kiloliters. After 45 minutes, or one-eighth of the way around, each plane has 135 kiloliters left. Orokana gives 45 to the professor and 45 to Fugōri, fully refueling them both. With her remaining 45, Orokana returns to the airport and heads to the lounge for a well-deserved break. 45 minutes later, with one-quarter of the trip complete, the professor and Fugōri are both at 135 kiloliters again. Fugōri transfers 45 into the professor's tank, leaving himself with the 90 he needs to return. Professor Fukanō stretches and puts on his favorite album. He'll be alone for a while. In the meantime, Orokana has been anxiously awaiting Fugōri's return, her plane fully refueled and ready to go. As soon as his plane touches the ground, she takes off, this time flying east. At this point, exactly 180 minutes have passed and the professor is at the halfway point of his journey with 90 kiloliters of fuel left. For the next 90 minutes, the professor and Orokana's planes fly towards each other, meeting at the three-quarter mark. Just as the professor's fuel is about the run out, he sees Orokana's plane. She gives him 45 kiloliters of her remaining 90, leaving them with 45 each. But that's just half of what they need to make it to the airport. Fortunately, this is exactly when Fugōri, having refueled, takes off. 45 minutes later, just as the other two planes are about to run empty, he meets them at the 315 degree point and transfers 45 kiloliters of fuel to each, leaving 45 for himself. All three planes land at the airport just as their fuel gauges reach zero. As the reporters and photographers cheer, the professor promises his planes will soon be available for commercial flights, just as soon as they figure out how to keep their inflight meals from spilling everywhere.

**P412 2016-11-22 How smudge-proof lipstick was invented \_ Moments of Vision 6 - Jessic**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=412)

In a Moment of Vision... It's the 1940's. The world is at war, and for the first time in American history, women are joining the full-time work force in droves. An organic chemist by the name of Hazel Bishop is in the midst of designing aircraft fuel for different oil companies. But her true interests lie elsewhere. The influx of women in the workforce hasn't changed the superficial expectations of society, and working women are expected to look well-groomed no matter their trade. Bishop is sick of having to take time to powder her nose and reapply her lipstick. Although the FDA has already begun regulating cosmetics, various ingredients in lipsticks can be detrimental to lip health. The bromo acid stains used to maintain color in most lipsticks are terribly drying. Bishop spends her spare time working with stains and dyes, mixing oils, and experimenting with molten wax. In a moment of vision and after years of hard work, Bishop introduces one of the first smudge-proof, long-lasting, working woman's lipsticks that doesn't just tint the lips, but also keeps them healthy and moisturized. Marketed as the only kissable lipstick, Bishop's product takes off and it isn't long before rival companies are not just replicating the lipstick but creating other, more practical cosmetics. Today, lip cosmetics are a billion dollar industry.

**P413 2016-11-22 The secrets of Mozart’s “Magic Flute” - Joshua Borths**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=413)

A boy named Prince Tamino runs through a dark wood pursued by a dragon. Just as it rears up to devour him, three mysterious ladies appear and slay the dragon with their fierce battle cry. So begins Wolfgang Amadeus Mozart's "Die Zauberflöte," or "The Magic Flute." This fantasy singspiel, a type of folk opera with music and dialogue, premiered in 1791 in Vienna. Though it may seem like a childish fairytale, this intricate opera is full of subversive symbolism, and it's now regarded as one of the most influential operas in history. Tamino's run in with the dragon is only the start of his journey. The three women summon their leader, the Queen of the Night. She, in turn, sends Tamino on a quest to rescue her daughter Pamina from the evil sorcerer, Sarastro. And to help him on his journey, she gives him the titular magic flute. Tamino eventually finds Pamina at Sarastro's temple, but behind enemy lines, Tamino and Pamina learn that they're on the wrong side. The Queen of Night actually wants to plunge the world into darkness. Everything Tamino thought he knew was wrong, filling him with doubt and confusion. So, a new quest begins for Tamino and Pamina. They must pass three trials of wisdom, and only then can the day vanquish the night. Helped by the flute's magic power, the two youths overcome these trials and the Queen's attempts to sabotage them. They're finally initiated into the temple having restored balance to the kingdom. Many elements in this peculiar fairytale were inspired by Mozart's involvement in Freemasonry, a network of fraternal organizations throughout Europe. Much of their history, symbolism, and ritual came from the Middle Ages. But the Freemasons of Mozart's time were also influenced by 18th century European ideals - rationalism, humanism, and skepticism towards traditional authorities, like monarchy and the church. The symbols of Freemasonry and these ideals of the Enlightenment are found throughout the opera. If this sounds like a conspiracy theory, that's because it sort of was at the time, but it's now taken quite seriously and has been the subject of considerable scholarly publication. For example, some Mozart scholars believe the Queen of the Night symbolizes Maria Theresa, the Empress of the Holy Roman Empire who opposed Freemasonry and banned it in Austria. While there continues to be debate as to the specific meaning, interpretation, and location of these masonic references, scholars agree that they're there and are fully intentional. One of these symbols is the number three, which represented balance and order to Freemasons. Now the number three is, of course, easy to find in any work of storytelling, but it's particularly prominent in "The Magic Flute": three trials, three ladies, three spirits, and three doors, much of the music is written in E-flat major, which has three flats in its key signature, and historically, masonic rituals began with three knocks. The opera references them by opening with three majestic chords complete with dramatic pauses. Those chords, which reoccur throughout the opera, serve another purpose. They capture the dramatic arc of the opera in miniature. The first chord, E-flat major, is in its most natural root position, simple and unadorned. It echoes the child-like Prince Tamino, who, in his naiveté, accepts everything the Queen and her ladies say without question. The second chord is C minor, a sour sonority that mirrors Tamino's sadness and doubt in the middle of the opera. That's when his world and notions of good and evil get turned on their heads. And good and evil are just two of the opera's extreme opposites. It features some of the highest and lowest notes in opera, day and night, simple hummable melodies and complicated forward-looking music. The opera's central theme concerns balancing these extremes to achieve perfect harmony. To reflect this, the final chord in the opening restores musical order. It returns to the triumphant E-flat major, the same chord it started with but inverted, meaning Mozart moved the bottom note to the top. Although it retains its original harmony, the chord sounds higher, pointing towards enlightenment. That's similar to Tamino, who in passing his trials restores balance to the kingdom while growing stronger, wiser, and more complete.

**P414 2016-11-23 How does your body know what time it is - Marco A. Sotomayor**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=414)

In 1962, a cave explorer named Michel Siffre started a series of experiments where he isolated himself underground for months without light or clocks. He attached himself to electrodes that monitored his vital signs and kept track of when he slept and ate. When Siffre finally emerged, the results of his pioneering experiments revealed that his body had kept to a regular sleeping-waking cycle. Despite having no external cues, he fell asleep, woke up, and ate at fixed intervals. This became known as a circadian rhythm from the Latin for "about a day." Scientists later found these rhythms affect our hormone secretion, how our bodies process food, and even the effects of drugs on our bodies. The field of sciences studying these changes is called chronobiology. Being able to sense time helps us do everything from waking and sleeping to knowing precisely when to catch a ball that's hurtling towards us. We owe all these abilities to an interconnected system of timekeepers in our brains. It contains the equivalent of a stopwatch telling us how many seconds elapsed, a clock counting the hours of the day, and a calendar notifying us of the seasons. Each one is located in a different brain region. Siffre, stuck in his dark cave, relied on the most primitive clock in the suprachiasmatic nucleus, or SCN of the hypothalamus. Here's the basics of how we think it works based on fruitfly and mouse studies. Proteins known as CLK, or clock, accumulate in the SCN throughout the day. In addition to activating genes that tell us to stay awake, they make another protein called PER. When enough PER accumulates, it deactivates the gene that makes CLK, eventually making us fall asleep. Then, clock falls low, so PER concentrations also drop again, allowing CLK to rise, starting the cycle over. There are other proteins involved, but our day and night cycle may be driven in part by this seesaw effect between CLK by day and PER by night. For more precision, our SCNs also rely on external cues like light, food, noise, and temperature. We called these zeitgebers, German for "givers of time." Siffre lacked many of these cues underground, but in normal life, they fine tune our daily behavior. For instance, as natural morning light filters into our eyes, it helps wake us up. Traveling through the optic nerve to the SCN, it communicates what's happening in the outside world. The hypothalamus then halts the production of melatonin, a hormone that triggers sleep. At the same time, it increases the production of vasopressin and noradrenaline throughout the brain, which help control our sleep cycles. At about 10 am, the body's rising temperature drives up our energy and alertness, and later in the afternoon, it also improves our muscle activity and coordination. Bright screens at night can confuse these signals, which is why binging on TV before bed makes it harder to sleep. But sometimes we need to be even more precise when telling the time, which is where the brain's internal stopwatch chimes in. One theory for how this works involves the fact that communication between a given pair of neurons always takes roughly the same amount of time. So neurons in our cortex and other brain areas may communicate in scheduled, predictable loops that the cortex uses to judge with precision how much time has passed. That creates our perception of time. In his cave, Siffre made a fascinating additional discovery about this. Every day, he challenged himself to count up to 120 at the rate of one digit per second. Over time, instead of taking two minutes, it began taking him as long as five. Life in the lonely, dark cave had warped Siffre's own perception of time despite his brain's best efforts to keep him on track. This makes us wonder what else influences our sense of time. And if time isn't objective, what does that mean? Could each of us be experiencing it differently? Only time will tell.

**P415 2016-11-26 Is there a reproducibility crisis in science - Matt Anticole**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=415)

In 2011, a team of physicists reported a startling discovery: neutrinos traveled faster than the speed of light by 60 billionths of a second in their 730 kilometer trip from Geneva to a detector in Italy. Despite six months of double checking, the bizarre discovery refused to yield. But rather than celebrating a physics revolution, the researchers published a cautious paper arguing for continued research in an effort to explain the observed anomaly. In time, the error was tracked to a single incorrectly connected fiber optic cable. This example reminds us that real science is more than static textbooks. Instead, researchers around the world are continuously publishing their latest discoveries with each paper adding to the scientific conversation. Published studies can motivate future research, inspire new products, and inform government policy. So it's important that we have confidence in the published results. If their conclusions are wrong, we risk time, resources, and even our health in the pursuit of false leads. When findings are significant, they are frequently double-checked by other researchers, either by reanalyzing the data or by redoing the entire experiment. For example, it took repeated investigation of the CERN data before the timing error was tracked down. Unfortunately, there are currently neither the resources nor professional incentives to double check the more than 1 million scientific papers published annually. Even when papers are challenged, the results are not reassuring. Recent studies that examined dozens of published pharmaceutical papers managed to replicate the results of less than 25% of them. And similar results have been found in other scientific disciplines. There are a variety of sources for irreproducible results. Errors could hide in their original design, execution, or analysis of the data. Unknown factors, such as patients' undisclosed condition in a medical study, can produce results that are not repeatable in new test subjects. And sometimes, the second research group can't reproduce the original results simply because they don't know exactly what the original group did. However, some problems might stem from systematic decisions in how we do science. Researchers, the institutions that employ them, and the scientific journals that publish findings are expected to produce big results frequently. Important papers can advance careers, generate media interest, and secure essential funding, so there's slim motivation for researchers to challenge their own exciting results. In addition, little incentive exists to publish results unsupportive of the expected hypothesis. That results in a deluge of agreement between what was expected and what was found. In rare occasions, this can even lead to deliberate fabrication, such as in 2013, when a researcher spiked rabbit blood with human blood to give false evidence that his HIV vaccine was working. The publish or perish mindset can also compromise academic journals' traditional peer-review processes which are safety checks where experts examine submitted papers for potential shortcomings. The current system, which might involve only one or two reviewers, can be woefully ineffective. That was demonstrated in a 1998 study where eight weaknesses were deliberately inserted into papers, but only around 25% were caught upon review. Many scientists are working toward improving reproducibility in their fields. There's a push to make researchers raw data, experimental procedures, and analytical techniques more openly available in order to ease replication efforts. The peer review process can also be strengthened to more efficiently weed out weak papers prior to publication. And we could temper the pressure to find big results by publishing more papers that fail to confirm the original hypothesis, an event that happens far more than current scientific literature suggests. Science always has, and always will, encounter some false starts as part of the collective acquisition of new knowledge. Finding ways to improve the reproducibility of our results can help us weed out those false starts more effectively, keeping us moving steadily toward exciting new discoveries.

**P416 2016-11-28 Can machines read your emotions - Kostas Karpouzis**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=416)

With every year, machines surpass humans in more and more activities we once thought only we were capable of. Today's computers can beat us in complex board games, transcribe speech in dozens of languages, and instantly identify almost any object. But the robots of tomorrow may go futher by learning to figure out what we're feeling. And why does that matter? Because if machines and the people who run them can accurately read our emotional states, they may be able to assist us or manipulate us at unprecedented scales. But before we get there, how can something so complex as emotion be converted into mere numbers, the only language machines understand? Essentially the same way our own brains interpret emotions, by learning how to spot them. American psychologist Paul Ekman identified certain universal emotions whose visual cues are understood the same way across cultures. For example, an image of a smile signals joy to modern urban dwellers and aboriginal tribesmen alike. And according to Ekman, anger, disgust, fear, joy, sadness, and surprise are equally recognizable. As it turns out, computers are rapidly getting better at image recognition thanks to machine learning algorithms, such as neural networks. These consist of artificial nodes that mimic our biological neurons by forming connections and exchanging information. To train the network, sample inputs pre-classified into different categories, such as photos marked happy or sad, are fed into the system. The network then learns to classify those samples by adjusting the relative weights assigned to particular features. The more training data it's given, the better the algorithm becomes at correctly identifying new images. This is similar to our own brains, which learn from previous experiences to shape how new stimuli are processed. Recognition algorithms aren't just limited to facial expressions. Our emotions manifest in many ways. There's body language and vocal tone, changes in heart rate, complexion, and skin temperature, or even word frequency and sentence structure in our writing. You might think that training neural networks to recognize these would be a long and complicated task until you realize just how much data is out there, and how quickly modern computers can process it. From social media posts, uploaded photos and videos, and phone recordings, to heat-sensitive security cameras and wearables that monitor physiological signs, the big question is not how to collect enough data, but what we're going to do with it. There are plenty of beneficial uses for computerized emotion recognition. Robots using algorithms to identify facial expressions can help children learn or provide lonely people with a sense of companionship. Social media companies are considering using algorithms to help prevent suicides by flagging posts that contain specific words or phrases. And emotion recognition software can help treat mental disorders or even provide people with low-cost automated psychotherapy. Despite the potential benefits, the prospect of a massive network automatically scanning our photos, communications, and physiological signs is also quite disturbing. What are the implications for our privacy when such impersonal systems are used by corporations to exploit our emotions through advertising? And what becomes of our rights if authorities think they can identify the people likely to commit crimes before they even make a conscious decision to act? Robots currently have a long way to go in distinguishing emotional nuances, like irony, and scales of emotions, just how happy or sad someone is. Nonetheless, they may eventually be able to accurately read our emotions and respond to them. Whether they can empathize with our fear of unwanted intrusion, however, that's another story.

**P417 2016-11-29 The neuroscience of imagination - Andrey Vyshedskiy**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=417)

Imagine, for a second, a duck teaching a French class, a ping-pong match in orbit around a black hole, a dolphin balancing a pineapple. You probably haven't actually seen any of these things, but you could imagine them instantly. How does your brain produce an image of something you've never seen? That may not seem hard, but that's only because we're so used to doing it. It turns out that this is actually a complex problem that requires sophisticated coordination inside your brain. That's because to create these new, weird images, your brain takes familiar pieces and assembles them in new ways, like a collage made from fragments of photos. The brain has to juggle a sea of thousands of electrical signals getting them all to their destination at precisely the right time. When you look at an object, thousands of neurons in your posterior cortex fire. These neurons encode various characteristics of the object: spiky, fruit, brown, green, and yellow. This synchronous firing strengthens the connections between that set of neurons, linking them together into what's known as a neuronal ensemble, in this case the one for pineapple. In neuroscience, this is called the Hebbian principle, neurons that fire together wire together. If you try to imagine a pineapple later, the whole ensemble will light up, assembling a complete mental image. Dolphins are encoded by a different neuronal ensemble. In fact, every object that you've seen is encoded by a neuronal ensemble associated with it, the neurons wired together by that synchronized firing. But this principle doesn't explain the infinite number of objects that we can conjure up in our imaginations without ever seeing them. The neuronal ensemble for a dolphin balancing a pineapple doesn't exist. So how come you can imagine it anyway? One hypothesis, called the Mental Synthesis Theory, says that, again, timing is key. If the neuronal ensembles for the dolphin and pineapple are activated at the same time, we can perceive the two separate objects as a single image. But something in your brain has to coordinate that firing. One plausible candidate is the prefrontal cortex, which is involved in all complex cognitive functions. Prefrontal cortex neurons are connected to the posterior cortex by long, spindly cell extensions called neural fibers. The mental synthesis theory proposes that like a puppeteer pulling the strings, the prefrontal cortex neurons send electrical signals down these neural fibers to multiple ensembles in the posterior cortex. This activates them in unison. If the neuronal ensembles are turned on at the same time, you experience the composite image just as if you'd actually seen it. This conscious purposeful synchronization of different neuronal ensembles by the prefrontal cortex is called mental synthesis. In order for mental sythesis to work, signals would have to arrive at both neuronal ensembles at the same time. The problem is that some neurons are much farther away from the prefrontal cortex than others. If the signals travel down both fibers at the same rate, they'd arrive out of sync. You can't change the length of the connections, but your brain, especially as it develops in childhood, does have a way to change the conduction velocity. Neural fibers are wrapped in a fatty substance called myelin. Myelin is an insulator and speeds up the electrical signals zipping down the nerve fiber. Some neural fibers have as many as 100 layers of myelin. Others only have a few. And fibers with thicker layers of myelin can conduct signals 100 times faster or more than those with thinner ones. Some scientists now think that this difference in myelination could be the key to uniform conduction time in the brain, and consequently, to our mental synthesis ability. A lot of this myelination happens in childhood, so from an early age, our vibrant imaginations may have a lot to do with building up brains whose carefully myelinated connections can craft creative symphonies throughout our lives.

**P418 2016-12-07 Why doesn’t anything stick to Teflon - Ashwini Bharathula**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=418)

Nothing stuck to Mafia boss John Gotti who evaded justice for years by bribing and threatening jurors and witnesses. That earned him the name the Teflon Don after one of the slipperiest materials on Earth. Teflon was in the spacesuits the Apollo crew wore for the moon landing, in pipes and valves used in the Manhattan Project, and maybe in your kitchen as the nonstick coating on frying pans and cookie sheets. So what is this slippery solid, and why doesn't anything stick to it? Teflon is a brand name for polytetrafluoroethylene, or PTFE. It was stumbled upon accidentally in 1938 by a 27-year-old American chemist named Roy Plunkett while he was trying to develop a non-toxic refrigerant fluid for DuPont, a chemicals company. The strange, white substance that formed inside his lab canister was chemically inert, meaning it wouldn't react with other substances. It also had an extremely low coefficient of friction, making other materials slide right off it. Teflon's properties make it perfect when you need something slippery, chemical resistant, or waterproof, which means it has a lot of applications. It can be found all over the place, as a coating on raincoats, industrial ball bearings, artificial joints, circuit boards, and even the Rocky Mountains-themed roof of the Denver International Airport. The incredible properties of PTFE come from its molecular structure. It's a polymer, meaning it's made of long chains of repeating units of atoms strung together. A PTFE chain has a backbone of carbon atoms, each of which is attached to two fluorines. The fluorine atoms surround the carbon like armor, spiraling around the chain, and the bond between carbon and fluorine is incredibly tight. Like a couple that ignores everyone except each other, carbon and fluorine interact so strongly that the normal, intermolecular forces that help substances stick to each other don't stand a chance. Even the famously adhesive feet of geckos usually can't get a grip. But wait! If PTFE doesn't stick to anything, how can it be so firmly attached to something like a pan? One method involves sandblasting the pan or etching it with chemicals to make it rough. Then, a special primer is applied, which acts like glue. Its exact composition is a trade secret guarded by each manufacturer. The pan is sprayed with liquid PTFE and heated to around 800 degrees Fahrenheit. The layers then solidify into a smooth, slick coating. When you later cook eggs in this PTFE-coated pan, the extra tight carbon-fluorine bonds just ignore the water and fat and protein molecules in the eggs. Without those interactions, the food just slides around without sticking. You might wonder if it's safe to cook in a PTFE-coated pan. The answer is yes, if you're careful. PTFE is stable at moderate temperatures, like you'd use to cook eggs or fish, but above 500 degrees Fahrenheit, it starts to degrade, and heating it further releases fumes that can make you feel sick. An empty pan can reach 500 degrees fast over high heat, but most kitchens are ventilated well enough to dissipate the fumes. People used to also think that accidentally consuming PTFE that flaked off a scratched pan was bad for you, but the current consensus is that it's harmless. Because PTFE doesn't interact with other chemicals very well, it isn't thought to break down inside your body. Whether it's safe to manufacture Teflon is another story. DuPont and its spin-off company Chemours now face lawsuits worth millions of dollars. They've been accused of polluting the environment for decades and exposing employees and local communities to health risks associated with a toxic chemical called PFOA. That chemical was involved in manufacturing Teflon. As for John Gotti, in 1992, the Mob boss was finally convicted of five counts of murder, among other charges. That prompted the head of the FBI office in New York City to announce, "The Teflon is gone. The don is covered in Velcro, and all the charges stuck."

**P419 2016-12-13 How to master your sense of smell - Alexandra Horowitz**

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Perfumers can learn to distinguish individual odors in a fragrance made of hundreds of scents. Tea experts have been known to sniff out not just the location where a tea was from, but the season of harvest and whether it was planted by a plum tree. And the New York City Transit Authority once had an employee responsible only for sniffing out gas leaks in the subway system. Can just anyone learn to smell with the sensitivity of those experts? For most of us, what we smell is largely involuntary, whether it's garbage behind a restaurant, the shampoo of the woman leaving an elevator as you enter, or a bakery's fresh-made bread. With a few million olfactory receptors in our noses, we clearly don't lack the ability to smell well. We just might not always pay close enough attention. That's a shame because we may be missing opportunities to make strong emotional connections. Smells are powerfully linked to emotions and can awaken memories of places we've long ago left and people we've loved. But fortunately, it is possible to train our brains to smell better. For example, Helen Keller was able to recognize a person's work, and in her words, distinguish the carpenter from the iron worker, the artist from the mason or the chemist, by a simple inhale. Follow these steps and you too can change the way the world smells to you. First, stick your nose in it. Some animals that are known to be great smellers, like dogs who can sniff out explosives and pigs who can find truffles underground, put their noses right at the place they want to smell. Human noses, meanwhile, are casting around in the middle of the air, giving us an anatomical disadvantage. So bring your nose close to the world around you. The ground, surfaces, objects, the food in your hand. Get close to your dog, your partner, the book you're reading. Not only will your nose be closer to the odor source, but the warmth of your breath will make odors easier to smell. Second, sniff like you mean it. Smelling actually happens way up near the bridge of our noses in a postage stamp-sized square of tissue called the olfactory epithelium. When we sniff, odor molecules are sucked up into our nostrils until they hit this tissue where they combine to our olfactory, or scent, receptors. When we inhale normally, only a little air makes it there. But one or two solid sharp sniffs will ensure that more air gets to your smell receptors. After just a few more sniffs, the receptors, which are best at noticing new smells, turn off temporarily. So you can give your nose a rest and sniff again later. Finally, dwell on the smell. Most smells pass by us with little attention, but simply noticing what you're smelling and by trying to describe it, name it, and locate its source, you can expand your vocabulary of smells. When an odor molecule binds to a scent receptor, it sends an electrical signal from the sensory neurons to our brain's olfactory bulbs. The signal then continues to other areas of the brain, where it's integrated with taste, memory, or emotional information before registering to us as a smell. FMRI research shows that the extra time spent focusing on scent changes the brain of experienced smellers. For them, perceiving and imagining odors becomes more automatic than for non-experts. To get started yourself, take ingredients from your kitchen: spices, vanilla, or fruit, but never anything toxic. Close your eyes and have someone bring them under your nose. Sniff and try to name the source. Over time, you'll begin to appreciate nuances in familiar odors and recognize characteristics of new and unusual smells. The perfumer has practiced these steps enough to become an artist of odor, but even if you never pursue smelling to that degree, the spectacular result of an unspectacular action will change how you sense and experience your days.

**P420 2016-12-13 Is there a limit to technological progress - Clément Vidal**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=420)

Many generations have felt they've reached the pinnacle of technological advancement, yet look back 100 years, and the technologies we take for granted today would seem like impossible magic. So will there be a point where we reach an actual limit of technological progress? And if so, are we anywhere near that limit now? Half a century ago, Russian astronomer Nikolai Kardashev was asking similar questions when he came up with a way to measure technological progress, even when we have no idea exactly what it might look like. Anything we do in the future will require energy, so Kardashev's scale classifies potential civilizations, whether alien civilizations out there in the universe or our own, into three levels based on energy consumption. The tiny amount of energy we currently consume pales next to what we leave untapped. A Type I, or planetary civilization, can access all the energy resources of its home planet. In our case, this is the 174,000 terawatts Earth receives from the Sun. We currently only harness about 15 terawatts of it, mostly by burning solar energy stored in fossil fuels. To approach becoming a Type I civilization, we would need to capture solar energy more directly and efficiently by covering the planet with solar panels. Based on the most optimistic models, we might get there within just four centuries. What would be next? Well, the Earth only gets a sliver of the Sun's energy, while the rest of its 400 yottawatts is wasted in dead space. But a Type II, or stellar civilization, would make the most of its home star's energy. Instead of installing solar panels around a planet, a Type II civilization would install them directly orbiting its star, forming a theoretical structure called a Dyson sphere. And the third step? A Type III civilization would harness all the energy of its home galaxy. But we can also think of progress in the opposite way. How small can we go? To that end, British cosmologist John Barrow classified civilizations by the size of objects they control. That ranges from mechanical structures at our own scale, to the building blocks of our own biology, down to unlocking atoms themselves. We've currently touched the atomic level, though our control remains limited. But we potentially could go much smaller in the future. To get a sense of the extent to which that's true, the observable universe is 26 orders of magnitude larger than a human body. That means if you zoomed out by a factor of ten 26 times, you'd be at the scale of the universe. But to reach the minimum length scale, known as the Planck length, you would need to zoom in 35 times. As physicist Richard Feynman once said, "There's plenty of room at the bottom." Instead of one or the other, it's likely that our civilization will continue to develop along both Kardashev and Barrow scales. Precision on a smaller scale lets us use energy more efficiently and unlocks new energy sources, like nuclear fusion, or even antimatter. And this increased energy lets us expand and build on a larger scale. A truly advanced civilization, then, would harness both stellar energy and subatomic technologies. But these predictions weren't made just for us humans. They double as a possible means of detecting intelligent life in the universe. If we find a Dyson sphere around a distant star, that's a pretty compelling sign of life. Or, what if, instead of a structure that passively soaked up all the star's energy, like a plant, an alien civilization built one that actively sucked the energy out of the star like a hummingbird. Frighteningly enough, we've observed super dense celestial bodies about the size of a planet that drain energy out of a much bigger star. It would be much too premature to conclude that this is evidence of life in the universe. There are also explanations for these observations that don't involve alien life forms. But that doesn't stop us from asking, "What if?"

**P421 2016-12-13 Why are we so attached to our things - Christian Jarrett**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=421)

After witnessing the violent rage shown by babies whenever deprived of an item they considered their own, Jean Piaget, a founding father of child psychology, observed something profound about human nature. Our sense of ownership emerges incredibly early. Why are we so clingy? There's a well-established phenomenon in psychology known as the endowment effect where we value items much more highly just as soon as we own them. In one famous demonstration, students were given a choice between a coffee mug or a Swiss chocolate bar as a reward for helping out with research. Half chose the mug, and half chose the chocolate. That is, they seemed to value the two rewards similarly. Other students were given a mug first and then a surprise chance to swap it for a chocolate bar, but only 11% wanted to. Yet another group started out with chocolate, and most preferred to keep it rather than swap. In other words, the students nearly always put greater value on whichever reward they started out with. Part of this has to do with how quickly we form connections between our sense of self and the things we consider ours. That can even be seen at the neural level. In one experiment, neuroscientists scanned participants' brains while they allocated various objects either to a basket labeled "mine," or another labeled, "Alex's." When participants subsequently looked at their new things, their brains showed more activity in a region that usually flickers into life whenever we think about ourselves. Another reason we're so fond of our possessions is that from a young age we believe they have a unique essence. Psychologists showed us this by using an illusion to convince three to six-year-olds they built a copying machine, a device that could create perfect replicas of any item. When offered a choice between their favorite toy or an apparently exact copy, the majority of the children favored the original. In fact, they were often horrified at the prospect of taking home a copy. This magical thinking about objects isn't something we grow out of. Rather it persists into adulthood while becoming ever more elaborate. For example, consider the huge value placed on items that have been owned by celebrities. It's as if the buyers believed the objects they'd purchased were somehow imbued with the essence of their former celebrity owners. For similar reasons, many of us are reluctant to part with family heirlooms which help us feel connected to lost loved ones. These beliefs can even alter our perception of the physical world and change our athletic abilities. Participants in a recent study were told they were using a golf putter once owned by the champion Ben Curtis. During the experiment, they perceived the hole as being about a centimeter larger than controlled participants using a standard putter and they sank slightly more putts. Although feelings of ownership emerge early in life, culture also plays a part. For example, it was recently discovered that Hadza people of northern Tanzania who are isolated from modern culture don't exhibit the endowment effect. That's possibly because they live in an egalitarian society where almost everything is shared. At the other extreme, sometimes our attachment to our things can go too far. Part of the cause of hoarding disorder is an exaggerated sense of responsibility and protectiveness toward one's belongings. That's why people with this condition find it so difficult to throw anything away. What remains to be seen today is how the nature of our relationship with our possessions will change with the rise of digital technologies. Many have forecast the demise of physical books and music, but for now, at least, this seems premature. Perhaps there will always be something uniquely satisfying about holding an object in our hands and calling it our own.

**P422 2016-12-14 How high can you count on your fingers (Spoiler - much higher than 10**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=422)

How high can you count on your fingers? It seems like a question with an obvious answer. After all, most of us have ten fingers, or to be more precise, eight fingers and two thumbs. This gives us a total of ten digits on our two hands, which we use to count to ten. It's no coincidence that the ten symbols we use in our modern numbering system are called digits as well. But that's not the only way to count. In some places, it's customary to go up to twelve on just one hand. How? Well, each finger is divided into three sections, and we have a natural pointer to indicate each one, the thumb. That gives us an easy to way to count to twelve on one hand. And if we want to count higher, we can use the digits on our other hand to keep track of each time we get to twelve, up to five groups of twelve, or 60. Better yet, let's use the sections on the second hand to count twelve groups of twelve, up to 144. That's a pretty big improvement, but we can go higher by finding more countable parts on each hand. For example, each finger has three sections and three creases for a total of six things to count. Now we're up to 24 on each hand, and using our other hand to mark groups of 24 gets us all the way to 576. Can we go any higher? It looks like we've reached the limit of how many different finger parts we can count with any precision. So let's think of something different. One of our greatest mathematical inventions is the system of positional notation, where the placement of symbols allows for different magnitudes of value, as in the number 999. Even though the same symbol is used three times, each position indicates a different order of magnitude. So we can use positional value on our fingers to beat our previous record. Let's forget about finger sections for a moment and look at the simplest case of having just two options per finger, up and down. This won't allow us to represent powers of ten, but it's perfect for the counting system that uses powers of two, otherwise known as binary. In binary, each position has double the value of the previous one, so we can assign our fingers values of one, two, four, eight, all the way up to 512. And any positive integer, up to a certain limit, can be expressed as a sum of these numbers. For example, the number seven is 4+2+1. so we can represent it by having just these three fingers raised. Meanwhile, 250 is 128+64+32+16+8+2. How high an we go now? That would be the number with all ten fingers raised, or 1,023. Is it possible to go even higher? It depends on how dexterous you feel. If you can bend each finger just halfway, that gives us three different states - down, half bent, and raised. Now, we can count using a base-three positional system, up to 59,048. And if you can bend your fingers into four different states or more, you can get even higher. That limit is up to you, and your own flexibility and ingenuity. Even with our fingers in just two possible states, we're already working pretty efficiently. In fact, our computers are based on the same principle. Each microchip consists of tiny electrical switches that can be either on or off, meaning that base-two is the default way they represent numbers. And just as we can use this system to count past 1,000 using only our fingers, computers can perform billions of operations just by counting off 1's and 0's.

**P423 2016-12-14 How the stethoscope was invented \_ Moments of Vision 7 - Jessica Orec**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=423)

In a Moment of Vision... It's 1816. A 35-year-old doctor by the name of René Laennec is walking through Paris. He pauses to watch as two children signal to each other across a long piece of wooden board. One child holds the board to her ear. The other scratches the opposite end sending the amplified sound down the length of wood. Later, Laennec is called to assess a young woman with a heart condition. The patient is purportedly quite well developed and Laennec expresses some hesitation in pressing his ear directly against her chest. Remembering the children with the board, Laennec, in a moment of vision and dignity, tightly rolls a sheet of paper and places one end to his ear and one end over the young woman's heaving bosom. He is delighted by the clarity of the sound. Laennec spends the next three years developing and testing various materials and mechanisms before settling on a hollow wooden tube with detachable plug. His device becomes the forerunner to the metal, plastic, and rubber stethoscope we still use today.

**P424 2016-12-14 What does this symbol actually mean - Adrian Treharne**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=424)

Some of the world's most recognizable symbols exist to sell products, others to steer traffic or advance political causes. But there's one whose main purpose is to help people. You may know it as the wheelchair symbol, or a sign for people with disabilities, but its formal title as maintained by the ISO is the International Symbol of Access. But despite its familiarity, many people are unclear as to what the symbol actually means, which has a lot to do with the symbol itself and the way it came about. In 1968, the International Commission on Technology and Accessibility held a design contest. They were looking for a symbol that would be readily identifiable from a reasonable distance, self-descriptive, simple, practical, and couldn't be confused with existing signage. The winning design, which didn't have a head, was created by a Danish designer named Susanne Koefed. The addition of a head a year later gave it a more human form, and within ten years, it was endorsed by both the United Nations and the ISO. With minimal cost and minimal fuss, a global icon was born. There have been a few tweaks over the decades. The Graphic Artists Guild added more rounded, human-like features, and in 2012, the Accessible Icon Project produced a more dynamic version. But what does it really represent? What's its purpose? Put simply, it's a sign to identify where there are accessible facilities. The strength of such an internationally recognized image is that wherever you travel, you don't need to speak the language or have in-depth cultural knowledge. If you require an accessible toilet, the sign shows the way. But the confusion comes from the term accessibility and what that actually means. Many people assume that because the symbol depicts a wheelchair, that accessible facilities are meant only for people who use wheelchairs, or those, at the very least, who have a visible physical condition. But accessibility is a broad concept that applies to many, many different conditions. That includes people with autism, visual impairments, and autoimmune diseases, like lupus, which can cause pain and fatigue, along with many other conditions. In fact, the World Health Organization estimates that there are approximately 1 billion people who experience some form of disability, which means that this group is very likely to include yourself, or a family member, a classmate, a friend, or a work colleague. And people who use wheelchairs only make up about 65 million, or 15% of the total. The vast majority have non-visible disabilities. Accessible parking spaces, facilities, and entrances are designed with that entire group in mind. So it's easy to see why in recent years people have begun to raise questions about whether the symbol is really appropriate for what it's meant to do. And it's not just about accuracy. It's common for people to become indignant, sometimes abusive, when they see people without visible disabilities using accessible facilities. The symbol is unfortunately creating widespread issues for the very people and families it's meant to help. The recent redesigns have attempted with some success to acknowledge concerns over the current symbol. But some think that a complete redesign is in order. It's a difficult task, though. How do you replace a symbol that's familiar the world over? And what do you replace it with?

**P425 2016-12-15 How super glue was invented \_ Moments of Vision 8 - Jessica Oreck**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=425)

In a Moment of Vision... It's the 1940s, the height of World War II, Rochester, New York. A chemist by the name of Harry Coover is conducting research for Eastman Kodak. He and his team are looking for a clear plastic to produce precision gunsights for the military. They begin working with a family of chemicals called cyanoacrylates, but find, to their extreme annoyance, that the chemicals stick to everything permanently. The cyanoacrylates are discarded. After the war, Coover is working at Kodak's chemical plant in Tennessee. This time, he and his team are researching heat-resistant polymers for jet airplane canopies. They try cyanoacrylates, but find, to their great frustration, that the chemicals stick to everything permanently. Again, the cyanoacrylates are discarded. Coover, however, in a moment of vision, realizes that the quality that makes these chemicals so infuriating to work with is exactly what makes them valuable. He takes out a patent and begins marketing a super glue. Years later during the Vietnam War, field medics find that using super glue on an open wound instantly stops the bleeding, saving countless lives. Today, medical grade super glue is still used in surgery, but it's also a nearly indispensable household item.

**P426 2016-12-22 A brief history of numerical systems - Alessandra King**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=426)

One, two, three, four, five, six, seven, eight, nine, and zero. With just these ten symbols, we can write any rational number imaginable. But why these particular symbols? Why ten of them? And why do we arrange them the way we do? Numbers have been a fact of life throughout recorded history. Early humans likely counted animals in a flock or members in a tribe using body parts or tally marks. But as the complexity of life increased, along with the number of things to count, these methods were no longer sufficient. So as they developed, different civilizations came up with ways of recording higher numbers. Many of these systems, like Greek, Hebrew, and Egyptian numerals, were just extensions of tally marks with new symbols added to represent larger magnitudes of value. Each symbol was repeated as many times as necessary and all were added together. Roman numerals added another twist. If a numeral appeared before one with a higher value, it would be subtracted rather than added. But even with this innovation, it was still a cumbersome method for writing large numbers. The way to a more useful and elegant system lay in something called positional notation. Previous number systems needed to draw many symbols repeatedly and invent a new symbol for each larger magnitude. But a positional system could reuse the same symbols, assigning them different values based on their position in the sequence. Several civilizations developed positional notation independently, including the Babylonians, the Ancient Chinese, and the Aztecs. By the 8th century, Indian mathematicians had perfected such a system and over the next several centuries, Arab merchants, scholars, and conquerors began to spread it into Europe. This was a decimal, or base ten, system, which could represent any number using only ten unique glyphs. The positions of these symbols indicate different powers of ten, starting on the right and increasing as we move left. For example, the number 316 reads as 6x10^0 plus 1x10^1 plus 3x10^2. A key breakthrough of this system, which was also independently developed by the Mayans, was the number zero. Older positional notation systems that lacked this symbol would leave a blank in its place, making it hard to distinguish between 63 and 603, or 12 and 120. The understanding of zero as both a value and a placeholder made for reliable and consistent notation. Of course, it's possible to use any ten symbols to represent the numerals zero through nine. For a long time, the glyphs varied regionally. Most scholars agree that our current digits evolved from those used in the North African Maghreb region of the Arab Empire. And by the 15th century, what we now know as the Hindu-Arabic numeral system had replaced Roman numerals in everyday life to become the most commonly used number system in the world. So why did the Hindu-Arabic system, along with so many others, use base ten? The most likely answer is the simplest. That also explains why the Aztecs used a base 20, or vigesimal system. But other bases are possible, too. Babylonian numerals were sexigesimal, or base 60. Any many people think that a base 12, or duodecimal system, would be a good idea. Like 60, 12 is a highly composite number that can be divided by two, three, four, and six, making it much better for representing common fractions. In fact, both systems appear in our everyday lives, from how we measure degrees and time, to common measurements, like a dozen or a gross. And, of course, the base two, or binary system, is used in all of our digital devices, though programmers also use base eight and base 16 for more compact notation. So the next time you use a large number, think of the massive quantity captured in just these few symbols, and see if you can come up with a different way to represent it.

**P427 2016-12-22 How do animals experience pain - Robyn J. Crook**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=427)

Humans know the surprising prick of a needle, the searing pain of a stubbed toe, and the throbbing of a toothache. We can identify many types of pain and have multiple ways of treating it. But what about other species? How do the animals all around us experience pain? It's important that we find out. We keep animals as pets, they enrich our environment, we farm many species for food, and we use them in experiments to advance science and human health. Animals are clearly important to us, so it's equally important that we avoid causing them unnecessary pain. For animals that are similar to us, like mammals, it's often obvious when they're hurting. But there's a lot that isn't obvious, like whether pain relievers that work on us also help them. And the more different an animal is from us, the harder it is to understand their experience. How do you tell whether a shrimp is in pain? A snake? A snail? In vertebrates, including humans, pain can be split into two distinct processes. In first, nerves and the skin sense something harmful and communicate that information to the spinal cord. There, motor neurons activate movements that make us rapidly jerk away from the threat. This is the physical recognition of harm called nociception, and nearly all animals, even those with very simple nervous systems, experience it. Without this ability, animals would be unable to avoid harm and their survival would be threatened. The second part is the conscious recognition of harm. In humans, this occurs when the sensory neurons in our skin make a second round of connections via the spinal cord to the brain. There, millions of neurons in multiple regions create the sensations of pain. For us, this is a very complex experience associated with emotions like fear, panic, and stress, which we can communicate to others. But it's harder to know exactly how animals experience this part of the process because most them can't show us what they feel. However, we get clues from observing how animals behave. Wild, hurt animals are known to nurse their wounds, make noises to show their distress, and become reclusive. In the lab, scientists have discovered that animals like chickens and rats will self-administer pain-reducing drugs if they're hurting. Animals also avoid situations where they've been hurt before, which suggests awareness of threats. We've reached the point that research has made us so sure that vertebrates recognize pain that it's illegal in many countries to needlessly harm these animals. But what about other types of animals like invertebrates? These animals aren't legally protected, partly because their behaviors are harder to read. We can make good guesses about some of them, like oysters, worms, and jellyfish. These are examples of animals that either lack a brain or have a very simple one. So an oyster may recoil when squirted with lemon juice, for instance, because of nociception. But with such a simple nervous system, it's unlikely to experience the conscious part of pain. Other invertebrate animals are more complicated, though, like the octopus, which has a sophisticated brain and is thought to be one of the most intelligent invertebrate animals. Yet, in many countries, people continue the practice of eating live octopus. We also boil live crawfish, shrimp, and crabs even though we don't really know how they're affected either. This poses an ethical problem because we may be causing these animals unnecessary suffering. Scientific experimentation, though controversial, gives us some clues. Tests on hermit crabs show that they'll leave an undesirable shell if they're zapped with electricity but stay if it's a good shell. And octopi that may originally curl up an injured arm to protect it will risk using it to catch prey. That suggests that these animals make value judgements around sensory input instead of just reacting reflexively to harm. Meanwhile, crabs have been known to repeatedly rub a spot on their bodies where they've received an electric shock. And even sea slugs flinch when they know they're about to receive a noxious stimulus. That means they have some memory of physical sensations. We still have a lot to learn about animal pain. As our knowledge grows, it may one day allow us to live in a world where we don't cause pain needlessly.

**P428 2017-01-05 Would you sacrifice one person to save five - Eleanor Nelsen**

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Imagine you're watching a runaway trolley barreling down the tracks straight towards five workers who can't escape. You happen to be standing next to a switch that will divert the trolley onto a second track. Here's the problem. That track has a worker on it, too, but just one. What do you do? Do you sacrifice one person to save five? This is the trolley problem, a version of an ethical dilemma that philosopher Philippa Foot devised in 1967. It's popular because it forces us to think about how to choose when there are no good choices. Do we pick the action with the best outcome or stick to a moral code that prohibits causing someone's death? In one survey, about 90% of respondents said that it's okay to flip the switch, letting one worker die to save five, and other studies, including a virtual reality simulation of the dilemma, have found similar results. These judgments are consistent with the philosophical principle of utilitarianism which argues that the morally correct decision is the one that maximizes well-being for the greatest number of people. The five lives outweigh one, even if achieving that outcome requires condemning someone to death. But people don't always take the utilitarian view, which we can see by changing the trolley problem a bit. This time, you're standing on a bridge over the track as the runaway trolley approaches. Now there's no second track, but there is a very large man on the bridge next to you. If you push him over, his body will stop the trolley, saving the five workers, but he'll die. To utilitarians, the decision is exactly the same, lose one life to save five. But in this case, only about 10% of people say that it's OK to throw the man onto the tracks. Our instincts tell us that deliberately causing someone's death is different than allowing them to die as collateral damage. It just feels wrong for reasons that are hard to explain. This intersection between ethics and psychology is what's so interesting about the trolley problem. The dilemma in its many variations reveal that what we think is right or wrong depends on factors other than a logical weighing of the pros and cons. For example, men are more likely than women to say it's okay to push the man over the bridge. So are people who watch a comedy clip before doing the thought experiment. And in one virtual reality study, people were more willing to sacrifice men than women. Researchers have studied the brain activity of people thinking through the classic and bridge versions. Both scenarios activate areas of the brain involved in conscious decision-making and emotional responses. But in the bridge version, the emotional response is much stronger. So is activity in an area of the brain associated with processing internal conflict. Why the difference? One explanation is that pushing someone to their death feels more personal, activating an emotional aversion to killing another person, but we feel conflicted because we know it's still the logical choice. "Trolleyology" has been criticized by some philosophers and psychologists. They argue that it doesn't reveal anything because its premise is so unrealistic that study participants don't take it seriously. But new technology is making this kind of ethical analysis more important than ever. For example, driver-less cars may have to handle choices like causing a small accident to prevent a larger one. Meanwhile, governments are researching autonomous military drones that could wind up making decisions of whether they'll risk civilian casualties to attack a high-value target. If we want these actions to be ethical, we have to decide in advance how to value human life and judge the greater good. So researchers who study autonomous systems are collaborating with philosophers to address the complex problem of programming ethics into machines, which goes to show that even hypothetical dilemmas can wind up on a collision course with the real world.

**P429 2017-01-09 What’s so great about the Great Lakes - Cheri Dobbs and Jennifer Gabr**

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What's so great about the Great Lakes? They're known as America's inland seas. The North American Great Lakes Huron, Ontario, Michigan, Erie, and Superior are so massive that they border eight states and contain 23 quadrillion liters of water. That's enough to cover the land area of the contiguous United States three meters deep. These vast bodies of water span forest, grassland, and wetland habitats, supporting a region that's home to over 3,500 species. But how did such a vast and unique geological feature come to be? The story begins near the end of the last ice age over 10,000 years ago, a time when the climate was warming and the glaciers that cloaked the Earth's surface began their slow retreat. These immense ice sheets carved out a series of basins. Those basins filled with water as the ice began to melt, creating the world's largest area of freshwater lakes. Over time, channels developed between these basins, and water began to flow in an ongoing exchange that persists to this day. In fact, today, the interconnected Great Lakes contain almost 20% of the world's supply of fresh surface water. The water's journey begins in the far north of Lake Superior, which is the deepest, coldest, and clearest of the lakes, containing half the system's water. Lake Superior sinks to depths of 406 meters, creating a unique and diverse ecosystem that includes more that 80 fish species. A given drop of water spends on average 200 years in this lake before flowing into Lake Michigan or Lake Huron. Linked by the Straits of Mackinac, these two lakes are technically one. To the west lies Lake Michigan, the third largest of the lakes by surface area. Water slowly moves through its cul-de-sac shape and encounters the world's largest freshwater dunes, many wildlife species, and unique fossilized coral. To the east is Lake Huron, which has the longest shoreline. It's sparsely populated, but heavily forested, including 7,000-year-old petrified trees. Below them, water continues to flow southeastwards from Lake Huron into Lake Erie. This lake's status as the warmest and shallowest of the five has ensured an abundance of animal life, including millions of migrating birds. Finally, the water reaches its last stop by dramatically plunging more than 50 meters down the thundering Niagara Falls into Lake Ontario, the smallest lake by surface area. From there, some of this well-traveled water enters the St. Lawrence River, eventually reaching the Atlantic Ocean. In addition to being a natural wonder, the perpetually flowing Great Lakes bring us multiple benefits. They provide natural water filtration, flood control, and nutrients cycling. By moving water across more than 3,200 kilometers, the Great Lakes also provide drinking water for upward of 40 million people and 212 billion liters a day for the industries and farms that line their banks. But our dependence on the system is having a range of negative impacts, too. The Great Lakes coastal habitats are being degraded and increasingly populated, exposing the once pristine waters to industrial, urban, and agricultural pollutants. Because less than 1% of the water leaves the Lake's system annually, decades-old pollutants still lurk in its waters. Humans have also inadvertently introduced more than 100 non-native and invasive species into the lakes, such as zebra and quagga mussels, and sea lampreys that have decimated some indigenous fish populations. On a larger scale, climate change is causing the waters to warm, thus reducing water levels and changing the distribution of aquatic life. Luckily, in recent years, governments have started to recognize the immense value of this natural resource. Partnerships between the United States and Canada are underway to reduce pollution, protect coastal habitats, and halt the spread of invasive species. Protecting something as massive as the Great Lakes system will require the collaboration of many organizations, but the effort is critical if we can preserve the wonder of this flowing inland sea.

**P430 2017-01-12 What is bipolar disorder - Helen M. Farrell**

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What is bipolar disorder? The word bipolar means two extremes. For the many millions experiencing bipolar disorder around the world, life is split between two different realities - elation and depression. Although there are many variations of bipolar disorder, let's consider a couple. Type 1 has extreme highs alongside the lows, while Type 2 involves briefer, less extreme periods of elation interspersed with long periods of depression. For someone seesawing between emotional states, it can feel impossible to find the balance necessary to lead a healthy life. Type 1's extreme highs are known as manic episodes, and they can make a person range from feeling irritable to invincible. But these euphoric episodes exceed ordinary feelings of joy, causing troubling symptoms like racing thoughts, sleeplessness, rapid speech, impuslive actions, and risky behaviors. Without treatment, these episodes become more frequent, intense, and take longer to subside. The depressed phase of bipolar disorder manifests in many ways - a low mood, dwindling interest in hobbies, changes in appetite, feeling worthless or excessively guilty, sleeping either too much or too little, restlessness or slowness, or persistent thoughts of suicide. Worldwide, about one to three percent of adults experience the broad range of symptoms that indicate bipolar disorder. Most of those people are functional, contributing members of society, and their lives, choices, and relationships aren't defined by the disorder, but still, for many, the consequences are serious. The illness can undermine educational and professional performance, relationships, financial security, and personal safety. So what causes bipolar disorder? Researchers think a key player is the brain's intricate wiring. Healthy brains maintain strong connections between neurons thanks to the brain's continuous efforts to prune itself and remove unused or faulty neural connections. This process is important because our neural pathways serve as a map for everything we do. Using functional magnetic resonance imaging, scientists have discovered that the brain's pruning ability is disrupted in people with bipolar disorder. That means their neurons go haywire and create a network that's impossible to navigate. With only confusing signals as a guide, people with bipolar disorder develop abnormal thoughts and behaviors. Also, psychotic symptoms, like disorganized speech and behavior, delusional thoughts, paranoia, and hallucinations can emerge during extreme phases of bipolar disorder. This is attributed to the overabundance of a neurotransmitter called dopamine. But despite these insights, we can't pin bipolar disorder down to a single cause. In reality, it's a complex problem. For example, the brain's amygdala is involved in thinking, long-term memory, and emotional processing. In this brain region, factors as varied as genetics and social trauma may create abnormalities and trigger the symptoms of bipolar disorder. The condition tends to run in families, so we do know that genetics have a lot to do with it. But that doesn't mean there's a single bipolar gene. In fact, the likelihood of developing bipolar disorder is driven by the interactions between many genes in a complicated recipe we're still trying to understand. The causes are complex, and consequently, diagnosing and living with bipolar disorder is a challenge. Despite this, the disorder is controllable. Certain medications like lithium can help manage risky thoughts and behaviors by stabilizing moods. These mood stabilizing medications work by decreasing abnormal activity in the brain, thereby strengthening the viable neural connections. Other frequently used medications include antipsychotics, which alter the effects of dopamine, and electroconvulsive therapy, which works like a carefully controlled seizure in the brain, is sometimes used as an emergency treatment. Some bipolar patients reject treatment because they're afraid it will dim their emotions and destroy their creativity. But modern psychiatry is actively trying to avoid that. Today, doctors work with patients on a case-by-case basis to administer a combination of treatments and therapies that allows them to live to their fullest possible potential. And beyond treatment, people with bipolar disorder can benefit from even simpler changes. Those include regular exercise, good sleep habits, and sobriety from drugs and alcohol, not to mention the acceptance and empathy of family and friends. Remember, bipolar disorder is a medical condition, not a person's fault, or their whole identity, and it's something that can be controlled through a combination of medical treatments doing their work internally, friends and family fostering acceptance and understanding on the outside, and people with bipolar disorder empowering themselves to find balance in their lives.

**P431 2017-01-19 The mathematics of sidewalk illusions - Fumiko Futamura**

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If you're ever walking down the street and come across an oddly stretched out image, like this, you'll have an opportunity to see something remarkable, but only if you stand in exactly the right spot. That happens because these works employ a technique called anamorphosis. Anamorphosis is a special case of perspective art, where artists represent realistic three-dimensional views on two-dimensional surfaces. Though it's common today, this kind of perspective drawing has only been around since the Italian Renaissance. Ancient art often showed all figures on the same plane, varying in size by symbolic importance. Classical Greek and Roman artists realized they could make objects seem further by drawing them smaller, but many early attempts at perspective were inconsistent or incorrect. In 15th century Florence, artists realized the illusion of perspective could be achieved with higher degrees of sophistication by applying mathematical principles. In 1485, Leonardo da Vinci manipulated the mathematics to create the first known anamorphic drawing. A number of other artists later picked up the technique, including Hans Holbein in "The Ambassadors." This painting features a distorted shape that forms into a skull as the viewer approaches from the side. In order to understand how artists achieve that effect, we first have to understand how perspective drawings work in general. Imagine looking out a window. Light bounces off objects and into your eye, intersecting the window along the way. Now, imagine you could paint the image you see directly onto the window while standing still and keeping only one eye open. The result would be nearly indistinguishable from the actual view with your brain adding depth to the 2-D picture, but only from that one spot. Standing even just a bit off to the side would make the drawing lose its 3-D effect. Artists understand that a perspective drawing is just a projection onto a 2-D plane. This allows them to use math to come up with basic rules of perspective that allow them to draw without a window. One is that parallel lines, like these, can only be drawn as parallel if they're parallel to the plane of the canvas. Otherwise, they need to be drawn converging to a common point known as the vanishing point. So that's a standard perspective drawing. With an anamorphic drawing, like "The Ambassadors," directly facing the canvas makes the image look stretched and distorted, but put your eye in exactly the right spot way off to the side, and the skull materializes. Going back to the window analogy, it's as if the artist painted onto a window positioned at an angle instead of straight on, though that's not how Renaissance artists actually created anamorphic drawings. Typically, they draw a normal image onto one surface, then use a light, a grid, or even strings to project it onto a canvas at an angle. Now let's say you want to make an anamorphic sidewalk drawing. In this case, you want to create the illusion that a 3-D image has been added seamlessly into an existing scene. You can first put a window in front of the sidewalk and draw what you want to add onto the window. It should be in the same perspective as the rest of the scene, which might require the use of those basic rules of perspective. Once the drawing's complete, you can use a projector placed where your eye was to project your drawing down onto the sidewalk, then chalk over it. The sidewalk drawing and the drawing on the window will be nearly indistinguishable from that point of view, so viewers' brains will again be tricked into believing that the drawing on the ground is three-dimensional. And you don't have to project onto a flat surface to create this illusion. You can project onto multiple surfaces, or assemble a jumble of objects, that from the right point of view, appears to be something else entirely. All over the planet, you can find solid surfaces giving way to strange, wonderful, or terrifying visions. From your sidewalk to your computer screen, these are just some of the ways that math and perspective can open up whole new worlds.

**P432 2017-01-25 The myth behind the Chinese zodiac - Megan Campisi and Pen-Pen Chen**

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What's your sign? In Western astrology, it's a constellation determined by when your birthday falls in the calendar. But according to the Chinese zodiac, or shēngxiào, it's your shǔxiàng, meaning the animal assigned to your birth year. And of the many myths explaining these animal signs and their arrangement, the most enduring one is that of the Great Race. As the story goes, Yù Dì, or Jade Emperor, Ruler of the Heavens, wanted to devise a way to measure time, so he organized a race. The first twelve animals to make it across the river would earn a spot on the zodiac calendar in the order they arrived. The rat rose with the sun to get an early start, but on the way to the river, he met the horse, the tiger, and the ox. Because the rat was small and couldn't swim very well, he asked the bigger animals for help. While the tiger and horse refused, the kind-hearted ox agreed to carry the rat across. Yet, just as they were about to reach the other side, the rat jumped off the ox's head and secured first place. The ox came in second, with the powerful tiger right behind him. The rabbit, too small to battle the current, nimbly hopped across stones and logs to come in fourth. Next came the dragon, who could have flown directly across, but stopped to help some creatures she had encountered on the way. After her came the horse, galloping across the river. But just as she got across, the snake slithered by. The startled horse reared back, letting the snake sneak into sixth place. The Jade Emperor looked out at the river and spotted the sheep, the monkey, and the rooster all atop a raft, working together to push it through the weeds. When they made it across, the trio agreed to give eighth place to the sheep, who had been the most comforting and harmonious of them, followed by the monkey and the rooster. Next came the dog, scrambling onto the shore. He was a great swimmer, but frolicked in the water for so long that he only managed to come in eleventh. The final spot was claimed by the pig, who had gotten hungry and stopped to eat and nap before finally waddling across the finish line. And so, each year is associated with one of the animals in this order, with the cycle starting over every 60 years. Why 60 and not twelve? Well, the traditional Chinese calendar is made up of two overlapping systems. The animals of the zodiac are associated with what's called the Twelve Earthly Branches, or shí'èrzhī. Another system, the Ten Heavenly Stems, or tiāngān, is linked with the five classical elements of metal, xīn, wood, mù, water, shuǐ, fire, huǒ, and earth, tǔ. Each element is assigned yīn or yáng, creating a ten-year cycle. When the twelve animals of the Earthly Branches are matched with the five elements plus the yīn or the yáng of the Heavenly Stems, it creates 60 years of different combinations, known as a sexagenary cycle, or gānzhī. So someone born in 1980 would have the sign of yáng metal monkey, while someone born in 2007 would be yīn fire pig. In fact, you can also have an inner animal based on your birth month, a true animal based on your birth date, and a secret animal based on your birth hour. It was the great race that supposedly determined which animals were enshrined in the Chinese zodiac, but as the system spread through Asia, other cultures made changes to reflect their communities. So if you consult the Vietnamese zodiac, you may discover that you're a cat, not a rabbit, and if you're in Thailand, a mythical snake called a Naga replaces the dragon. So whether or not you place stock in what the zodiac says about you as an individual, it certainly reveals much about the culture it comes from.

**P433 2017-01-30 The science of milk - Jonathan J. O'Sullivan**

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Why do humans drink so much milk? And given that all mammals lactate, why do we favor certain types of milk over others? Milk is the first thing we drink, and thanks to developments in the production and variety of dairy products, it can take on countless forms for our dietary and sensory well-being. Milk's primary function is as a complete source of nutrition for newborns. In fact, since it has all of the vital nutrients for development and growth, proteins, carbohydrates, fats, vitamins and minerals, and water, milk is the only thing a baby even needs to ingest for the first six months of life. The unique makeup of milk can vary depending on factors like species, diet, and location. Reindeer of the Arctic Circle, for example, make energy-dense milk that's about 20% fat, roughly five times more than human or cow's milk, to help their young survive the harsh, freezing climate. So how is milk made? In the uniquely mammalian process of lactation, a special class of milk-secreting cells known as mammocytes line up in a single layer around pear-shaped alveoli. Those cells absorb all of the building blocks of milk, then synthesize tiny droplets of fat on structures called smooth endoplasmic reticula. The droplets combine with each other and other molecules and are then expelled and stored in spaces between cells. Mammary glands eventually secrete the milk through the breasts, udders, or, in the rare case of the platypus, through ducts in the abdomen. Although this process is typically reserved for females, in some species, like dayak fruit bats, goats, and even cats, males can also lactate. Milk drinkers worldwide consume dairy from buffalo, goats, sheeps, camels, yaks, horses, and cows. Almost all of these species are ruminants, a type of mammal with four-chambered stomachs that yield large quantities of milk. Of these, cows were the most easily domesticated and produce a milk that is both easily separated into cream and liquid and has a similar fat content to human milk. In their natural environment, mammals secrete milk on call for immediate consumption by their young. But with the demands of thirsty consumers, the dairy industry has enlisted methods to step up production, enhance shelf life, and provide a variety of milk products. In the dairy, centrifugation machines spin milk at high speeds, forcing less dense fats to separate from the liquid and float up. After being skimmed off, this fat, known as butterfat, can be used in dairy products like butter, cream, and cheese. Or it can be later added back to the liquid in varying proportions to yield different fat content milks. Full fat milk, sometimes referred to as whole milk, has 3.25% butterfat added compared to 1-2% for low and reduced fat milk, and less than half a percent for skim milk. To stop reseparation of the fat from the water, or creaming, the mixture undergoes the high-energy pressurized process of homogenization. Before milk hits the shelves, it's also typically heat treated to reduce its level of microbes, a government-sanctioned process that raw milk enthusiasts argue may reduce milk's nutritional worth. Milk spoilage is started by microbes, which consume and break down the nutrients in milk. That process causes butterfat to clump together, leading to a visually unpleasant product. And the byproducts of the microbes' consumption are compounds that taste and smell nasty. But there's a bigger problem. Raw milk can carry microbes that are the sources of deadly diseases, so in order to kill as many of those microbes as possible, and keep milk fresh longer, we use a technique called pasteurization. One version of this process involves exposing milk to about 30 seconds of high heat. Another version, called ultra-high temperature processing, or ultra pasteurization, blasts the milk with considerably higher temperatures over just a few seconds. UHT milk boasts a much longer shelf life, up to twelve months unrefrigerated, compared to pasteurized milk's two weeks in the fridge. That's because the higher temperatures of UHT processing inactivate far more microbes. Yet the higher processing temperatures may adversely affect the nutritional and sensory properties of the milk. Ultimately, that choice lies in the consumer's taste and need for convenience. Fortunately, there are many choices available in an industry that produces in excess of 840 million tons of products each year.

**P434 2017-02-01 Would winning the lottery make you happier - Raj Raghunathan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=434)

Will winning the lottery make you happier? Imagine winning a multi-million dollar lottery tomorrow. If you're like many of us, you'd be ecstatic, unable to believe your good luck. But would that joy still be there a few years later? Maybe not. A famous study of 22 lottery winners showed that months after winning, their average reported levels of happiness had increased no more than that of a control group who hadn't won the lottery. Some were actually unhappier than they had been before winning. And later studies have confirmed that our emotional well-being, how often and how intensely we feel things like joy, sorrow, anxiety, or anger, don't seem to improve with wealth or status beyond a certain point. This has to do with a phenomenon known as hedonic adaptation, or the hedonic treadmill. It describes our tendency to adapt to new situations to maintain a stable emotional equilibrium. When it comes to feeling happy, most of us seem to have a base level that stays more or less constant throughout our existence. Of course, the novelty of better food, superior vacations, and more beautiful homes can at first make you feel like you're walking on air, but as you get used to those things, you revert to your default emotional state. That might sound pretty gloomy, but hedonic adaptation makes us less emotionally sensitive to any kind of change, including negative ones. The study with the lottery winners also looked at people who had suffered an accident that left them paralyzed. When asked several months after their accidents how happy they were, they reported levels of happiness approaching their original baseline. So while the hedonic treadmill may inhibit our enjoyment of positive changes, it seems to also enable our resilience in recovering from adversity. There are other reasons that winning the lottery may not make us happier in the long run. It can be difficult to manage large sums of money, and some lottery winners wind up spending or losing it all quickly. It can also be socially isolating. Some winners experience a deluge of unwelcome requests for money, so they wind up cutting themselves off from others. And wealth may actually make us meaner. In one study, participants played a rigged game of monopoly where the experimenters made some players rich quickly. The wealthy players started patronizing the poorer players and hogging the snacks they were meant to share. But just because a huge influx of cash isn't guaranteed to bring joy into your life doesn't mean that money can never make us happier. Findings show that we adapt to extrinsic and material things, like a new car or a bigger house, much faster than we do to novel experiences, like visiting a new place or learning a new skill. So by that reasoning, the more you spend money on experiences rather than things, the happier you'd be. And there's another way to turn your money into happiness: spend it on other people. In one study, participants were given some money and were either asked to spend it on themselves or on someone else. Later that evening, researchers called up these participants and asked them how happy they were. The happiness levels of those who had spent the money on others were significantly greater than that of those who had spent it on themselves. And that seems to be true around the world. Another study examined the generosity of over 200,000 people from 136 countries. In over 90% of these countries, people who donated tended to be happier than those who didn't. But this may all be easier said than done. Let's say a million dollars falls into your lap tomorrow. What do you do with it?

**P435 2017-02-06 How small are we in the scale of the universe - Alex Hofeldt**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=435)

In the winter of 1995, scientists pointed the Hubble Telescope at an area of the sky near the Big Dipper, a spot that was dark and out of the way of light pollution from surrounding stars. The location was apparently empty, and the whole endeavor was risky. What, if anything, was going to show up? Over ten consecutive days, the telescope took close to 150 hours of exposure of that same area. And what came back was nothing short of spectacular: an image of over 1,500 distinct galaxies glimmering in a tiny sliver of the universe. Now, let's take a step back to understand the scale of this image. If you were to take a ballpoint pen and hold it at arm's length in front of the night sky, focusing on its very tip, that is what the Hubble Telescope captured in its first Deep Field image. In other words, those 3,000 galaxies were seen in just a tiny speck of the universe, approximately one two-millionth of the night sky. To put all this in perspective, the average human measures about 1.7 meters. With Earth's diameter at 12,700 kilometers, that's nearly 7.5 million humans lined up head to toe. The Apollo 8 astronauts flew a distance of 380,000 kilometers to the moon. And our relatively small Sun has a diameter of about 1.4 million kilometers, or 110 times the Earth's diameter. A step further, the Milky Way holds somewhere between 100 to 400 billion stars, including our Sun. And each glowing dot of a galaxy captured in the Deep Field image contains billions of stars at the very least. Almost a decade after taking the Deep Field image, scientists adjusted the optics on the Hubble Telescope and took another long exposure over a period of about four months. This time, they observed 10,000 galaxies. Half of these galaxies have since been analyzed more clearly in what's known as the eXtreme Deep Field image, or XDF. By combining over ten years of photographs, the XDF shows galaxies so distant that they're only one ten-billionth the brightness that the human eye can perceive. So, what can we learn about the universe from the Deep Field images? In a study of the universe, space and time are inextricably linked. That's because of the finite speed of light. So the Deep Field images are like time machines to the ancient universe. They reach so far into space and time that we can observe galaxies that existed over 13 billion years ago. This means we're looking at the universe as it was less than a billion years after the Big Bang, and it allows scientists to research galaxies in their infancy. The Deep Field images have also shown that the universe is homogeneous. That is, images taken at different spots in the sky look similar. That's incredible when we think about how vast the universe is. Why would we expect it to be the same across such huge distances? On the scale of a galaxy, let alone the universe, we're smaller than we can readily comprehend, but we do have the capacity to wonder, to question, to explore, to investigate, and to imagine. So the next time you stand gazing up at the night sky, take a moment to think about the enormity of what is beyond your vision, out in the dark spaces between the stars.

**P436 2017-02-13 What happens during a heart attack - Krishna Sudhir**

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Approximately 7 million people around the world die from heart attacks every year, and cardiovascular disease, which causes heart attacks and other problems like strokes, is the world's leading killer. So what causes a heart attack? Like all muscles, the heart needs oxygen, and during a heart attack, it can't get enough. Fatty deposits, or plaques, develop on the walls of our coronary arteries. Those are the vessels that supply oxygenated blood to the heart. These plaques grow as we age, sometimes getting chunky, hardened, or enflamed. Eventually, the plaques can turn into blockages. If one of the plaques ruptures or cracks, a blood clot will form around it in minutes, and a partially closed artery can become completely blocked. Blood flow is cut off to the cardiac muscle and the oxygen-starved cells start to die within several minutes. This is a myocardial infarction, or heart attack. Things can rapidly deteriorate in the absence of treatment. The injured muscle may not be able to pump blood as well, and its rhythm might be thrown off. In the worst case scenario, a heart attack can cause sudden death. And how do you know that someone is having a heart attack? The most common symptom is chest pain caused by the oxygen-deprived heart muscle. Patients describe it as crushing or vice-like. It can radiate to the left arm, jaw, back, or abdomen. But it's not always as sudden and dramatic as it is in the movies. Some people experience nausea or shortness of breath. Symptoms may be less prominent in women and the elderly. For them, weakness and tiredness may be the main signal. And surprisingly, in many people, especially those with diabetes, which affects the nerves that carry pain, a heart attack may be silent. If you think that someone might be having a heart attack, the most important thing is to respond quickly. If you have access to emergency medical services, call them. They're the fastest way to get to a hospital. Taking aspirin, which thins the blood, and nitroglycerin, which opens up the artery, can help keep the heart attack from getting worse. In the emergency room, doctors can diagnose a heart attack. They commonly use an electrocardiogram to measure the heart's electrical activity and a blood test to assess heart muscle damage. The patient is then taken to a high-tech cardiac suite where tests are done to locate the blockages. Cardiologists can reopen the blocked artery by inflating it with a balloon in a procedure called an angioplasty. Frequently, they also insert a metal or polymer stent that will hold the artery open. More extensive blockages might require coronary artery bypass surgery. Using a piece of vein or artery from another part of the body, heart surgeons can reroute blood flow around the blockage. These procedures reestablish circulation to the cardiac muscle, restoring heart function. Heart attack treatment is advancing, but prevention is vital. Genetics and lifestyle factors both affect your risk. And the good news is that you can change your lifestyle. Exercise, a healthy diet, and weight loss all lower the risk of heart attacks, whether you've had one before or not. Doctors recommend exercising a few times a week, doing both aerobic activity and strength training. A heart-healthy diet is low in sugar and saturated fats, which are both linked to heart disease. So what should you eat? Lots of fiber from vegetables, chicken and fish instead of red meat, whole grains and nuts like walnuts and almonds all seem to be beneficial. A good diet and exercise plan can also keep your weight in a healthy range, which will lower your heart attack risk as well. And of course, medications can also help prevent heart attacks. Doctors often prescribe low-dose aspirin, for example, particularly for patients who've already had a heart attack and for those known to be at high risk. And drugs that help manage risk factors, like high blood pressure, cholesterol, and diabetes, will make heart attacks less likely, too. Heart attacks may be common, but they don't have to be inevitable. A healthy diet, avoiding tobacco use, staying fit, and enjoying plenty of sleep and lots of laughter all go a long way in making sure your body's most important muscle keeps on beating.

**P437 2017-02-14 Can you solve the three gods riddle - Alex Gendler**

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Created by logician Raymond Smullyan and popularized by his colleague George Boolos, this riddle has been called the hardest logic puzzle ever. You and your team have crash-landed on an ancient planet. The only way off is to appease its three alien overlords, Tee, Eff, and Arr, by giving them the correct artifacts. Unfortunately, you don't know who is who. From an inscription, you learn that you may ask three yes or no questions, each addressed to any one lord. Tee's answers are always true, Eff's are always false, and Arr's answer is random each time. But there's a problem. You've deciphered the language enough to ask any question, but you don't know which of the two words 'ozo' and 'ulu' means yes and which means no. How can you still figure out which alien is which? Pause here if you want to figure it out for yourself! Answer in: 3 2 1 At first, this puzzle seems not just hard, but downright impossible. What good is asking a question if you can neither understand the answer nor know if it's true? But it can be done. The key is to carefully formulate our questions so that any answer yields useful information. First of all, we can get around to not knowing what 'ozo' and 'ulu' mean by including the words themselves in the questions, and secondly, if we load each question with a hypothetical condition, whether an alien is lying or not won't actually matter. To see how that could work, imagine our question is whether two plus two is four. Instead of posing it directly, we say, "If I asked you whether two plus two is four, would you answer 'ozo'?" If 'ozo' means yes and the overlord is Tee, it truthfully replies, "ozo." But what if we ask Eff? Well, it would answer "ulu," or no to the embedded question, so it lies and replies 'ozo' instead. And if 'ozo' actually means no, then the answer to our embedded question is 'ulu,' and both Tee and Eff still reply 'ozo,' each for their own reasons. If you're confused about why this works, the reason involves logical structure. A double positive and a double negative both result in a positive. Now, we can be sure that asking either Tee or Eff a question put this way will yield 'ozo' if the hypothetical question is true and 'ulu' if it's false regardless of what each word actually means. Unfortunately, this doesn't help us with Arr. But don't worry, we can use our first question to identify one alien lord that definitely isn't Arr. Then we can use the second to find out whether its Tee or Eff. And once we know that, we can ask it to identify one of the others. So let's begin. Ask the alien in the middle, "If I asked you whether the overlord on my left is Arr, would you answer 'ozo'?" If the reply is 'ozo,' there are two possibilities. You could already be talking to Arr, in which case the answer is meaningless. But otherwise, you're talking to either Tee or Eff, and as we know, getting 'ozo' from either one means your hypothetical question was correct, and the left overlord is indeed Arr. Either way, you can be sure the alien on the right is not Arr. Similarly, if the answer is 'ulu,' then you know the alien on the left can't be Arr. Now go to the overlord you've determined isn't Arr and ask, "If I asked 'are you Eff?' would you answer 'ozo'?" Since you don't have to worry about the random possibility, either answer will establish its identity. Now that you know whether its answers are true or false, ask the same alien whether the center overlord is Arr. The process of elimination will identify the remaining one. The satisfied overlords help you repair your ship and you prepare for takeoff. Allowed one final question, you ask Tee if it's a long way to Earth, and he answers "ozo." Too bad you still don't know what that means.

**P438 2017-02-14 TED-Ed Clubs - Celebrating and amplifying student voices around the w**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=438)

There are over 2 billion school-aged individuals living in the world today. That's more young people than any other time in human history. And it's this generation's creativity, their actions, their art, their poetry, their protests, their questions, their code, their dreams. It's this generation's ideas that will define the future of our world. One well articulated idea can reach and inspire millions. That's why TED's youth and education initiative, TED-Ed, has created a program that's dedicated to sparking and celebrating the best ideas of young people around the world. "The essence of TED-Ed was to create more confident individuals." "It was our club; it was run by us and for us." The program is called TED-Ed Clubs. It supports students in identifying their passions, learning public speaking skills, connecting with a global network of classrooms, and sharing student ideas in the form of short, TED-style talks. Here's how it works. Participating students and teachers gain access to a free and flexible curriculum they can use to start a TED-Ed Club at their school. Each suggested meeting uses TED Talks to help students engage in critical thinking exercises and gain invaluable presentation skills. In the final meeting, students are invited to give their own TED Talk, and if they record their Talk, they can upload it to TED-Ed's award-winning platform, where it can be referenced on a résumé, a college application, and shared with participating clubs around the world. Over 2 billion young people empowered and encouraged to share their ideas. Imagine that future and bring TED-Ed Clubs to your community today.

**P439 2017-02-14 The exceptional life of Benjamin Banneker - Rose-Margaret Ekeng-Itua**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=439)

Sometime in the early 1750s, a 22-year-old man named Benjamin Banneker sat industriously carving cogs and gears out of wood. He pieced the parts together to create the complex inner working of a striking clock that would, hopefully, chime every hour. All he had to help him was a pocket watch for inspiration and his own calculations. And yet, his careful engineering worked. Striking clocks had already been around for hundreds of years, but Banneker's may have been the first created in America, and it drew fascinated visitors from across the country. In a show of his brilliance, the clock continued to chime for the rest of Banneker's life. Born in 1731 to freed slaves on a farm in Baltimore, Maryland, from his earliest days, the young Banneker was obsessed with math and science. And his appetite for knowledge only grew as he taught himself astronomy, mathematics, engineering, and the study of the natural world. As an adult, he used astronomy to accurately predict lunar and solar events, like the solar eclipse of 1789, and even applied his mathematical skills to land use planning. These talents caught the eye of a local Baltimore businessman, Andrew Ellicott, who was also the Surveyor General of the United States. Recognizing Banneker's skills in 1791, Ellicott appointed him as an assistant to work on a prestigious new project, planning the layout of the nation's capitol. Meanwhile, Banneker turned his brilliant mind to farming. He used his scientific expertise to pioneer new agricultural methods on his family's tobacco farm. His fascination with the natural world also led to a study on the plague life cycle of locusts. Then in 1792, Banneker began publishing almanacs. These provided detailed annual information on moon and sun cycles, weather forecasts, and planting and tidal time tables. Banneker sent a handwritten copy of his first almanac to Virginia's Secretary of State Thomas Jefferson. This was a decade before Jefferson became president. Banneker included a letter imploring Jefferson to "embrace every opportunity to eradicate that train of absurd and false ideas and opinions" that caused prejudice against black people. Jefferson read the almanac and wrote back in praise of Banneker's work. Banneker's correspondence with the future president is now considered to be one of the first documented examples of a civil rights protest letter in America. For the rest of his life, he fought for this cause, sharing his opposition to slavery through his writing. In 1806 at the age of 75, Banneker died after a lifetime of study and activism. On the day of his funeral, his house mysteriously burned down, and the majority of his life's work, including his striking clock, was destroyed. But still, his legacy lives on.

**P440 2017-02-15 How blue jeans were invented \_ Moments of Vision 10 - Jessica Oreck**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=440)

In a Moment of Vision... It's the height of the Gold Rush, 1850s California. A young tailor named Jacob Davis notices that his gold-mining customers are wearing through pants faster than they can patch them. In a moment of vision, Davis adds reinforcing metal rivets to his pant design, strategically placing them at points of strain, like the corners of pockets and the base of the fly. The enhanced trousers are soon in high demand. In order to take out a patent on the highly successful riveted pant, Davis needs a business partner. He approaches the supplier of his cloth, a dry goods merchant by the name of Levi Strauss. Strauss and Davis begin manufacturing pants out of denim, and continue to modify the design to accommodate their customers. It is rumored that the removal of the crotch rivet was due to a complaint from the miners that squatting too near a campfire in their typical underwear-free fashion could be painful. Jeans continued to be modified and diversified over the years, eventually becoming an everyday fashion item for both work and play by the 1960s. Today, 96% of American consumers own at least one, if not many, pairs of jeans.

**P441 2017-02-17 Everything you need to know to read 'Frankenstein' - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=441)

In 1815, the eruption of Mount Tambora plunged parts of the world into darkness and marked a gloomy period that came to be known as The Year Without a Summer. So when Mary and Percy Shelley arrived at the House of Lord Byron on Lake Geneva, their vacation was mostly spent indoors. For amusement, Byron proposed a challenge to his literary companions: Who could write the most chilling ghost story? This sparked an idea in 18-year-old Mary. Over the next few months, she would craft the story of Frankenstein. Popular depictions may evoke a green and groaning figure, but that's not Mary Shelley's monster. In fact, in the book, Frankenstein refers to the nameless monster's maker, Dr. Victor Frankenstein. So tense is the struggle between creator and creature that the two have merged in our collective imagination. Before you read or reread the original text, there are several other things that are helpful to know about Frankenstein and how it came to assume its multiple meanings. The book traces Dr. Frankenstein's futile quest to impart and sustain life. He constructs his monster part by part from dead matter and electrifies it into conscious being. Upon completing the experiment, however, he's horrified at the result and flees. But time and space aren't enough to banish the abandoned monster, and the plot turns on a chilling chase between the two. Shelley subtitled her fireside ghost story, "The Modern Prometheus." That's in reference to the Greek myth of the Titan Prometheus who stole fire from the gods and gave it to humanity. This gave humanity knowledge and power, but for tampering with the status quo, Prometheus was chained to a rock and eaten by vultures for eternity. Prometheus enjoyed a resurgence in the literature of the Romantic Period during the 18th century. Mary was a prominent Romantic, and shared the movement's appreciation for nature, emotion, and the purity of art. Two years after Mary released "Frankenstein", Percy reimagined the plight of Prometheus in his lyrical drama, "Prometheus Unbound." The Romantics used these mythical references to signal the purity of the Ancient World in contrast to modernity. They typically regarded science with suspicion, and "Frankenstein" is one of the first cautionary tales about artificial intelligence. For Shelley, the terror was not supernatural, but born in a lab. In addition, gothic devices infuse the text. The gothic genre is characterized by unease, eerie settings, the grotesque, and the fear of oblivion - all elements that can be seen in "Frankenstein." But this horror had roots in personal trauma, as well. The text is filled with references to Shelley's own circumstances. Born in 1797, Mary was the child of William Godwin and Mary Wollstonecraft. Both were radical intellectual figures, and her mother's book, "A Vindication of the Rights of Women," is a key feminist text. Tragically, she died as a result of complications from Mary's birth. Mary was haunted by her mother's death, and later experienced her own problems with childbirth. She became pregnant following her elopement with Percy at 16, but that baby died shortly after birth. Out of four more pregnancies, only one of their children survived. Some critics have linked this tragedy to the themes explored in "Frankenstein." Shelley depicts birth as both creative and destructive, and the monster becomes a disfigured mirror of the natural cycle of life. The monster, therefore, embodies Dr. Frankenstein's corruption of nature in the quest for glory. This constitutes his fatal flaw, or hamartia. His god complex is most clear in the line, "Life and death appear to me ideal bounds which I should first break through and pour a torrent of light onto our dark world." Although he accomplishes something awe-inspiring, he has played with fire at his own ethical expense. And that decision echoes throughout the novel, which is full of references to fire and imagery that contrasts light and dark. These moments suggest not only the spark of Prometheus's fire, but the power of radical ideas to expose darker areas of life.

**P442 2017-02-22 Are ghost ships real - Peter B. Campbell**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=442)

One foggy morning in 1884, the British steamer "Rumney" crashed into the French ship "Frigorifique." Seeing their ship filling with water, the French crew climbed aboard the "Rumney." But as they sailed towards the nearest port, a silent form suddenly emerged from the fog: the abandoned "Frigorifique." It was too late to turn, and the impact was enough to sink the "Rumney." As the sailors scrambled into the lifeboats, the empty "Frigorifique" sailed back into the fog, having seemingly taken its revenge. In reality, the French sailors had left the engines running, and the "Frigorifique" sailed in a circle before striking the "Rumney" and finally sinking. But its story became one of the many tales of ghost ships, unmanned vessels that apparently sail themselves. And although they've influenced works like "Dracula" and "Pirates of the Caribbean," crewless ships aren't the product of ghostly spirits, just physics at work. One of the most famous ghost ships was the "Mary Celeste" found sailing the Atlantic in 1872 with no one aboard, water in its hold, and lifeboats missing. The discovery of its intact cargo and a captain's log that ended abruptly led to wild rumors and speculation. But the real culprits were two scientific phenomena: buoyancy and fluid dynamics. Here's how buoyancy works. An object placed in a liquid displaces a certain volume of fluid. The liquid in turn exerts an upward buoyant force equal to the weight of the fluid that's been displaced. This phenomenon is called Archimedes's Principle. Objects that are less dense than water, such as balsa wood, icebergs, and inflatable rafts always float. That's because the upward buoyant force is always stronger than the downward force of gravity. But for objects or ships to float when they're made of materials, like steel, that are denser than water, they must displace a volume of water larger than their weight. Normally, the water filling a ship's hull would increase its weight and cause it to sink - just what the "Mary Celeste's" crew feared when they abandoned ship. But the sailors didn't account for fluid dynamics. The water stopped flowing at the point of equilibrium, when it reached the same level as the hull. As it turned out, the weight of the water wasn't enough to sink the ship and the "Mary Celeste" was found a few days later while the unfortunate crew never made it to shore. Far stranger is the tale of "A. Ernest Mills," a schooner transporting salt, whose crew watched it sink to the sea floor following a collision. Yet four days later, it was spotted floating on the surface. The key to the mystery lay in the ship's heavy cargo of salt. The added weight of the water in the hull made the vessel sink, but as the salt dissolved in the water, the weight decreased enough that the force of gravity became less than the buoyant force and the ship floated back to the surface. But how do we explain the most enduring aspect of ghost ship legends: multiple sightings of the same ships hundreds of miles and several years apart? The answer lies in ocean currents, which are like invisible rivers flowing through the ocean. Factors, like temperature, salinity, wind, gravity, and the Coriolis effect from the Earth's rotation create a complex system of water movement. That applies both at the ocean's surface and deep below. Sailors have always known about currents, but their patterns weren't well known until recently. In fact, tracking abandoned ships was how scientists determined the shape and speed of the Atlantic Gyre, the Gulf Stream, and related currents in the first place. Beginning in 1883, the U.S. Hydrographic Office began collecting monthly data that included navigation hazards, like derelict ships, whose locations were reported by passing vessels. So abandoned ships may not be moved by ghost crews or supernatural curses, but they are a real and fascinating phenomenon born through the ocean and kept afloat by powerful, invisible, scientifically studied forces.

**P443 2017-02-23 How to practice effectively...for just about anything - Annie Bosler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=443)

Mastering any physical skill, be it performing a pirouette, playing an instrument, or throwing a baseball, takes practice. Practice is the repetition of an action with the goal of improvement, and it helps us perform with more ease, speed, and confidence. So what does practice do in our brains to make us better at things? Our brains have two kinds of neural tissue: grey matter and white matter. The grey matter processes information in the brain, directing signals and sensory stimuli to nerve cells, while white matter is mostly made up of fatty tissue and nerve fibers. In order for our bodies to move, information needs to travel from the brain's grey matter, down the spinal cord, through a chain of nerve fibers called axons to our muscles. So how does practice or repetition affect the inner workings of our brains? The axons that exist in the white matter are wrapped with a fatty substance called myelin. And it's this myelin covering, or sheath, that seems to change with practice. Myelin is similar to insulation on electrical cables. It prevents energy loss from electrical signals that the brain uses, moving them more efficiently along neural pathways. Some recent studies in mice suggest that the repetition of a physical motion increases the layers of myelin sheath that insulates the axons. And the more layers, the greater the insulation around the axon chains, forming a sort of superhighway for information connecting your brain to your muscles. So while many athletes and performers attribute their successes to muscle memory, muscles themselves don't really have memory. Rather, it may be the myelination of neural pathways that gives these athletes and performers their edge with faster and more efficient neural pathways. There are many theories that attempt to quantify the number of hours, days, and even years of practice that it takes to master a skill. While we don't yet have a magic number, we do know that mastery isn't simply about the amount of hours of practice. It's also the quality and effectiveness of that practice. Effective practice is consistent, intensely focused, and targets content or weaknesses that lie at the edge of one's current abilities. So if effective practice is the key, how can we get the most out of our practice time? Try these tips. Focus on the task at hand. Minimize potential distractions by turning off the computer or TV and putting your cell phone on airplane mode. In one study, researchers observed 260 students studying. On average, those students were able to stay on task for only six minutes at a time. Laptops, smartphones, and particularly Facebook were the root of most distractions. Start out slowly or in slow-motion. Coordination is built with repetitions, whether correct or incorrect. If you gradually increase the speed of the quality repetitons, you have a better chance of doing them correctly. Next, frequent repetitions with allotted breaks are common practice habits of elite performers. Studies have shown that many top athletes, musicians, and dancers spend 50-60 hours per week on activities related to their craft. Many divide their time used for effective practice into multiple daily practice sessions of limited duration. And finally, practice in your brain in vivid detail. It's a bit surprising, but a number of studies suggest that once a physical motion has been established, it can be reinforced just by imagining it. In one study, 144 basketball players were divided into two groups. Group A physically practiced one-handed free throws while Group B only mentally practiced them. When they were tested at the end of the two week experiment, the intermediate and experienced players in both groups had improved by nearly the same amount. As scientists get closer to unraveling the secrets of our brains, our understanding of effective practice will only improve. In the meantime, effective practice is the best way we have of pushing our individual limits, achieving new heights, and maximizing our potential.

**P444 2017-02-23 What happened to trial by jury - Suja A. Thomas**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=444)

Dating back at least to the time of Socrates, some early societies decided that certain disputes, such as whether a person committed a particular crime, should be heard by a group of citizens. Several centuries later, trial by jury was introduced to England, where it became a fundamental feature of the legal system, checking the government and involving citizens in decision-making. Juries decided whether defendants would be tried on crimes, determined whether the accused defendants were guilty, and resolved monetary disputes. While the American colonies eventually cast off England's rule, its legal tradition of the jury persisted. The United States Constitution instructed a grand jury to decide whether criminal cases proceeded, required a jury to try all crimes, except impeachment, and provided for juries in civil cases as well. Yet, in the US today, grand juries often are not convened, and juries decide less than 4% of criminal cases and less than 1% of civil cases filed in court. That's at the same time as jury systems in other countries are growing. So what happened in the U.S.? Part of the story lies in how the Supreme Court has interpreted the Constitution. It's permitted plea bargaining, which now occurs in almost every criminal case. The way it works is the prosecutor presents the accused with a decision of whether to plead guilty. If they accept the plea, the case won't go in front of a jury, but they'll receive a shorter prison sentence than they'd get if a jury did convict them. The risk of a much greater prison sentence after a trial can frighten even an innocent defendant into taking a plea. Between the 19th century and the 21st century, the proportion of guilty pleas has increased from around 20% to 90%, and the numbers continue to grow. The Supreme Court has permitted the use of another procedure that interferes with the jury called summary judgement. Using summary judgement, judges can decide that civil trials are unnecessary if the people who sue have insufficient evidence. This is intended only for cases where no reasonable jury would disagree. That's a difficult thing to determine, yet usage of summary judgement has stretched to the point where some would argue it's being abused. For instance, judges grant fully, or in part, over 70% of employers' requests to dismiss employment discrimination cases. In other cases, both the person who sues and the person who defends forgo their right to go to court, instead resolving their dispute through a professional arbitrator. These are generally lawyers, professors, or former judges. Arbitration can be a smart decision by both parties to avoid the requirements of a trial in court, but it's often agreed to unwittingly when people sign contracts like employment applications and consumer agreements. That can become a problem. For example, some arbitrators may be biased towards the companies that give them cases. These are just some of the ways in which juries have disappeared. But could the disappearance of juries be a good thing? Well, juries aren't perfect. They're costly, time-consuming, and may make errors. And they're not always necessary, like when people can simply agree to settle their disputes. But juries have their advantages. When properly selected, jurors are more representative of the general population and don't have the same incentives as prosecutors, legislators, or judges seeking reelection or promotion. The founders of the United States trusted in the wisdom of impartial groups of citizens to check the power of all three branches of government. And the jury trial itself has given ordinary citizens a central role in upholding the social fabric. So will the jury system in the U.S. survive into the future?

**P445 2017-02-24 Does 'The Wonderful Wizard of Oz' have a hidden message - David B. Pa**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=445)

In the summer of 1963, a high school teacher changed the way the world looked at "The Wizard of Oz." His name was Henry Littlefield, and he was teaching an American history class. He'd made it to the late 19th century, a time called The Gilded Age, but he was struggling to keep his class interested in the complex social and economic issues of the time. Then one night, while he was reading "The Wonderful Wizard of Oz" to his daughters, he had an idea. In the 1890s, farmers wanted to add silver to the gold standard to put more money in circulation and make it easier for farmers to borrow. In the book, Dorothy walked to the Emerald City on the Yellow Brick Road in her silver shoes. The movie's ruby red slippers started out as silver. Silver and gold on the road to prosperity. L. Frank Baum had published the book in 1900 at the height of The Gilded Age, and the analogy didn't seem out of the question. No one else had seen these connections, but that didn't deter Littlefield. He taught his class about The Gilded Age using the book, and soon he and his students were finding more connections. For instance, in the late 1890s, the U.S. had recently recovered from the Civil War and integrated vast new territories, bringing an era of prosperity for some. But while industry and finance in the North and East prospered, farmers across the South and Midwest struggled. This led to the Populist movement, uniting farmers and workers against urban elites. By 1896, the movement had grown into the People's Party, and its support of Democrat Williams Jennings Bryan put him in reach of the presidency. Meanwhile in Oz, claimed Littlefield, Dorothy is a typical American girl whose hard life in Kansas is literally turned upside down by powerful forces outside her control. The munchkins are the common people oppressed by the Witch of the East, banks and monopolies. The Scarecrow is the farmer, considered naive but actually quite resourceful, the Tin Woodman is the industrial worker dehumanized by factory labor, and the Cowardly Lion is William Jennings Bryan who could be an influential figure if only he were brave enough to adopt the Populist's radical program. Together, they travel along a golden yellow road towards a grand city whose ruler's power turns out to be built on illusions. Littlefield published some of these observations in an essay. His claim that this fantasy was actually a subversive critique of American capitalism appealed to many people in 1960s. Other scholars took up the theme, and the proposed analogies and connections multiplied. They suggested that Dorothy's dog Toto represented the teetotalers of the prohibition party. Oz was clearly the abbreviation for ounces, an important unit in the silver debate. The list goes on. By the 1980s, this understanding of the book was accepted so widely that several American history textbooks mentioned it in discussions of late 19th century politics. But is the theory right? L. Frank Baum's introduction claims the book is just an innocent children's story. Could he have been deliberately throwing people off the trail? And is it fair to second guess him so many decades later? There's no definitive answer, which is part of why authorial intent is a complex, tangled, fun question to unravel. And some recent scholars have interpreted "The Wonderful Wizard of Oz" in the opposite way as Littlefield. They claim it's a celebration of the new urban consumer culture. Historian William Leach argued that the dazzling Emerald City of Oz was meant to acclimate people to the shiny, new America. In the end, all we know for sure is that Baum, inspired by European folk legends, had set out to create one for American children. And whether or not he intended any hidden meanings, its continuing relevance suggests he succeeded in creating a fairytale America can call its own.

**P446 2017-03-01 How the popsicle was invented \_ Moments of Vision 11 - Jessica Oreck**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=446)

In a Moment of Vision... It's 1905, Northern California. Frank Epperson is eleven years old. He's sitting on his front porch making a sort of DIY drink that's very popular at this time. He has just poured a sugary soda powder into a glass of water and is mixing enthusiastically with a wooden stir stick. We don't know exactly how the next 24 hours play out, but we can imagine that something catches Frank's attention and he abandons his drink mid-stir. After a cold Bay Area night, Frank rediscovers his mix drink the next morning. It's frozen solid. But instead of throwing it out, Frank pulls the icy block of soda out of the glass by the embedded stir stick and, in a moment of vision, licks it. Delighted by his invention, Frank begins making the frozen treat for friends, and as he grows older, begins selling them as Eppsicles, a contraction of his last name and the word icicle. It is rumored that later, Frank's own kids dubbed the icy delicacy Pop's 'cicle. Others claim the name is a combination of lollipop and icicle. Regardless where the name comes from, the popsicle is here to stay. Approximately 2 billion popsicles are sold each year.

**P447 2017-03-08 Where do superstitions come from - Stuart Vyse**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=447)

Are you afraid of black cats? Would you open an umbrella indoors? And how do you feel about the number thirteen? Whether or not you believe in them, you're probably familiar with a few of these superstitions. So how did it happen that people all over the world knock on wood, or avoid stepping on sidewalk cracks? Well, although they have no basis in science, many of these weirdly specific beliefs and practices do have equally weird and specific origins. Because they involve supernatural causes, it's no surprise that many superstitions are based in religion. For example. the number thirteen was associated with the biblical Last Supper, where Jesus Christ dined with his twelve disciples just before being arrested and crucified. The resulting idea that having thirteen people at a table was bad luck eventually expanded into thirteen being an unlucky number in general. Now, this fear of the number thirteen, called triskaidekaphobia, is so common that many buildings around the world skip the thirteenth floor, with the numbers going straight from twelve to fourteen. Of course, many people consider the story of the Last Supper to be true but other superstitions come from religious traditions that few people believe in or even remember. Knocking on wood is thought to come from the folklore of the ancient Indo-Europeans or possibly people who predated them who believed that trees were home to various spirits. Touching a tree would invoke the protection or blessing of the spirit within. And somehow, this tradition survived long after belief in these spirits had faded away. Many superstitions common today in countries from Russia to Ireland are thought to be remnants of the pagan religions that Christianity replaced. But not all superstitions are religious. Some are just based on unfortunate coincidences and associations. For example, many Italians fear the number 17 because the Roman numeral XVII can be rearranged to form the word vixi, meaning my life had ended. Similarly, the word for the number four sounds almost identical to the word for death in Cantonese, as well as languages like Japanese and Korean that have borrowed Chinese numerals. And since the number one also sounds like the word for must, the number fourteen sounds like the phrase must die. That's a lot of numbers for elevators and international hotels to avoid. And believe it or not, some superstitions actually make sense, or at least they did until we forgot their original purpose. For example, theater scenery used to consist of large painted backdrops, raised and lowered by stagehands who would whistle to signal each other. Absentminded whistles from other people could cause an accident. But the taboo against whistling backstage still exists today, long after the stagehands started using radio headsets. Along the same lines, lighting three cigarettes from the same match really could cause bad luck if you were a soldier in a foxhole where keeping a match lit too long could draw attention from an enemy sniper. Most smokers no longer have to worry about snipers, but the superstition lives on. So why do people cling to these bits of forgotten religions, coincidences, and outdated advice? Aren't they being totally irrational? Well, yes, but for many people, superstitions are based more on cultural habit than conscious belief. After all, no one is born knowing to avoid walking under ladders or whistling indoors, but if you grow up being told by your family to avoid these things, chances are they'll make you uncomfortable, even after you logically understand that nothing bad will happen. And since doing something like knocking on wood doesn't require much effort, following the superstition is often easier than consciously resisting it. Besides, superstitions often do seem to work. Maybe you remember hitting a home run while wearing your lucky socks. This is just our psychological bias at work. You're far less likely to remember all the times you struck out while wearing the same socks. But believing that they work could actually make you play better by giving you the illusion of having greater control over events. So in situations where that confidence can make a difference, like sports, those crazy superstitions might not be so crazy after all.

**P448 2017-03-09 The myth of Icarus and Daedalus - Amy Adkins**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=448)

In mythological ancient Greece, soaring above Crete on wings made from wax and feathers, Icarus, the son of Daedalus, defied the laws of both man and nature. Ignoring the warnings of his father, he rose higher and higher. To witnesses on the ground, he looked like a god, and as he peered down from above, he felt like one, too. But, in mythological ancient Greece, the line that separated god from man was absolute and the punishment for mortals who attempted to cross it was severe. Such was the case for Icarus and Daedalus. Years before Icarus was born, his father Daedalus was highly regarded as a genius inventor, craftsman, and sculptor in his homeland of Athens. He invented carpentry and all the tools used for it. He designed the first bathhouse and the first dance floor. He made sculptures so lifelike that Hercules mistook them for actual men. Though skilled and celebrated, Daedalus was egotistical and jealous. Worried that his nephew was a more skillful craftsman, Daedalus murdered him. As punishment, Daedalus was banished from Athens and made his way to Crete. Preceded by his storied reputation, Daedalus was welcomed with open arms by Crete's King Minos. There, acting as the palace technical advisor, Daedalus continued to push the boundaries. For the king's children, he made mechanically animated toys that seemed alive. He invented the ship's sail and mast, which gave humans control over the wind. With every creation, Daedalus challenged human limitations that had so far kept mortals separate from gods, until finally, he broke right through. King Minos's wife, Pasiphaë, had been cursed by the god Poseidon to fall in love with the king's prized bull. Under this spell, she asked Daedalus to help her seduce it. With characteristic audacity, he agreed. Daedalus constructed a hollow wooden cow so realistic that it fooled the bull. With Pasiphaë hiding inside Daedalus's creation, she conceived and gave birth to the half-human half-bull minotaur. This, of course, enraged the king who blamed Daedalus for enabling such a horrible perversion of natural law. As punishment, Daedalus was forced to construct an inescapable labyrinth beneath the palace for the minotaur. When it was finished, Minos then imprisoned Daedalus and his only son Icarus within the top of the tallest tower on the island where they were to remain for the rest of their lives. But Daedalus was still a genius inventor. While observing the birds that circled his prison, the means for escape became clear. He and Icarus would fly away from their prison as only birds or gods could do. Using feathers from the flocks that perched on the tower, and the wax from candles, Daedalus constructed two pairs of giant wings. As he strapped the wings to his son Icarus, he gave a warning: flying too near the ocean would dampen the wings and make them too heavy to use. Flying too near the sun, the heat would melt the wax and the wings would disintegrate. In either case, they surely would die. Therefore, the key to their escape would be in keeping to the middle. With the instructions clear, both men leapt from the tower. They were the first mortals ever to fly. While Daedalus stayed carefully to the midway course, Icarus was overwhelmed with the ecstasy of flight and overcome with the feeling of divine power that came with it. Daedalus could only watch in horror as Icarus ascended higher and higher, powerless to change his son's dire fate. When the heat from the sun melted the wax on his wings, Icarus fell from the sky. Just as Daedalus had many times ignored the consequences of defying the natural laws of mortal men in the service of his ego, Icarus was also carried away by his own hubris. In the end, both men paid for their departure from the path of moderation dearly, Icarus with his life and Daedalus with his regret.

**P449 2017-03-15 Why do people get so anxious about math - Orly Rubinsten**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=449)

When French mathematician Laurent Schwartz was in high school, he started to worry that he wasn't smart enough to solve math problems. Maybe you know a similar feeling. You sit down to take a math test, and you feel your heart beat faster and your palms start to sweat. You get butterflies in your stomach, and you can't concentrate. This phenomenon is called math anxiety, and if it happens to you, you're not alone. Researchers think about 20% of the population suffers from it. Some psychologists even consider it a diagnosable condition. But having mathematical anxiety doesn't necessarily mean you're bad at math - not even close. Laurent Schwartz went on to win the Fields Medal, the highest award in mathematics. People might think that they're anxious about math because they're bad at it, but it's often the other way around. They're doing poorly in math because they're anxious about it. Some psychologists think that's because math anxiety decreases a cognitive resource called working memory. That's the short-term memory system that helps you organize the information you need to complete a task. Worrying about being able to solve math problems, or not doing well on a test, eats up working memory, leaving less of it available to tackle the math itself. People can suddenly struggle with even basic math skills, like arithmetic, that they've otherwise mastered. Academic anxiety certainly isn't limited to math, but it does seem to happen much more frequently, and cause more harm in that subject. So why would that be? Researchers aren't yet sure, but some studies suggest that the way children are exposed to math by their parents and teachers play a large part. If parents talk about math like something challenging and unfamiliar, children can internalize that. Teachers with math anxiety are also likely to spread it to their students. Pressure to solve problems quickly dials up stress even more. And in some cultures, being good at math is a sign of being smart in general. When the stakes are that high, it's not surprising that students are anxious. Even Maryam Mirzakhani, an influential mathematician who was the first woman to win the Fields Medal, felt unconfident and lost interest in mathematics because her math teacher in middle school didn't think she was talented. So if you experience mathematical anxiety, what can you do? Relaxation techniques, like short breathing exercises, have improved test performance in students with math anxiety. Writing down your worries can also help. This strategy may give you a chance to reevaluate a stressful experience, freeing up working memory. And if you have the chance, physical activity, like a brisk walk, deepens breathing and helps relieve muscle tension, preventing anxiety from building. You can also use your knowledge about the brain to change your mindset. The brain is flexible, and the areas involved in math skills can always grow and develop. This is a psychological principle called the growth mindset. Thinking of yourself as someone who can grow and improve can actually help you grow and improve. If you're a teacher or parent of young children, try being playful with math and focusing on the creative aspects. That can build the numerical skills that help students approach math with confidence later on. Importantly, you should give children the time and space to work through their answers. And if you're an administrator, make sure your teachers have the positive attitudes and mathematical confidence necessary to inspire confidence in all of their students. Also, don't let anyone spread the myth that boys are innately better than girls at math. That is completely false. If you experience math anxiety, it may not help to just know that math anxiety exists. Or perhaps it's reassuring to put a name to the problem. Regardless, if you take a look around yourself, the odds are good that you'll see someone experiencing the same thing as you. Just remember that the anxiety is not a reflection of your ability, but it is something you can conquer with time and awareness.

**P450 2017-03-16 How the bendy straw was invented \_ Moments of Vision 12 - Jessica Ore**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=450)

In a Moment of Vision... It's the 1930s, San Francisco. Joseph B. Friedman and his young daughter Judith are sitting at the counter in a soda parlor. Judith has just ordered a milkshake. Vanilla or strawberry, we may never know. When the milkshake arrives, Joseph watches as little Judith struggles. Seated on the parlor stool, she is unable to reach the mouth of the striped paper straw protruding from her shake. Joseph, in a moment of vision, modifies Judith's straw. He inserts a screw into one end, and using a piece of dental floss, crushes the paper between the threads of the screw creating a series of tiny equidistant corrugations. After removing the screw, the straw is able to bend over the side of the glass and Judith is able to savor her milkshake. Joseph initially markets the new flexible straw to hospitals to help patients drink while reclining, but eventually, with the marketing and business savvy from his sister Betty, the bendy straw becomes a beloved utensil of every child and a regular household item.

**P451 2017-03-16 How the food you eat affects your gut - Shilpa Ravella**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=451)

Trillions of bacteria, viruses, and fungi live on or inside of us, and maintaining a good, balanced relationship with them is to our advantage. Together, they form the gut microbiome, a rich ecosystem that performs a variety of functions in our bodies. The bacteria in our guts can break down food the body can't digest, produce important nutrients, regulate the immune system, and protect against harmful germs. We don't yet have the blueprint for exactly which good bacteria a robust gut needs, but we do know that it's important for a healthy microbiome to have a variety of bacterial species. Many factors affect our microbiomes, including our environment, medications like antibiotics, and even whether we were delivered by C-section or not. Diet, too, is emerging as one of the leading influences on the health of our guts. And while we can't control all these factors, we can manipulate the balance of our microbes by paying attention to what we eat. Dietary fiber from foods like fruits, vegetables, nuts, legumes, and whole grains is the best fuel for gut bacteria. When bacteria digest fiber, they produce short chain fatty acids that nourish the gut barrier, improve immune function, and can help prevent inflammation, which reduces the risk of cancer. And the more fiber you ingest, the more fiber-digesting bacteria colonize your gut. In a recent study, scientists exchanged the regular high-fiber diets of a group of rural South Africans with the high-fat, meat-heavy diets of a group of African-Americans. After just two weeks on the high-fat, low-fiber, Western-style diet, the rural African group showed increased inflammation of the colon, as well as a decrease of butyrate. That's a short chain fatty acid thought to lower risk of colon cancer. Meanwhile, the group that switched to a high-fiber, low-fat diet had the opposite result. So what goes wrong with our gut bacteria when we eat low-fiber processed foods? Lower fiber means less fuel for the gut bacteria, essentially starving them until they die off. This results in less diversity and hungry bacteria. In fact, some can even start to feed on the mucus lining. We also know that specific foods can affect gut bacteria. In one recent microbiome study, scientists found that fruits, vegetables, tea, coffee, red wine, and dark chocolate were correlated with increased bacterial diversity. These foods contain polyphenols, which are naturally occurring antioxidant compounds. On the other hand, foods high in dairy fat, like whole milk, and sugar-sweetened sodas were correlated with decreased diversity. How food is prepared also matters. Minimally processed, fresh foods generally have more fiber and provide better fuel. So lightly steamed, sautéed, or raw vegetables are typically more beneficial than fried dishes. There are also ways of preparing food that can actually introduce good bacteria, also known as probiotics, into your gut. Fermented foods are teeming with helpful probiotic bacteria, like lactobacillus and bifidobacteria. Originally used as a way of preserving foods before the invention of refrigeration, fermentation remains a traditional practice all over the world. Foods like kimchi, sauerkraut, tempeh, and kombucha provide variety and vitality to our diets. Yogurt is another fermented food that can introduce helpful bacteria into our guts. That doesn't necessarily mean that all yogurt is good for us, though. Brands with too much sugar and not enough bacteria may not actually help. These are just general guidelines. More research is needed before we fully understand exactly how any of these foods interact with our microbiomes. We see positive correlations, but the insides of our guts are difficult places to make direct observations. For instance, we don't currently know whether these foods are directly responsible for the changes in diversity, or if something more complicated is happening. While we're only beginning to explore the vast wilderness inside our guts, we already have a glimpse of how crucial our microbiomes are for digestive health. The great news is we have the power to fire up the bacteria in our bellies. Fill up on fibers, fresh and fermented foods, and you can trust your gut to keep you going strong.

**P452 2017-03-16 The history of chocolate - Deanna Pucciarelli**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=452)

If you can't imagine life without chocolate, you're lucky you weren't born before the 16th century. Until then, chocolate only existed in Mesoamerica in a form quite different from what we know. As far back as 1900 BCE, the people of that region had learned to prepare the beans of the native cacao tree. The earliest records tell us the beans were ground and mixed with cornmeal and chili peppers to create a drink - not a relaxing cup of hot cocoa, but a bitter, invigorating concoction frothing with foam. And if you thought we make a big deal about chocolate today, the Mesoamericans had us beat. They believed that cacao was a heavenly food gifted to humans by a feathered serpent god, known to the Maya as Kukulkan and to the Aztecs as Quetzalcoatl. Aztecs used cacao beans as currency and drank chocolate at royal feasts, gave it to soldiers as a reward for success in battle, and used it in rituals. The first transatlantic chocolate encounter occurred in 1519 when Hernán Cortés visited the court of Moctezuma at Tenochtitlan. As recorded by Cortés's lieutenant, the king had 50 jugs of the drink brought out and poured into golden cups. When the colonists returned with shipments of the strange new bean, missionaries' salacious accounts of native customs gave it a reputation as an aphrodisiac. At first, its bitter taste made it suitable as a medicine for ailments, like upset stomachs, but sweetening it with honey, sugar, or vanilla quickly made chocolate a popular delicacy in the Spanish court. And soon, no aristocratic home was complete without dedicated chocolate ware. The fashionable drink was difficult and time consuming to produce on a large scale. That involved using plantations and imported slave labor in the Caribbean and on islands off the coast of Africa. The world of chocolate would change forever in 1828 with the introduction of the cocoa press by Coenraad van Houten of Amsterdam. Van Houten's invention could separate the cocoa's natural fat, or cocoa butter. This left a powder that could be mixed into a drinkable solution or recombined with the cocoa butter to create the solid chocolate we know today. Not long after, a Swiss chocolatier named Daniel Peter added powdered milk to the mix, thus inventing milk chocolate. By the 20th century, chocolate was no longer an elite luxury but had become a treat for the public. Meeting the massive demand required more cultivation of cocoa, which can only grow near the equator. Now, instead of African slaves being shipped to South American cocoa plantations, cocoa production itself would shift to West Africa with Cote d'Ivoire providing two-fifths of the world's cocoa as of 2015. Yet along with the growth of the industry, there have been horrific abuses of human rights. Many of the plantations throughout West Africa, which supply Western companies, use slave and child labor, with an estimation of more than 2 million children affected. This is a complex problem that persists despite efforts from major chocolate companies to partner with African nations to reduce child and indentured labor practices. Today, chocolate has established itself in the rituals of our modern culture. Due to its colonial association with native cultures, combined with the power of advertising, chocolate retains an aura of something sensual, decadent, and forbidden. Yet knowing more about its fascinating and often cruel history, as well as its production today, tells us where these associations originate and what they hide. So as you unwrap your next bar of chocolate, take a moment to consider that not everything about chocolate is sweet.

**P453 2017-03-24 How did Dracula become the world's most famous vampire - Stanley Step**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=453)

How did Dracula become the world's most famous vampire? More than 100 years after his creator was laid to rest, Dracula lives on as the most famous vampire in history. But this Transylvanian noble, neither the first fictional vampire nor the most popular of his time, may have remained buried in obscurity if not for a twist of fate. Dracula's first appearance was in Bram Stoker's 1897 novel of the same name. But that was far from the beginning of vampire myths. Blood-sucking monsters had already been part of folklore for at least 800 years. It was Slavic folklore that gave us the word vampire, or "upir" in Old Russian. The term's first known written mention comes from the 11th century. Vampire lore in the region predated Christianity's arrival and persisted despite the church's efforts to eliminate pagan beliefs. Stories of vampires originated from misinterpretations of diseases, such as rabies, and pellagra, and decomposition. In the case of the latter, gasses swelling the body and blood oozing from the mouth could make a corpse look like it had recently been alive and feeding. Vampires were describe as bloated with overgrown teeth and nails. This gave rise to many rituals intended to prevent the dead from rising, such as burying bodies with garlic or poppyseeds, as well as having them staked, burned, or mutilated. Vampire lore remained a local phenomenon until the 18th century when Serbia was caught in the struggle between two great powers, the Habsburg Monarchy and Ottoman Empire. Austrian soldiers and government officials observed and documented the strange local burial rituals, and their reports became widely publicized. The resulting vampire hysteria got so out of hand that in 1755, the Austrian Empress was forced to dispatch her personal physician. He investigated and put an end to the rumors by publishing a thorough, scientific refutation. The panic subsided, but the vampire had already taken root in Western Europe's imagination, spawning works like "The Vampyre" in 1819, and Joseph Sheridan Le Fanu's "Carmilla" in 1872. This book would greatly influence a young Irish drama critic named Bram Stoker. Stoker, who was born in Dublin in 1847, was famously bedridden with an unknown illness until the age of seven. During that time, his mother told him folktales and true tales of horror, including her experiences during an outbreak of cholera in 1832. There, she described victims buried alive in mass graves. Later in his life, Stoker went on to write fantasy, romance, adventure stories, and, in 1897, "Dracula." Although the book's main villain and namesake is thought to be based on the historical figure of Vlad III Dracula, or Vlad the Impaler, the association is mostly just that they share a name. Other elements and characters were inspired directly and indirectly by various works in the Victorian Era, such as "The Mysterious Stranger." The novel, upon release, was only a moderate success in its day, nor was it even Stoker's most well-known work, mentioned only briefly in a 1912 obituary. But a critical copyright battle would completely change Dracula's fate, and catapult the character into literary renown. In 1922, a German studio adapted the novel into the now classic silent film "Nosferatu" without paying royalties. Despite changes in character names and minor plot points, the parallels were obvious, and the studio was sued into bankruptcy. To prevent more plagiarism attempts, Stoker's widow decided to establish copyright over the stage version of "Dracula" by approving a production by family-friend Hamilton Deane. Although Deane's adaptation made drastic cuts to the story, it became a classic, thanks largely to Bela Lugosi's performance on Broadway. Lugosi would go on to star in the 1931 film version by Universal, lending the character many of his signature characteristics. And since then, Dracula has risen again in countless adaptations, finding eternal life far beyond the humble pages of his birth.

**P454 2017-03-24 Why do animals have such different lifespans - Joao Pedro de Magalhae**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=454)

For the microscopic lab worm, C. elegans life equates to just a few short weeks on Earth. Compare that with the tortoise, which can age to more than 100 years. Mice and rats reach the end of their lives after just four years, while for the bowhead whale, Earth's longest-lived mammal, death can come after 200. Like most living things, the vast majority of animals gradually degenerate after reaching sexual maturity in the process known as aging. But what does it really mean to age? The drivers behind this process are varied and complicated, but aging is ultimately caused by cell death and dysfunction. When we're young, we constantly regenerate cells in order to replace dead and dying ones. But as we age, this process slows down. In addition, older cells don't perform their functions as well as young ones. That makes our bodies go into a decline, which eventually results in disease and death. But if that's consistently true, why the huge variance in aging patterns and lifespan within the animal kingdom? The answer lies in several factors, including environment and body size. These can place powerful evolutionary pressures on animals to adapt, which in turn makes the aging process different across species. Consider the cold depths of the Atlantic and Arctic Seas, where Greenland sharks can live to over 400 years, and the Arctic clam known as the quahog can live up to 500. Perhaps the most impressive of these ocean-dwelling ancients is the Antarctic glass sponge, which can survive over 10,000 years in frigid waters. In cold environments like these, heartbeats and metabolic rates slow down. Researchers theorize that this also causes a slowing of the aging process. In this way, the environment shapes longevity. When it comes to size, it's often, but not always, the case that larger species have a longer lifespan than smaller ones. For instance, an elephant or whale will live much longer than a mouse, rat, or vole, which in turn have years on flies and worms. Some small animals, like worms and flies, are also limited by the mechanics of their cell division. They're mostly made up of cells that can't divide and be replaced when damaged, so their bodies expire more quickly. And size is a powerful evolutionary driver in animals. Smaller creatures are more prone to predators. A mouse, for instance, can hardly expect to survive more than a year in the wild. So, it has evolved to grow and reproduce more rapidly, like an evolutionary defense mechanism against its shorter lifespan. Larger animals, by contrast, are better at fending off predators, and so they have the luxury of time to grow to large sizes and reproduce multiple times during their lives. Exceptions to the size rule include bats, birds, moles, and turtles, but in each case, these animals have other adaptations that allow them to escape predators. But there are still cases where animals with similar defining features, like size and habitat, age at completely different rates. In these cases, genetic differences, like how each organism's cells respond to threats, often account for the discrepancies in longevity. So it's the combination of all these factors playing out to differing degrees in different animals that explains the variability we see in the animal kingdom. So what about us? Humans currently have an average life expectancy of 71 years, meaning that we're not even close to being the longest living inhabitants on Earth. But we are very good at increasing our life expectancy. In the early 1900s, humans only lived an average of 50 years. Since then, we've learned to adapt by managing many of the factors that cause deaths, like environmental exposure and nutrition. This, and other increases in life expectancy make us possibly the only species on Earth to take control over our natural fate.

**P455 2017-03-30 Can you solve the virus riddle - Lisa Winer**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=455)

Your research team has found a prehistoric virus preserved in the permafrost and isolated it for study. After a late night working, you're just closing up the lab when a sudden earthquake hits and knocks out the power. As the emergency generators kick in, an alarm confirms your worst fears: all the sample vials have broken. The virus is contained for now, but unless you can destroy it, the vents will soon open and unleash a deadly airborne plague. Without hesitation, you grab your HazMat suit and get ready to save the world. The lab is a four by four compound of 16 rooms with an entrance on the northwest corner and an exit at the southeast. Each room is connected to the adjacent ones by an airlock, and the virus has been released in every room except the entrance. To destroy it, you must enter each contaminated room and pull its emergency self-destruct switch. But there's a catch. Because the security system is on lockdown, once you enter the contaminated room, you can't exit without activating the switch, and once you've done so, you won't be able to go back in to that room. You start to draw out possible routes on a pad of paper, but nothing seems to get you to the exit without missing at least one room. So how can you destroy the virus in every contaminated room and survive to tell the story? Pause here if you want to figure it out for yourself. Answer in: 3 Answer in: 2 Answer in: 1 If your first instinct is to try to graph your possible moves on a grid, you've got the right idea. This puzzle is related to the Hamiltonian path problem named after the 19th century Irish mathematician William Rowan Hamilton. The challenge of the path problem is to find whether a given graph has a Hamiltonian path. That's a route that visits every point within it exactly once. This type of problem, classified as NP-complete, is notoriously difficult when the graph is sufficiently large. Although any proposed solution can be easily verified, we have no reliable formula or shortcut for finding one, or determining that one exists. And we're not even sure if it's possible for computers to reliably find such solutions, either. This puzzle adds a twist to the Hamiltonian path problem in that you have to start and end at specific points. But before you waste a ton of graph paper, you should know that a true Hamiltonian path isn't possible with these end points. That's because the rooms form a grid with an even number of rooms on each side. In any grid with that configuration, a Hamiltonian path that starts and ends in opposite corners is impossible. Here's one way of understanding why. Consider a checkerboard grid with an even number of squares on each side. Every path through it will alternate black and white. These grids will all also have an even total number of squares because an even number times and even number is even. So a Hamiltonian path on an even-sided grid that starts on black will have to end on white. And one that starts on white will have to end on black. However, in any grid with even numbered sides, opposite corners are the same color, so it's impossible to start and end a Hamiltonian path on opposite corners. It seems like you're out of luck, unless you look at the rules carefully and notice an important exception. It's true that once you activate the switch in a contaminated room, it's destroyed and you can never go back. But there's one room that wasn't contaminated - the entrance. This means that you can leave it once without pulling the switch and return there when you've destroyed either of these two rooms. The corner room may have been contaminated from the airlock opening, but that's okay because you can destroy the entrance after your second visit. That return trip gives you four options for a successful route, and a similar set of options if you destroyed this room first. Congratulations. You've prevented an epidemic of apocalyptic proportions, but after such a stressful episode, you need a break. Maybe you should take up that recent job offer to become a traveling salesman.

**P456 2017-03-31 How do focus groups work - Hector Lanz**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=456)

Why do we buy certain products or choose certain brands? This is the sort of question advertisers have always asked, and there are no easy answers. However, there is a handy tool that helps companies explore this and similar questions, and it's called the focus group. Until the 1940s, market research was often quantitative using things like sales figures and customer polls to track consumption. But this changed during World War II. Sociologists Robert Merton and Paul Lazarsfeld set out to learn how unprecedented exposure to wartime propaganda was affecting the public. Instead of polling large numbers of people with straightforward questions and quantifiable answers, the researchers conducted in-person interviews, sometimes with small groups, engaging them in more open discussions. Later, this method was picked up by the advertising industry with the help of consultants, like Austrian-born psychologist Ernest Dichter, who first coined the term focus group. This new technique was a type of qualitative research focused on the nature of people's preferences and thoughts. It couldn't tell marketers what percentage of people buy a certain product or brand, but it could tell them more about the people who do, their reasoning for doing so, and even the unconscious motivations behind those reasons. Rather than providing definite conclusions for business and sales, focus groups would be used for exploratory research, generating new ideas for products and marketing based on deeper understanding of consumer habits. For example, early focus groups found that contrary to popular opinion at the time, wives often had more influence than their husbands when choosing which car to buy, so Chrysler shifted gears by marketing cars directly to women. And Dr. Dichter himself conducted focus groups for Mattel to learn what girls wanted in a doll. The result was the original Barbie doll. So how does a focus group work? First, companies recruit between six and ten participants according to specific criteria that meet their research objectives. They could be mothers of children between five and seven, or teenagers planning to buy a new phone in the next three months. This is often done through professional recruiters who manage lists of people who've agreed to participate in focus groups for payment or other rewards. During a session, participants are asked to respond to various prompts from the group moderator, like sharing their opinions on a certain product, or their emotional reactions to an advertisement. They may even be asked to do seemingly unrelated tasks, like imagining brands as animals in a zoo. The idea is that this can reveal useful information about the participant's feelings that traditional questions might not get to. Beyond these basics, many variations are possible. A focus group may have two or more moderators perhaps taking opposite sides on a question, or a researcher might be hidden in the focus group unknown to other participants to see how their answers can be influenced. And the whole process may also be observed by researchers through a one-way mirror. But although they can provide valuable insight, focus groups do have their limitations, and one of the main ones is that the simple act of observing something can change it. This principle is called observer interference. The answers participants give are likely to be affected by the presence of the researchers, social pressure from the rest of the group, or simply knowing that they're taking part in a focus group. And because researchers often use a small sample size in a specific setting, it's hard to generalize their results. The findings that researchers do reach from focus groups are often tested through experiments and data gathering. Those put numbers on questions like how many potential customers there are and what price they'd be willing to pay. This part of the process changes as technology evolves. But focus groups have remained largely the same for decades. Perhaps when it comes to the big, important questions, there's no substitute for people genuinely interacting with each other.

**P457 2017-03-31 The three different ways mammals give birth - Kate Slabosky**

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What do these animals have in common? More than you might think. Along with over 5,000 other species, they're mammals, or members of class mammalia. All mammals are vertebrates, meaning they have backbones. But mammals are distinguished from other vertebrates by a number of shared features. That includes warm blood, body hair or fur, the ability to breathe using lungs, and nourishing their young with milk. But despite these similarities, these creatures also have many biological differences, and one of the most remarkable is how they give birth. Let's start with the most familiar, placental mammals. This group includes humans, cats, dogs, giraffes, and even the blue whale, the biggest animal on Earth. Its placenta, a solid disk of blood-rich tissue, attaches to the wall of the uterus to support the developing embryo. The placenta is what keeps the calf alive during pregnancy. Directly connected to the mother's blood supply, it funnels nutrients and oxygen straight into the calf's body via the umbilical cord, and also exports its waste. Placental mammals can spend far longer inside the womb than other mammals. Baby blue whales, for instance, spend almost a full year inside their mother. The placenta keeps the calf alive right up until its birth, when the umbilical cord breaks and the newborn's own respiratory, circulatory, and waste disposal systems take over. Measuring about 23 feet, a newborn calf is already able to swim. It will spend the next six months drinking 225 liters of its mothers thick, fatty milk per day. Meanwhile, in Australia, you can find a second type of mammal - marsupials. Marsupial babies are so tiny and delicate when they're born that they must continue developing in the mother's pouch. Take the quoll, one of the world's smallest marsupials, which weighs only 18 milligrams at birth, the equivalent of about 30 sugar grains. The kangaroo, another marsupial, gives birth to a single jelly bean-sized baby at a time. The baby crawls down the middle of the mother's three vaginas, then must climb up to the pouch, where she spends the next 6-11 months suckling. Even after the baby kangaroo leaves this warm haven, she'll return to suckle milk. Sometimes, she's just one of three babies her mother is caring for. A female kangaroo can often simultaneously support one inside her uterus and another in her pouch. In unfavorable conditions, female kangaroos can pause their pregnancies. When that happens, she's able to produce two different kinds of milk, one for her newborn, and one for her older joey. The word mammalia means of the breast, which is a bit of a misnomer because while kangaroos do produce milk from nipples in their pouches, they don't actually have breasts. Nor do monotremes, the third and arguably strangest example of mammalian birth. There were once hundreds of monotreme species, but there are only five left: four species of echidnas and the duck-billed platypus. The name monotreme means one hole referring to the single orifice they use for reproduction, excretion, and egg-laying. Like birds, reptiles, fish, dinosaurs, and others, these species lay eggs instead of giving birth to live young. Their eggs are soft-shelled, and when their babies hatch, they suckle milk from pores on their mother's body until they're large enough to feed themselves. Despite laying eggs and other adaptations that we associate more with non-mammals, like the duck-bill platypus's webbed feet, bill, and the venomous spur males have on their feet, they are, in fact, mammals. That's because they share the defining characteristics of mammalia and are evolutionarily linked to the rest of the class. Whether placental, marsupial, or monotreme, each of these creatures and its unique birthing methods, however bizarre, have succeeded for many millennia in bringing new life and diversity into the mammal kingdom.

**P458 2017-04-05 Secrets of the X chromosome - Robin Ball**

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The secrets of the X chromosome. These women are identical twins. They have the same nose, the same hair color, the same eye color. But this one is color blind for green light, and this one isn't. How is that possible? The answer lies in their genes. For humans, the genetic information that determines our physical traits is stored in 23 pairs of chromosomes in the nucleus of every cell. These chromosomes are made up of proteins and long, coiled strands of DNA. Segments of DNA, called genes, tell the cell to build specific proteins, which control its identity and function. For every chromosome pair, one comes from each biological parent. In 22 of these pairs, the chromosomes contain the same set of genes, but may have different versions of those genes. The differences arrive from mutations, which are changes to the genetic sequence that may have occurred many generations ago. Some of those changes have no effect, some cause diseases, and some lead to advantageous adaptations. The result of having two versions of each gene is that you display a combination of your biological parents' traits. But the 23rd pair is unique, and that's the secret behind the one color blind twin. This pair, called the X and Y chromosomes, influences your biological sex. Most women have two X chromosomes while most men have one X and one Y. The Y chromosome contains genes for male development and fertility. The X chromosome, on the other hand, contains important genes for things other than sex determination or reproduction, like nervous system development, skeletal muscle function, and the receptors in the eyes that detect green light. Biological males with an XY chromosome pair only get one copy of all these X chromosome genes, so the human body has evolved to function without duplicates. But that creates a problem for people with two X chromosomes. If both X chromosomes produced proteins, as is normal in other chromosomes, development of the embryo would be completely impaired. The solution is X inactivation. This happens early in development when an embryo with two X chromosomes is just a ball of cells. Each cell inactivates one X chromosome. There's a certain degree of randomness to this process. One cell may inactivate the X chromosome from one parent, and another the chromosome from the other parent. The inactive X shrivels into a clump called a Barr body and goes silent. Almost none of its genes order proteins to be made. When these early cells divide, each passes on its X inactivation. So some clusters of cells express the maternal X chromosome, while others express the paternal X. If these chromosomes carry different traits, those differences will show up in the cells. This is why calico cats have patches. One X had a gene for orange fur and the other had a gene for black fur. The pattern of the coat reveals which one stayed active where. Now we can explain our color blind twin. Both sisters inherited one mutant copy of the green receptor gene and one normally functioning copy. The embryo split into twins before X inactivation, so each twin ended up with a different inactivation pattern. In one, the X chromosome with the normal gene was turned off in the cells that eventually became eyes. Without those genetic instructions, she now can't sense green light and is color blind. Disorders that are associated with mutations of X chromosome genes, like color blindness, or hemophilia, are often less severe in individuals with two X chromosomes. That's because in someone with one normal and one mutant copy of the gene, only some of their cells would be affected by the mutation. This severity of the disorder depends on which X got turned off and where those cells were. On the other hand, all the cells in someone with only one X chromosome can only express the mutant copy of the gene if that's what they inherited. There are still unresolved questions about X inactivation, like how some genes on the X chromosome escape inactivation and why inactivation isn't always random. What we do know is that this mechanism is one of the many ways that genes alone don't tell our whole story.

**P459 2017-04-06 Oxygen’s surprisingly complex journey through your body - Enda Butler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=459)

You breathe in about 17,000 times per day. It's a process you rarely think about, but behind the scenes, a huge coordinated effort is playing out. Your vital organs, the gut, brain, bones, lungs, blood, and heart work together to sustain your life by delivering oxygen to tissues throughout your body. Most of our cells need oxygen because it's one of the key ingredients of aerobic respiration. That's the process that produces a molecule called ATP, which our cells use to power their many incredible functions. But getting oxygen throughout our bodies is a surprisingly difficult task. Gas enters cells by diffusing in from their surroundings. And that only happens efficiently over tiny distances. So for oxygen to reach the cells within our bodies, it needs a transportation network. This is where our 20 trillion red blood cells come in. Each one contains about 270 million oxygen-binding molecules of hemoglobin, which is what gives blood its scarlet hue. To make these cells, the body uses raw materials that become available from the food we eat. So in some ways, you could say that oxygen's journey through the body really begins in the gut. Here, in an amazing display of mechanical and chemical digestion, food gets broken down into its smallest elements, like iron, the building block of hemoglobin. Iron is carried through the cardiovascular system to the body's hematopoietic tissue. This tissue is the birthplace of red blood cells, and it can be found enclosed within our bone marrow cavities. The kidneys regulate our levels of red blood cells through the release of erythropoietin, a hormone which causes marrow to increase production. Our bodies churn out roughly 2.5 million red blood cells per second, a number equivalent to the entire population of Paris, so that oxygen that makes it to the lungs will have ample transportation. But before oxygen can even reach the lungs, the brain needs to get involved. The brainstem initiates breathing by sending a message through your nervous system, all the way to muscles of the diaphragm and ribs. This causes them to contract, thus increasing the space inside the rib cage, which allows the lungs to expand. That expansion drops your lungs internal air pressure, making air rush in. It's tempting to think of our lungs as two big balloons, but they're actually a lot more complicated than that. Here's why. The red blood cells in the vessels within your lungs can only pick up oxygen molecules that are very close to them. If our lungs were shaped like balloons, air that was not in direct contact with the balloon's inner surface couldn't diffuse through. Luckily, our lungs' architecture ensures that very little oxygen is wasted. Their interior is divided into hundreds of millions of miniature balloon-like projections called alveoli that dramatically increase the contact area to somewhere around 100 square meters. The alveolar walls are made of extremely thin flat cells that are surrounded by capillaries. Together, the alveolar wall and capillaries make a two-cell thick membrane that brings blood and oxygen close enough for diffusion. These oxygen-enriched cells are then carried from the lungs through the cardiovascular network, a massive collection of blood vessels that reaches every cell in the body. If we laid this system out end to end in a straight line, the vessels would wrap around the Earth several times. Propelling red blood cells through this extensive network requires a pretty powerful pump, and that's where your heart comes in. The human heart pumps an average of about 100,000 times per day, and it's the powerhouse that ultimately gets oxygen where it needs to go, completing the body's team effort. Just think - this entire complex system is built around the delivery of tiny molecules of oxygen. If just one part malfunctioned, so would we. Breathe in. Your gut, brain, bones, lungs, blood, and heart are continuing their incredible act of coordination that keeps you alive. Breathe out.

**P460 2017-04-07 Why do we itch - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=460)

You're standing at the ready inside the goal when suddenly, you feel an intense itch on the back of your head. We've all experienced the annoyance of an inconvenient itch, but have you ever pondered why we itch in the first place? The average person experiences dozens of individual itches each day. They can be triggered by all sorts of things, including allergic reactions, dryness, and even some diseases. And then there are the mysterious ones that pop up for no reason at all, or just from talking about itching. You're scratching your head right now, aren't you? Anyhow, let's take one of the most common sources: bug bites. When a mosquito bites you, it releases a compound into your body called an anticoagulant that prevents your blood from clotting. That compound, which we're mildly allergic to, triggers the release of histamine, a chemical that makes our capillaries swell. This enables increased blood flow, which helpfully accelerates the body's immune response to this perceived threat. That explains the swelling, and it's the same reason pollen can make your eyes puff up. Histamine also activates the nerves involved in itching, which is why bug bites make you scratch. But the itchy sensation itself isn't yet fully understood. In fact, much of what we do know comes from studying the mechanics of itching in mice. Researchers have discovered that itch signals in their skin are transmitted via a subclass of the nerves that are associated with pain. These dedicated nerves produce a molecule called natriuretic polypetide B, which triggers a signal that's carried up the spinal cord to the brain, where it creates the feeling of an itch. When we scratch, the action of our fingernails on the skin causes a low level pain signal that overrides the itching sensation. It's almost like a distraction, which creates the sensation of relief. But is there actually an evolutionary purpose to the itch, or is it simply there to annoy us? The leading theory is that our skin has evolved to be acutely aware of touch so that we're equipped to deal with risks from the outside world. Think about it. Our automatic scratching response would dislodge anything harmful that's potentially lurking on our skin, like a harmful sting, a biting insect, or the tendrils of a poisonous plant. This might explain why we don't feel itching inside our bodies, like in our intestines, which is safe from these external threats, though imagine how maddening that would be. In some people, glitches in the pathways responsible for all of this can cause excessive itching that can actually harm their health. One extreme example is a psychological condition called delusory parasitosis where people believe their bodies are infested with mites or fleas scurrying over and under their skin, making them itch incessantly. Another phenomenon called phantom itching can occur in patients who've had amputations. Because this injury has so severely damaged the nervous system, it confuses the body's normal nerve signaling and creates sensations in limbs that are no longer there. Doctors are now finding ways to treat these itching anomalies. In amputees, mirrors are used to reflect the remaining limb, which the patient scratches. That creates an illusion that tricks the brain into thinking the imaginary itch has been satisfied. Oddly enough, that actually works. Researchers are also searching for the genes involved in itching and developing treatments to try and block the pathway of an itch in extreme cases. If having an unscratchable itch feels like your own personal hell, Dante agreed. The Italian poet wrote about a section of hell where people were punished by being left in pits to itch for all eternity.

**P461 2017-04-24 Why are sloths so slow - Kenny Coogan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=461)

In 1796, Thomas Jefferson received a box of bones he couldn't identify. A long, sharp claw reminded him of a lion, but the arm bones suggested a larger animal, one about three meters long. Thinking it might be huge unknown species of North American lion, Jefferson warned explorers Lewis and Clark to keep an eye out for this mysterious predator. But Jefferson's box of bones didn't come from a lion. They came from an extinct giant sloth. Prehistoric ground sloths first appeared around 35 million years ago. Dozens of species lived across North, Central and South America, alongside other ancient creatures like mastodons and giant armadillos. Some ground sloths, like the megalonychid, were cat-sized, but many were massive. Jefferson's sloth, Megalonyx, weighed about a ton, and that was small compared to megatherium, which could reach six metric tons, as much as an elephant. They ambled through the forests and savannas using their strong arms and sharp claws to uproot plants and climb trees, grazing on grasses, leaves, and prehistoric avocados. In fact, we might not have avocados today if not for the giant sloths. Smaller animals couldn't swallow the avocado's huge seed, but the sloths could, and they spread avocado trees far and wide. Ground sloths flourished for millions of years, but around 10,000 years ago, they started disappearing along with the Western Hemisphere's other giant mammals. Researchers think that ground sloths could have been pushed out by an oncoming ice age, or competition with other species, maybe humans, who arrived in the region around the time most of the sloths went extinct. Some of the smaller sloths did survive and migrated to the treetops. Today, there are six species left living in the rainforest canopies of Central and South America. Hanging out in the trees is a good way to avoid predators, and there are plenty of leaves to eat. But this diet has its drawbacks. Animals extract energy from food and use that energy to move around, maintain their body temperature, keep their organs working, and all the other activities necessary for survival. But leaves don't contain much energy, and that which they do have is tough to extract. Most herbivores supplement a leafy diet with higher energy foods like fruit and seeds. But sloths, especially three-toed sloths, rely on leaves almost exclusively. They've evolved finely tuned strategies for coping with this restricted diet. First, they extract as much energy from their food as possible. Sloths have a multi-chambered stomach that takes up a third of their body, and depending on the species, they can spend five to seven days, or even weeks, processing a meal. The other piece of the puzzle is to use as little energy as possible. One way sloths do this is, of course, by not moving very much. They spend most of their time eating, resting, or sleeping. They descend from the canopy just once a week for a bathroom break. When sloths do move, it's not very fast. It would take a sloth about five minutes to cross an average neighborhood street. This unhurried approach to life means that sloths don't need very much muscle. In fact, they have about 30% less muscle mass than other animals their size. Sloths also use less energy to keep themselves warm because their body temperature can fluctuate by about five degrees Celsius, less than a cold-blooded reptile, but more than most mammals. These physical and behavioral adaptations minimize the sloth's energy expenditure, or metabolic rate. Three-toed sloths have the slowest metabolism of any mammal. The giant panda is second slowest, and two-toed sloths come in third. Moving slowly has allowed sloths to thrive in their treetop habitat. But it's also made the sloths themselves a great habitat for other organisms, including algae, which provides a little extra camouflage, and maybe even a snack. Sloths may not be giant anymore, but that doesn't make them any less remarkable.

**P462 2017-04-25 Why should you read Tolstoy's 'War and Peace' - Brendan Pelsue**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=462)

"War and Peace," a tome, a slog, the sort of book you shouldn't read in bed because if you fall asleep, it could give you a concussion, right? Only partly. "War and Peace" is a long book, sure, but it's also a thrilling examination of history, populated with some of the deepest, most realistic characters you'll find anywhere. And if its length intimidates you, just image how poor Tolstoy felt. In 1863, he set out to write a short novel about a political dissident returning from exile in Siberia. Five years later, he had produced a 1,200 page epic featuring love stories, battlefields, bankruptcies, firing squads, religious visions, the burning of Moscow, and a semi-domesticated bear, but no exile and no political dissidents. Here's how it happened. Tolstoy, a volcanic soul, was born to a famously eccentric aristocratic family in 1828. By the time he was 30, he had already dropped out of Kazan University, gambled away the family fortune, joined the army, written memoirs, and rejected the literary establishment to travel Europe. He then settled into Yasnaya Polyana, his ancestral mansion, to write about the return of the Decembrists, a band of well-born revolutionaries pardoned in 1856 after 30 years in exile. But, Tolstoy thought, how could he tell the story of the Decembrists return from exile without telling the story of 1825, when they revolted against the conservative Tsar Nicholas I? And how could he do that without telling the story of 1812, when Napoleon's disastrous invasion of Russia helped trigger the authoritarianism the Decembrists were rebelling against? And how could he tell the story of 1812 without talking about 1805, when the Russians first learned of the threat Napoleon posed after their defeat at the Battle of Austerlitz? So Tolstoy began writing, both about the big events of history and the small lives that inhabit those events. He focused on aristocrats, the class he knew best. The book only occasionally touches on the lives of the vast majority of the Russian population, who were peasants, or even serfs, farmers bound to serve the owners of the land on which they lived. "War and Peace" opens on the eve of war between France and Russia. Aristocrats at a cocktail party fret about the looming violence, but then change the topic to those things aristocrats always seem to care about: money, sex, and death. This first scene is indicative of the way the book bounces between the political and personal over an ever-widening canvas. There are no main characters in "War and Peace." Instead, readers enter a vast interlocking web of relationships and questions. Will the hapless and illegitimate son of a count marry a beautiful but conniving princess? Will his only friend survive the battlefields of Austria? And what about that nice young girl falling in love with both men at once? Real historical figures mix and mingle with all these fictional folk, Napoleon appears several times, and even one of Tolstoy's ancestors plays a background part. But while the characters and their psychologies are gripping, Tolstoy is not afraid to interrupt the narrative to pose insightful questions about history. Why do wars start? What are good battlefield tactics? Do nations rise and fall on the actions of so-called great men like Napoleon, or are there larger cultural and economic forces at play? These extended digressions are part of what make "War and Peace" so panoramic in scope. But for some 19th century critics, this meant "War and Peace" barely felt like a novel at all. It was a "large, loose, baggy monster," in the words of Henry James. Tolstoy, in fact, agreed. To him, novels were a western European form. Russian writers had to write differently because Russian people lived differently. "What is 'War and Peace'?" he asked. "It is not a novel. Still less an epic poem. Still less a historical chronicle. 'War and Peace' is what the author wanted and was able to express in the form in which it was expressed." It is, in other words, the sum total of Tolstoy's imaginative powers, and nothing less. By the time "War and Peace" ends, Tolstoy has brought his characters to the year 1820, 36 years before the events he originally hoped to write about. In trying to understand his own times, he had become immersed in the years piled up behind him. The result is a grand interrogation into history, culture, philosophy, psychology, and the human response to war.

**P463 2017-05-01 How do nuclear power plants work - M. V. Ramana and Sajan Saini**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=463)

On a December afternoon in Chicago during the middle of World War II, scientists cracked open the nucleus at the center of the uranium atom and turned nuclear mass into energy over and over again. They did this by creating for the first time a chain reaction inside a new engineering marvel: the nuclear reactor. Since then, the ability to mine great amounts of energy from uranium nuclei has led some to bill nuclear power as a plentiful utopian source of electricity. A modern nuclear reactor generates enough electricity from one kilogram of fuel to power an average American household for nearly 34 years. But rather than dominate the global electricity market, nuclear power has declined from an all-time high of 18% in 1996 to 11% today. And it's expected to drop further in the coming decades. What happened to the great promise of this technology? It turns out nuclear power faces many hurdles, including high construction costs and public opposition. And behind these problems lie a series of unique engineering challenges. Nuclear power relies on the fission of uranium nuclei and a controlled chain reaction that reproduces this splitting in many more nuclei. The atomic nucleus is densely packed with protons and neutrons bound by a powerful nuclear force. Most uranium atoms have a total of 238 protons and neutrons, but roughly one in every 140 lacks three neutrons, and this lighter isotope is less tightly bound. Compared to its more abundant cousin, a strike by a neutron easily splits the U-235 nuclei into lighter, radioactive elements called fission products, in addition to two to three neutrons, gamma rays, and a few neutrinos. During fission, some nuclear mass transforms into energy. A fraction of the newfound energy powers the fast-moving neutrons, and if some of them strike uranium nuclei, fission results in a second larger generation of neutrons. If this second generation of neutrons strike more uranium nuclei, more fission results in an even larger third generation, and so on. But inside a nuclear reactor, this spiraling chain reaction is tamed using control rods made of elements that capture excess neutrons and keep their number in check. With a controlled chain reaction, a reactor draws power steadily and stably for years. The neutron-led chain reaction is a potent process driving nuclear power, but there's a catch that can result in unique demands on the production of its fuel. It turns out, most of the neutrons emitted from fission have too much kinetic energy to be captured by uranium nuclei. The fission rate is too low and the chain reaction fizzles out. The first nuclear reactor built in Chicago used graphite as a moderator to scatter and slow down neutrons just enough to increase their capture by uranium and raise the rate of fission. Modern reactors commonly use purified water as a moderator, but the scattered neutrons are still a little too fast. To compensate and keep up the chain reaction, the concentration of U-235 is enriched to four to seven times its natural abundance. Today, enrichment is often done by passing a gaseous uranium compound through centrifuges to separate lighter U-235 from heavier U-238. But the same process can be continued to highly enrich U-235 up to 130 times its natural abundance and create an explosive chain reaction in a bomb. Methods like centrifuge processing must be carefully regulated to limit the spread of bomb-grade fuel. Remember, only a fraction of the released fission energy goes into speeding up neutrons. Most of the nuclear power goes into the kinetic energy of the fission products. Those are captured inside the reactor as heat by a coolant, usually purified water. This heat is eventually used to drive an electric turbine generator by steam just outside the reactor. Water flow is critical not only to create electricity, but also to guard against the most dreaded type of reactor accident, the meltdown. If water flow stops because a pipe carrying it breaks, or the pumps that push it fail, the uranium heats up very quickly and melts. During a nuclear meltdown, radioactive vapors escape into the reactor, and if the reactor fails to hold them, a steel and concrete containment building is the last line of defense. But if the radioactive gas pressure is too high, containment fails and the gasses escape into the air, spreading as far and wide as the wind blows. The radioactive fission products in these vapors eventually decay into stable elements. While some decay in a few seconds, others take hundreds of thousands of years. The greatest challenge for a nuclear reactor is to safely contain these products and keep them from harming humans or the environment. Containment doesn't stop mattering once the fuel is used up. In fact, it becomes an even greater storage problem. Every one to two years, some spent fuel is removed from reactors and stored in pools of water that cool the waste and block its radioactive emissions. The irradiated fuel is a mix of uranium that failed to fission, fission products, and plutonium, a radioactive material not found in nature. This mix must be isolated from the environment until it has all safely decayed. Many countries propose deep time storage in tunnels drilled far underground, but none have been built, and there's great uncertainty about their long-term security. How can a nation that has existed for only a few hundred years plan to guard plutonium through its radioactive half-life of 24,000 years? Today, many nuclear power plants sit on their waste, instead, storing them indefinitely on site. Apart from radioactivity, there's an even greater danger with spent fuel. Plutonium can sustain a chain reaction and can be mined from the waste to make bombs. Storing spent fuel is thus not only a safety risk for the environment, but also a security risk for nations. Who should be the watchmen to guard it? Visionary scientists from the early years of the nuclear age pioneered how to reliably tap the tremendous amount of energy inside an atom - as an explosive bomb and as a controlled power source with incredible potential. But their successors have learned humbling insights about the technology's not-so-utopian industrial limits. Mining the subatomic realm makes for complex, expensive, and risky engineering.

**P464 2017-05-02 How does your body process medicine - Céline Valéry**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=464)

Have you ever wondered what happens to a painkiller, like ibuprofen, after you swallow it? Medicine that slides down your throat can help treat a headache, a sore back, or a throbbing sprained ankle. But how does it get where it needs to go in the first place? The answer is that it hitches a ride in your circulatory blood stream, cycling through your body in a race to do its job before it's snared by organs and molecules designed to neutralize and expel foreign substances. This process starts in your digestive system. Say you swallow an ibuprofen tablet for a sore ankle. Within minutes, the tablet starts disintegrating in the acidic fluids of your stomach. The dissolved ibuprofen travels into the small intestine and then across the intestinal wall into a network of blood vessels. These blood vessels feed into a vein, which carries the blood, and anything in it, to the liver. The next step is to make it through the liver. As the blood and the drug molecules in it travel through liver blood vessels, enzymes attempt to react with the ibuprofen molecules to neutralize them. The damaged ibuprofen molecules, called metabolites, may no longer be effective as painkillers. At this stage, most of the ibuprofen makes it through the liver unscathed. It continues its journey out of the liver, through veins, into the body's circulatory system. Half an hour after you swallow the pill, some of the dose has already made it into the circulatory blood stream. This blood loop travels through every limb and organ, including the heart, brain, kidneys, and back through the liver. When ibuprofen molecules encounter a location where the body's pain response is in full swing, they bind to specific target molecules that are a part of that reaction. Painkillers, like ibuprofen, block the production of compounds that help the body transmit pain signals. As more drug molecules accumulate, the pain-cancelling affect increases, reaching a maximum within about one or two hours. Then the body starts efficiently eliminating ibuprofen, with the blood dose decreasing by half every two hours on average. When the ibuprofen molecules detach from their targets, the systemic blood stream carries them away again. Back in the liver, another small fraction of the total amount of the drug gets transformed into metabolites, which are eventually filtered out by the kidneys in the urine. The loop from liver to body to kidneys continues at a rate of about one blood cycle per minute, with a little more of the drug neutralized and filtered out in each cycle. These basic steps are the same for any drug that you take orally, but the speed of the process and the amount of medicine that makes it into your blood stream varies based on drug, person, and how it gets into the body. The dosing instructions on medicine labels can help, but they're averages based on a sample population that doesn't represent every consumer. And getting the dose right is important. If it's too low, the medicine won't do its job. If it's too high, the drug and its metabolites can be toxic. That's true of any drug. One of the hardest groups of patients to get the right dosage for are children. That's because how they process medicine changes quickly, as do their bodies. For instance, the level of liver enzymes that neutralize medication highly fluctuates during infancy and childhood. And that's just one of many complicating factors. Genetics, age, diet, disease, and even pregnancy influence the body's efficiency of processing medicine. Some day, routine DNA tests may be able to dial in the precise dose of medicine personalized to your liver efficiency and other factors, but in the meantime, your best bet is reading the label or consulting your doctor or pharmacist, and taking the recommended amounts with the recommended timing.

**P465 2017-05-02 What is entropy - Jeff Phillips**

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There's a concept that's crucial to chemistry and physics. It helps explain why physical processes go one way and not the other: why ice melts, why cream spreads in coffee, why air leaks out of a punctured tire. It's entropy, and it's notoriously difficult to wrap our heads around. Entropy is often described as a measurement of disorder. That's a convenient image, but it's unfortunately misleading. For example, which is more disordered - a cup of crushed ice or a glass of room temperature water? Most people would say the ice, but that actually has lower entropy. So here's another way of thinking about it through probability. This may be trickier to understand, but take the time to internalize it and you'll have a much better understanding of entropy. Consider two small solids which are comprised of six atomic bonds each. In this model, the energy in each solid is stored in the bonds. Those can be thought of as simple containers, which can hold indivisible units of energy known as quanta. The more energy a solid has, the hotter it is. It turns out that there are numerous ways that the energy can be distributed in the two solids and still have the same total energy in each. Each of these options is called a microstate. For six quanta of energy in Solid A and two in Solid B, there are 9,702 microstates. Of course, there are other ways our eight quanta of energy can be arranged. For example, all of the energy could be in Solid A and none in B, or half in A and half in B. If we assume that each microstate is equally likely, we can see that some of the energy configurations have a higher probability of occurring than others. That's due to their greater number of microstates. Entropy is a direct measure of each energy configuration's probability. What we see is that the energy configuration in which the energy is most spread out between the solids has the highest entropy. So in a general sense, entropy can be thought of as a measurement of this energy spread. Low entropy means the energy is concentrated. High entropy means it's spread out. To see why entropy is useful for explaining spontaneous processes, like hot objects cooling down, we need to look at a dynamic system where the energy moves. In reality, energy doesn't stay put. It continuously moves between neighboring bonds. As the energy moves, the energy configuration can change. Because of the distribution of microstates, there's a 21% chance that the system will later be in the configuration in which the energy is maximally spread out, there's a 13% chance that it will return to its starting point, and an 8% chance that A will actually gain energy. Again, we see that because there are more ways to have dispersed energy and high entropy than concentrated energy, the energy tends to spread out. That's why if you put a hot object next to a cold one, the cold one will warm up and the hot one will cool down. But even in that example, there is an 8% chance that the hot object would get hotter. Why doesn't this ever happen in real life? It's all about the size of the system. Our hypothetical solids only had six bonds each. Let's scale the solids up to 6,000 bonds and 8,000 units of energy, and again start the system with three-quarters of the energy in A and one-quarter in B. Now we find that chance of A spontaneously acquiring more energy is this tiny number. Familiar, everyday objects have many, many times more particles than this. The chance of a hot object in the real world getting hotter is so absurdly small, it just never happens. Ice melts, cream mixes in, and tires deflate because these states have more dispersed energy than the originals. There's no mysterious force nudging the system towards higher entropy. It's just that higher entropy is always statistically more likely. That's why entropy has been called time's arrow. If energy has the opportunity to spread out, it will.

**P466 2017-05-03 The history of tea - Shunan Teng**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=466)

During a long day spent roaming the forest in search of edible grains and herbs, the weary divine farmer Shennong accidentally poisoned himself 72 times. But before the poisons could end his life, a leaf drifted into his mouth. He chewed on it and it revived him, and that is how we discovered tea. Or so an ancient legend goes at least. Tea doesn't actually cure poisonings, but the story of Shennong, the mythical Chinese inventor of agriculture, highlights tea's importance to ancient China. Archaeological evidence suggests tea was first cultivated there as early as 6,000 years ago, or 1,500 years before the pharaohs built the Great Pyramids of Giza. That original Chinese tea plant is the same type that's grown around the world today, yet it was originally consumed very differently. It was eaten as a vegetable or cooked with grain porridge. Tea only shifted from food to drink 1,500 years ago when people realized that a combination of heat and moisture could create a complex and varied taste out of the leafy green. After hundreds of years of variations to the preparation method, the standard became to heat tea, pack it into portable cakes, grind it into powder, mix with hot water, and create a beverage called muo cha, or matcha. Matcha became so popular that a distinct Chinese tea culture emerged. Tea was the subject of books and poetry, the favorite drink of emperors, and a medium for artists. They would draw extravagant pictures in the foam of the tea, very much like the espresso art you might see in coffee shops today. In the 9th century during the Tang Dynasty, a Japanese monk brought the first tea plant to Japan. The Japanese eventually developed their own unique rituals around tea, leading to the creation of the Japanese tea ceremony. And in the 14th century during the Ming Dynasty, the Chinese emperor shifted the standard from tea pressed into cakes to loose leaf tea. At that point, China still held a virtual monopoly on the world's tea trees, making tea one of three essential Chinese export goods, along with porcelain and silk. This gave China a great deal of power and economic influence as tea drinking spread around the world. That spread began in earnest around the early 1600s when Dutch traders brought tea to Europe in large quantities. Many credit Queen Catherine of Braganza, a Portuguese noble woman, for making tea popular with the English aristocracy when she married King Charles II in 1661. At the time, Great Britain was in the midst of expanding its colonial influence and becoming the new dominant world power. And as Great Britain grew, interest in tea spread around the world. By 1700, tea in Europe sold for ten times the price of coffee and the plant was still only grown in China. The tea trade was so lucrative that the world's fastest sailboat, the clipper ship, was born out of intense competition between Western trading companies. All were racing to bring their tea back to Europe first to maximize their profits. At first, Britain paid for all this Chinese tea with silver. When that proved too expensive, they suggested trading tea for another substance, opium. This triggered a public health problem within China as people became addicted to the drug. Then in 1839, a Chinese official ordered his men to destroy massive British shipments of opium as a statement against Britain's influence over China. This act triggered the First Opium War between the two nations. Fighting raged up and down the Chinese coast until 1842 when the defeated Qing Dynasty ceded the port of Hong Kong to the British and resumed trading on unfavorable terms. The war weakened China's global standing for over a century. The British East India company also wanted to be able to grow tea themselves and further control the market. So they commissioned botanist Robert Fortune to steal tea from China in a covert operation. He disguised himself and took a perilous journey through China's mountainous tea regions, eventually smuggling tea trees and experienced tea workers into Darjeeling, India. From there, the plant spread further still, helping drive tea's rapid growth as an everyday commodity. Today, tea is the second most consumed beverage in the world after water, and from sugary Turkish Rize tea, to salty Tibetan butter tea, there are almost as many ways of preparing the beverage as there are cultures on the globe.

**P467 2017-05-04 Check your intuition - The birthday problem - David Knuffke**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=467)

Imagine a group of people. How big do you think the group would have to be before there's more than a 50% chance that two people in the group have the same birthday? Assume for the sake of argument that there are no twins, that every birthday is equally likely, and ignore leap years. Take a moment to think about it. The answer may seem surprisingly low. In a group of 23 people, there's a 50.73% chance that two people will share the same birthday. But with 365 days in a year, how's it possible that you need such a small group to get even odds of a shared birthday? Why is our intuition so wrong? To figure out the answer, let's look at one way a mathematician might calculate the odds of a birthday match. We can use a field of mathematics known as combinatorics, which deals with the likelihoods of different combinations. The first step is to flip the problem. Trying to calculate the odds of a match directly is challenging because there are many ways you could get a birthday match in a group. Instead, it's easier to calculate the odds that everyone's birthday is different. How does that help? Either there's a birthday match in the group, or there isn't, so the odds of a match and the odds of no match must add up to 100%. That means we can find the probability of a match by subtracting the probability of no match from 100. To calculate the odds of no match, start small. Calculate the odds that just one pair of people have different birthdays. One day of the year will be Person A's birthday, which leaves only 364 possible birthdays for Person B. The probability of different birthdays for A and B, or any pair of people, is 364 out of 365, about 0.997, or 99.7%, pretty high. Bring in Person C. The probability that she has a unique birthday in this small group is 363 out of 365 because there are two birthdates already accounted for by A and B. D's odds will be 362 out of 365, and so on, all the way down to W's odds of 343 out of 365. Multiply all of those terms together, and you'll get the probability that no one shares a birthday. This works out to 0.4927, so there's a 49.27% chance that no one in the group of 23 people shares a birthday. When we subtract that from 100, we get a 50.73% chance of at least one birthday match, better than even odds. The key to such a high probability of a match in a relatively small group is the surprisingly large number of possible pairs. As a group grows, the number of possible combinations gets bigger much faster. A group of five people has ten possible pairs. Each of the five people can be paired with any of the other four. Half of those combinations are redundant because pairing Person A with Person B is the same as pairing B with A, so we divide by two. By the same reasoning, a group of ten people has 45 pairs, and a group of 23 has 253. The number of pairs grows quadratically, meaning it's proportional to the square of the number of people in the group. Unfortunately, our brains are notoriously bad at intuitively grasping non-linear functions. So it seems improbable at first that 23 people could produce 253 possible pairs. Once our brains accept that, the birthday problem makes more sense. Every one of those 253 pairs is a chance for a birthday match. For the same reason, in a group of 70 people, there are 2,415 possible pairs, and the probability that two people have the same birthday is more than 99.9%. The birthday problem is just one example where math can show that things that seem impossible, like the same person winning the lottery twice, actually aren't unlikely at all. Sometimes coincidences aren't as coincidental as they seem.

**P468 2017-05-11 History’s deadliest colors - J. V. Maranto**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=468)

In 1898, Marie and Pierre Curie discovered radium. Claimed to have restorative properties, radium was added to toothpaste, medicine, water, and food. A glowing, luminous green, it was also used in beauty products and jewelry. It wasn't until the mid-20th century we realized that radium's harmful effects as a radioactive element outweighed its visual benefits. Unfortunately, radium isn't the only pigment that historically seemed harmless or useful but turned out to be deadly. That lamentable distinction includes a trio of colors and pigments that we've long used to decorate ourselves and the things we make: white, green, and orange. Our story begins with white. As far back as the 4th century BCE, the Ancient Greeks treated lead to make the brilliant white pigment we know today. The problem? In humans, lead is directly absorbed into the body and distributed to the blood, soft tissues, and mineralized tissues. Once in the nervous system, lead mimics and disrupts the normal functions of calcium, causing damages ranging from learning disabilities to high blood pressure. Yet the practice of using this toxic pigment continued across time and cultures. Lead white was the only practical choice for white oil or tempera paint until the 19th century. To make their paint, artists would grind a block of lead into powder, exposing highly toxic dust particles. The pigment's liberal use resulted in what was known as painter's colic, or what we'd now call lead poisoning. Artists who worked with lead complained of palseys, melancholy, coughing, enlarged retinas, and even blindness. But lead white's density, opacity, and warm tone were irresistible to artists like Vermeer, and later, the Impressionists. Its glow couldn't be matched, and the pigment continued to be widely used until it was banned in the 1970s. As bad as all that sounds, white's dangerous effects pale in comparison to another, more wide-spread pigment, green. Two synthetic greens called Scheele's Green and Paris Green were first introduced in the 18th century. They were far more vibrant and flashy than the relatively dull greens made from natural pigments, so they quickly became popular choices for paint as well as dye for textiles, wallpaper, soaps, cake decorations, toys, candy, and clothing. These green pigments were made from a compound called cupric hydrogen arsenic. In humans, exposure to arsenic can damage the way cells communicate and function. And high levels of arsenic have been directly linked to cancer and heart disease. As a result, 18th century fabric factory workers were often poisoned, and women in green dresses reportedly collapsed from exposure to arsenic on their skin. Bed bugs were rumored not to live in green rooms, and it's even been speculated that Napoleon died from slow arsenic poisoning from sleeping in his green wallpapered bedroom. The intense toxicity of these green stayed under wraps until the arsenic recipe was published in 1822. And a century later, it was repurposed as an insecticide. Synthetic green was probably the most dangerous color in widespread use, but at least it didn't share radium's property of radioactivity. Another color did, though - orange. Before World War II, it was common for manufacturers of ceramic dinnerware to use uranium oxide in colored glazes. The compound produced brilliant reds and oranges, which were appealing attributes, if not for the radiation they emitted. Of course, radiation was something we were unaware of until the late 1800s, let alone the associated cancer risks, which we discovered much later. During World War II, the U.S. government confiscated all uranium for use in bomb development. However, the atomic energy commission relaxed these restrictions in 1959, and depleted uranium returned to ceramics and glass factory floors. Orange dishes made during the next decade may still have some hazardous qualities on their surfaces to this day. Most notably, vintage fiestaware reads positive for radioactivity. And while the levels are low enough that they don't officially pose a health risk if they're on a shelf, the U.S. EPA warns against eating food off of them. Though we still occasionally run into issues with synthetic food dyes, our scientific understanding has helped us prune hazardous colors out of our lives.

**P469 2017-05-17 A brief history of goths - Dan Adams**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=469)

What do fans of atmospheric post-punk music have in common with ancient barbarians? Not much. So why are both known as goths? Is it a weird coincidence or a deeper connection stretching across the centuries? The story begins in Ancient Rome. As the Roman Empire expanded, it faced raids and invasions from the semi-nomadic populations along its borders. Among the most powerful were a Germanic people known as Goths who were composed of two tribal groups, the Visigoths and Ostrogoths. While some of the Germanic tribes remained Rome's enemies, the Empire incorporated others into the imperial army. As the Roman Empire split in two, these tribal armies played larger roles in its defense and internal power struggles. In the 5th century, a mercenary revolt lead by a soldier named Odoacer captured Rome and deposed the Western Emperor. Odoacer and his Ostrogoth successor Theoderic technically remained under the Eastern Emperor's authority and maintained Roman traditions. But the Western Empire would never be united again. Its dominions fragmented into kingdoms ruled by Goths and other Germanic tribes who assimilated into local cultures, though many of their names still mark the map. This was the end of the Classical Period and the beginning of what many call the Dark Ages. Although Roman culture was never fully lost, its influence declined and new art styles arose focused on religious symbolism and allegory rather than proportion and realism. This shift extended to architecture with the construction of the Abbey of Saint Denis in France in 1137. Pointed arches, flying buttresses, and large windows made the structure more skeletal and ornate. That emphasized its open, luminous interior rather than the sturdy walls and columns of Classical buildings. Over the next few centuries, this became a model for Cathedrals throughout Europe. But fashions change. With the Italian Renaissance's renewed admiration for Ancient Greece and Rome, the more recent style began to seem crude and inferior in comparison. Writing in his 1550 book, "Lives of the Artists," Giorgio Vasari was the first to describe it as Gothic, a derogatory reference to the Barbarians thought to have destroyed Classical civilization. The name stuck, and soon came to describe the Medieval period overall, with its associations of darkness, superstition, and simplicity. But time marched on, as did what was considered fashionable. In the 1700s, a period called the Enlightenment came about, which valued scientific reason above all else. Reacting against that, Romantic authors like Goethe and Byron sought idealized visions of a past of natural landscapes and mysterious spiritual forces. Here, the word Gothic was repurposed again to describe a literary genre that emerged as a darker strain of Romanticism. The term was first applied by Horace Walpole to his own 1764 novel, "The Castle of Otranto" as a reference to the plot and general atmosphere. Many of the novel's elements became genre staples inspiring classics and the countless movies they spawned. The gothic label belonged to literature and film until the 1970s when a new musical scene emerged. Taking cues from artists like The Doors and The Velvet Underground, British post-punk groups, like Joy Division, Bauhaus, and The Cure, combined gloomy lyrics and punk dissonance with imagery inspired by the Victorian era, classic horror, and androgynous glam fashion. By the early 1980s, similar bands were consistently described as Gothic rock by the music press, and the stye's popularity brought it out of dimly lit clubs to major labels and MTV. And today, despite occasional negative media attention and stereotypes, Gothic music and fashion continue as a strong underground phenomenon. They've also branched into sub-genres, such as cybergoth, gothabilly, gothic metal, and even steampunk. The history of the word gothic is embedded in thousands of years worth of countercultural movements, from invading outsiders becoming kings to towering spires replacing solid columns to artists finding beauty in darkness. Each step has seen a revolution of sorts and a tendency for civilization to reach into its past to reshape its present.

**P470 2017-05-23 The world’s most mysterious book - Stephen Bax**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=470)

Deep inside Yale University's Beinecke Rare Book and Manuscript Library lies the only copy of a 240-page tome. Recently carbon dated to around 1420, its vellum pages features looping handwriting and hand-drawn images seemingly stolen from a dream. Real and imaginary plants, floating castles, bathing women, astrology diagrams, zodiac rings, and suns and moons with faces accompany the text. This 24x16 centimeter book is called the Voynich manuscript, and its one of history's biggest unsolved mysteries. The reason why? No one can figure out what it says. The name comes from Wilfrid Voynich, a Polish bookseller who came across the document at a Jesuit college in Italy in 1912. He was puzzled. Who wrote it? Where was it made? What do these bizarre words and vibrant drawings represent? What secrets do its pages contain? He purchased the manuscript from the cash-strapped priest at the college, and eventually brought it to the U.S., where experts have continued to puzzle over it for more than a century. Cryptologists say the writing has all the characteristics of a real language, just one that no one's ever seen before. What makes it seem real is that in actual languages, letters and groups of letters appear with consistent frequencies, and the language in the Voynich manuscript has patterns you wouldn't find from a random letter generator. Other than that, we know little more than what we can see. The letters are varied in style and height. Some are borrowed from other scripts, but many are unique. The taller letters have been named gallows characters. The manuscript is highly decorated throughout with scroll-like embellishments. It appears to be written by two or more hands, with the painting done by yet another party. Over the years, three main theories about the manuscript's text have emerged. The first is that it's written in cypher, a secret code deliberately designed to hide secret meaning. The second is that the document is a hoax written in gibberish to make money off a gullible buyer. Some speculate the author was a medieval con man. Others, that it was Voynich himself. The third theory is that the manuscript is written in an actual language, but in an unknown script. Perhaps medieval scholars were attempting to create an alphabet for a language that was spoken but not yet written. In that case, the Voynich manuscript might be like the rongorongo script invented on Easter Island, now unreadable after the culture that made it collapsed. Though no one can read the Voynich manuscript, that hasn't stopped people from guessing what it might say. Those who believe the manuscript was an attempt to create a new form of written language speculate that it might be an encyclopedia containing the knowledge of the culture that produced it. Others believe it was written by the 13th century philosopher Roger Bacon, who attempted to understand the universal laws of grammar, or in the 16th century by the Elizabethan mystic John Dee, who practiced alchemy and divination. More fringe theories that the book was written by a coven of Italian witches, or even by Martians. After 100 years of frustration, scientists have recently shed a little light on the mystery. The first breakthrough was the carbon dating. Also, contemporary historians have traced the provenance of the manuscript back through Rome and Prague to as early as 1612, when it was perhaps passed from Holy Roman Emperor Rudolf II to his physician, Jacobus Sinapius. In addition to these historical breakthroughs, linguistic researchers recently proposed the provisional identification of a few of the manuscript's words. Could the letters beside these seven stars spell Tauran, a name for Taurus, a constellation that includes the seven stars called the Pleiades? Could this word be Centaurun for the Centaurea plant in the picture? Perhaps, but progress is slow. If we can crack its code, what might we find? The dream journal of a 15th-century illustrator? A bunch of nonsense? Or the lost knowledge of a forgotten culture? What do you think it is?

**P471 2017-05-23 Who were the Vestal Virgins, and what was their job - Peta Greenfield**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=471)

A lone priestess walks towards an underground chamber. People line the streets to watch as she proclaims her innocence. It doesn't matter. She's already been judged and found guilty. The sentence? Live burial. The underground chamber contains a portion of bread, water, milk, and oil. She will have a lamp, a bed, and a blanket, but she won't emerge alive. At the threshold, the priestess pauses, claims her innocence one last time, then enters the chamber never to be seen again by the Roman people. The priestess is one of Rome's six Vestal Virgins, each carefully selected as children from Rome's most aristocratic families. But now with her death, there are only five, and a new priestess must be chosen. The six-year-old Licinia witnessed the spectacle, never suspecting that a few days later, she'd be chosen as the next Vestal Virgin. Her age, her patrician family lineage, and her apparent good health makes her the best candidate to serve the goddess Vesta in the eyes of the Romans. Her parents are proud that their daughter's been chosen. Licinia is afraid, but she has no choice in the matter. She must serve the goddess for at least the next 30 years. For the first ten years of Licinia's service, she's considered in training, learning how to be a Vestal Virgin. Her most important duty is keeping vigil over the flame of Vesta, the virgin goddess of the hearth. Vesta doesn't have a statue like other Roman gods and goddesses. Instead, she's represented by the flame which burns day and night in her temple located next to the Forum in the center of the city. Like all Vestal priestesses, Licinia spends part of each day on shift, watching and tending to the flame. The flame represents two things. The first is the continuation of Rome as a power in the world. The Romans believed that if the flame goes out, the city's in danger. The flame also symbolizes the continuing virginity of Vesta's priestesses. For the Romans, a Vestal's virginity signaled not only her castitas, or modest spirit and body, but also her ritual purity. So Licinia knows she must never let the flame go out. Her life, the lives of her fellow Vestals, and the safety of Rome itself depends upon it. Licinia learns to collect water each day from a nearby fountain to cleanse the temple. She learns the Fasti, the calendar of sacred rituals and she watches while the senior priestesses conduct sacrifices. By the time Licinia completes her training, she's 16 years old. Licinia understands that the way she must act is a reflection of the goddess she serves. When it's her turn to collect the water, she keeps her eyes lowered to the ground. When she performs sacrifices, she focuses intently on the task. Licinia directs her energy towards being the best priestess she can be. She's worried that someday the state will claim her life for its own purposes to protect itself from danger. Licinia could be accused of incestum, meaning unchastity, at any time and be sacrificed whether she's innocent or guilty. Licinia fully understands now why her predecessor was buried alive. Ten years ago, the flame of Vesta went out. The priestesses knew that they couldn't keep it a secret. The future of Rome depended upon it. They went to the chief priest and he opened an investigation to discover why the flame had failed. Someone came forward and claimed that one of the Vestals was no longer a virgin. That was the beginning of the end. The accused protested her innocence, but it wasn't enough. She was tried and found guilty. That Vestal's death was meant to protect the city, but Licinia weeps for what has been lost and for what she knows now. Her own path was paved by the death of another, and her life could be taken just as easily for something as simple as a flame going out.

**P472 2017-05-26 The ferocious predatory dinosaurs of Cretaceous Sahara - Nizar Ibrahi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=472)

There are few places on Earth less hospitable to life than the bone-dry Sahara Desert. Yet it wasn't always this way. 100 million years ago, during a period known as the Mid-Cretaceous, a gargantuan river system flowed across the region from modern day Egypt to Morocco. The whole world at that time would look rather different to us. The continents had yet to assume their current positions. Extreme temperatures were common and fierce storms made life unpredictable. Dinosaurs flourished on land, pterosaurs roamed the skies, and giant marine reptiles and sharks swam in warm seas. Small mammals, our ancestors, lived quite literally in the shadow of these extraordinary creatures. In this world of huge predators, the River of Giants, which is what some call this region of what is now northern Africa, stood out as particularly dangerous. In most ecosystems, it's lonely at the top of the food chain. There usually isn't enough prey to sustain many predators. Yet an incredible variety of aquatic prey species in the river-based ecosystem may have allowed a large and diverse population of apex predators to coexist. We know this thanks to a wealth of fossils we found in an area called the Kem Kem Beds. Many of the predators we've discovered had head and body shapes that made them uniquely adapted to hunt the different types and sizes of aquatic prey. This allowed many Kem Kem predators to take full advantage of the one abundant food source in this environment: fish. This also allowed them to avoid direct competition with the predators going after land-loving animals. Prey species in the river system had to contend with attacks from all sides, including from above. Flying reptiles dominated the skies. Alanqa Saharica had a wingspan of up to nine meters, and long slender jaws that helped it snatch fish and small terrestrial animals. At least seven different types of crocodile-like predators patrolled the waterways, including the roughly ten-meter-long Elosuchus. And multiple species of T-rex-sized carnivorous dinosaurs called theropods, lived side by side. In the River of Giants, Spinosaurus was king. This 15-meter-long dinosaur was even longer than T-rex, with short muscular hind legs, a flexible tail, and broad feet. It's two-meter-high sail warned other creatures of its fearsome size and may have also been used to attract mates. Spinosaurus' long slender jaws were spiked with conical teeth, perfect for swiftly clamping down on slippery aquatic prey. This apex predator, as well as its ecosystem, is unparalleled in the history of life on Earth. All that's left of these fearsome predators are fossils. About 93 million years ago, sea levels rose, submerging the Kem Kem region in a shallow sea. Tens of millions of years later, an asteroid impact, volcanic eruptions, and associated changes in climate wiped out the dinosaurs, pterosaurs, and many other groups of animals and plants, including their unique ecoysystems. That mass extinction paved the way for the rise of new kinds of birds, larger mammals, and eventually us.

**P473 2017-05-26 The genius of Marie Curie - Shohini Ghose**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=473)

If you want a glimpse of Marie Curie's manuscripts, you'll have to sign a waiver and put on protective gear to shield yourself from radiation contamination. Madame Curie's remains, too, were interred in a lead-lined coffin, keeping the radiation that was the heart of her research, and likely the cause of her death, well contained. Growing up in Warsaw in Russian-occupied Poland, the young Marie, originally named Maria Sklodowska, was a brilliant student, but she faced some challenging barriers. As a woman, she was barred from pursuing higher education, so in an act of defiance, Marie enrolled in the Floating University, a secret institution that provided clandestine education to Polish youth. By saving money and working as a governess and tutor, she eventually was able to move to Paris to study at the reputed Sorbonne. There, Marie earned both a physics and mathematics degree surviving largely on bread and tea, and sometimes fainting from near starvation. In Paris, Marie met the physicist Pierre Curie, who shared his lab and his heart with her. But she longed to be back in Poland. Upon her return to Warsaw, though, she found that securing an academic position as a woman remained a challenge. All was not lost. Back in Paris, the lovelorn Pierre was waiting, and the pair quickly married and became a formidable scientific team. Another physicist's work sparked Marie Curie's interest. In 1896, Henri Becquerel discovered that uranium spontaneously emitted a mysterious X-ray-like radiation that could interact with photographic film. Curie soon found that the element thorium emitted similar radiation. Most importantly, the strength of the radiation depended solely on the element's quantity, and was not affected by physical or chemical changes. This led her to conclude that radiation was coming from something fundamental within the atoms of each element. The idea was radical and helped to disprove the long-standing model of atoms as indivisible objects. Next, by focusing on a super radioactive ore called pitchblende, the Curies realized that uranium alone couldn't be creating all the radiation. So, were there other radioactive elements that might be responsible? In 1898, they reported two new elements, polonium, named for Marie's native Poland, and radium, the Latin word for ray. They also coined the term radioactivity along the way. By 1902, the Curies had extracted a tenth of a gram of pure radium chloride salt from several tons of pitchblende, an incredible feat at the time. Later that year, Pierre Curie and Henri Becquerel were nominated for the Nobel Prize in physics, but Marie was overlooked. Pierre took a stand in support of his wife's well-earned recognition. And so both of the Curies and Becquerel shared the 1903 Nobel Prize, making Marie Curie the first female Nobel Laureate. Well funded and well respected, the Curies were on a roll. But tragedy struck in 1906 when Pierre was crushed by a horse-drawn cart as he crossed a busy intersection. Marie, devastated, immersed herself in her research and took over Pierre's teaching position at the Sorbonne, becoming the school's first female professor. Her solo work was fruitful. In 1911, she won yet another Nobel, this time in chemistry for her earlier discovery of radium and polonium, and her extraction and analysis of pure radium and its compounds. This made her the first, and to this date, only person to win Nobel Prizes in two different sciences. Professor Curie put her discoveries to work, changing the landscape of medical research and treatments. She opened mobile radiology units during World War I, and investigated radiation's effects on tumors. However, these benefits to humanity may have come at a high personal cost. Curie died in 1934 of a bone marrow disease, which many today think was caused by her radiation exposure. Marie Curie's revolutionary research laid the groundwork for our understanding of physics and chemistry, blazing trails in oncology, technology, medicine, and nuclear physics, to name a few. For good or ill, her discoveries in radiation launched a new era, unearthing some of science's greatest secrets.

**P474 2017-05-31 Why do people join cults - Janja Lalich**

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When Reverend Jim Jones founded the Peoples Temple in 1955, few could have imagined its horrifying end. This progressive religious movement rose in popularity and gained support from some of San Francisco's most prominent politicians. But in 1977, amidst revelations of brainwashing and abuse, Jones moved with several hundred followers to establish the commune of Jonestown in Guyana. Billed as a utopian paradise, the colony was more like a prison camp, and when a congressional delegation arrived to investigate its conditions, Jones executed his final plan. On November 18, 1978, 909 men, women, and children died after being forced to drink poisoned Flavor Aid. That grizzly image has since been immortalized as shorthand slang for single-minded cult-like thinking, "They drank the Kool-aid." Today, there are thousands of cults around the world. It's important to note two things about them. First, not all cults are religious. Some are political, therapy-based, focused on self-improvement, or otherwise. And on the flip side, not all new religions are what we're referring to as cults. So what exactly defines our modern understanding of cults, and why do people join them? Broadly speaking, a cult is a group or movement with a shared commitment to a usually extreme ideology that's typically embodied in a charismatic leader. And while few turn out as deadly as Jonestown or Heaven's Gate, which ended in a mass suicide of 39 people in 1997, most cults share some basic characteristics. A typical cult requires a high level of commitment from its members and maintains a strict hierarchy, separating unsuspecting supporters and recruits from the inner workings. It claims to provide answers to life's biggest questions through its doctrine, along with the required recipe for change that shapes a new member into a true believer. And most importantly, it uses both formal and informal systems of influence and control to keep members obedient, with little tolerance for internal disagreement or external scrutiny. You might wonder whether some of these descriptions might also apply to established religions. In fact, the world "cultus" originally described people who cultivated the worship of certain gods by performing rituals and maintaining temples. But in time, it came to mean excessive devotion. Many religions began as cults, but integrated into the fabric of the larger society as they grew. A modern cult, by contrast, separates its members from others. Rather than providing guidelines for members to live better lives, a cult seeks to directly control them, from personal and family relationships, to financial assets and living arrangements. Cults also demand obedience to human leaders who tend to be highly persuasive people with authoritarian and narcissistic streaks motivated by money, sex, power, or all three. While a cult leader uses personal charisma to attract initial followers, further expansion works like a pyramid scheme, with early members recruiting new ones. Cults are skilled at knowing whom to target, often focusing on those new to an area, or who have recently undergone some personal or professional loss. Loneliness and a desire for meaning make one susceptible to friendly people offering community. The recruitment process can be subtle, sometimes taking months to establish a relationship. In fact, more than two-thirds of cult members are recruited by a friend, family member, or co-worker whose invitations are harder to refuse. Once in the cult, members are subjected to multiple forms of indoctrination. Some play on our natural inclination to mimic social behaviors or follow orders. Other methods may be more intense using techniques of coercive persuasion involving guilt, shame, and fear. And in many cases, members may willingly submit out of desire to belong and to attain the promised rewards. The cult environment discourages critical thinking, making it hard to voice doubts when everyone around you is modeling absolute faith. The resulting internal conflict, known as cognitive dissonance, keeps you trapped, as each compromise makes it more painful to admit you've been deceived. And though most cults don't lead members to their death, they can still be harmful. By denying basic freedoms of thought, speech, and association, cults stunt their members' psychological and emotional growth, a particular problem for children, who are deprived of normal developmental activities and milestones. Nevertheless, many cult members eventually find a way out, whether through their own realizations, the help of family and friends, or when the cult falls apart due to external pressure or scandals. Many cults may be hard to identify, and for some, their beliefs, no matter how strange, are protected under religious freedom. But when their practices involve harassment, threats, illegal activities, or abuse, the law can intervene. Believing in something should not come at the cost of your family and friends, and if someone tells you to sacrifice your relationships or morality for the greater good, they're most likely exploiting you for their own.

**P475 2017-06-01 Why don't perpetual motion machines ever work - Netta Schramm**

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Around 1159 A.D., a mathematician called Bhaskara the Learned sketched a design for a wheel containing curved reservoirs of mercury. He reasoned that as the wheels spun, the mercury would flow to the bottom of each reservoir, leaving one side of the wheel perpetually heavier than the other. The imbalance would keep the wheel turning forever. Bhaskara's drawing was one of the earliest designs for a perpetual motion machine, a device that can do work indefinitely without any external energy source. Imagine a windmill that produced the breeze it needed to keep rotating. Or a lightbulb whose glow provided its own electricity. These devices have captured many inventors' imaginations because they could transform our relationship with energy. For example, if you could build a perpetual motion machine that included humans as part of its perfectly efficient system, it could sustain life indefinitely. There's just one problem. They don't work. Ideas for perpetual motion machines all violate one or more fundamental laws of thermodynamics, the branch of physics that describes the relationship between different forms of energy. The first law of thermodynamics says that energy can't be created or destroyed. You can't get out more energy than you put in. That rules out a useful perpetual motion machine right away because a machine could only ever produce as much energy as it consumed. There wouldn't be any left over to power a car or charge a phone. But what if you just wanted the machine to keep itself moving? Inventors have proposed plenty of ideas. Several of these have been variations on Bhaskara's over-balanced wheel with rolling balls or weights on swinging arms. None of them work. The moving parts that make one side of the wheel heavier also shift its center of mass downward below the axle. With a low center of mass, the wheel just swings back and forth like a pendulum, then stops. What about a different approach? In the 17th century, Robert Boyle came up with an idea for a self-watering pot. He theorized that capillary action, the attraction between liquids and surfaces that pulls water through thin tubes, might keep the water cycling around the bowl. But if the capillary action is strong enough to overcome gravity and draw the water up, it would also prevent it from falling back into the bowl. Then there are versions with magnets, like this set of ramps. The ball is supposed to be pulled upwards by the magnet at the top, fall back down through the hole, and repeat the cycle. This one fails because like the self-watering pot, the magnet would simply hold the ball at the top. Even if it somehow did keep moving, the magnet's strength would degrade over time and eventually stop working. For each of these machines to keep moving, they'd have to create some extra energy to nudge the system past its stopping point, breaking the first law of thermodynamics. There are ones that seem to keep going, but in reality, they invariably turn out to be drawing energy from some external source. Even if engineers could somehow design a machine that didn't violate the first law of thermodynamics, it still wouldn't work in the real world because of the second law. The second law of thermodynamics tells us that energy tends to spread out through processes like friction. Any real machine would have moving parts or interactions with air or liquid molecules that would generate tiny amounts of friction and heat, even in a vacuum. That heat is energy escaping, and it would keep leeching out, reducing the energy available to move the system itself until the machine inevitably stopped. So far, these two laws of thermodynamics have stymied every idea for perpetual motion and the dreams of perfectly efficient energy generation they imply. Yet it's hard to conclusively say we'll never discover a perpetual motion machine because there's still so much we don't understand about the universe. Perhaps we'll find new exotic forms of matter that'll force us to revisit the laws of thermodynamics. Or maybe there's perpetual motion on tiny quantum scales. What we can be reasonably sure about is that we'll never stop looking. For now, the one thing that seems truly perpetual is our search.

**P476 2017-06-07 Can you solve the fish riddle -** **Steve Wyborney**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=476)

You are the cargo director on the maiden voyage of the S.S. Buoyant, and you've agreed to transport several tanks containing the last specimens of a critically endangered fish species to their new aquarium. Unfortunately, as you're passing through shark-infested waters, the boat is battered by a fierce storm, throwing your precious cargo overboard. And to make matters worse, no one seems certain just how many fish tanks are missing. Fortunately, you have a rescue sub at your disposal, but only enough fuel for one trip to the ocean floor. You need to know where the tanks are so you can gather them all in one quick pass. Not a single fish can be lost. You decide to scan the three sectors of the ocean floor where the cargo could have landed. Thermal imaging shows 50 organisms in the area, and you quickly realize that that number includes both your fish and some ravenous sharks. You flip on the sonar to get a better look. The image for Sector Alpha shows four tanks and two sharks, the image for Sector Beta shows two tanks and four sharks, and the image for Sector Gamma is blank. Your sonar has malfunctioned, and you're going to have to go with the info you have. You check the shipping notes, but all you learn is that each tank had the same number of fish inside. The cargo hold had space for anywhere from 1 to 13 total tanks. And finally, the old captain tells you that this area has the odd property that no two sectors can have the same number of sharks, but every sector will have at least one, and no more than seven. There's no time to waste. The tanks won't withstand the pressure much longer. As you descend in the sub, you review everything you know. How many fish tanks do you need to find in Sector Gamma? Hurry, the fate of an entire species depends on you. Pause here if you want to figure it out for yourself. Answer in: 3 Answer in: 2 Answer in: 1 At first, it seems like there are just too many missing pieces of information. After all, you don't know how many fish or how many tanks there are, let alone how many fish are in each one. But then you remember the best way to compare multiple pieces of partial information - a table. Since we know there are thirteen tanks at most, and we already see six tanks in Sectors Alpha and Beta, we know the total number of tanks must be between 6 and 13. We also know that each sector has a different amount of sharks with no more than seven in each one. Since there are two in Sector Alpha and four in Sector Beta, Sector Gamma can have 1, 3, 5, 6, or 7 sharks. What about the number of endangered fish? Out of the 50 total organisms in all three sectors, we know at least seven are sharks, leaving a maximum of 43 fish inside all the tanks. And the more sharks we find in Sector 3, the fewer fish there are to save. Now, remember that the fish are equally distributed across all the tanks. Why is that important? Because it means that one of the possible values for the total amount of fish must be divisible by one of the possible values for the total amount of tanks. And looking at the table, we can see that the only combination that works is 39 fish divided between 13 tanks with three fish in each. With sharks swarming around, you quickly pilot the sub through the first two sectors before retrieving the remaining seven tanks in Sector Gamma. You've saved the species and taken an impromptu dive. All in all, not a bad day, unless you happen to be a hungry shark.

**P477 2017-06-07 The power of creative constraints - Brandon Rodriguez**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=477)

Imagine you're asked to invent something new. It could be whatever you want made from anything you choose in any shape or size. That kind of creative freedom sounds so liberating, doesn't it? Or does it? If you're like most people, you'd probably be paralyzed by this task. Without more guidance, where would you even begin? As it turns out, boundless freedom isn't always helpful. In reality, any project is restricted by many factors, such as the cost, what materials you have at your disposal, and unbreakable laws of physics. These factors are called creative constraints, and they're the requirements and limitations we have to address in order to accomplish a goal. Creative constraints apply across professions, to architects and artists, writers, engineers, and scientists. In many fields, constraints play a special role as drivers of discovery and invention. During the scientific process in particular, constraints are an essential part of experimental design. For instance, a scientist studying a new virus would consider, "How can I use the tools and techniques at hand to create an experiment that tells me how this virus infects the body's cells? And what are the limits of my knowledge that prevent me from understanding this new viral pathway?" In engineering, constraints have us apply our scientific discoveries to invent something new and useful. Take, for example, the landers Viking 1 and 2, which relied on thrusters to arrive safely on the surface of Mars. The problem? Those thrusters left foreign chemicals on the ground, contaminating soil samples. So a new constraint was introduced. How can we land a probe on Mars without introducing chemicals from Earth? The next Pathfinder mission used an airbag system to allow the rover to bounce and roll to a halt without burning contaminating fuel. Years later, we wanted to send a much larger rover: Curiosity. However, it was too large for the airbag design, so another constraint was defined. How can we land a large rover while still keeping rocket fuel away from the Martian soil? In response, engineers had a wild idea. They designed a skycrane. Similar to the claw machine at toy stores, it would lower the rover from high above the surface. With each invention, the engineers demonstrated an essential habit of scientific thinking - that solutions must recognize the limitations of current technology in order to advance it. Sometimes this progress is iterative, as in, "How can I make a better parachute to land my rover?" And sometimes, it's innovative, like how to reach our goal when the best possible parachute isn't going to work. In both cases, the constraints guide decision-making to ensure we reach each objective. Here's another Mars problem yet to be solved. Say we want to send astronauts who will need water. They'd rely on a filtration system that keeps the water very clean and enables 100% recovery. Those are some pretty tough constraints, and we may not have the technology for it now. But in the process of trying to meet these objectives, we might discover other applications of any inventions that result. Building an innovative water filtration system could provide a solution for farmers working in drought-stricken regions, or a way to clean municipal water in polluted cities. In fact, many scientific advances have occurred when serendipitous failures in one field address the constraints of another. When scientist Alexander Fleming mistakenly contaminated a Petri dish in the lab, it led to the discovery of the first antibiotic, penicillin. The same is true of synthetic dye, plastic, and gunpowder. All were created mistakenly, but went on to address the constraints of other problems. Understanding constraints guides scientific progress, and what's true in science is also true in many other fields. Constraints aren't the boundaries of creativity, but the foundation of it.

**P478 2017-06-21 Who built Great Zimbabwe And why - Breeanna Elliott**

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Stretched across a tree-peppered expanse in southern Africa lies the magnificent ruins of Great Zimbabwe, a medieval stone city of astounding wealth and prestige. Located in the present-day country of Zimbabwe, it's the sight of the largest known settlement ruins in Sub-Saharan Africa, second on the continent only to the pyramids of Egypt. But the history of this city is shrouded in controversy, defined by decades of dispute about who built it and why. Its name comes from the Shona word madzimbabwe, meaning big house of stone for its unscalable stone walls that reach heights of nearly ten meters and run for a length of about 250 meters. For its grandeur and historical significance, it was named a UNESCO World Heritage site in 1986. Back in the 14th and 15th centuries, it was a thriving city. Spread across nearly eight square-kilometers, Great Zimbabwe was defined by three main areas: the Hill Complex, where the king lived; the Great Enclosure, reserved for members of the royal family; and the Valley Complex, where regular citizens lived. Rulers were both powerful economic and religious leaders for the region. At its highest point, the city had a bustling urban population of 18,000 people and was one of the major African trade centers at the time. What enabled this growth was Great Zimbabwe's influential role in an intercontinental trade network. Connected to several key city-states along the East African Swahili Coast, it was part of the larger Indian Ocean trade routes. The city generated its riches by controlling the sources and trade of the most prized items: gold, ivory, and copper. With this mercantile power, it was able to extend its sphere of influence across continents, fostering a strong Arab and Indian trader presence throughout its zenith. Archaeologists have since pieced together the details of this history through artifacts discovered on site. There were pottery shards and glassworks from Asia, as well as coins minted in the coastal trading city of Kilwa Kisiwani over 1,500 miles away. They also found soapstone bird figures, which are thought to represent each of the city's rulers, and young calf bones, only unearthed near the royal residence, show how the diet of the elite differed from the general population. These clues have also led to theories about the city's decline. By the mid-15th century, the buildings at Great Zimbabwe were almost all that remained. Archaeological evidence points to overcrowding and sanitation issues as the cause, compounded by soil depletion triggered by overuse. Eventually, as crops withered and conditions in the city worsened, the population of Great Zimbabwe is thought to have dispersed and formed the nearby Mutapa and Torwa states. Centuries later, a new phase of Great Zimbabwe's influence began to play out in the political realm as people debated who had built the famous city of stone. During the European colonization of Africa, racist colonial officials claimed the ruins couldn't be of African origin. So, without a detailed written record on hand, they instead relied on myths to explain the magnificence of Great Zimbabwe. Some claimed it proved the Bible story of the Queen of Sheba who lived in a city of riches. Others argued it was built by the Ancient Greeks. Then, in the early 20th century after extensive excavation at the site, the archaeologist David Randall-MacIver presented clear evidence that Great Zimbabwe was built by indigenous peoples. Yet, at the time, the country's white minority colonial government sought to discredit this theory because it challenged the legitimacy of their rule. In fact, the government actively encouraged historians to produce accounts that disputed the city's African origins. Over time, however, an overwhelming body of evidence mounted, identifying Great Zimbabwe as an African city built by Africans. During the 1960s and 70s, Great Zimbabwe became an important symbol for the African Nationalist movement that was spreading across the continent. Today, the ruins at Great Zimbabwe, alluded to on the Zimbabwean flag by a soapstone bird, still stand as a source of national pride and cultural value.

**P479 2017-06-23 Can you find the next number in this sequence - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=479)

These are the first five elements of a number sequence. Can you figure out what comes next? Pause here if you want to figure it out for yourself. Answer in: 3 Answer in: 2 Answer in: 1 There is a pattern here, but it may not be the kind of pattern you think it is. Look at the sequence again and try reading it aloud. Now, look at the next number in the sequence. 3, 1, 2, 2, 1, 1. Pause again if you'd like to think about it some more. Answer in: 3 Answer in: 2 Answer in: 1 This is what's known as a look and say sequence. Unlike many number sequences, this relies not on some mathematical property of the numbers themselves, but on their notation. Start with the left-most digit of the initial number. Now, read out how many times it repeats in succession followed by the name of the digit itself. Then move on to the next distinct digit and repeat until you reach the end. So the number 1 is read as "one one" written down the same way we write eleven. Of course, as part of this sequence, it's not actually the number eleven, but 2 ones, which we then write as 2 1. That number is then read out as 1 2 1 1, which written out we'd read as one one, one two, two ones, and so on. These kinds of sequences were first analyzed by mathematician John Conway, who noted they have some interesting properties. For instance, starting with the number 22, yields an infinite loop of two twos. But when seeded with any other number, the sequence grows in some very specific ways. Notice that although the number of digits keeps increasing, the increase doesn't seem to be either linear or random. In fact, if you extend the sequence infinitely, a pattern emerges. The ratio between the amount of digits in two consecutive terms gradually converges to a single number known as Conway's Constant. This is equal to a little over 1.3, meaning that the amount of digits increases by about 30% with every step in the sequence. What about the numbers themselves? That gets even more interesting. Except for the repeating sequence of 22, every possible sequence eventually breaks down into distinct strings of digits. No matter what order these strings show up in, each appears unbroken in its entirety every time it occurs. Conway identified 92 of these elements, all composed only of digits 1, 2, and 3, as well as two additional elements whose variations can end with any digit of 4 or greater. No matter what number the sequence is seeded with, eventually, it'll just consist of these combinations, with digits 4 or higher only appearing at the end of the two extra elements, if at all. Beyond being a neat puzzle, the look and say sequence has some practical applications. For example, run-length encoding, a data compression that was once used for television signals and digital graphics, is based on a similar concept. The amount of times a data value repeats within the code is recorded as a data value itself. Sequences like this are a good example of how numbers and other symbols can convey meaning on multiple levels.

**P480 2017-06-28 How do drugs affect the brain - Sara Garofalo**

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Most people will take a pill, receive an injection, or otherwise take some kind of medicine during their lives, but most of us don't know anything about how these substances actually work. How can various compounds impact the way we physically feel, think, and even behave? For the most part, this depends on how a drug alters the communication between cells in the brain. There are a number of different ways that can happen. But before it gets into the brain, any drug must first reach the bloodstream on a journey that can take anywhere from seconds to hours, depending on factors like how it's administered. The slowest method is to take a drug orally because it must be absorbed by our digestive system before it takes effect. Inhaling a drug gets it into the bloodstream faster. And injecting a drug intravenously works quickly too because it pumps the chemicals directly into the blood. Once there, the drug quickly reaches the gates of its destination, the brain. The entrance to this organ is guarded by the blood-brain barrier, which separates blood from the nervous system to keep potentially dangerous substances out. So all drugs must have a specific chemical composition which gives them the key to unlock this barrier and pass through. Once inside, drugs start to interfere with the brain's normal functioning by targeting its web of neurons and synapses. Neurons are brain cells that have a nucleus, dendrites, and an axon. Synapses are structures placed along the dendrites or the axon which allow the exchange of electrochemical signals between neurons. Those signals take the form of chemicals called neurotransmitters. Each neurotransmitter plays different roles in regulating our behaviors, emotions, and cognition. But they all work in one of two ways. They can either inhibit the receiving neuron, limiting its activity, or excite it, creating a new electrochemical signal that spreads throughout the network. Any leftover neurotransmitter usually gets degraded or reabsorbed into the transmitting neuron. A drug's effectiveness stems from its ability to manipulate these synaptic transmissions at different phases of the process. That results in an increase or a decrease in the amount of neurotransmitters being spread. For instance, common antidepressants, like SSRIs, stop the reabsorption of serotonin, a neurotransmitter that modulates our moods. This effectively pushes more of it into the neural network. Meanwhile, painkillers, like morphine, raise levels of serotonin and noradrenaline, which regulate energy, arousal, alertness, and pleasure. Those same neurotransmitters also affect endorphin receptors, reducing pain perception. And tranquilizers works by increasing the production of GABA to inhibit neural activity putting the person in a relaxed or sedated state. What about illegal or elicit drugs? These have powerful impacts on the brain that we're still trying to understand. Crystal meth, an amphetamine, induces a long-lasting release of dopamine, a neurotransmitter linked with the perception of reward and pleasure. It also activates noradrenaline receptors, which increases the heart rate, dilates pupils, and triggers the body's fight or flight response. Cocaine blocks the reuptake of dopamine and serotonin, pushing more into the network where they boost energy, create feelings of euphoria, and suppress appetites. And hallucinogenic drugs have some of the most puzzling effects. Substances like LSD, mescaline, and DMT all block the release of serotonin, which regulates mood and impulsivity. They also have an impact on the neural circuits involved in perception, learning, and behavioral regulation, which may explain why these drugs have such powerful impacts. Even if some of these effects sound exciting, there are reasons why some of these drugs are highly controlled and often illegal. Drugs have the power to alter the brain's chemistry, and repeated use can permanently rewire the neural networks that support our ability to think, make decisions, learn, and remember things. There's a lot we still don't know about drugs and their effects, both the good and the bad. But those we do know about are the ones we've studied closely, and turned into effective medicines. As our knowledge grows about drugs and the brain, the possibilities will also increase for treating the many medical problems that puzzle researchers today.

**P481 2017-06-29 How to spot a misleading graph - Lea Gaslowitz**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=481)

A toothpaste brand claims their product will destroy more plaque than any product ever made. A politician tells you their plan will create the most jobs. We're so used to hearing these kinds of exaggerations in advertising and politics that we might not even bat an eye. But what about when the claim is accompanied by a graph? Afterall, a graph isn't an opinion. It represents cold, hard numbers, and who can argue with those? Yet, as it turns out, there are plenty of ways graphs can mislead and outright manipulate. Here are some things to look out for. In this 1992 ad, Chevy claimed to make the most reliable trucks in America using this graph. Not only does it show that 98% of all Chevy trucks sold in the last ten years are still on the road, but it looks like they're twice as dependable as Toyota trucks. That is, until you take a closer look at the numbers on the left and see that the figure for Toyota is about 96.5%. The scale only goes between 95 and 100%. If it went from 0 to 100, it would look like this. This is one of the most common ways graphs misrepresent data, by distorting the scale. Zooming in on a small portion of the y-axis exaggerates a barely detectable difference between the things being compared. And it's especially misleading with bar graphs since we assume the difference in the size of the bars is proportional to the values. But the scale can also be distorted along the x-axis, usually in line graphs showing something changing over time. This chart showing the rise in American unemployment from 2008 to 2010 manipulates the x-axis in two ways. First of all, the scale is inconsistent, compressing the 15-month span after March 2009 to look shorter than the preceding six months. Using more consistent data points gives a different picture with job losses tapering off by the end of 2009. And if you wonder why they were increasing in the first place, the timeline starts immediately after the U.S.'s biggest financial collapse since the Great Depression. These techniques are known as cherry picking. A time range can be carefully chosen to exclude the impact of a major event right outside it. And picking specific data points can hide important changes in between. Even when there's nothing wrong with the graph itself, leaving out relevant data can give a misleading impression. This chart of how many people watch the Super Bowl each year makes it look like the event's popularity is exploding. But it's not accounting for population growth. The ratings have actually held steady because while the number of football fans has increased, their share of overall viewership has not. Finally, a graph can't tell you much if you don't know the full significance of what's being presented. Both of the following graphs use the same ocean temperature data from the National Centers for Environmental Information. So why do they seem to give opposite impressions? The first graph plots the average annual ocean temperature from 1880 to 2016, making the change look insignificant. But in fact, a rise of even half a degree Celsius can cause massive ecological disruption. This is why the second graph, which show the average temperature variation each year, is far more significant. When they're used well, graphs can help us intuitively grasp complex data. But as visual software has enabled more usage of graphs throughout all media, it's also made them easier to use in a careless or dishonest way. So the next time you see a graph, don't be swayed by the lines and curves. Look at the labels, the numbers, the scale, and the context, and ask what story the picture is trying to tell.

**P482 2017-06-29 What causes kidney stones - Arash Shadman**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=482)

The biggest kidney stone on record weighed more than a kilogram and was 17 centimeters in diameter. The patient didn't actually swallow a stone the size of a coconut. Kidney stones form inside the body, but unfortunately, they're extremely painful to get out. A kidney stone is a hard mass of crystals that can form in the kidneys, ureters, bladder, or urethra. Urine contains compounds that consist of calcium, sodium, potassium, oxalate, uric acid, and phosphate. If the levels of these particles get too high, or if urine becomes too acidic or basic, the particles can clump together and crystallize. Unless the problem is addressed, the crystals will gradually grow over a few weeks, months, or even years, forming a detectable stone. Calcium oxalate is the most common type of crystal to form this way, and accounts for about 80% of kidney stones. Less common kidney stones are made of calcium phosphate, or uric acid. A slightly different type of stone made of the minerals magnesium ammonium phosphate, or struvite, can be caused by bacterial infection. And even rarer stones can result from genetic disorders or certain medications. A kidney stone can go undetected until it starts to move. When a stone travels through the kidney and into the ureter, its sharp edges scratch the walls of the urinary tract. Nerve endings embedded in this tissue transmit excruciating pain signals through the nervous system. And the scratches can send blood flowing into the urine. This can be accompanied by symptoms of nausea, vomiting, and a burning sensation while urinating. If a stone gets big enough to actually block the flow of urine, it can create an infection, or back flow, and damage the kidneys themselves. But most kidney stones don't become this serious, or even require invasive treatment. Masses less than five millimeters in diameter will usually pass out of the body on their own. A doctor will often simply recommend drinking large amounts of water to help speed the process along, and maybe taking some pain killers. If the stone is slightly larger, medications like alpha blockers can help by relaxing the muscles in the ureter and making it easier for the stone to get through. Another medication called potassium citrate can help dissolve the stones by creating a less acidic urine. For medium-sized stones up to about ten millimeters, one option is pulverizing them with soundwaves. Extracorporeal shock wave lithotripsy uses high-intensity pulses of focused ultrasonic energy aimed directly at the stone. The pulses create vibrations inside the stone itself and small bubbles jostle it. These combined forces crush the stone into smaller pieces that can pass out of the body more easily. But zapping a stone with sound doesn't work as well if it's simply too big. So sometimes, more invasive treatments are necessary. A rigid tube called a stent can be placed in the ureter to expand it. Optical fibers can deliver laser pulses to break up the stone. Stones can also be surgically removed through an incision in the patient's back or groin. What about just avoiding kidney stones in the first place? For people prone to them, their doctor may recommend drinking plenty of water, which dilutes the calcium oxalate and other compounds that eventually build up into painful stones. Foods like potato chips, spinach, rhubarb, and beets are high in oxalate, so doctors might advise limiting them. Even though calcium is often found in stones, calcium in foods and beverages can actually help by binding to oxalate in the digestive tract before it can be absorbed and reach the kidneys. If you do end up with a kidney stone, you're not alone. Data suggests that rates are rising, but that world record probably won't be broken any time soon.

**P483 2017-07-10 How does caffeine keep us awake - Hanan Qasim**

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Over 100,000 metric tons of caffeine are consumed around the world every year. That's equivalent to the weight of 14 Eiffel Towers. Most of this caffeine is consumed in coffee and tea, but it's also ingested in some sodas, chocolate, caffeine pills, and even beverages labeled decaf. Caffeine helps us feel alert, focused, happy, and energetic, even if we haven't had enough sleep. But it can also raise our blood pressure, and make us feel anxious. It's the world most widely used drug. So how does it keep us awake? Caffeine evolved in plants where it serves a few purposes. In high doses, as it's found in the leaves and seeds of certain species, it's toxic to insects. But when they consume it in lower doses, as it's found in nectar, it can actually help them remember and revisit flowers. In the human body, caffeine acts as a stimulant for the central nervous system. It keeps us awake by blocking one of the body's key sleep-inducing molecules, a substance called adenosine. Your body needs a constant supply of energy, which it gets by breaking down a high-energy molecule called ATP. In the process, it liberates adenosine, ATP's chemical backbone. Neurons in your brain have receptors perfectly tailored to this molecule. When adenosine docks to these receptors, it activates a cascade of biochemical reactions that cause neurons to fire more sluggishly and slow the release of important brain-signaling molecules. In other words, you get sleepy. Caffeine is what's called an adenosine receptor antagonist. That means it derails this process of slowing your neurons down by blocking adenosine receptors. Caffeine and adenosine have a similar molecular structure, close enough that caffeine can wedge into the adenosine receptors, but not close enough to activate them. To summarize, adenosine inhibits your neurons. Caffeine inhibits the inhibitor, so it stimulates you. Caffeine can also boost positive feelings. In some neurons, the adenosine receptors are linked to receptors for another molecule called dopamine. One of dopamine's roles in the brain is to promote feelings of pleasure. When adenosine docks in one of these paired receptors, that can make it harder for dopamine to fit in its own spot, interrupting its mood-lifting work. But when caffeine takes adenosine's place, it doesn't have the same effect, and dopamine can slide in. There's evidence that caffeine's effects on adenosine and dopamine receptors can have long-term benefits, too, reducing the risk of diseases like Parkinson's, Alzheimer's, and some types of cancer. Caffeine can also ramp up the body's ability to burn fat. In fact, some sports organizations think that caffeine gives athletes an unfair advantage and have placed limits on its consumption. From 1972 until 2004, Olympic athletes had to stay below a certain blood-caffeine concentration to compete. Of course, not all of caffeine's effects are so helpful. It might make you feel better and more alert, but it can also raise your heart rate and blood pressure, cause increased urination or diarrhea, and contribute to insomnia and anxiety. Plus, the foods and beverages caffeine is found in have their own impacts on your body that have to be taken into account. Your brain can adapt to regular consumption of caffeine. If your adenosine receptors are perpetually clogged, your body will manufacture extra ones. That way, even with caffeine around, adenosine can still do its job of signaling the brain to power down. That's why you may find you need to consume more and more caffeine to feel as alert. There are more and more adenosine receptors to block. It's also why if you suddenly quit caffeine, you may experience an unpleasant withdrawal. With plenty of receptors and no competition, adenosine can work overtime, causing symptoms like headaches, tiredness, and depressed moods. But in a few days, the extra adenosine receptors will disappear, your body will readjust, and you'll feel just as alert as ever, even without an infusion of the world's most popular stimulant.

**P484 2017-07-13 The left brain vs. right brain myth - Elizabeth Waters**

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Behold the human brain, it's lumpy landscape visibly split into a left and right side. This structure has inspired one of the most pervasive ideas about the brain, that the left side controls logic and the right, creativity. And yet, this is a myth unsupported by scientific evidence. So how did this misleading idea come about, and what does it get wrong? It's true that the brain has a right and a left side. This is most apparent with the outer layer, or the cortex. Internal regions, like the striatum, hypothalamus, thalamus, and brain stem appear to be made from continuous tissue, but in fact, they're also organized with left and right sides. The left and the right sides of the brain do control different body functions, such as movement and sight. The brain's right side controls the motion of the left arm and leg and vice versa. The visual system is even more complex. Each eye has a left and right visual field. Both left visual fields are sent to the right side of the brain, and both right fields are sent to the left side. So the brain uses both sides to make a complete image of the world. Scientists don't know for sure why we have that crossing over. One theory is it began soon after animals developed more complex nervous systems because it gave the survival advantage of quicker reflexes. If an animal sees a predator coming from its left side, it's best off escaping to the right. So we can say that vision and movement control are two systems that rely on this left-right structure, but problems arise when we over-extend that idea to logic and creativity. This misconception began in the mid-1800s when two neurologists, Broca and Wernicke, examined patients who had problems communicating due to injuries. The researchers found damage to the patients' left temporal lobes, so they suggested that language is controlled by the left side of the brain. That captured the popular imagination. Author Robert Louis Stevenson then introduced the idea of a logical left hemisphere competing with an emotional right hemisphere represented by his characters Dr. Jekyll and Mr. Hyde. But this idea didn't hold up when doctors and scientists examined patients who were missing a hemisphere or had their two hemispheres separated. These patients showed a complete range of behaviors, both logical and creative. Later research showed that one side of the brain is more active than the other for some functions. Language is more localized to the left and attention to the right. So one side of the brain may do more work, but this varies by system rather than by person. There isn't any evidence to suggest that individuals have dominant sides of the brain, or to support the idea of a left-right split between logic and creativity. Some people may be particularly logical or creative, but that has nothing to do with the sides of their brains. And even the idea of logic and creativity being at odds with each other doesn't hold up well. Solving complex math problems requires inspired creativity and many vibrant works of art have intricate logical frameworks. Almost every feat of creativity and logic carries the mark of the whole brain functioning as one.

**P485 2017-07-18 When is water safe to drink - Mia Nacamulli**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=485)

Take a look at the water in this glass. Refreshing, hydrating, and invaluable to your survival. Before you take a sip, though, how do you know that the water inside is free from disease-causing organisms and pollutants? One out of ten people in the world can't actually be sure that their water is clean and safe to drink. Why is that? Inadequate sanitation, poor protection of drinking water sources, and improper hygiene often lead to sewage and feces-contaminated water. That's the ideal breeding ground for dangerous bacteria, viruses, and parasites. And the effects of these pathogens are staggering. Diarrheal disease from unsafe water is one of the leading causes of death around the world for children under five. And according to a U.N. report from 2010, microbial water-borne illnesses killed more people per year than war. Proper treatment processes, though, can address these threats. They usually have three parts: sedimentation, filtration, and disinfection. Once water has been collected in a treatment facility, it's ready for cleaning. The first step, sedimentation, just takes time. The water sits undisturbed, allowing heavier particles to sink to the bottom. Often, though, particles are just too small to be removed by sedimentation alone and need to be filtered. Gravity pulls the water downward through layers of sand that catch leftover particles in their pores, prepping the water for its final treatment, a dose of disinfectant. Chemicals, primarily forms of chlorine and ozone, are mixed in to kill off any pathogens and to disinfect pipes and storage systems. Chlorine is highly effective in destroying water's living organisms, but its use remains government-regulated because it has potentially harmful chemical byproducts. And if an imbalance of chlorine occurs during the disinfection process, it can trigger other chemical reactions. For example, levels of chlorine byproducts, like trihalomethanes, could skyrocket, leading to pipe corrosion and the release of iron, copper, and lead into drinking water. Water contamination from these and other sources including leaching, chemical spills, and runoffs, has been linked to long-term health effects, like cancer, cardiovascular and neurological diseases, and miscarriage. Unfortunately, analyzing the exact risks of chemically contaminated water is difficult. So while it's clear that disinfectants make us safer by removing disease-causing pathogens, experts have yet to determine the full scope of how the chemical cocktail in our drinking water really impacts human health. So how can you tell whether the water you have access to, whether from a tap or otherwise, is drinkable? Firstly, too much turbidity, trace organic compounds, or high-density heavy metals like arsenic, chromium, or lead, mean that the water is unsuitable for consumption. A lot of contaminants, like lead or arsenic, won't be obvious without tests, but some clues, like cloudiness, brown or yellow coloration, a foul odor, or an excessive chlorine smell can indicate the need to investigate further. Water testing kits can go a step further and confirm the presence of many different contaminants and chemicals. With many types of contamination, there are ways of treating water where it's used instead of close to its source. Point-of-use treatment has actually been around for thousands of years. Ancient Egyptians boiled away many organic contaminants with the sun's heat. And in Ancient Greece, Hippocrates designed a bag that trapped bad tasting sediments from water. Today, point-of-use processes usually involve ionization to lower mineral content. They also use adsorption filtration, where a porous material called activated carbon strains the water to remove contaminants and chemical byproducts. While it's not always an effective long-term solution, point-of-use treatment is portable, easy to install, and adaptable. And in regions where large-scale systems are unavailable, or where water has been contaminated further along its journey, these systems can mean the difference between life and death. Clean water remains a precious and often scarce commodity. There are nearly 800 million of us who still don't have regular access to it. The good news is that continued developments in water treatment, both on a large and small scale, can alleviate a lot of unsafe conditions. Implementing proper systems where they're needed and paying careful attention to the ones already in place will fulfill one of the most basic of our human needs.

**P486 2017-07-18 Will we ever be able to teleport - Sajan Saini**

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Is teleportation possible? Could a baseball transform into something like a radio wave, travel through buildings, bounce around corners, and change back into a baseball? Oddly enough, thanks to quantum mechanics, the answer might actually be yes. Sort of. Here's the trick. The baseball itself couldn't be sent by radio, but all the information about it could. In quantum physics, atoms and electrons are interpreted as a collection of distinct properties, for example, position, momentum, and intrinsic spin. The values of these properties configure the particle, giving it a quantum state identity. If two electrons have the same quantum state, they're identical. In a literal sense, our baseball is defined by a collective quantum state resulting from its many atoms. If this quantum state information could be read in Boston and sent around the world, atoms for the same chemical elements could have this information imprinted on them in Bangalore and be carefully directed to assemble, becoming the exact same baseball. There's a wrinkle though. Quantum states aren't so easy to measure. The uncertainty principle in quantum physics implies the position and momentum of a particle can't be measured at the same time. The simplest way to measure the exact position of an electron requires scattering a particle of light, a photon, from it, and collecting the light in a microscope. But that scattering changes the momentum of the electron in an unpredictable way. We lose all previous information about momentum. In a sense, quantum information is fragile. Measuring the information changes it. So how can we transmit something we're not permitted to fully read without destroying it? The answer can be found in the strange phenomena of quantum entanglement. Entanglement is an old mystery from the early days of quantum physics and it's still not entirely understood. Entangling the spin of two electrons results in an influence that transcends distance. Measuring the spin of the first electron determines what spin will measure for the second, whether the two particles are a mile or a light year apart. Somehow, information about the first electron's quantum state, called a qubit of data, influences its partner without transmission across the intervening space. Einstein and his colleagues called this strange communcation spooky action at a distance. While it does seem that entanglement between two particles helps transfer a qubit instantaneously across the space between them, there's a catch. This interaction must begin locally. The two electrons must be entangled in close proximity before one of them is transported to a new site. By itself, quantum entanglement isn't teleportation. To complete the teleport, we need a digital message to help interpret the qubit at the receiving end. Two bits of data created by measuring the first particle. These digital bits must be transmitted by a classical channel that's limited by the speed of light, radio, microwaves, or perhaps fiberoptics. When we measure a particle for this digital message, we destroy its quantum information, which means the baseball must disappear from Boston for it to teleport to Bangalore. Thanks to the uncertainty principle, teleportation transfers the information about the baseball between the two cities and never duplicates it. So in principle, we could teleport objects, even people, but at present, it seems unlikely we can measure the quantum states of the trillion trillion or more atoms in large objects and then recreate them elsewhere. The complexity of this task and the energy needed is astronomical. For now, we can reliably teleport single electrons and atoms, which may lead to super-secured data encryption for future quantum computers. The philosophical implications of quantum teleportation are subtle. A teleported object doesn't exactly transport across space like tangible matter, nor does it exactly transmit across space, like intangible information. It seems to do a little of both. Quantum physics gives us a strange new vision for all the matter in our universe as collections of fragile information. And quantum teleportation reveals new ways to influence this fragility. And remember, never say never. In a little over a century, mankind has advanced from an uncertain new understanding of the behavior of electrons at the atomic scale to reliably teleporting them across a room. What new technical mastery of such phenomena might we have in 1,000, or even 10,000 years? Only time and space will tell.

**P487 2017-07-20 What happens when you have a concussion - Clifford Robbins**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=487)

Each year in the United States, players of sports and recreational activities receive between 2.5 and 4 million concussions. How dangerous are all those concussions? The answer is complicated, and lies in how the brain responds when something strikes it. The brain is made of soft fatty tissue, with a consistency something like jello. Inside its protective membranes and the skull's hard casing, this delicate organ is usually well-shielded. But a sudden jolt can make the brain shift and bump against the skull's hard interior, and unlike jello, the brain's tissue isn't uniform. It's made of a vast network of 90 billion neurons, which relay signals through their long axons to communicate throughout the brain and control our bodies. This spindly structure makes them very fragile so that when impacted, neurons will stretch and even tear. That not only disrupts their ability to communicate but as destroyed axons begin to degenerate, they also release toxins causing the death of other neurons, too. This combination of events causes a concussion. The damage can manifest in many different ways including blackout, headache, blurry vision, balance problems, altered mood and behavior, problems with memory, thinking, and sleeping, and the onset of anxiety and depression. Every brain is different, which explains why people's experiences of concussions vary so widely. Luckily, the majority of concussions fully heal and symptoms disappear within a matter of days or weeks. Lots of rest and a gradual return to activity allows the brain to heal itself. On the subject of rest, many people have heard that you're not supposed to sleep shortly after receiving a concussion because you might slip into a coma. That's a myth. So long as doctors aren't concerned there may also be a more severe brain injury, like a brain bleed, there's no documented problem with going to sleep after a concussion. Sometimes, victims of concussion can experience something called post-concussion syndrome, or PCS. People with PCS may experience constant headaches, learning difficulties, and behavioral symptoms that even affect their personal relationships for months or years after the injury. Trying to play through a concussion, even for only a few minutes, or returning to sports too soon after a concussion, makes it more likely to develop PCS. In some cases, a concussion can be hard to diagnose because the symptoms unfold slowly over time. That's often true of subconcussive impacts which result from lower impact jolts to the head than those that cause concussions. This category of injury doesn't cause noticable symptoms right away, but can lead to severe degenerative brain diseases over time if it happens repeatedly. Take soccer players, who are known for repeatedly heading soccer balls. Using a technique called Diffusion Tensor Imaging, we're beginning to find out what effect that has on the brain. This method allows scientists to find large axon bundles and see how milder blows might alter them structurally. In 2013, researchers using this technique discovered that athletes who had headed the ball most, about 1,800 times a year, had damaged the structural integrity of their axon bundles. The damage was similar to how a rope will fail when the individual fibers start to fray. Those players also performed worse on short-term memory tests, so even though no one suffered full-blown concussions, these subconcussive hits added up to measurable damage over time. In fact, researchers know that an overload of subconcussive hits is linked to a degenerative brain disease known as Chronic Traumatic Encephalopathy, or CTE. People with CTE suffer from changes in their mood and behavior that begin appearing in their 30s or 40s followed by problems with thinking and memory that can, in some cases, even result in dementia. The culprit is a protein called tau. Usually, tau proteins support tiny tubes inside our axons called microtubules. It's thought that repeated subconcussive hits damage the microtubules, causing the tau proteins to dislodge and clump together. The clumps disrupt transport and communication along the neuron and drive the breakdown of connections within the brain. Once the tau proteins start clumping together, they cause more clumps to form and continue to spread throughout the brain, even after head impacts have stopped. The data show that at least among football players, between 50 and 80% of concussions go unreported and untreated. Sometimes that's because it's hard to tell a concussion has occurred in the first place. But it's also often due to pressure or a desire to keep going despite the fact that something's wrong. This doesn't just undermine recovery. It's also dangerous. Our brains aren't invincible. They still need us to shield them from harm and help them undo damage once it's been done.

**P488 2017-07-24 Will the ocean ever run out of fish - Ayana Elizabeth Johnson and Jen**

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Fish are in trouble. The cod population off Canada's East Coast collapsed in the 1990s, intense recreational and commercial fishing has decimated goliath grouper populations in South Florida, and most populations of tuna have plummeted by over 50%, with the Southern Atlantic bluefin on the verge of extinction. Those are just a couple of many examples. Overfishing is happening all over the world. How did this happen? When some people think of fishing, they imagine relaxing in a boat and patiently reeling in the day's catch. But modern industrial fishing, the kind that stocks our grocery shelves, looks more like warfare. In fact, the technologies they employ were developed for war. Radar, sonar, helicopters, and spotter planes are all used to guide factory ships towards dwindling schools of fish. Long lines with hundreds of hooks or huge nets round up massive amounts of fish, along with other species, like seabirds, turtles, and dolphins. And fish are hauled up onto giant boats, complete with onboard flash freezing and processing facilities. All of these technologies have enabled us to catch fish at greater depths and farther out at sea than ever before. And as the distance and depth of fishing have expanded, so has the variety of species we target. For example, the Patagonian toothfish neither sounds nor looks very appetizing. And fishermen ignored it until the late 1970s. Then it was rebranded and marketed to chefs in the U.S. as Chilean sea bass, despite the animal actually being a type of cod. Soon it was popping up in markets all over the world and is now a delicacy. Unfortunately, these deep water fish don't reproduce until they're at least ten years old, making them extremely vulnerable to overfishing when the young are caught before they've had the chance to spawn. Consumer taste and prices can also have harmful effects. For example, shark fin soup is considered such a delicacy in China and Vietnam that the fin has become the most profitable part of the shark. This leads many fishermen to fill their boats with fins leaving millions of dead sharks behind. The problems aren't unique to toothfish and sharks. Almost 31% of the world's fish populations are overfished, and another 58% are fished at the maximum sustainable level. Wild fish simply can't reproduce as fast as 7 billion people can eat them. Fishing also has impacts on broader ecosystems. Wild shrimp are typically caught by dragging nets the size of a football field along the ocean bottom, disrupting or destroying seafloor habitats. The catch is often as little as 5% shrimp. The rest is by-catch, unwanted animals that are thrown back dead. And coastal shrimp farming isn't much better. Mangroves are bulldozed to make room for shrimp farms, robbing coastal communities of storm protection and natural water filtration and depriving fish of key nursery habitats. So what does it look like to give fish a break and let them recover? Protection can take many forms. In national waters, governments can set limits about how, when, where, and how much fishing occurs, with restrictions on certain boats and equipment. Harmful practices, such as bottom trawling, can be banned altogether, and we can establish marine reserves closed to all fishing to help ecosystems restore themselves. There's also a role for consumer awareness and boycotts to reduce wasteful practices, like shark finning, and push fishing industries towards more sustainable practices. Past interventions have successfully helped depleted fish populations recover. There are many solutions. The best approach for each fishery must be considered based on science, respect for the local communities that rely on the ocean, and for fish as wild animals. And then the rules must be enforced. International collaboration is often needed, too, because fish don't care about our borders. We need to end overfishing. Ecosystems, food security, jobs, economies, and coastal cultures all depend on it.

**P489 2017-07-26 Explore cave paintings in this 360° animated cave - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=489)

In 1879, amateur archaeologist Marcelino Sanz de Sautuola and his young daughter Maria explored a dark cave in Northern Spain. When Maria wondered off by herself, she made an amazing discovery. They were standing inside a site of ancient art, the walls and roofs decorated with prehistoric paintings and engravings, ranging from 19,000 to 35,000 years old. Similar marks of our ancestors have been preserved in caves all over the world. The oldest we've found were made up to 40,000 years ago. What do these images tell us about the ancient human mind and the lives of their creators? These early artists mixed minerals, clay, charcoal, and ochre with spit or animal fat to create paint. They drew with their hands and tools, like pads of moss, twigs, bones, and hair. In many instances, their images follow the contours of the cave to create depth and shade. The most common depictions are of geometric shapes, followed by large mammals, like bison, horses, mammoths, deer, and boars. Human figures appear rarely, as well as occasional hand prints. Some have theorized that these artworks are the creation of hunters, or of holy men in trance-like states. And we've found examples created by men, women, and even children. And why did they create this art? Perhaps they were documenting what they knew about the natural world, like modern scientists, or marking their tribal territory. Maybe the images were the culmination of sacred hunting rituals or spiritual journeys. Or could they be art for art's sake, the sheer joy and fulfillment of creation? As with many unsolved mysteries of the ancient world, we may never know for sure, barring the invention of a time machine, that is. But while the answers remain elusive, these images are our earliest proof of human communication, testifying to the human capacity for creativity thousands of years before writing. They are a distinct visual language that imagines the world outside the self, just like modern art forms, from graffiti and painting to animated virtual-reality caves.

**P490 2017-08-01 The myth of Cupid and Psyche - Brendan Pelsue**

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"Beauty is a curse," Psyche thought as she looked over the cliff's edge where she'd been abandoned by her father. She'd been born with the physical perfection so complete that she was worshipped as a new incarnation of Venus, the goddess of love. But real-life human lovers were too intimidated even to approach her. When her father asked for guidance from the Oracle of Apollo, the god of light, reason, and prophecy. He was told to abandon his daughter on a rocky crag where she would marry a cruel and savage serpent-like winged evil. Alone on the crag, Psyche felt Zephyr the West Wind gently lifting her into the air. It set her down before a palace. "You are home," she heard an unseen voice say. "Your husband awaits you in the bedroom, if you dare to meet him." She was brave enough, Psyche told herself. The bedroom was so dark that she couldn't see her husband. But he didn't feel serpent-like at all. His skin was soft, and his voice and manner were gentle. She asked him who he was, but he told her this was the one question he could never answer. If she loved him, she would not need to know. His visits continued night after night. Before long, Psyche was pregnant. She rejoiced, but was also conflicted. How could she raise her baby with a man she'd never seen? That night, Psyche approached her sleeping husband holding an oil lamp. What she found was the god Cupid who sent gods and humans lusting after each other with the pinpricks of his arrows. Psyche dropped her lamp, burning Cupid with hot oil. He said he'd been in love with Psyche ever since his jealous mother, Venus, asked him to embarrass the young woman by pricking her with an arrow. But taken with Psyche's beauty, Cupid used the arrow on himself. He didn't believe, however, that gods and humans could love as equals. Now that she knew his true form, their hopes for happiness were dashed, so he flew away. Psyche was left in despair until the unseen voice returned and told her that it was indeed possible for her and Cupid to love each other as equals. Encouraged, she set out to find him. But Venus intercepted Psyche and said she and Cupid could only wed if she completed a series of impossible tasks. First, Psyche was told to sort a huge, messy pile of seeds in a single night. Just as she was abandoning hope, an ant colony took pity on her and helped with the work. Successfully passing the first trial, Psyche next had to bring Venus the fleece of the golden sheep, who had a reputation for disemboweling stray adventurers, but a river god showed her how to collect the fleece the sheep had snagged on briars, and she succeeded. Finally, Psyche had to travel to the Underworld and convince Proserpina, queen of the dead, to put a drop of her beauty in a box for Venus. Once again, the unseen voice came to Psyche's aide. It told her to bring barley cakes for Cerberus, the guard dog to the Underworld and coins to pay the boatman, Charon to ferry her across the river Styx. With her third and final task complete, Psyche returned to the land of the living. Just outside Venus's palace, she opened the box of Proserpina's beauty, hoping to keep some for herself. But the box was filled with sleep, not beauty, and Psyche collapsed in the road. Cupid, now recovered from his wounds, flew to his sleeping bride. He told her he'd been wrong and foolish. Her fearlessness in the face of the unknown proved that she was more than his equal. Cupid gave Psyche amborsia, the nectar of the gods, making her immortal. Shortly after, Psyche bore their daughter. They named her Pleasure, and she, Cupid, and Psyche, whose name means soul, have been complicating people's love lives ever since.

**P491 2017-08-11 Cell membranes are way more complicated than you think - Nazzy Pakpou**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=491)

Cell membranes are structures of contradictions. These oily films are hundreds of times thinner than a strand of spider silk, yet strong enough to protect the delicate contents of life: the cell's watery cytoplasm, genetic material, organelles, and all the molecules it needs to survive. How does the membrane work, and where does that strength come from? First of all, it's tempting to think of a cell membrane like the tight skin of a balloon, but it's actually something much more complex. In reality, it's constantly in flux, shifting components back and forth to help the cell take in food, remove waste, let specific molecules in and out, communicate with other cells, gather information about the environment, and repair itself. The cell membrane gets this resilience, flexibility, and functionality by combining a variety of floating components in what biologists call a fluid mosaic. The primary component of the fluid mosaic is a simple molecule called a phospholipid. A phospholipid has a polar, electrically-charged head, which attracts water, and a non-polar tail, which repels it. They pair up tail-to-tail in a two layer sheet just five to ten nanometers thick that extends all around the cell. The heads point in towards the cytoplasm and out towards the watery fluid external to the cell with the lipid tails sandwiched in between. This bilayer, which at body temperature has the consistency of vegetable oil, is studded with other types of molecules, including proteins, carbohydrates, and cholesterol. Cholesterol keeps the membrane at the right fluidity. It also helps regulate communication between cells. Sometimes, cells talk to each other by releasing and capturing chemicals and proteins. The release of proteins is easy, but the capture of them is more complicated. That happens through a process called endocytosis in which sections of the membrane engulf substances and transport them into the cell as vesicles. Once the contents have been released, the vesicles are recycled and returned to the cell membrane. The most complex components of the fluid mosaic are proteins. One of their key jobs is to make sure that the right molecules get in and out of the cell. Non-polar molecules, like oxygen, carbon dioxide, and certain vitamins can cross the phospholipid bilayer easily. But polar and charged molecules can't make it through the fatty inner layer. Transmembrane proteins stretch across the bilayer to create channels that allow specific molecules through, like sodium and potassium ions. Peripheral proteins floating in the inner face of the bilayer help anchor the membrane to the cell's interior scaffolding. Other proteins in cell membranes can help fuse two different bilayers. That can work to our benefit, like when a sperm fertilizes an egg, but also harm us, as it does when a virus enters a cell. And some proteins move within the fluid mosaic, coming together to form complexes that carry out specific jobs. For instance, one complex might activate cells in our immune system, then move apart when the job is done. Cell membranes are also the site of an ongoing war between us and all the things that want to infect us. In fact, some of the most toxic substances we know of are membrane-breaching proteins made by infectious bacteria. These pore-forming toxins poke giant holes in our cell membranes, causing a cell's contents to leak out. Scientists are working on developing ways to defend against them, like using a nano-sponge that saves our cells by soaking up the membrane-damaging toxins. The fluid mosaic is what makes all the functions of life possible. Without a cell membrane, there could be no cells, and without cells, there would be no bacteria, no parasites, no fungi, no animals, and no us.

**P492 2017-08-14 Could we create dark matter - Rolf Landua**

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85% of the matter in our universe is a mystery. We don't know what it's made of, which is why we call it dark matter. But we know it's out there because we can observe its gravitational attraction on galaxies and other celestial objects. We've yet to directly observe dark matter, but scientists theorize that we may actually be able to create it in the most powerful particle collider in the world. That's the 27 kilometer-long Large Hadron Collider, or LHC, in Geneva, Switzerland. So how would that work? In the LHC, two proton beams move in opposite directions and are accelerated to near the speed of light. At four collision points, the beams cross and protons smash into each other. Protons are made of much smaller components called quarks and gluons In most ordinary collisions, the two protons pass through each other without any significant outcome. However, in about one in a million collisions, two components hit each other so violently, that most of the collision energy is set free producing thousands of new particles. It's only in these collisions that very massive particles, like the theorized dark matter, can be produced. The collision points are surrounded by detectors containing about 100 million sensors. Like huge three-dimensional cameras, they gather information on those new particles, including their trajectory, electrical charge, and energy. Once processed, the computers can depict a collision as an image. Each line is the path of a different particle, and different types of particles are color-coded. Data from the detectors allows scientists to determine what each of these particles is, things like photons and electrons. Now, the detectors take snapshots of about a billion of these collisions per second to find signs of extremely rare massive particles. To add to the difficulty, the particles we're looking for may be unstable and decay into more familiar particles before reaching the sensors. Take, for example, the Higgs boson, a long-theorized particle that wasn't observed until 2012. The odds of a given collision producing a Higgs boson are about one in 10 billion, and it only lasts for a tiny fraction of a second before decaying. But scientists developed theoretical models to tell them what to look for. For the Higgs, they thought it would sometimes decay into two photons. So they first examined only the high-energy events that included two photons. But there's a problem here. There are innumerable particle interactions that can produce two random photons. So how do you separate out the Higgs from everything else? The answer is mass. The information gathered by the detectors allows the scientists to go a step back and determine the mass of whatever it was that produced two photons. They put that mass value into a graph and then repeat the process for all events with two photons. The vast majority of these events are just random photon observations, what scientists call background events. But when a Higgs boson is produced and decays into two photons, the mass always comes out to be the same. Therefore, the tell-tale sign of the Higgs boson would be a little bump sitting on top of the background. It takes billions of observations before a bump like this can appear, and it's only considered a meaningful result if that bump becomes significantly higher than the background. In the case of the Higgs boson, the scientists at the LHC announced their groundbreaking result when there was only a one in 3 million chance this bump could have appeared by a statistical fluke. So back to the dark matter. If the LHC's proton beams have enough energy to produce it, that's probably an even rarer occurrence than the Higgs boson. So it takes quadrillions of collisions combined with theoretical models to even start to look. That's what the LHC is currently doing. By generating a mountain of data, we're hoping to find more tiny bumps in graphs that will provide evidence for yet unknown particles, like dark matter. Or maybe what we'll find won't be dark matter, but something else that would reshape our understanding of how the universe works entirely. That's part of the fun at this point. We have no idea what we're going to find.

**P493 2017-08-14 TED-Ed is on Patreon! We need your help to revolutionize education...**

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**P494 2017-08-14 The rise and fall of the Berlin Wall - Konrad H. Jarausch**

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In the early hours of August 13, 1961, East German construction workers flanked by soldiers and police began tearing up streets and erecting barriers throughout the city of Berlin and its surroundings. This night marked the beginning of one of history's most infamous dividing lines, the Berlin Wall. Construction on the wall continued for the next decade as it cut through neighborhoods, separated families, and divided not just Germany, but the world. To understand how we got to this point, we have to go back to World War II. America, Britain, and France joined forces with the Soviet Union against the Axis Powers. After they defeated Nazi Germany, each of the victorious nations occupied part of the country. The division was meant to be temporary, but the former allies found themselves at odds over their visions for post-war Europe. While Western powers promoted liberal market economies, the Soviet Union sought to surround itself with obedient Communist nations, including a weakened Germany. As their relations deteriorated, the Federal Republic of Germany was formed in the West while the Soviets established the German Democratic Republic in the East. The Soviet satellite countries restricted Western trade and movement, so a virtually impassable border formed. It became known as the Iron Curtain. In the former German capital of Berlin, things were particularly complicated. Although the city lay fully within the East German territory of the GDR, the post-war agreement gave the allies joint administration. So America, Britain, and France created a Democratic enclave in Berlin's western districts. While East Germans were officially banned from leaving the country, in Berlin, it was simply a matter of walking, or riding a subway, streetcar or bus, to the Western half, then traveling on to West Germany or beyond. This open border posed a problem for the East German leadership. They had staked a claim to represent the Communist resistance against Hitler and portrayed Western Germany as a continuation of the Nazi regime. While the U.S. and its allies poured money into West Germany's reconstruction, the Soviet Union extracted resources from the East as war reparations, making its planned economy even less competitive. Life in East Germany passed under the watchful eye of the Stasi, the secret police whose wiretaps and informants monitored citizens for any hint of disloyalty. While there was free health care and education in the East, the West boasted higher salaries, more consumer goods, and greater personal freedom. By 1961, about 3.5 million people, nearly 20% of the East German population, had left, including many young professionals. To prevent further losses, East Germany decided to close the border, and that's where the Berlin Wall came in. Extending for 43 kilometers through Berlin, and a further 112 through East Germany, the initial barrier consisted of barbed wire and mesh fencing. Some Berliners escaped by jumping over the wire or leaving from windows, but as the wall expanded, this became more difficult. By 1965, 106 kilometers of 3.6-meter-high concrete barricades had been added topped with a smooth pipe to prevent climbing. Over the coming years, the barrier was strengthened with spike strips, guard dogs, and even landmines, along with 302 watchtowers and 20 bunkers. A parallel fence in the rear set off a 100-meter area called the death strip. There, all buildings were demolished and the ground covered with sand to provide a clear line of sight for the hundreds of guards ordered to shoot anyone attempting to cross. Nevertheless, nearly 5,000 people in total managed to flee East Germany between 1961 and 1989. Some were diplomats or athletes who defected while abroad, but others were ordinary citizens who dug tunnels, swam across canals, flew hot air balloons, or even crashed a stolen tank through the wall. Yet the risk was great. Over 138 people died while attempting escape. Some shot in full view of West Germans powerless to help them. The wall stabilized East Germany's economy by preventing its work force from leaving, but tarnished its reputation, becoming a global symbol of Communist repression. As part of reconciliation with the East, the Basic Treaty of 1972 recognized East Germany pragmatically while West Germany retained its hope for eventual reunification. Although the Eastern regime gradually allowed family visits, it tried to discourage people from exercising these rights with an arduous bureaucratic process and high fees. Nonetheless, it was still overwhelmed by applications. By the end of the 1980's, the liberalization of other Eastern Bloc regimes caused mass demonstrations for free travel and demands for democracy. On the evening of November 9, 1989, East Germany tried to defuse tension by making travel permits easier to obtain. But the announcement brought thousands of East Berliners to the border crossing points in the wall, forcing the surprised guards to open the gates immediately. Rejoicing crowds poured into West Berlin as people from both sides danced atop the wall. And others began to demolish it with whatever tools they could find. Although the border guards initially tried to maintain order, it was soon clear that the years of division were at an end. After four decades, Germany was officially reunified in October 1990. And the Soviet Union fell soon after. Today, parts of the wall still stand as a reminder that any barriers we put up to impede freedom, we can also break down.

**P495 2017-08-18 Is it possible to create a perfect vacuum - Rolf Landua and Anais Ras**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=495)

The universe is bustling with matter and energy. Even in the vast apparent emptiness of intergalactic space, there's one hydrogen atom per cubic meter. That's not the mention a barrage of particles and electromagnetic radiation passing every which way from stars, galaxies, and into black holes. There's even radiation left over from the Big Bang. So is there such thing as a total absence of everything? This isn't just a thought experiment. Empty spaces, or vacuums, are incredibly useful. Inside our homes, most vacuum cleaners work by using a fan to create a low-pressure relatively empty area that sucks matter in to fill the void. But that's far from empty. There's still plenty of matter bouncing around. Manufacturers rely on more thorough, sealed vacuums for all sorts of purposes. That includes vacuum-packed food that stays fresh longer, and the vacuums inside early light bulbs that protected filaments from degrading. These vacuums are generally created with some version of what a vacuum cleaner does using high-powered pumps that create enough suction to remove as many stray atoms as possible. But the best of these industrial processes tends to leave hundreds of millions of atoms per cubic centimeter of space. That isn't empty enough for scientists who work on experiments, like the Large Hadron Collider, where particle beams need to circulate at close to the speed of light for up to ten hours without hitting any stray atoms. So how do they create a vacuum? The LHC's pipes are made of materials, like stainless steel, that don't release any of their own molecules and are lined with a special coating to absorb stray gases. Raising the temperature to 200 degrees Celsius burns off any moisture, and hundreds of vacuum pumps take two weeks to trap enough gas and debris out of the pipes for the collider's incredibly sensitive experiments. Even with all this, the Large Hadron Collider isn't a perfect vacuum. In the emptiest places, there are still about 100,000 particles per cubic centimeter. But let's say an experiment like that could somehow get every last atom out. There's still an unfathomably huge amount of radiation all around us that can pass right through the walls. Every second, about 50 muons from cosmic rays, 10 million neutrinos coming directly from the Big Bang, 30 million photons from the cosmic microwave background, and 300 trillion neutrinos from the Sun pass through your body. It is possible to shield vacuum chambers with substances, including water, that absorb and reflect this radiation, except for neutrinos. Let's say you've somehow removed all of the atoms and blocked all of the radiation. Is the space now totally empty? Actually, no. All space is filled with what physicists call quantum fields. What we think of as subatomic particles, electrons and photons and their relatives, are actually vibrations in a quantum fabric that extends throughout the universe. And because of a physical law called the Heisenberg Principle, these fields never stop oscillating, even without any particles to set off the ripples. They always have some minimum fluctuation called a vacuum fluctuation. This means they have energy, a huge amount of it. Because Einstein's equations tell us that mass and energy are equivalent, the quantum fluctuations in every cubic meter of space have an energy that corresponds to a mass of about four protons. In other words, the seemingly empty space inside your vacuum would actually weigh a small amount. Quantum fluctuations have existed since the earliest moments of the universe. In the moments after the Big Bang, as the universe expanded, they were amplified and stretched out to cosmic scales. Cosmologists believe that these original quantum fluctuations were the seeds of everything we see today: galaxies and the entire large scale structure of the universe, as well as planets and solar systems. They're also the center of one of the greatest scientific mysteries of our time because according to the current theories, the quantum fluctuations in the vacuum of space ought to have 120 orders of magnitude more energy than we observe. Solving the mystery of that missing energy may entirely rewrite our understanding of physics and the universe.

**P496 2017-08-18 Where do new words come from - Marcel Danesi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=496)

Every year, about 1,000 new words are added to the Oxford English Dictionary. Where do they come from, and how do they make it into our everyday lives? With over 170,000 words currently in use in the English language, it might seem we already have plenty. Yet, as our world changes, new ideas and inventions spring forth, and science progresses, our existing words leave gaps in what we want to express and we fill those gaps in several ingenious, practical, and occasionally peculiar ways. One way is to absorb a word from another language. English has borrowed so many words over its history that nearly half of its vocabulary comes directly from other languages. Sometimes, this is simply because the thing the word describes was borrowed itself. Rome and France brought legal and religious concepts, like altar and jury, to Medieval England, while trade brought crops and cuisine, like Arabic coffee, Italian spaghetti, and Indian curry. But sometimes, another language has just the right word for a complex idea or emotion, like naïveté machismo, or schadenfreude. Scientists also use classical languages to name new concepts. Clone, for example, was derived from the Ancient Greek word for twig to describe creating a new plant from a piece of the old. And today, the process works both ways, with English lending words like software to languages all over the world. Another popular way to fill a vocabulary gap is by combining existing words that each convey part of the new concept. This can be done by combining two whole words into a compound word, like airport or starfish, or by clipping and blending parts of words together, like spork, brunch, or internet. And unlike borrowings from other languages, these can often be understood the first time you hear them. And sometimes a new word isn't new at all. Obsolete words gain new life by adopting new meanings. Villain originally meant a peasant farmer, but in a twist of aristocratic snobbery came to mean someone not bound by the knightly code of chivalry and, therefore, a bad person. A geek went from being a carnival performer to any strange person to a specific type of awkward genius. And other times, words come to mean their opposite through irony, metaphor, or misuse, like when sick or wicked are used to describe something literally amazing. But if words can be formed in all these ways, why do some become mainstream while others fall out of use or never catch on in the first place? Sometimes, the answer is simple, as when scientists or companies give an official name to a new discovery or technology. And some countries have language academies to make the decisions. But for the most part, official sources like dictionaries only document current usage. New words don't originate from above, but from ordinary people spreading words that hit the right combination of useful and catchy. Take the word meme, coined in the 1970s by sociobiologist Richard Dawkins from the Ancient Greek for imitation. He used it to describe how ideas and symbols propagate through a culture like genes through a population. With the advent of the Internet, the process became directly observable in how jokes and images were popularized at lightning speed. And soon, the word came to refer to a certain kind of image. So meme not only describes how words become part of language, the word is a meme itself. And there's a word for this phenomenon of words that describe themselves: autological. Not all new words are created equal. Some stick around for millennia, some adapt to changing times, and others die off. Some relay information, some interpret it, but the way these words are created and the journey they take to become part of our speech tells us a lot about our world and how we communicate within it.

**P497 2017-08-22 How does impeachment work - Alex Gendler**

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For most jobs, it's understood that you can be fired, whether for crime, incompetence, or just poor performance. But what if your job happens to be the most powerful position in the country, or the world? That's where impeachment comes in. Impeachment isn't the same as actually removing someone from office. Like an indictment in criminal court, it's only the formal accusation that launches a trial, which could end in conviction or acquittal. Originating in the United Kingdom, impeachment allowed Parliament to vote for removing a government official from office even without the king's consent. Although this was an important check on royal power, the king couldn't be impeached because the monarch was considered the source of all government power. But for the founders of the American Republic, there was no higher authority beyond the people themselves. And so impeachment was adopted in the United States as a power of Congress applying to any civil officers, up to and including the president. Although demands for impeachment can come from any members of the public, only the House of Representatives has the power to actually initiate the process. It begins by referring the matter to a committee, usually the House Committee on Rules and the House Committee on the Judiciary. These committees review the accusations, examine the evidence, and issue a recommendation. If they find sufficient grounds to proceed, the House holds a separate vote on each of the specific charges, known as Articles of Impeachment. If one or more passes by a simple majority, the official is impeached and the stage is set for trial. The actual trial that follows impeachment is held in the Senate. Selected members of the House, known as managers, act as the prosecution, while the impeached official and their lawyers present their defense. The Senate acts as both judge and jury, conducting the trial and deliberating after hearing all the arguments. If it's the president or vice president being impeached, the chief justice of the Supreme Court presides. A conviction requires a supermajority of two-thirds and results in automatic removal from power. Depending on the original charges, it can also disqualify them from holding office in the future and open them to standard criminal prosecution. So what exactly can get someone impeached? That's a bit more complicated. Unlike in the United Kingdom, impeachment in the U.S. pits an elected legislature against other democratically elected members of government. Therefore, to prevent the process from being used as a political weapon, the Constitution specifies that an official can only be impeached for treason, bribery, or other high crimes and misdemeanors. That still leaves a lot of room for interpretation, not to mention politics, and many impeachment trials have split along partisan lines. But the process is generally understood to be reserved for serious abuses of power. The first official to be impeached was Tennesse Senator William Blount in 1797 for conspiring with Britain to cease the Spanish colony of Louisiana. Since then, the House has launched impeachment investigations about 60 times, but only 19 have led to actual impeachment proceedings. The eight cases that ended in a conviction and removal from office were all federal judges. And impeachment of a sitting president is even more rare. Andrew Johnson was impeached in 1868 for attempting to replace Secretary of War Edwin Stanton without consulting the Senate. Over a century later, Bill Clinton was impeached for making false statements under oath during a sexual harassment trial. Both were ultimately acquitted when the Senate's votes to convict fell short of the required two-thirds majority. And contrary to popular belief, Richard Nixon was never actually impeached for the Watergate scandal. He resigned before it could happen knowing he would almost certainly be convicted. Theoretically, the U.S. government is already designed to prevent abuses of power, limiting different branches through a system of checks and balances, term limits, and free elections. But impeachment can be seen as an emergency brake for when these safeguards fail.

**P498 2017-08-22 The amazing ways plants defend themselves - Valentin Hammoudi**

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This is a tomato plant, and this is an aphid slowly killing the tomato plant by sucking the juice out of its leaves. The tomato is putting up a fight using both physical and chemical defenses to repel the attacking insects. But that's not all. The tomato is also releasing compounds that signal nearby tomato plants to release their own insect repellent. Plants are constantly under attack. They face threats ranging from microscopic fungi and bacteria, small herbivores, like aphids, caterpillars, and grasshoppers, up to large herbivores, like tortoises, koalas, and elephants. All are looking to devour plants to access the plentiful nutrients and water in their leaves, stems, fruits, and seeds. But plants are ready with a whole series of internal and external defenses that make them a much less appealing meal, or even a deadly one. Plants' defenses start at their surface. The bark covering tree trunks is full of lignin, a rigid web of compounds that's tough to chew and highly impermeable to pathogens. Leaves are protected by a waxy cuticle that deters insects and microbes. Some plants go a step further with painful structures to warn would-be predators. Thorns, spines, and prickles discourage bigger herbivores. To deal with smaller pests, some plants' leaves have sharp hair-like structures called trichomes. The kidney bean plant sports tiny hooks to stab the feet of bed bugs and other insects. In some species, trichomes also dispense chemical irritants. Stinging nettles release a mixture of histamine and other toxins that cause pain and inflammation when touched. For other plant species, the pain comes after an herbivore's first bite. Spinach, kiwi fruit, pineapple, fuchsia and rhubarb all produce microscopic needle-shaped crystals called raphides. They can cause tiny wounds in the inside of animals' mouths, which create entry points for toxins. The mimosa plant has a strategy designed to prevent herbivores from taking a bite at all. Specialized mechanoreceptor cells detect touch and shoot an electrical signal through the leaflet to its base causing cells there to release charged particles. The buildup of charge draws water out of these cells and they shrivel, pulling the leaflet closed. The folding movement scares insects away and the shrunken leaves look less appealing to larger animals. If these external defenses are breached, the plant immune system springs into action. Plants don't have a separate immune system like animals. Instead, every cell has the ability to detect and defend against invaders. Specialized receptors can recognize molecules that signal the presence of dangerous microbes or insects. In response, the immune system initiates a battery of defensive maneuvers. To prevent more pathogens from making their way inside, the waxy cuticle thickens and cell walls get stronger. Guard cells seal up pores in the leaves. And if microbes are devouring one section of the plant, those cells can self-destruct to quarantine the infection. Compounds toxic to microbes and insects are also produced, often tailor-made for a specific threat. Many of the plant molecules that humans have adopted as drugs, medicines and seasonings evolved as part of plants' immune systems because they're antimicrobial, or insecticidal. An area of a plant under attack can alert other regions using hormones, airborne compounds, or even electrical signals. When other parts of the plant detect these signals, they ramp up production of defensive compounds. And for some species, like tomatoes, this early warning system also alerts their neighbors. Some plants can even recruit allies to adopt a strong offense against their would-be attackers. Cotton plants under siege by caterpillars release a specific cocktail of ten to twelve chemicals into the air. This mixture attracts parasitic wasps that lay eggs inside the caterpillars. Plants may not be able to flee the scene of an attack, or fight off predators with teeth and claws, but with sturdy armor, a well-stocked chemical arsenal, a neighborhood watch, and cross-species alliances, a plant isn't always an easy meal.

**P499 2017-08-22 The science of smog - Kim Preshoff**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=499)

On July 26, 1943, Los Angeles was blanketed by a thick gas that stung people's eyes and blocked out the Sun. Panicked residents believed their city had been attacked using chemical warfare. But the cloud wasn't an act of war. It was smog. A portmanteau of smoke and fog, the word "smog" was coined at the beginning of the 20th century to describe the thick gray haze that covered cities such as London, Glasgow, and Edinburgh. This industrial smog was known to form when smoke from coal-burning home stoves and factories combined with moisture in the air. But the smog behind the LA panic was different. It was yellowish with a chemical odor. Since the city didn't burn much coal, its cause would remain a mystery until a chemist named Arie Haagen-Smit identified two culprits: volatile organic compounds, or VOCs, and nitrogen oxides. VOCs are compounds that easily become vapors and may contain elements, such as carbon, oxygen, hydrogen, chlorine, and sulfur. Some are naturally produced by plants and animals, but others come from manmade sources, like solvents, paints, glues, and petroleum. Meanwhile, the incomplete combustion of gas in motor vehicles releases nitrogen oxide. That's what gives this type of smog its yellowish color. VOCs and nitrogen oxide react with sunlight to produce secondary pollutants called PANs and tropospheric, or ground-level, ozone. PANs and ozone cause eye irritation and damage lung tissue. Both are key ingredients in photochemical smog, which is what had been plaguing LA. So why does smog affect some cities but not others? Both industrial and photochemical smog combine manmade pollution with local weather and geography. London's high humidity made it a prime location for industrial smog. Photochemical smog is strongest in urban areas with calm winds and dry, warm, sunny weather. The ultraviolet radiation from sunlight provides the energy necessary to breakdown molecules that contribute to smog formation. Cities surrounded by mountains, like LA, or lying in a basin, like Beijing, are also especially vulnerable to smog since there's nowhere for it to dissipate. That's also partially due to a phenomenon known as temperature inversion, where instead of warm air continuously rising upward, a pollution-filled layer of air remains trapped near the Earth's surface by a slightly warmer layer above. Smog isn't just an aesthetic eyesore. Both forms of smog irritate the eyes, nose, and throat, exacerbate conditions like asthma and emphysema, and increase the risk of respiratory infections like bronchitis. Smog can be especially harmful to young children and older people and exposure in pregnant women has been linked to low birth weight and potential birth defects. Secondary pollutants found in photochemical smog can damage and weaken crops and decrease yield, making them more susceptible to insects. Yet for decades, smog was seen as the inevitable price of civilization. Londoners had become accustomed to the notorious pea soup fog swirling over their streets until 1952, when the Great Smog of London shut down all transportation in the city for days and caused more than 4,000 respiratory deaths. As a result, the Clean Air Act of 1956 banned burning coal in certain areas of the city, leading to a massive reduction in smog. Similarly, regulations on vehicle emissions and gas content in the US reduced the volatile compounds in the air and smog levels along with them. Smog remains a major problem around the world. Countries like China and Poland that depend on coal for energy experience high levels of industrial smog. Photochemical smog and airborne particles from vehicle emissions affect many rapidly developing cities, from Mexico City and Santiago to New Delhi and Tehran. Governments have tried many methods to tackle it, such as banning cars from driving for days at a time. As more than half of the world's population crowds into cities, considering a shift to mass transit and away from fossil fuels may allow us to breathe easier.

**P500 2017-08-24 How many ways are there to prove the Pythagorean theorem - Betty Fei**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=500)

What do Euclid, twelve-year-old Einstein, and American President James Garfield have in common? They all came up with elegant proofs for the famous Pythagorean theorem, the rule that says for a right triangle, the square of one side plus the square of the other side is equal to the square of the hypotenuse. In other words, a²+b²=c². This statement is one of the most fundamental rules of geometry, and the basis for practical applications, like constructing stable buildings and triangulating GPS coordinates. The theorem is named for Pythagoras, a Greek philosopher and mathematician in the 6th century B.C., but it was known more than a thousand years earlier. A Babylonian tablet from around 1800 B.C. lists 15 sets of numbers that satisfy the theorem. Some historians speculate that Ancient Egyptian surveyors used one such set of numbers, 3, 4, 5, to make square corners. The theory is that surveyors could stretch a knotted rope with twelve equal segments to form a triangle with sides of length 3, 4 and 5. According to the converse of the Pythagorean theorem, that has to make a right triangle, and, therefore, a square corner. And the earliest known Indian mathematical texts written between 800 and 600 B.C. state that a rope stretched across the diagonal of a square produces a square twice as large as the original one. That relationship can be derived from the Pythagorean theorem. But how do we know that the theorem is true for every right triangle on a flat surface, not just the ones these mathematicians and surveyors knew about? Because we can prove it. Proofs use existing mathematical rules and logic to demonstrate that a theorem must hold true all the time. One classic proof often attributed to Pythagoras himself uses a strategy called proof by rearrangement. Take four identical right triangles with side lengths a and b and hypotenuse length c. Arrange them so that their hypotenuses form a tilted square. The area of that square is c². Now rearrange the triangles into two rectangles, leaving smaller squares on either side. The areas of those squares are a² and b². Here's the key. The total area of the figure didn't change, and the areas of the triangles didn't change. So the empty space in one, c² must be equal to the empty space in the other, a² + b². Another proof comes from a fellow Greek mathematician Euclid and was also stumbled upon almost 2,000 years later by twelve-year-old Einstein. This proof divides one right triangle into two others and uses the principle that if the corresponding angles of two triangles are the same, the ratio of their sides is the same, too. So for these three similar triangles, you can write these expressions for their sides. Next, rearrange the terms. And finally, add the two equations together and simplify to get ab²+ac²=bc², or a²+b²=c². Here's one that uses tessellation, a repeating geometric pattern for a more visual proof. Can you see how it works? Pause the video if you'd like some time to think about it. Here's the answer. The dark gray square is a² and the light gray one is b². The one outlined in blue is c². Each blue outlined square contains the pieces of exactly one dark and one light gray square, proving the Pythagorean theorem again. And if you'd really like to convince yourself, you could build a turntable with three square boxes of equal depth connected to each other around a right triangle. If you fill the largest square with water and spin the turntable, the water from the large square will perfectly fill the two smaller ones. The Pythagorean theorem has more than 350 proofs, and counting, ranging from brilliant to obscure. Can you add your own to the mix?

**P501 2017-08-29 The life cycle of a t-shirt - Angel Chang**

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Consider the classic white t-shirt. Annually, we sell and buy two billion t-shirts globally, making it one of the most common garments in the world. But how and where is the average t-shirt made, and what's its environmental impact? Clothing items can vary a lot, but a typical t-shirt begins its life on a farm in America, China, or India where cotton seeds are sown, irrigated and grown for the fluffy bolls they produce. Self-driving machines carefully harvest these puffs, an industrial cotton gin mechanically separates the fluffy bolls from the seeds, and the cotton lint is pressed into 225-kilogram bales. The cotton plants require a huge quantity of water and pesticides. 2,700 liters of water are needed to produce the average t-shirt, enough to fill more than 30 bathtubs. Meanwhile, cotton uses more insecticides and pesticides than any other crop in the world. These pollutants can be carcinogenic, harm the health of field workers, and damage surrounding ecosystems. Some t-shirts are made of organic cotton grown without pesticides and insecticides, but organic cotton makes up less than 1% of the 22.7 million metric tons of cotton produced worldwide. Once the cotton bales leave the farm, textile mills ship them to a spinning facility, usually in China or India, where high-tech machines blend, card, comb, pull, stretch, and, finally, twist the cotton into snowy ropes of yarn called slivers. Then, yarns are sent to the mill, where huge circular knitting machines weave them into sheets of rough grayish fabric treated with heat and chemicals until they turn soft and white. Here, the fabric is dipped into commercial bleaches and azo dyes, which make up the vivid coloring in about 70% of textiles. Unfortunately, some of these contain cancer-causing cadmium, lead, chromium, and mercury. Other harmful compounds and chemicals can cause widespread contamination when released as toxic waste water in rivers and oceans. Technologies are now so advanced in some countries that the entire process of growing and producing fabric barely touches a human hand. But only up until this point. After the finished cloth travels to factories, often in Bangladesh, China, India, or Turkey, human labor is still required to stitch them up into t-shirts, intricate work that machines just can't do. This process has its own problems. Bangladesh, for example, which has surpassed China as the world's biggest exporter of cotton t-shirts, employs 4.5 million people in the t-shirt industry, but they typically face poor conditions and low wages. After manufacture, all those t-shirts travel by ship, train, and truck to be sold in high-income countries, a process that gives cotton an enormous carbon footprint. Some countries produce their own clothing domestically, which cuts out this polluting stage, but generally, apparel production accounts for 10% of global carbon emissions. And it's escalating. Cheaper garments and the public's willingness to buy boosted global production from 1994 to 2014 by 400% to around 80 billion garments each year. Finally, in a consumer's home, the t-shirt goes through one of the most resource-intensive phases of its lifetime. In America, for instance, the average household does nearly 400 loads of laundry per year each using about 40 gallons of water. Washing machines and dryers both use energy, with dryers requiring five to six times more than washers. This dramatic shift in clothing consumption over the last 20 years, driven by large corporations and the trend of fast fashion has cost the environment, the health of farmers, and driven questionable human labor practices. It's also turned fashion into the second largest polluter in the world after oil. But there are things we can do. Consider shopping secondhand. Try to look for textiles made from recycled or organic fabrics. Wash clothes less and line dry to save resources. Instead of throwing them away at the end of their life, donate, recycle, or reuse them as cleaning rags. And, finally, you might ask yourself, how many t-shirts and articles of clothing will you consume over your lifetime, and what will be their combined impact on the world?

**P502 2017-08-30 Are you a body with a mind or a mind with a body - Maryam Alimardani**

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Look at your hand. How do you know it's really yours? It seems obvious, unless you've experienced the rubber hand illusion. In this experiment, a dummy hand is placed in front of you and your real hand is hidden behind a screen. Both are simultaneously stroked with a paint brush. No matter how much you remind yourself the dummy hand isn't yours, you eventually start to feel like it is, and inevitably flinch when it's threatened with a knife. That may just be a temporary trick, but it speaks to a larger truth: our bodies, the physical, biological parts of us, and our minds, the thinking, conscious aspects, have a complicated, tangled relationship. Which one primarily defines you or your self? Are you a physical body that only experiences thoughts and emotions as a result of biochemical interactions in the brain? That would be a body with a mind. Or is there some non-physical part of you that's pulling the strings but could live outside of your biological body? That would be a mind with a body. That takes us to an old question of whether the body and mind are two separate things. In a famous thought experiment, 16th-century philosopher René Descartes pointed out that even if all our physical sensations were just a hallucinatory dream, our mind and thoughts would still be there. That, for him, was the ultimate proof of our existence. And it led him to conclude that the conscious mind is something separate from the material body that forms the core of our identity. The notion of a non-physical consciousness echoes the belief of many religions in an immaterial soul for which the body is only a temporary shell. If we accept this, another problem emerges. How can a non-physical mind have any interaction with the physical body? If the mind has no shape, weight, or motion, how can it move your muscles? Or if we assume it can, why can your mind only move your body and not others? Some thinkers have found creative ways to get around this dilemma. For example, the French priest and philosopher Nicolas Malebranche claimed that when we think about reaching for a fork, it's actually god who moves our hand. Another priest philosopher named George Berkeley concluded that the material world is an illusion, existing only as mental perceptions. This question of mind versus body isn't just the domain of philosophers. With the development of psychology and neuroscience, scientists have weighed in, as well. Many modern scientists reject the idea that there's any distinction between the mind and body. Neuroscience suggests that our bodies, along with their physical senses, are deeply integrated with the activity in our brains to form what we call consciousness. From the day we're born, our mental development is formed through our body's interaction with the external world. Every sight, sound, and touch create new maps and representations in the brain that eventually become responsible for regulating our experience of self. And we have other senses, besides the typical five, such as the sense of balance and a sense of the relative location of our body parts. The rubber hand illusion, and similar virtual reality experiments, show that our senses can easily mislead us in our judgment of self. They also suggest that our bodies and external sensations are inseparable from our subjective consciousness. If this is true, then perhaps Descartes' experiment was mistaken from the start. After all, if we close our eyes in a silent room, the feeling of having a body isn't something we can just imagine away. This question of mind and body becomes particularly interesting at a time when we're considering future technologies, such as neural prosthetics and wearable robots that could become extended parts of our bodies. Or the slightly more radical idea of mind uploading, which dangles the possibility of immortal life without a body by transferring a human consciousness into a computer. If the body is deeply mapped in the brain, then by extending our sense of self to new wearable devices, our brains may eventually adapt to a restructured version with new sensory representations. Or perhaps uploading our consciousness into a computer might not even be possible unless we can also simulate a body capable of delivering physical sensations. The idea that our bodies are part of our consciousness and vice versa also isn't new. It's found extensively in Buddhist thought, as well as the writings of philosophers from Heidegger to Aristotle. But for now, we're still left with the open question of what exactly our self is. Are we a mind equipped with a physical body as Descartes suggested? Or a complex organism that's gained consciousness over millions of years of evolution thanks to a bigger brain and more neurons than our distant ancestors? Or something else entirely that no one's yet dreamt up?

**P503 2017-08-30 Should we get rid of standardized testing - Arlo Kempf**

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The first standardized tests that we know of were administered in China over 2,000 years ago during the Han dynasty. Chinese officials used them to determine aptitude for various government posts. The subject matter included philosophy, farming, and even military tactics. Standardized tests continued to be used around the world for the next two millennia, and today, they're used for everything from evaluating stair climbs for firefighters in France to language examinations for diplomats in Canada to students in schools. Some standardized tests measure scores only in relation to the results of other test takers. Others measure performances on how well test takers meet predetermined criteria. So the stair climb for the firefighter could be measured by comparing the time of the climb to that of all other firefighters. This might be expressed in what many call a bell curve. Or it could be evaluated with reference to set criteria, such as carrying a certain amount of weight a certain distance up a certain number of stairs. Similarly, the diplomat might be measured against other test-taking diplomats, or against a set of fixed criteria, which demonstrate different levels of language proficiency. And all of these results can be expressed using something called a percentile. If a diplomat is in the 70th percentile, 70% of test takers scored below her. If she scored in the 30th percentile, 70% of test takers scored above her. Although standardized tests are sometimes controversial, they're simply a tool. As a thought experiment, think of a standardized test as a ruler. A ruler's usefulness depends on two things. First, the job we ask it to do. Our ruler can't measure the temperature outside or how loud someone is singing. Second, the ruler's usefulness depends on its design. Say you need to measure the circumference of an orange. Our ruler measures length, which is the right quantity, but it hasn't been designed with the flexibility required for the task at hand. So, if standardized tests are given the wrong job, or aren't designed properly, they may end up measuring the wrong things. In the case of schools, students with test anxiety may have trouble performing their best on a standardized test, not because they don't know the answers, but because they're feeling too nervous to share what they've learned. Students with reading challenges may struggle with the wording of a math problem, so their test results may better reflect their literacy rather than numeracy skills. And students who were confused by examples on tests that contain unfamiliar cultural references may do poorly, telling us more about the test taker's cultural familiarity than their academic learning. In these cases, the tests may need to be designed differently. Standardized tests can also have a hard time measuring abstract characteristics or skills, such as creativity, critical thinking, and collaboration. If we design a test poorly, or ask it to do the wrong job, or a job it's not very good at, the results may not be reliable or valid. Reliability and validity are two critical ideas for understanding standardized tests. To understand the difference between them, we can use the metaphor of two broken thermometers. An unreliable thermometer gives you a different reading each time you take your temperature, and the reliable but invalid thermometer is consistently ten degrees too hot. Validity also depends on accurate interpretations of results. If people say results of a test mean something they don't, that test may have a validity problem. Just as we wouldn't expect a ruler to tell us how much an elephant weighs, or what it had for breakfast, we can't expect standardized tests alone to reliably tell us how smart someone is, how diplomats will handle a tough situation, or how brave a firefighter might turn out to be. So standardized tests may help us learn a little about a lot of people in a short time, but they usually can't tell us a lot about a single person. Many social scientists worry about test scores resulting in sweeping and often negative changes for test takers, sometimes with long-term life consequences. We can't blame the tests, though. It's up to us to use the right tests for the right jobs, and to interpret results appropriately.

**P504 2017-09-07 Why do we harvest horseshoe crab blood - Elizabeth Cox**

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During the warmer months, especially at night during the full moon, horseshoe crabs emerge from the sea to spawn. Waiting for them are teams of lab workers who capture the horseshoe crabs by the hundreds of thousands, take them to labs, harvest their cerulean blood, then return them to the sea. Oddly enough, we capture horseshoe crabs on the beach because that's the only place we know we can find them. A female horseshoe crab lays as many as 20 batches of up to 4,000 eggs on her annual visit to the beach. When the eggs hatch, the juvenile horseshoe crabs often stay near shore, periodically shedding their shells as they grow. Once they leave these shallow waters, they don't return until they reach sexual maturity ten years later. Despite our best efforts, we don't know where they spend those years. Though we've spotted the occasional horseshoe crab as deep as 200 meters below the ocean's surface, we only see large groups of adults when they come ashore to spawn. Horseshoe crab blood contains cells called amebocytes that protect them from infection by viruses, fungi, and bacteria. Amebocytes form gels around these invaders to prevent them from spreading infections. This isn't unusual. All animals have protective immune systems. But horseshoe crab amebocytes are exceptionally sensitive to bacterial endotoxins. Endotoxins are molecules from the cell walls of certain bacteria, including E. coli. Large amounts of them are released when bacterial cells die, and they can make us sick if they enter the blood stream. Many of the medicines and medical devices we rely on can become contaminated, so we have to test them before they touch our blood. We do have tests called Gram stains that detect bacteria, but they can't recognize endotoxins which can be there even when bacteria aren't present. So scientists use an extract called LAL produced from harvested horseshoe crab blood to test for endotoxins. They add LAL to a medicine sample, and if gels form, bacterial endotoxins are present. Today, the LAL test is used so widely that millions of people who've never seen a horseshoe crab have been protected by their blood. If you've ever had an injection, that probably includes you. How did horseshoe crabs end up with such special blood? Like other invertebrates, the horseshoe crab has an open circulatory system. This means their blood isn't contained in blood vessels, like ours. Instead, horseshoe crab blood flows freely through the body cavity and comes in direct contact with tissues. If bacteria enters their blood, it can quickly spread over a large area. Pair this vulnerability with the horseshoe crab's bacteria-filled ocean and shoreline habitats, and it's easy to see why they need such a sensitive immune response. Horseshoe crabs survived mass extinction events that wiped out over 90% of life on Earth and killed off the dinosaurs, but they're not invincible. And the biggest disruptions they've faced in millions of years come from us. Studies have shown that up to 15% of horseshoe crabs die in the process of having their blood harvested. And recent research suggests this number may be even higher. Researchers have also observed fewer females returning to spawn at some of the most harvested areas. Our impact on horseshoe crabs extends beyond the biomedical industry, too. Coastal development destroys spawning sites, and horseshoe crabs are also killed for fishing bait. There's ample evidence that their populations are shrinking. Some researchers have started working to synthesize horseshoe crab blood in the lab. For now, we're unlikely to stop our beach trips, but hopefully, a synthetic alternative will someday eliminate our reliance on the blood of these ancient creatures.

**P505 2017-09-08 A brief history of banned numbers - Alessandra King**

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They say the pen is mightier than the sword, and authorities have often agreed. From outlawed religious tracts and revolutionary manifestos to censored and burned books, we know the potential power of words to overturn the social order. But as strange as it may seem, some numbers have also been considered dangerous enough to ban. Our distant ancestors long counted objects using simple tally marks. But as they developed agriculture and began living together in larger groups, this was no longer enough. As numbers grew more complex, people began not just using them, but thinking about what they are and how they work. And by 600 B.C.E. in Ancient Greece, the study of numbers was well-developed. The mathematician Pythagoras and his school of followers found numerical patterns in shapes, music, and the stars. For them, mathematics held the deepest secrets of the universe. But one Pythagorean named Hippasus discovered something disturbing. Some quantities, like the diagonal of a square with sides of length one couldn't be expressed by any combination of whole numbers or fractions, no matter how small. These numbers, which we call irrational numbers, were perceived as a threat to the Pythagorean's notion of a perfect universe. They imagined a reality that could be described with rational, numerical patterns. Historians write that Hippasus was exhiled for publicizing his findings, while legends claim he was drowned as punishment from the gods. While irrational numbers upset philosophers, later mathematical inventions would draw attention from political and religious authorities, as well. In the Middle Ages, while Europe was still using Roman numerals, other cultures had developed positional systems that included a symbol for zero. When Arab travelers brought this system to the bustling maritime cities of Italy, its advantages for merchants and bankers was clear. But the authorities were more wary. Hindu-Arabic numerals were considered easier to forge or alter, especially since they were less familiar to customers than to merchants. And the concept of zero opened the door to negative numbers and the recording of debt at a time when moneylending was regarded with suspicion. In the 13th century, Florence banned the use of Hindu-Arabic numerals for record keeping. And though they soon proved too useful to ignore, controversies over zero and negative numbers continued for a long time. Negative numbers were dismissed as absurd well into the 19th century. And prominent mathematicians, like Gerolamo Cardano, avoided using zero, even though it would have made it much easier to find solutions to cubic and the quartic equations. Even today it's illegal to use some numbers for different reasons. Some are banned because of what they represent. For example, governments have prohibited the display of numbers that have symbolic meaning, such as the date of a revolution or connections to oppositional political figures or parties. Other numbers are potentially illegal because of the information they carry. Just about any information, whether text, image, video, or executable programs can be translated into a string of numbers. But this means that protected information, whether copyrights, proprietary materials, or state secrets can also be represented as numbers, so possessing or publishing these numbers may be treated as a criminal offense. This idea gathered attention in 2001 when code that could be used to decrypt DVDs was widely shared and distributed in the form of a large prime number. The idea of illegal numbers may sound absurd, but like words, written numbers are a way of expressing concepts and information. And in a world where calculations and algorithms shape more and more of our lives, the mathematician's pencil grows stronger by the day.

**P506 2017-09-08 What are gravitational waves - Amber L. Stuver**

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At about six o'clock in the morning on September 14, 2015, scientists witnessed something no human had ever seen: two black holes colliding. Both about 30 times as massive as our Sun, they had been orbiting each other for millions of years. As they got closer together, they circled each other faster and faster. Finally, they collided and merged into a single, even bigger, black hole. A fraction of a second before their crash, they sent a vibration across the universe at the speed of light. And on Earth, billions of years later, a detector called the Laser Interferometer Gravitational Wave Observatory, or LIGO for short, picked it up. The signal only lasted a fifth of a second and was the detector's first observation of gravitational waves. What are these ripples in space? The answer starts with gravity, the force that pulls any two objects together. That's the case for everything In the observable universe. You're pulling on the Earth, the Moon, the Sun, and every single star, and they're pulling on you. The more mass something has, the stronger its gravitational pull. The farther away the object, the lower its pull. If every mass has an effect on every other mass in the universe, no matter how small, then changes in gravity can tell us about what those objects are doing. Fluctuations in the gravity coming from the universe are called gravitational waves. Gravitational waves move out from what caused them, like ripples on a pond, getting smaller as they travel farther from their center. But what are they ripples on? When Einstein devised his Theory of Relativity, he imagined gravity as a curve in a surface called space-time. A mass in space creates a depression in space-time, and a ball rolling across a depression will curve like it's being attracted to the other mass. The bigger the mass, the deeper the depression and the stronger the gravity. When the mass making the depression moves, that sends out ripples in space-time. These are gravitationl waves. What would a gravitational wave feel like? If our bodies were sensitive enough to detect them, we'd feel like we were being stretched sideways while being compressed vertically. And in the next instant, stretched up and down while being compressed horizontally, sideways, then up and down. This back and forth would happen over and over as the gravitational wave passed right through you. But this happens on such a minute scale that we can't feel any of it. So we've built detectors that can feel it for us. That's what the LIGO detectors do. And they're not the only ones. There are gravitational wave detectors spread across the world. These L-shaped instruments have long arms, whose exact length is measured with lasers. If the length changes, it could be because gravitational waves are stretching and compressing the arms. Once the detectors feel a gravitational wave, scientists can extract information about the wave's source. In a way, detectors like LIGO are big gravitational wave radios. Radio waves are traveling all around you, but you can't feel them or hear the music they carry. It takes the right kind of detector to extract the music. LIGO detects a gravitational wave signal, which scientists then study for data about the object that generated it. They can derive information, like its mass and the shape of its orbit. We can also hear gravitational waves by playing their signals through speakers, just like the music a radio extracts from radio waves. So those two black holes colliding sounds like this. Scientists call this slide whistle-like noise a chirp, and it's the signature of any two objects orbiting into each other. The black hole collision was just one example of what gravitational waves can tell us. Other high-energy astronomical events will leave gravitational echoes, too. The collapse of a star before it explodes in a supernova, or a very dense neutron stars colliding. Every time we create a new tool to look at space, we discover something we didn't expect, something that might revolutionize our understanding of the universe. LIGO's no different. In the short time it's been on, LIGO's already revealed surprises, like that black holes collide more often than we ever expected. It's impossible to say, but exciting to imagine, what revelations may now be propagating across space towards our tiny blue planet and its new way of perceiving the universe.

**P507 2017-09-11 The strange case of the cyclops sheep - Tien Nguyen**

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In the 1950s, a group of ranchers in Idaho were baffled when their sheep gave birth to lambs with a singular deformity. Mystified by these cyclops sheep, they called in scientists from the U.S. Department of Agriculture to investigate. The researchers hypothesized that the pregnant ewes had snacked on poisonous birth defect-causing plants. They collected the local flora and fed samples to lab rats, but struggled to replicate the effect. So they decided to directly observe the sheep with one scientist even living with the herd for three summers. After a decade of trial and error, the scientists finally found the culprit, wild corn lilies. The lilies contained an active molecule with six connected rings that they named cyclopamine in reference to the cyclops sheep. They didn't know exactly how cyclopamine caused the defect but told ranchers to steer clear. It took about four decades before a team of biologists, led by Professor Philip Beachy, stumbled upon the answer. His lab was studying a specific gene found in many species, from mice to humans, called the hedgehog gene. It was named by two scientists, who later shared the Noble Prize for their work, who found that mutating this gene in fruit flies produced pointy spikes like a hedgehog. Beachy and his colleagues performed genetic modifications to turn off the hedgehog genes in mice. This resulted in severe defects in the development of their brains, organs, and eyes or, rather, eye. Then while perusing a textbook, Beachy came across photos of the cyclops sheep and realized what had eluded scientists for four decades. Something must have gone awry involving the hedgehog gene. Let's take a step back. Genes contain instructions that tell cells what to do and when to do it, and they communicate their directives using proteins. The hedgehog gene itself tells cells to release a so-called hedgehog protein, which kicks off a complex series of cellular signals. Here's how it works in normal healthy development. Hedgehog protein latches on to a protein called patched. That inhibits, or holds, patched back, allowing another protein called smoothened to freely signal the cells, telling them where to go and what kind of tissues to become. Cyclopamine, say in the form of a delicious corn lily, interrupts this pathway by binding onto smoothened. That locks smoothened up so that it's unable to send the signals needed to mold the brain into two hemispheres, and form fingers or separate eyes. So even though the hedgehog protein is still doing its job of keeping the way clear for smoothened, cyclopamine blocks smoothened from passing along its chemical message. That settled the science behind the one-eyed sheep, but Beachy and his team caught the glimmer of another more beneficial connection. They noted that uncontrolled activation of the smoothened protein was associated with a human syndrome. It's known as Basal Cell Nevus Syndrome, and it predisposes people to certain cancers. The scientists proposed putting cyclopamine's smoothened binding powers to good use as a treatment for these cancers, as long as the patient wasn't pregnant. Unfortunately, researchers eventually found that cyclopamine causes negative side effects, and its chemical properties make it difficult to work with. But they did discover that closely related molecules are safe and effective, and two of these drugs were approved in 2012 and 2015 as skin cancer medicines. When those farmers first saw the cyclops sheep, they could have chalked it up to a freak genetic mutation and walked away. Instead, their decision to investigate turned a mystery into medicine showing that sometimes there's more than meets the eye.

**P508 2017-09-18 Why should you read Virginia Woolf - Iseult Gillespie**

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What if William Shakespeare had a sister who matched his imagination, his wit, and his way with words? Would she have gone to school and set the stage alight? In her essay "A Room of One's Own," Virginia Woolf argues that this would have been impossible. She concocts a fictional sister who's stuck at home, snatching time to scribble a few pages before she finds herself betrothed and runs away. While her brother finds fame and fortune, she remains abandoned and anonymous. In this thought experiment, Woolf demonstrates the tragedy of genius restricted, and looks back through time for hints of these hidden histories. She wrote, "When one reads of a witch being ducked, of a woman possessed by devils, of a wise woman selling herbs, or even a very remarkable man who had a mother, then I think we're on the track of a lost novelist, a suppressed poet, of some mute and inglorious Jane Austen." "A Room of One's Own" considers a world denied great works of art due to exclusion and inequality. How best can we understand the internal experience of alienation? In both her essays and fiction, Virginia Woolf shapes the slippery nature of subjective experience into words. Her characters frequently lead inner lives that are deeply at odds with their external existence. To help make sense of these disparities, the next time you read Woolf, here are some aspects of her life and work to consider. She was born Adeline Virginia Stephen in 1882 to a large and wealthy family, which enabled her to pursue a life in the arts. The death of her mother in 1895 was followed by that of her half-sister, father, and brother within the next ten years. These losses led to Woolf's first depressive episode and subsequent institutionalization. As a young woman, she purchased a house in the Bloomsbury area of London with her siblings. This brought her into contact with a circle of creatives, including E.M. Forster, Clive Bell, Roger Fry, and Leonard Woolf. These friends became known as the Bloomsbury Group, and Virginia and Leonard married in 1912. The members of this group were prominent figures in Modernism, a cultural movement that sought to push the boundaries of how reality is represented. Key features of Modernist writing include the use of stream of consciousness, interior monologue, distortions in time, and multiple or shifting perspectives. These appear in the work of Ezra Pound, Gertrude Stein, James Joyce, and Woolf herself. While reading Joyce's "Ulysses," Woolf began writing "Mrs. Dalloway." Like "Ulysses," the text takes place over the course of a single day and opens under seemingly mundane circumstances. "Mrs. Dalloway said she would buy the flowers herself." But the novel dives deeply into the characters' traumatic pasts, weaving the inner world of numbed socialite Clarissa Dalloway, with that of the shell-shocked veteran Septimus Warren Smith. Woolf uses interior monologue to contrast the rich world of the mind against her characters' external existences. In her novel "To the Lighthouse," mundane moments, like a dinner party, or losing a necklace trigger psychological revelations in the lives of the Ramsay's, a fictionalized version of Woolf's family growing up. "To the Lighthouse" also contains one of the most famous examples of Woolf's radical representation of time. In the Time Passes section, ten years are distilled into about 20 pages. Here, the lack of human presence in the Ramsays' beach house allows Woolf to reimagine time in flashes and fragments of prose. "The house was left. The house was deserted. It was left like a shell on a sand hill to fill with dry salt grains now that life had left it." In her novel "The Waves," there is little distinction between the narratives of the six main characters. Woolf experiments with collective consciousness, at times collapsing the six voices into one. "It is not one life that I look back upon: I am not one person: I am many people: I do not altogether know who I am, Jinny, Susan, Neville, Rhoda or Louis, or how to distinguish my life from their's." In "The Waves," six become one, but in the gender-bending "Orlando," a single character inhabits multiple identities. The protagonist is a poet who switches between genders and lives for 300 years. With its fluid language and approach to identity, "Orlando" is considered a key text in gender studies. The mind can only fly so far from the body before it returns to the constraints of life. Like many of her characters, Woolf's life ended in tragedy when she drowned herself at the age of 59. Yet, she expressed hope beyond suffering. Through deep thought, Woolf's characters are shown to temporarily transcend their material reality, and in its careful consideration of the complexity of the mind, her work charts the importance of making our inner lives known to each other.

**P509 2017-09-19 How aspirin was discovered - Krishna Sudhir**

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4,000 years ago, the ancient Sumerians made a surprising discovery. If they scraped the bark off a particular kind of tree and ate it, their pain disappeared. Little did they know that why they'd found was destined to influence the future course of medicine. What the Sumerians had discovered was a precursor to the medicine known today as aspirin. Aspirin's active ingredient is found commonly in willow trees and other wild plants, which is how it came to infuse the medical traditions of Sumer, ancient Egypt, ancient Greece, and other cultures. Around 400 BC, Hippocrates, thought of as the father of modern medicine, first recommended chewing willow bark for pain relief and making willow leaf tea to ease the pain of childbirth. But it took over 2,000 years for us to comprehensively investigate its potential. In the mid-18th century, an Englishman named Edward Stone ran five years of experiments, showing that willow bark crushed into a powder and eaten could cure a fever. It took nearly another 70 years for a German pharmacist, Johann Buchner, to finally identify and purify the substance that made all this possible, a compound called salicin. By then, doctors were routinely using willow bark and other salicin-rich plants, like the herb meadowsweet, to ease pain, fever, and inflammation. But identifying the exact compound suddenly opened up the possibility of manipulating its form. In 1853, a French chemist managed to chemically synthesize the compound, creating a substance called acetylsalicylic acid. Then in 1897, the pharmaceutical company Bayer found a new method and began marketing the compound as a pain reliever called aspirin. This was widely recognized as one of the first synthetic pharmaceutical drugs. Originally, aspirin was just Bayer's brand name: A for acetyl, and spir for meadowsweet, whose botanical name is Spiraea ulmaria. Soon, aspirin became synonymous with acetylsalicylic acid. As its influence grew, aspirin was found to ease not just pain, but also many inflammation-related problems, like rheumatoid arthritis, pericarditis, which enflames the fluid-filled sack around the heart, and Kawasaki disease, where blood vessels become inflamed. Yet, despite aspirin's medical value, at this point, scientists still didn't actually know how it worked. In the 1960s and 70s, Swedish and British scientists changed that. They showed that the drug interrupts the production of certain chemicals called prostaglandins, which control the transmission of pain sensations and inflammation. In 1982, that discovery won the researchers a Nobel Prize in Medicine. Over time, research has also uncovered aspirin's risks. Overconsumption can cause bleeding in the intestines and the brain. It can also trigger Reye's Syndrome, a rare but often fatal illness that affects the brain and liver in children with an infection. And in the late 20th century, aspirin's success had been overshadowed by newer pain killers with fewer side effects, like acetaminophen and ibuprofen. But in the 1980s, further discoveries about aspirin's benefits revived interest in it. In fact, the 1982 Nobel Prize winners also demonstrated that aspirin slows production of thromboxanes, chemicals that cause clumping of platelets, which in turn form blood clots. A landmark clinical trial showed that aspirin reduced heart attack risk by 44% in participants who took the drug. Today, we prescribe it to people at risk of heart attack or stroke because it cuts the likelihood of clots forming in the arteries that supply the heart and brain. Even more intriguingly, there's a growing body of research that suggests aspirin reduces the risk of getting and dying from cancer, especially colorectal cancer. This might be due to aspirin's anti-platelet effects. By reducing platelet activity, aspirin may decrease the levels of a certain protein that helps cancer cells spread. These discoveries have transformed aspirin from a mere pain reliever to a potentially life-saving treatment. Today, we consume about 100 billion aspirin tablets each year, and researchers continue searching for new applications. Already, aspirin's versatility has transformed modern medicine, which is astounding considering its humble beginnings in a scraping of willow bark.

**P510 2017-09-20 The surprising cause of stomach ulcers - Rusha Modi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=510)

In 1984, an enterprising Australian doctor named Barry Marshall decided to take a risk. Too many of his patients were complaining of severe abdominal pain due to stomach ulcers, which are sores in the lining of the upper intestinal tract. At the time, few effective treatments for ulcers existed, and many sufferers required hospitalization or even surgery. Desperate for answers, Dr. Marshall swallowed a cloudy broth of bacteria collected from the stomach of one of his patients. Soon, Dr. Marshall was experiencing the same abdominal pain, bloating, and vomiting. Ten days later, a camera called an endoscope peered inside his insides. Marshall's stomach was teeming with the same bacteria as his patient. He'd also developed gastritis, or severe inflammation of the stomach, the hallmark precursor of ulcers. Dr. Marshall's idea challenged a misconception that still persists to this day: that ulcers are caused by stress, food, or too much stomach acid. Marshall thought the culprit was bacterial infections. Initially, his idea was considered crazy by the brightest medical minds on the planet. But in 2005, he and Dr. Robin Warren received the ultimate validation when they were awarded the Nobel Prize for medicine. Our stomachs are J-shaped organs with surprisingly intricate ecosystems awash in hormones and chemicals. The stomach is under constant attack by digestive enzymes, bile, proteins, microbes, and the stomach's own acid. In response, it produces bicarbonate, mucus, and phospholipids called prostaglandins to maintain the integrity of its own lining. This delicate balance is constantly regulated and referred to as mucosal defense. Since the mid-1800s, doctors thought stress alone caused most stomach ulcers. Patients were given antidepressants or tranquilizers and told to visit health spas. This belief eventually shifted to the related notion of spicy foods and stress as culprits. Yet no convincing study has ever demonstrated that emotional upset, psychological distress, or spicy food directly causes ulcer disease. By the mid-20th century, it was widely accepted that excess hydrochloric acid prompted the stomach to eat itself. Fervent proponents of this idea were referred to as the acid mafia. The biggest hole in this theory was that antiacids only provide temporary relief. We now know that some rare ulcers are indeed caused by too much hydrochloric acid. But they make up less than 1% of all cases. Dr. Marshall and Dr. Warren pinpointed a spiral-shaped bacteria called Helicobacter pylori, or H. pylori, as the real offender. H. pylori is one of humanity's oldest and most frequent companions, having joined us at least 50,000 years ago, and now found in 50% of people. Previously, we thought the stomach was sterile on account of it being such an acidic, hostile environment. Yet H. pylori survives the acidic turmoil of the stomach with a variety of features that disrupt mucosal defense in its favor. For example, it produces an enzyme called urease that helps protect it from the surrounding gastric acid. H. pylori can make over 1,500 proteins, many of which are dedicated to maximizing its virulence. We still have unanswered questions, like why specific people develop ulcers at particular times. However, we do know individual genetics, other medical problems, use of certain medications, smoking, and the genetic diversity of Helicobacter strains all play a role. In particular, certain pain medications used to reduce inflammation in joints have been discovered to work with H. pylori to create more severe stomach ulcers. Dr. Marshall ended up being fine after his famous, albeit dangerous, experiment. He ingested a course of antibiotics similar to the ones taken now for ulcers. To be treated by simple antibiotics is a modern triumph for a disease that previously needed surgery. Marshall's work also reminded us that scientific progress is not always smooth. But there's value in trusting your proverbial, and sometimes literal, gut.

**P511 2017-09-21 Is DNA the future of data storage - Leo Bear-McGuinness**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=511)

Let's say there's a disaster that sends humanity back to the Stone Age. Can our knowledge and history survive? The printed page will decompose. Hard drive storage will deteriorate. Even stones will eventually crumble. But we might have something inside us that can outlast these physical limitations: deoxyribonucleic acid. DNA already stores our biological information. From eye color to skin tone, it programs our entire bodies. DNA is made of four organic bases: adenine, guanine, cytosine, and thymine, or A, G, C, and T. The specific sequence of these bases into groups of three, known as codons, gives our cells instructions to make each of the proteins in our bodies. But this code can be used for other things, too, like secret messages. In 1999, scientists in New York created an alphabet in which each of the 64 possible DNA codons substituted for a specific letter, number, or grammar symbol. They spliced a 22-character message into a long strand of DNA and surrounded it with specific genetic markers. They then hid the DNA over a period in a type-written letter with only a small smudge to give the location away. They mailed the letter back to themselves. Then they examined the letter looking for the DNA strand. Once the DNA strand was located, they found the genetic markers. Then, they sequenced the DNA and successfully decoded the message. It soon became obvious that DNA cryptography could code for much more than simple text. By translating the 1's and 0's of binary code into DNA codons, digital data could be programmed into synthetic DNA, then decoded back into its original form. In 2012, UK scientists encoded 739 kilobytes of computer files into DNA strands, including all 154 Shakespeare sonnets and an excerpt from Martin Luther King's "I Have a Dream" speech. And four years later, researchers at Microsoft and the University of Washington broke that record. They used binary coding to capture a whopping 200 megabytes of data, including the Universal Declaration of Human Rights and a high-def OK Go music video, all in strings of DNA. As far as storage capacity goes, DNA stands out because of the surprising amount of information it can hold in so little space. The current theoretical limit of DNA'S storage capacity is so high that you could fit 100 million HD movies on a pencil eraser. It's even conceivable that one day we could fit all of the information currently on the Internet into the space of a shoe box. Also, computers and the magnetic tape and discs that their information is stored on only last for a few decades, at most, before degrading and becoming unreliable. Meanwhile, DNA has a half-life of 500 years, meaning that's how long it takes for half of its bonds to break. And if left in a cold and dark environment, DNA could potentially last for hundreds of thousands of years. And if that isn't long enough, scientists experimented with having synthetic DNA auto-reproduce. After creating their own strands of DNA that spelled out the lyrics to the children's song "It's a Small World," they placed them into the genome of a microbe nicknamed Conan the Bacterium. Conan belongs to a species which can survive in a vacuum, or without water, for six years, or come out unscathed after being exposed to a dose of radiation 1,000 times that which would kill a human. According to the experiment, the bacterium was able to reproduce at least 100 generations without data loss. Theoretically, if the organism had redundant copies of the information that could be used to automatically correct mistakes, the information could stay preserved even longer. So one day, you might be able to create a living, growing, knowledge archive in your own backyard, and its seeds might carry your family's history, a detailed breakdown of the world's political upheavals, or the sum of humanity's knowledge into forests and across continents. Perhaps even into the far reaches of space. Though we might one day disappear, perhaps our legacy can still live on, if anyone would think to find it.

**P512 2017-09-30 How did Polynesian wayfinders navigate the Pacific Ocean - Alan Tamay**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=512)

Imagine setting sail from Hawaii in a canoe. Your target is a small island thousands of kilometers away in the middle of the Pacific Ocean. That's a body of water that covers more than 160 million square kilometers, greater than all the landmasses on Earth combined. For thousands of years, Polynesian navigators managed voyages like this without the help of modern navigational aids. Ancient Polynesians used the Sun, Moon, stars, planets, ocean currents, and clouds as guides that allowed them to see the ocean as a series of pathways rather than an obstacle. Their voyages began around 1500 B.C. when the people who would settle Polynesia first set sail from Southeast Asia. Early Polynesians eventually settled a vast area of islands spread over 40 million square kilometers of the Pacific Ocean. Some historians believe the voyagers moved from place to place to avoid overpopulation. Others, that they were driven by war. Voyages became less frequent by around 1300 A.D. as Polynesian societies became more rooted in specific locations. During the voyaging period, successful journeys depended on a number of factors: well-built canoes, the skill of navigators, and weather being some of the biggest. Voyages relied on sturdy wa'a kaulua, or double-hulled canoes, which were powered by sails and steered with a single large oar. Canoe building involved the whole community, bringing together the navigators, canoe builders, priests, chanters, and hula dancers. Navigators were keen observers of the natural world. They were abundantly familiar with trade wind-generated ocean swells, which typically flow northeast or southeast. By day, navigators could identify direction by the rocking motion of their canoes caused by these swells. But sunrise and sunset were even more useful. The Sun's position indicated east and west and created low light on the ocean that made it possible to see swells directly. At night, navigators used something called a star compass, which wasn't a physical object, but rather a sort of mental map. They memorized the rising and setting points of stars and constellations at different times of the year. They used those to divide the sky into four quadrants, subdivided into 32 houses, with the canoe in the middle. So, for example, when they saw the star Pira‘atea rising from the ocean, they knew that to be northeast. They had some other tricks, too. The Earth's axis points towards Hokupa'a, or the North Star, so called because it's the one fixed point in the sky as the Earth rotates and always indicates north. However, it's not visible south of the Equator, so navigators there could use a constellation called Newe, or the Southern Cross, and some mental tricks to estimate where south is. For instance, draw a line through these two stars, extend it 4.5 times, and draw another line from there to the horizon. That's south. But the sky also contains navigational aids much closer to Earth, the clouds. Besides being useful weather cues, under the right conditions, they can indicate landmasses. For instance, the lagoons of Pacific atolls can actually be seen reflected on the underside of clouds, if you know what to look for. And high masses of clouds can indicate mountainous islands. Once navigators neared their destination, other clues, such as the flight patterns of birds, floating debris or vegetation, and types of fish in the area helped determine the proximity of land. For example, the Manu-O-Ku had a known flight range of 190 kilometers, and could be followed back to shore. So how do we know all of this? Partially through evidence in petroglyphs, written observations of European explorers, and Polynesian oral traditions. But also by trying them out for ourselves. In 2017, a voyaging canoe called Hokulea completed a worldwide voyage using only these techniques. If that seems remarkable, remember the ancient Polynesians, who through close study and kinship with nature, were able to forge these paths across an unfathomably vast, vibrant living ocean.

**P513 2017-10-04 The first asteroid ever discovered - Carrie Nugent**

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On the night of January 1, 1801, Giuseppe Piazzi, a priest in Palermo, Italy, was mapping the stars in the sky. Over three nights, he'd look at and draw the same set of stars, carefully measuring their relative positions. That night, he measured the stars. The next night, he measured them again. To his surprise, one had moved. The third night, the peculiar star had moved again. This meant it couldn't be a star at all. It was something new, the first asteroid ever discovered, which Piazzi eventually named Ceres. Asteroids are bits of rock and metal that orbit the Sun. At over 900 kilometers across, Ceres is a very large asteroid. But through a telescope, like Piazzi's, Ceres looked like a pinpoint of light similar to a star. In fact, the word asteroid means star-like. You can tell the difference between stars and asteroids by the way they move across the sky. Of course, Piazzi knew none of that at the time, just that he had discovered something new. To learn about Ceres, Piazzi needed to track its motion across the sky and then calculate its orbit around the Sun. So each clear night, Piazzi trained his telescope to the heavens. Night after night, he made careful measurements until finally, he couldn't. The Sun got in the way. When Piazzi first spotted Ceres, it was here, and the Earth was here. As he tracked it each night, the Earth and Ceres moved like this until Ceres was here. And that meant that Ceres was only in the sky when it was daytime on Earth. During the day, bright sunlight made this small asteroid impossible to see. Astronomers needed to calculate Ceres's orbit. This would let them predict where it was going to be in the vast night sky on any given night. But the calculations were grueling and the results imprecise. Many astronomers searched for Ceres, but not knowing exactly where to look, no one could find it. Luckily, a hardworking mathematician named Carl Friedrich Gauss heard about the lost asteroid. He thought it was an exciting puzzle and went to work. When he realized he didn't have the mathematical methods he needed, he invented new ones that we still use today. He derived a new orbit and new predictions of where to look for Ceres. Hungarian astronomer Baron Franz Xaver von Zach searched for Ceres with Gauss's predictions. After weeks of frustrating clouds, von Zach finally had clear skies on December 31, 1801. He looked through his telescope and finally saw Ceres. We haven't lost track of it since. Today, we've discovered hundreds of thousands of asteroids. Many, including Ceres, orbit the Sun between Mars and Jupiter, while near-Earth asteroids orbit the Sun relatively close to Earth. When we recorded this narration, astronomers had discovered 16,407 near-Earth asteroids, but since we find new asteroids all the time, that number will have grown by hundreds or thousands by the time you watch this. Today, asteroid hunters use modern telescopes, including one in space. Computers analyze the images, and humans check the output before reporting the asteroid observations to an archiving center. Each discovered asteroid has its unique orbit measured. An orbit lets astronomers predict where asteroids are going to be at any given time. Most asteroid trajectories can be predicted for about 80 years though we can calculate where the best studied asteroids will be every day between now and 800 years into the future. We must keep searching for asteroids in case there's one out there on a collision course with Earth. Astronomers don't only search for asteroids, though. They also study them to learn how they formed, what they're made of, and what they can tell us about our solar system. Today, we can do something that Piazzi could only dream of: send spacecraft to study asteroids up close. One spacecraft called Dawn journeyed billions of kilometers over four years to the main asteroid belt. There, it visited Ceres and another asteroid, Vesta. Dawn's stunning images transformed Piazzi's dot of light into a spectacular landscape of craters, landslides, and mountains.

**P514 2017-10-09 What in the world is topological quantum matter - Fan Zhang**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=514)

What if electricity could travel forever without being diminished? What if a computer could run exponentially faster with perfect accuracy? What technology could those abilities build? We may be able to find out thanks to the work of the three scientists who won the Nobel Prize in Physics in 2016. David Thouless, Duncan Haldane, and Michael Kosterlitz won the award for discovering that even microscopic matter at the smallest scale can exhibit macroscopic properties and phases that are topological. But what does that mean? First of all, topology is a branch of mathematics that focuses on fundamental properties of objects. Topological properties don't change when an object is gradually stretched or bent. The object has to be torn or attached in new places. A donut and a coffee cup look the same to a topologist because they both have one hole. You could reshape a donut into a coffee cup and it would still have just one. That topological property is stable. On the other hand, a pretzel has three holes. There are no smooth incremental changes that will turn a donut into a pretzel. You'd have to tear two new holes. For a long time, it wasn't clear whether topology was useful for describing the behaviors of subatomic particles. That's because particles, like electrons and photons, are subject to the strange laws of quantum physics, which involve a great deal of uncertainty that we don't see at the scale of coffee cups. But the Nobel Laureates discovered that topological properties do exist at the quantum level. And that discovery may revolutionize materials science, electronic engineering, and computer science. That's because these properties lend surprising stability and remarkable characteristics to some exotic phases of matter in the delicate quantum world. One example is called a topological insulator. Imagine a film of electrons. If a strong enough magnetic field passes through them, each electron will start traveling in a circle, which is called a closed orbit. Because the electrons are stuck in these loops, they're not conducting electricity. But at the edge of the material, the orbits become open, connected, and they all point in the same direction. So electrons can jump from one orbit to the next and travel all the way around the edge. This means that the material conducts electricity around the edge but not in the middle. Here's where topology comes in. This conductivity isn't affected by small changes in the material, like impurities or imperfections. That's just like how the hole in the coffee cup isn't changed by stretching it out. The edge of such a topological insulator has perfect electron transport: no electrons travel backward, no energy is lost as heat, and the number of conducting pathways can even be controlled. The electronics of the future could be built to use this perfectly efficient electron highway. The topological properties of subatomic particles could also transform quantum computing. Quantum computers take advantage of the fact that subatomic particles can be in different states at the same time to store information in something called qubits. These qubits can solve problems exponentially faster than classical digital computers. The problem is that this data is so delicate that interaction with the environment can destroy it. But in some exotic topological phases, the subatomic particles can become protected. In other words, the qubits formed by them can't be changed by small or local disturbances. These topological qubits would be more stable, leading to more accurate computation and a better quantum computer. Topology was originally studied as a branch of purely abstract mathematics. Thanks to the pioneering work of Thouless, Haldane, and Kosterlitz, we now know it can be used to understand the riddles of nature and to revolutionize the future of technologies.

**P515 2017-10-09 Why is it so hard to cure cancer - Kyuson Yun**

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Why is it so difficult to cure cancer? We've harnessed electricity, sequenced the human genome, and eradicated small pox. But after billions of dollars in research, we haven't found a solution for a disease that affects more than 14 million people and their families at any given time. Cancer arises as normal cells accumulate mutations. Most of the time, cells can detect mutations or DNA damage and either fix them or self destruct. However, some mutations allow cancerous cells to grow unchecked and invade nearby tissues, or even metastasize to distant organs. Cancers become almost incurable once they metastasize. And cancer is incredibly complex. It's not just one disease. There are more than 100 different types and we don't have a magic bullet that can cure all of them. For most cancers, treatments usually include a combination of surgery to remove tumors and radiation and chemotherapy to kill any cancerous cells left behind. Hormone therapies, immunotherapy, and targeted treatments tailored for a specific type of cancer are sometimes used, too. In many cases, these treatments are effective and the patient becomes cancer-free. But they're very far from 100% effective 100% of the time. So what would we have to do to find cures for all the different forms of cancer? We're beginning to understand a few of the problems scientists would have to solve. First of all, we need new, better ways of studying cancer. Most cancer treatments are developed using cell lines grown in labs from cultures of human tumors. These cultured cells have given us critical insights about cancer genetics and biology, but they lack much of the complexity of a tumor in an actual living organism. It's frequently the case that new drugs, which work on these lab-grown cells, will fail in clinical trials with real patients. One of the complexities of aggressive tumors is that they can have multiple populations of slightly different cancerous cells. Over time, distinct genetic mutations accumulate in cells in different parts of the tumor, giving rise to unique subclones. For example, aggressive brain tumors called glioblastomas can have as many as six different subclones in a single patient. This is called clonal heterogeneity, and it makes treatment difficult because a drug that works on one subclone may have no effect on another. Here's another challenge. A tumor is a dynamic interconnected ecosystem where cancer cells constantly communicate with each other and with healthy cells nearby. They can induce normal cells to form blood vessels that feed the tumor and remove waste products. They can also interact with the immune system to actually suppress its function, keeping it from recognizing or destroying the cancer. If we could learn how to shut down these lines of communication, we'd have a better shot at vanquishing a tumor permanently. Additionally, mounting evidence suggests we'll need to figure out how to eradicate cancer stem cells. These are rare but seem to have special properties that make them resistant to chemotherapy and radiation. In theory, even if the rest of the tumor shrinks beyond detection during treatment, a single residual cancer stem cell could seed the growth of a new tumor. Figuring out how to target these stubborn cells might help prevent cancers from coming back. Even if we solved those problems, we might face new ones. Cancer cells are masters of adaptation, adjusting their molecular and cellular characteristics to survive under stress. When they're bombarded by radiation or chemotherapy, some cancer cells can effectively switch on protective shields against whatever's attacking them by changing their gene expression. Malignant cancers are complex systems that constantly evolve and adapt. To defeat them, we need to find experimental systems that match their complexity, and monitoring and treatment options that can adjust as the cancer changes. But the good news is we're making progress. Even with all we don't know, the average mortality rate for most kinds of cancer has dropped significantly since the 1970s and is still falling. We're learning more every day, and each new piece of information gives us one more tool to add to our arsenal.

**P516 2017-10-18 Why should you read Virgil's 'Aeneid' - Mark Robinson**

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In 19 B.C., the Roman poet Virgil was traveling from Greece to Rome with the emperor Augustus. On the way, he stopped to go sightseeing in Megara, a town in Greece. Out in the sun for too long, he suffered heatstroke and died on his journey back to Italy. On his deathbed, Virgil thought about the manuscript he had been working on for over ten years, an epic poem that he called the "Aeneid." Unsatisfied with the final edit, he asked his friends to burn it, but they refused, and soon after Virgil's death, Augustus ordered it to be published. Why was Augustus so interested in saving Virgil's poem? The Romans had little tradition of writing serious literature and Virgil wanted to create a poem to rival the "Iliad" and "Odyssey" of Ancient Greece. The "Aeneid," a 9,896 line poem, spans twelve separate sections, or books, the first six of which mirror the structure of the "Odyssey" and the last six echo the "Iliad." Also like the Greek epics, The "Aeneid" is written entirely in dactylic hexameter. In this meter, each line has six syllable groups called feet made up of dactyls which go long, short, short, and spondees which go long, long. So the famous opening line in the original Latin starts, "Arma Virvmqve Cano," which can be translated as "I sing of arms and the man," arms, meaning battles and warfare, another "Iliad" reference, and the man being the hero Aeneas. To understand the "Aeneid," it's necessary to examine the unsettled nature of Roman politics in the second half of the 1st century B.C. In 49 B.C., Julius Caesar, Augustus's great uncle, triggered nearly 20 years of civil war when he led his army against the Roman Republic. After introducing a dictatorship, he was assassinated. Only after Augustus's victory over Marc Antony and Cleopatra in 31 B.C. did peace return to Rome and Augustus became the emperor. Virgil aimed to capture this sense of a new era and of the great sacrifices that the Romans had endured. He wanted to give the Romans a fresh sense of their origins, their past, and their potential. By connecting the founding of Rome to the mythological stories that his audience knew so well, Virgil was able to link his hero Aeneas to the character of Augustus. In the epic poem, Aeneas is on a quest to establish a new home for his people. This duty, or pietas as the Romans called it, faces all kinds of obstacles. Aeneas risks destruction in the ruins of Troy, agonizes over love when he meets the beautiful Queen of Carthage, Dido, and in one of the most vivid passages in all of ancient literature, has to pass through the underworld. On top of all that, he must then fight to win a homeland for his people around the future sight of Rome. Virgil presents Aeneas as a sort of model for Augustus, and that's probably one of the reasons the emperor was so eager to save the poem from destruction. But Virgil didn't stop there. In some sections, Aeneas even has visions of Rome's future and of Augustus himself. Virgil presents Augustus as a victor, entering Rome in triumph and shows him expanding the Roman Empire. Perhaps most importantly, he's hailed as only the third Roman leader in 700 years to shut the doors of the Temple of Janus signifying the arrival of permanent peace. But there's a twist. Virgil only read Augustus three selected extracts of the story and that was Augustus's entire exposure to it. Some of the other sections could be seen as critical, if not subtly subversive about the emperor's achievements. Aeneas, again a model for Augustus, struggles with his duty and often seems a reluctant hero. He doesn't always live up to the behavior expected of a good Roman leader. He struggles to balance mercy and justice. By the end, the reader is left wondering about the future of Rome and the new government of Augustus. Perhaps in wanting the story published, Augustus had been fooled by his own desire for self-promotion. As a result, Virgil's story has survived to ask questions about the nature of power and authority ever since.

**P517 2017-10-19 Where do math symbols come from - John David Walters**

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In the 16th century, the mathematician Robert Recorde wrote a book called "The Whetstone of Witte" to teach English students algebra. But he was getting tired of writing the words "is equal to" over and over. His solution? He replaced those words with two parallel horizontal line segments because the way he saw it, no two things can be more equal. Could he have used four line segments instead of two? Of course. Could he have used vertical line segments? In fact, some people did. There's no reason why the equals sign had to look the way it does today. At some point, it just caught on, sort of like a meme. More and more mathematicians began to use it, and eventually, it became a standard symbol for equality. Math is full of symbols. Lines, dots, arrows, English letters, Greek letters, superscripts, subscripts. It can look like an illegible jumble. It's normal to find this wealth of symbols a little intimidating and to wonder where they all came from. Sometimes, as Recorde himself noted about his equals sign, there's an apt conformity between the symbol and what it represents. Another example of that is the plus sign for addition, which originated from a condensing of the Latin word et meaning and. Sometimes, however, the choice of symbol is more arbitrary, such as when a mathematician named Christian Kramp introduced the exclamation mark for factorials just because he needed a shorthand for expressions like this. In fact, all of these symbols were invented or adopted by mathematicians who wanted to avoid repeating themselves or having to use a lot of words to write out mathematical ideas. Many of the symbols used in mathematics are letters, usually from the Latin alphabet or Greek. Characters are often found representing quantities that are unknown, and the relationships between variables. They also stand in for specific numbers that show up frequently but would be cumbersome or impossible to fully write out in decimal form. Sets of numbers and whole equations can be represented with letters, too. Other symbols are used to represent operations. Some of these are especially valuable as shorthand because they condense repeated operations into a single expression. The repeated addition of the same number is abbreviated with a multiplication sign so it doesn't take up more space than it has to. A number multiplied by itself is indicated with an exponent that tells you how many times to repeat the operation. And a long string of sequential terms added together is collapsed into a capital sigma. These symbols shorten lengthy calculations to smaller terms that are much easier to manipulate. Symbols can also provide succinct instructions about how to perform calculations. Consider the following set of operations on a number. Take some number that you're thinking of, multiply it by two, subtract one from the result, multiply the result of that by itself, divide the result of that by three, and then add one to get the final output. Without our symbols and conventions, we'd be faced with this block of text. With them, we have a compact, elegant expression. Sometimes, as with equals, these symbols communicate meaning through form. Many, however, are arbitrary. Understanding them is a matter of memorizing what they mean and applying them in different contexts until they stick, as with any language. If we were to encounter an alien civilization, they'd probably have a totally different set of symbols. But if they think anything like us, they'd probably have symbols. And their symbols may even correspond directly to ours. They'd have their own multiplication sign, symbol for pi, and, of course, equals.

**P518 2017-10-19 Why should you read James Joyce's 'Ulysses' - Sam Slote**

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James Joyce's "Ulysses" is widely considered to be both a literary masterpiece and one of the hardest works of literature to read. It inspires such devotion that once a year on a day called Bloomsday, thousands of people all over the world dress up like the characters, take to the streets, and read the book aloud. And some even make a pilgrimage to Dublin just to visit the places so vividly depicted in Joyce's opus. So what is it about this famously difficult novel that inspires so many people? There's no one simple answer to that question, but there are a few remarkable things about the book that keep people coming back. The plot, which transpires over the course of a single day, is a story of three characters: Stephen Dedalus, reprised from Joyce's earlier novel, "A Portrait of the Artist as a Young Man"; Leopold Bloom, a half-Jewish advertising canvasser for a Dublin newspaper; and Bloom's wife Molly, who is about to embark on an affair. Stephen is depressed because of his mother's recent death. Meanwhile, Bloom wanders throughout the city. He goes to a funeral, his work, a pub, and so on, avoiding going home because Molly is about to begin her affair. Where it really starts to get interesting, though, is how the story's told. Each chapter is written in a different style. 15 is a play, 13 is like a cheesy romance novel, 12 is a story with bizarre, exaggerated interruptions, 11 uses techniques, like onomatopoeia, repetitions, and alliteration to imitate music, and 14 reproduces the evolution of English literary prose style, from its beginnings in Anglo-Saxon right up to the 20th century. That all culminates in the final chapter which follows Molly's stream of consciousness as it spools out in just eight long paragraphs with almost no punctuation. The range of styles Joyce uses in "Ulysses" is one of the things that makes it so difficult, but it also helps make it enjoyable. And it's one of the reasons that the book is held up as one of the key texts of literary modernism, a movement characterized by overturning traditional modes of writing. Joyce fills his narrative gymnastic routines with some of the most imaginative use of language you'll find anywhere. Take, for instance, "The figure seated on a large boulder at the foot of a round tower was that of a broadshouldered deepchested stronglimbed frankeyed redhaired freelyfreckled shaggybearded widemouthed largenosed longheaded deepvoiced barekneed brawnyhanded hairlegged ruddyfaced sinewyarmed hero." Here, Joyce exaggerates the description of a mangy old man in a pub to make him seem like an improbably gigantesque hero. It's true that some sections are impenetrably dense at first glance, but it's up to the reader to let their eyes skim over them or break out a shovel and dig in. And once you start excavating the text, you'll find the book to be an encyclopedic treasure trove. It's filled with all manner of references and allusions from medieval philosophy to the symbolism of tattoos, and from Dante to Dublin slang. As suggested by the title, some of these allusions revolve around Homer's "Odyssey." Each chapter is named after a character or episode from the "Odyssey," but the literary references are often coy, debatable, sarcastic, or disguised. For example, Homer's Odysseus, after an epic 20-year-long journey, returns home to Ithaca and reunites with his faithful wife. In contrast, Joyce's Bloom wanders around Dublin for a day and returns home to his unfaithful wife. It's a very funny book. It has highbrow intellectual humor, if you have the patience to track down Joyce's references, and more lowbrow dirty jokes. Those, and other sexual references, were too much for some. In the U.S., the book was put on trial, banned, and censored before it had even been completed because it was originally published as a serial novel. Readers of "Ulysses" aren't just led through a variety of literary styles. They're also given a rich and shockingly accurate tour of a specific place at a time: Dublin in 1904. Joyce claimed that if Dublin were to be destroyed, it could be recreated from the pages of this book. While such a claim is not exactly true, it does show the great care that Joyce took in precisely representing details, both large and small, of his home city. No small feat considering he wrote the entire novel while living outside of his native Ireland. It's a testament to Joyce's genius that "Ulysses" is a difficult book. Some people find it impenetrable without a full book of annotations to help them understand what Joyce is even talking about. But there's a lot of joy to be found in reading it, more than just unpacking allusions and solving puzzles. And if it's difficult, or frustrating, or funny, that's because life is all that, and more. Responding to some criticism of "Ulysses," and there was a lot when it was first published, Joyce said that if "Ulysses" isn't worth reading, then life isn't worth living.

**P519 2017-10-19 Why should you read 'Macbeth' - Brendan Pelsue**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=519)

There's a play so powerful that an old superstition says its name should never even be uttered in a theater, a play that begins with witchcraft and ends with a bloody severed head, a play filled with riddles, prophesies, nightmare visions, and lots of brutal murder, a play by William Shakespeare sometimes referred to as the "Scottish Play" or the "Tragedy of Macbeth." First performed at the Globe Theater in London in 1606, "Macbeth" is Shakespeare's shortest tragedy. It is also one of his most action-packed. In five acts, he recounts a story of a Scottish nobleman who steals the throne, presides over a reign of terror, and then meets a bloody end. Along the way, it asks important questions about ambition, power, and violence that spoke directly to the politics of Shakespeare's time and continue to echo in our own. England in the early 17th century was politically precarious. Queen Elizabeth I died in 1603 without producing an heir, and in a surprise move, her advisors passed the crown to James Stewart, King of Scotland. Two years later, James was subject to an assassination attempt called the Gunpowder Plot. Questions of what made for a legitimate king were on everyone's lips. So Shakespeare must have known he had potent material when he conflated and adapted the stories of a murderous 11th century Scottish King named Macbeth and those of several other Scottish nobles. He found their annals in Hollinshed's "Chronicles," a popular 16th century history of Britain and Ireland. Shakespeare would also have known he needed to tell his story in a way that would immediately grab the attention of his diverse and rowdy audience. The Globe welcomed all sections of society. Wealthier patrons watched the stage from covered balconies while poorer people paid a penny to take in the show from an open-air section called the pit. Talking, jeering, and cheering was common during performances. There are even accounts of audiences throwing furniture when plays were flops. So "Macbeth" opens with a literal bang. Thunder cracks and three witches appear. They announce they're searching for a Scottish nobleman and war hero named Macbeth, then fly off while chanting a curse that predicts a world gone mad. "Fair is foul and foul is fair. Hover through the fog and filthy air." As seen later, they find Macbeth and his fellow nobleman Banquo. "All hail Macbeth," they prophesize, "that shalt be king hereafter!" "King?" Macbeth wonders. Just what would he have to do to gain the crown? Macbeth and his wife Lady Macbeth soon chart a course of murder, lies, and betrayal. In the ensuing bloodbath, Shakespeare provides viewers with some of the most memorable passages in English literature. "Out, damned spot! Out, I say!" Lady Macbeth cries when she believes she can't wipe her victim's blood off her hands. Her obsession with guilt is one of many themes that runs through the play, along with the universal tendency to abuse power, the endless cycles of violence and betrayal, the defying political conflict. As is typical with Shakespeare's language, a number of phrases that got their start in the play have been repeated so many times that they now feel commonplace. They include "the milk of human kindness," "what's done is done," and the famous witches' spell, "Double, double toil and trouble; Fire burn, and caldron bubble." But Shakespeare saves the juiciest bit of all for Macbeth himself. Towards the end of the play, Macbeth reflects on the universality of death and the futility of life. "Out, out, brief candle!" he laments. "Life's but a walking shadow, a poor player that struts and frets his hour upon the stage and then is heard no more. It is a tale told by an idiot, full of sound and fury signifying nothing." Life may be a tale told my an idiot, but "Macbeth" is not. Shakespeare's language and characters have entered our cultural consciousness to a rare extent. Directors often use the story to shed light on abuses of power, ranging from the American mafia to dictators across the globe. The play has been adapted to film many times, including Akira Kurosawa's "Throne of Blood," which takes place in feudal Japan, and a modernized version called "Scotland, PA," in which Macbeth and his rivals are managers of competing fast food restaurants. No matter the presentation, questions of morality, politics, and power are still relevant today, and so, it seems, is Shakespeare's "Macbeth."

**P520 2017-10-23 How does your body know you're full - Hilary Coller**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=520)

Hunger claws at your grumbling belly. It tugs at your intestines, which begin to writhe, aching to be fed. Being hungry generates a powerful, often unpleasant physical sensation that's almost impossible to ignore. After you've reacted by gorging on your morning pancakes, you start to experience an opposing force, fullness, but how does your body actually know when you're full? The sensation of fullness is set in motion as food moves from your mouth down your esophagus. Once it hits your stomach, it gradually fills the space. That causes the surrounding muscular wall to stretch, expanding slowly like a balloon. A multitude of nerves wrapped intricately around the stomach wall sense the stretching. They communicate with the vagus nerve up to the brainstem and hypothalamus, the main parts of the brain that control food intake. But that's just one input your brain uses to sense fullness. After all, if you fill your stomach with water, you won't feel full for long. Your brain also takes into account chemical messengers in the form of hormones produced by endocrine cells throughout your digestive system. These respond to the presence of specific nutrients in your gut and bloodstream, which gradually increase as you digest your food. As the hormones seep out, they're swept up by the blood and eventually reach the hypothalamus in the brain. Over 20 gastrointestinal hormones are involved in moderating our appetites. One example is cholecystokinin, which is produced in response to food by cells in the upper small bowel. When it reached the hypothalamus, it causes a reduction in the feeling of reward you get when you eat food. When that occurs, the sense of being satiated starts to sink in and you stop eating. Cholecystokinin also slows down the movement of food from the stomach into the intestines. That makes your stomach stretch more over a period of time, allowing your body to register that you're filling up. This seems to be why when you eat slowly, you actually feel fuller compared to when you consume your food at lightning speed. When you eat quickly, your body doesn't have time to recognize the state it's in. Once nutrients and gastrointestinal hormones are present in the blood, they trigger the pancreas to release insulin. Insulin stimulates the body's fat cells to make another hormone called leptin. Leptin reacts with receptors on neuron populations in the hypothalamus. The hypothalamus has two sets of neurons important for our feeling of hunger. One set produces the sensation of hunger by making and releasing certain proteins. The other set inhibits hunger through its own set of compounds. Leptin inhibits the hypothalamus neurons that drive food intake and stimulates the neurons that suppress it. By this point, your body has reached peak fullness. Through the constant exchange of information between hormones, the vagus nerve, the brainstem, and the different portions of hypothalamus, your brain gets the signal that you've eaten enough. Researchers have discovered that some foods produce more long-lasting fullness than others. For instance, boiled potatoes are ranked as some of the most hunger-satisfying foods, while croissants are particularly unsatisfying. In general, foods with more protein, fiber, and water tend to keep hunger at bay for longer. But feeling full won't last forever. After a few hours, your gut and brain begin their conversation again. Your empty stomach produces other hormones, such as ghrelin, that increase the activity of the hunger-causing nerve cells in the hypothalamus. Eventually, the growling beast of hunger is reawakened. Luckily, there's a dependable antidote for that.

**P521 2017-10-24 How many verb tenses are there in English - Anna Ananichuk**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=521)

Grammatical tense is how languages talk about time without explicitly naming time periods by, instead, modifying verbs to specify when action occurs. So how many different tenses are there in a language like English? At first, the answer seems obvious: there's past, present, and future. But thanks to something called grammatical aspect, each of those time periods actually divides further. There are four kinds of aspect. In the continuous or progressive aspect, the actions are still happening at the time of reference. The perfect aspect describes actions that are finished. The perfect progressive aspect is a combination, describing a completed part of a continuous action. And finally, there's the simple aspect, the basic form of the past, present, and future tense, where an action is not specified as continuous or discrete. That's all a little hard to follow, so let's see how it works in action. Let's say your friends tell you they went on a secret naval mission to collect evidence of a mysterious sea creature. The tense sets the overall frame of reference in the past, but within that, there are many options. Your friends might say a creature attacked their boat, that's the past simple, the most general aspect, which gives no further clarification. They were sleeping when it happened, a continuous process underway at that point. They might also tell you they had departed from Nantucket to describe an action completed even earlier. That's an example of the past perfect. Or that they had been sailing for three weeks, something that was ongoing up until that point. In the present, they tell you that they still search for the creature today, their present simple activity. Perhaps they are preparing for their next mission continuously as they speak. And they have built a special submarine for it, a completed achievement. Plus, if they have been researching possible sightings of the creature, it's something they've been doing for a while and are still doing now making it present perfect progressive. So what does this next mission hold? You know it still hasn't happened because they will depart next week, the future simple. Your friends will be searching for the elusive creature, an extended continuous undertaking. They tell you the submarine will have reached uncharted depths a month from now. That's a confident prediction about what will be achieved by a specific point in the future, a point at which they will have been voyaging for three weeks in the future perfect progressive. The key insight to all these different tenses is that each sentence takes place in a specific moment, whether it's past, present, or future. The point of aspects is that they tell you as of that moment the status of the action. In total, they give us twelve possibilities in English. What about other languages? Some, like French, Swahili, and Russian take a similar approach to English. Others describe and divide time differently. Some have fewer grammatical tenses, like Japanese, which only distinguishes past from non-past, Buli and Tukang Basi, which only distinguish future from non-future, and Mandarin Chinese with no verb tenses at all, only aspect. On the other hand, languages like Yagwa split past tense into multiple degrees, like whether something happened hours, weeks, or years ago. In others, tenses are intertwined with moods that can convey urgency, necessity, or probability of events. This makes translation difficult but not impossible. Speakers of most languages without certain tenses can express the same ideas with auxiliary words, like would or did, or by specifying the time they mean. Are the variations from language to language just differents ways of describing the same fundamental reality? Or do their diverse structures reflect different ways of thinking about the world and even time itself? And if so, what other ways of conceiving time may be out there?

**P522 2017-10-25 How your muscular system works - Emma Bryce**

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Each time you take a step, 200 muscles work in unison to lift your foot, propel it forward, and set it down. It's just one of the many thousands of tasks performed by the muscular system. This network of over 650 muscles covers the body and is the reason we can blink, smile, run, jump, and stand upright. It's even responsible for the heart's dependable thump. First, what exactly is the muscular system? It's made up of three main muscle types: skeletal muscle, which attaches via tendons to our bones, cardiac muscle, which is only found in the heart, and smooth muscle, which lines the blood vessels and certain organs, like the intestine and uterus. All three types are made up of muscle cells, also known as fibers, bundled tightly together. These bundles receive signals from the nervous system that contract the fibers, which in turn generates force and motion. This produces almost all the movements we make. Some of the only parts of the body whose motions aren't governed by the muscular system are sperm cells, the hair-like cilia in our airways, and certain white blood cells. Muscle contraction can be split into three main types. The first two, shortening muscle fibers and lengthening them, generate opposing forces. So the biceps will shorten while the triceps will lengthen or relax, pulling up the arm and making it bend at the elbow. This allows us to, say, pick up a book, or if the muscle relationship is reversed, put it down. This complementary partnership exists throughout the muscular system. The third type of contraction creates a stabilizing force. In these cases, the muscle fibers don't change in length, but instead keep the muscles rigid. This allows us to grip a mug of coffee or lean against a wall. It also maintains our posture by holding us upright. Skeletal muscles form the bulk of the muscular system, make up about 30-40% of the body's weight, and generate most of its motion. Some muscles are familiar to us, like the pectorals and the biceps. Others may be less so, like the buccinator, a muscle that attaches your cheek to your teeth, or the body's tiniest skeletal muscle, a one-millimeter-long tissue fragment called the stapedius that's nestled deep inside the ear. Wherever they occur, skeletal muscles are connected to the somatic nervous system, which gives us almost complete control over their movements. This muscle group also contains two types of muscle fibers to refine our motions even further, slow-twitch and fast-twitch. Fast-twitch fibers react instantly when triggered but quickly use up their energy and tire out. Slow-twitch fibers, on the other hand, are endurance cells. They react and use energy slowly so they can work for longer periods. A sprinter will accumulate more fast-twitch muscles in her legs through continuous practice, enabling her to quickly, if briefly, pick up the pace, whereas back muscles contain more slow-twitch muscles to maintain your posture all day. Unlike the skeletal muscles, the body's cardiac and smooth muscles are managed by the autonomic nervous system beyond our direct control. That makes your heart thump roughly 3 billion times over the course of your life, which supplies the body with blood and oxygen. Autonomic control also contracts and relaxes smooth muscle in a rhythmic cycle. That pumps blood through the smooth internal walls of blood vessels, enables the intestine to constrict and push food through the digestive system, and allows the uterus to contract when a person is giving birth. As muscles work, they also use energy and produce an important byproduct, heat. In fact, muscle provides about 85% of your warmth, which the heart and blood vessels then spread evenly across the body via the blood. Without that, we couldn't maintain the temperature necessary for our survival. The muscular system may be largely invisible to us, but it leaves its mark on almost everything we do, whether it's the blink of an eye or a race to the finish line.

**P523 2017-10-31 How to make your writing suspenseful - Victoria Smith**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=523)

What makes a good horror story? Sure, you could throw in some hideous monsters, fountains of blood, and things jumping out from every corner, but as classic horror author H.P. Lovecraft wrote, "The oldest and strongest kind of fear is fear of the unknown." And writers harness that fear not by revealing horrors, but by leaving the audience hanging in anticipation of them. That is, in a state of suspense. The most familiar examples of suspense come from horror films and mystery novels. What's inside the haunted mansion? Which of the dinner guests is the murderer? But suspense exists beyond these genres. Will the hero save the day? Will the couple get together in the end? And what is the dark secret that causes the main character so much pain? The key to suspense is that it sets up a question, or several, that the audience hopes to get an answer to and delays that answer while maintaining their interest and keeping them guessing. So what are some techniques you can use to achieve this in your own writing? Limit the point of view. Instead of an omniscient narrator who can see and relay everything that happens, tell the story from the perspective of the characters. They may start off knowing just as little as the audience does, and as they learn more, so do we. Classic novels, like "Dracula," for example, are told through letters and diary entries where characters relate what they've experienced and fear what's to come. Next, choose the right setting and imagery. Old mansions or castles with winding halls and secret passageways suggest that disturbing things are being concealed. Nighttime, fog, and storms all play similar roles in limiting visibility and restricting characters' movements. That's why Victorian London is such a popular setting. And even ordinary places and objects can be made sinister as in the Gothic novel "Rebecca" where the flowers at the protagonist's new home are described as blood red. Three: play with style and form. You can build suspense by carefully paying attention not just to what happens but how it's conveyed and paced. Edgar Allan Poe conveys the mental state of the narrator in "The Tell-Tale Heart" with fragmented sentences that break off suddenly. And other short declarative sentences in the story create a mix of breathless speed and weighty pauses. On the screen, Alfred Hitchcock's cinematography is known for its use of extended silences and shots of staircases to create a feeling of discomfort. Four: use dramatic irony. You can't just keep the audience in the dark forever. Sometimes, suspense is best served by revealing key parts of the big secret to the audience but not to the characters. This is a technique known as dramatic irony, where the mystery becomes not what will happen but when and how the characters will learn. In the classic play "Oedipus Rex," the title character is unaware that he has killed his own father and married his mother. But the audience knows, and watching Oedipus gradually learn the truth provides the story with its agonizing climax. And finally, the cliffhanger. Beware of overusing this one. Some consider it a cheap and easy trick, but it's hard to deny its effectiveness. This is where a chapter, episode, volume, or season cuts off right before something crucial is revealed, or in the midst of a dangerous situation with a slim chance of hope. The wait, whether moments or years, makes us imagine possibilities about what could happen next, building extra suspense. The awful thing is almost always averted, creating a sense of closure and emotional release. But that doesn't stop us from worrying and wondering the next time the protagonists face near-certain disaster.

**P524 2017-11-01 Can you solve the egg drop riddle - Yossi Elran**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=524)

The city has just opened its one-of-a-kind Fabergé Egg Museum with a single egg displayed on each floor of a 100-story building. And the world's most notorious jewel thief already has her eyes on the prize. Because security is tight and the eggs are so large, she'll only get the chance to steal one by dropping it out the window into her waiting truck and repelling down before the police can arrive. All eggs are identical in weight and construction, but each floor's egg is more rare and valuable than the one below it. While the thief would naturally like to take the priceless egg at the top, she suspects it won't survive a 100-story drop. Being pragmatic, she decides to settle for the most expensive egg she can get. In the museum's gift shop, she finds two souvenir eggs, perfect replicas that are perfectly worthless. The plan is to test drop them to find the highest floor at which an egg will survive the fall without breaking. Of course, the experiment can only be repeated until both replica eggs are smashed. And throwing souvenirs out the window too many times is probably going to draw the guards' attention. What's the least number of tries it would take to guarantee that she find the right floor? Pause here if you want to figure it out for yourself! Answer in: 3 Answer in: 2 Answer in: 1 If you're having trouble getting started on the solution, it might help to start with a simpler scenario. Imagine our thief only had one replica egg. She'd have a single option: To start by dropping it from the first floor and go up one by one until it breaks. Then she'd know that the floor below that is the one she needs to target for the real heist. But this could require as many as 100 tries. Having an additional replica egg gives the thief a better option. She can drop the first egg from different floors at larger intervals in order to narrow down the range where the critical floor can be found. And once the first breaks, she can use the second egg to explore that interval floor by floor. Large floor intervals don't work great. In the worst case scenario, they require many tests with the second egg. Smaller intervals work much better. For example, if she starts by dropping the first egg from every 10th floor, once it breaks, she'll only have to test the nine floors below. That means it'll take at most 19 tries to find the right floor. But can she do even better? After all, there's no reason every interval has to be the same size. Let's say there were only ten floors. The thief could test this whole building with just four total throws by dropping the first egg at floors four, seven, and nine. If it broke at floor four, it would take up to three throws of the second egg to find the exact floor. If it broke at seven, it would take up to two throws with the second egg. And if it broke at floor nine, it would take just one more throw of the second egg. Intuitively, what we're trying to do here is divide the building into sections where no matter which floor is correct, it takes up to the same number of throws to find it. We want each interval to be one floor smaller than the last. This equation can help us solve for the first floor we need to start with in the 100 floor building. There are several ways to solve this equation, including trial and error. If we plug in two for n, that equation would look like this. If we plug in three, we get this. So we can find the first n to pass 100 by adding more terms until we get to our answer, which is 14. And so our thief starts on the 14th floor, moving up to the 27th, the 39th, and so on, for a maximum of 14 drops. Like the old saying goes, you can't pull a heist without breaking a few eggs.

**P525 2017-11-02 Why incompetent people think they're amazing - David Dunning**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=525)

Are you as good at things as you think you are? How good are you at managing money? What about reading people's emotions? How healthy are you compared to other people you know? Are you better than average at grammar? Knowing how competent we are and how are skill stack up against other people's is more than a self-esteem boost. It helps us figure out when we can forge ahead on our own decisions and instincts and when we need, instead, to seek out advice. But psychological research suggests that we're not very good at evaluating ourselves accurately. In fact, we frequently overestimate our own abilities. Researchers have a name for this phenomena, the Dunning-Kruger effect. This effect explains why more than 100 studies have shown that people display illusory superiority. We judge ourselves as better than others to a degree that violates the laws of math. When software engineers at two companies were asked to rate their performance, 32% of the engineers at one company and 42% at the other put themselves in the top 5%. In another study, 88% of American drivers described themselves as having above average driving skills. These aren't isolated findings. On average, people tend to rate themselves better than most in disciplines ranging from health, leadership skills, ethics, and beyond. What's particularly interesting is that those with the least ability are often the most likely to overrate their skills to the greatest extent. People measurably poor at logical reasoning, grammar, financial knowledge, math, emotional intelligence, running medical lab tests, and chess all tend to rate their expertise almost as favorably as actual experts do. So who's most vulnerable to this delusion? Sadly, all of us because we all have pockets of incompetence we don't recognize. But why? When psychologists Dunning and Kruger first described the effect in 1999, they argued that people lacking knowledge and skill in particular areas suffer a double curse. First, they make mistakes and reach poor decisions. But second, those same knowledge gaps also prevent them from catching their errors. In other words, poor performers lack the very expertise needed to recognize how badly they're doing. For example, when the researchers studied participants in a college debate tournament, the bottom 25% of teams in preliminary rounds lost nearly four out of every five matches. But they thought they were winning almost 60%. WIthout a strong grasp of the rules of debate, the students simply couldn't recognize when or how often their arguments broke down. The Dunning-Kruger effect isn't a question of ego blinding us to our weaknesses. People usually do admit their deficits once they can spot them. In one study, students who had initially done badly on a logic quiz and then took a mini course on logic were quite willing to label their original performances as awful. That may be why people with a moderate amount of experience or expertise often have less confidence in their abilities. They know enough to know that there's a lot they don't know. Meanwhile, experts tend to be aware of just how knowledgeable they are. But they often make a different mistake: they assume that everyone else is knowledgeable, too. The result is that people, whether they're inept or highly skilled, are often caught in a bubble of inaccurate self-perception. When they're unskilled, they can't see their own faults. When they're exceptionally competent, they don't perceive how unusual their abilities are. So if the Dunning-Kruger effect is invisible to those experiencing it, what can you do to find out how good you actually are at various things? First, ask for feedback from other people, and consider it, even if it's hard to hear. Second, and more important, keep learning. The more knowledgeable we become, the less likely we are to have invisible holes in our competence. Perhaps it all boils down to that old proverb: When arguing with a fool, first make sure the other person isn't doing the same thing.

**P526 2017-11-03 The myth of Prometheus - Iseult Gillespie**

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Before the creation of humanity, the Greek gods won a great battle against a race of giants called the Titans. Most Titans were destroyed or driven to the eternal hell of Tartarus. But the Titan Prometheus, whose name means foresight, persuaded his brother Epimetheus to fight with him on the side of the gods. As thanks, Zeus entrusted the brothers with the task of creating all living things. Epimetheus was to distribute the gifts of the gods among the creatures. To some, he gave flight; to others, the ability to move through water or race through grass. He gave the beasts glittering scales, soft fur, and sharp claws. Meanwhile, Prometheus shaped the first humans out of mud. He formed them in the image of the gods, but Zeus decreed they were too remain mortal and worship the inhabitants of Mount Olympus from below. Zeus deemed humans subservient creatures vulnerable to the elements and dependent on the gods for protection. However, Prometheus envisioned his crude creations with a greater purpose. So when Zeus asked him to decide how sacrifices would be made, the wily Prometheus planned a trick that would give humans some advantage. He killed a bull and divided it into two parts to present to Zeus. On one side, he concealed the succulent flesh and skin under the unappealing belly of the animal. On the other, he hid the bones under a thick layer of fat. When Zeus chose the seemingly best portion for himself, he was outraged at Prometheus's deception. Fuming, Zeus forbade the use of fire on Earth, whether to cook meat or for any other purpose. But Prometheus refused to see his creations denied this resource. And so, he scaled Mount Olympus to steal fire from the workshop of Hephaestus and Athena. He hid the flames in a hollow fennel stalk and brought it safely down to the people. This gave them the power to harness nature for their own benefit and ultimately dominate the natural order. With fire, humans could care for themselves with food and warmth. But they could also forge weapons and wage war. Prometheus's flames acted as a catalyst for the rapid progression of civilization. When Zeus looked down at this scene, he realized what had happened. Prometheus had once again wounded his pride and subverted his authority. Furious, Zeus imposed a brutal punishment. Prometheus was to be chained to a cliff for eternity. Each day, he would be visited by a vulture who would tear out his liver and each night his liver would grow back to be attacked again in the morning. Although Prometheus remained in perpetual agony, he never expressed regret at his act of rebellion. His resilience in the face of oppression made him a beloved figure in mythology. He was also celebrated for his mischievous and inquisitive spirit, and for the knowledge, progress, and power he brought to human hands. He's also a recurring figure in art and literature. In Percy Bysshe Shelley's lyrical drama "Prometheus Unbound," the author imagines Prometheus as a romantic hero who escapes and continues to spread empathy and knowledge. Of his protagonist, Shelley wrote, "Prometheus is the type of the highest perfection of moral and intellectual nature, impelled by the purest and the truest motives to the best and noblest ends." His wife Mary envisaged Prometheus as a more cautionary figure and subtitled her novel "Frankenstein: The Modern Prometheus." This suggests the damage of corrupting the natural order and remains relevant to the ethical questions surrounding science and technology today. As hero, rebel, or trickster, Prometheus remains a symbol of our capacity to capture the powers of nature, and ultimately, he reminds us of the potential of individual acts to ignite the world.

**P527 2017-11-06 How long will human impacts last - David Biello**

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Imagine aliens land on the planet a million years from now and look into the geologic record. What will these curious searchers find of us? They will find what geologists, scientists, and other experts are increasingly calling the Anthropocene, or new age of mankind. The impacts that we humans make have become so pervasive, profound, and permanent that some geologists argue we merit our own epoch. That would be a new unit in the geologic time scale that stretches back more than 4.5 billion years, or ever since the Earth took shape. Modern humans may be on par with the glaciers behind various ice ages or the asteroid that doomed most of the dinosaurs. What is an epoch? Most simply, it's a unit of geologic time. There's the Pleistocene, an icy epoch that saw the evolution of modern humans. Or there's the Eocene, more than 34 million years ago, a hothouse time during which the continents drifted into their present configuration. Changes in climate or fossils found in the rock record help distinguish these epochs and help geologists tell deep time. So what will be the record of modern people's impact on the planet? It doesn't rely on the things that may seem most obvious to us today, like sprawling cities. Even New York or Shanghai may prove hard to find buried in the rocks a million years from now. But humans have put new things into the world that never existed on Earth before, like plutonium and plastics. In fact, the geologists known as stratigraphers who determine the geologic timescale, have proposed a start date for the Anthropocene around 1950. That's when people started blowing up nuclear bombs all around the world and scattering novel elements to the winds. Those elements will last in the rock record, even in our bones and teeth for millions of years. And in just 50 years, we've made enough plastic, at least 8 billion metric tons, to cover the whole world in a thin film. People's farming, fishing, and forestry will also show up as a before and after in any such strata because it's those kinds of activities that are causing unique species of plants and animals to die out. This die-off started perhaps more than 40,000 years ago as humanity spread out of Africa and reached places like Australia, kicking off the disappearance of big, likable, and edible animals. This is true of Europe and Asia, think woolly mammoth, as well as North and South America, too. For a species that has only roamed the planet for a few hundred thousand years, Homo sapiens has had a big impact on the future fossil record. That also means that even if people were to disappear tomorrow, evolution would be driven by our choices to date. We're making a new homogenous world of certain favored plants and animals, like corn and rats. But it's a world that's not as resilient as the one it replaces. As the fossil record shows, it's a diversity of plants and animals that allows unique pairings of flora and fauna to respond to environmental challenges, and even thrive after an apocalypse. That goes for people, too. If the microscopic plants of the ocean suffer as a result of too much carbon dioxide, say, we'll lose the source of as much as half of the oxygen we need to breathe. Then there's the smudge in future rocks. People's penchant for burning coal, oil, and natural gas has spread tiny bits of soot all over the planet. That smudge corresponds with a meteoric rise in the amount of carbon dioxide in the air, now beyond 400 parts per million, or higher than any other Homo sapiens has ever breathed. Similar soot can still be found in ancient rocks from volcanic fires of 66 million years ago, a record of the cataclysm touched off by an asteroid at the end of the late Cretaceous epoch. So odds are our soot will still be here 66 million years from now, easy enough to find for any aliens who care to look. Of course, there's an important difference between us and an asteroid. A space rock has no choice but to follow gravity. We can choose to do differently. And if we do, there might still be some kind of human civilization thousands or even millions of years from now. Not a bad record to hope for.

**P528 2017-11-08 Why should you read 'The Handmaid's Tale' - Naomi R. Mercer**

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In Margaret Atwood's near-future novel, "The Handmaid's Tale," a Christian fundamentalist regime called the Republic of Gilead has staged a military coup and established a theocratic government in the United States. The regime theoretically restricts everyone, but in practice a few men have structured Gilead so they have all the power, especially over women. The Handmaid's Tale is what Atwood calls speculative fiction, meaning it theorizes about possible futures. This is a fundamental characteristic shared by both utopian and dystopian texts. The possible futures in Atwood's novels are usually negative, or dystopian, where the actions of a small group have destroyed society as we know it. Utopian and dystopian writing tends to parallel political trends. Utopian writing frequently depicts an idealized society that the author puts forth as a blueprint to strive toward. Dystopias, on the other hand, are not necessarily predictions of apocalyptic futures, but rather warnings about the ways in which societies can set themselves on the path to destruction. The Handmaid's Tale was published in 1985, when many conservative groups attacked the gains made by the second-wave feminist movement. This movement had been advocating greater social and legal equality for women since the early 1960s. The Handmaid's Tale imagines a future in which the conservative counter-movement gains the upper hand and not only demolishes the progress women had made toward equality, but makes women completely subservient to men. Gilead divides women in the regime into distinct social classes based upon their function as status symbols for men. Even their clothing is color-coded. Women are no longer allowed to read or move about freely in public, and fertile women are subject to state-engineered rape in order to give birth to children for the regime. Although The Handmaid's Tale is set in the future, one of Atwood's self-imposed rules in writing it was that she wouldn't use any event or practice that hadn't already happened in human history. The book is set in Cambridge, Massachusetts, a city that during the American colonial period had been ruled by the theocratic Puritans. In many ways, the Republic of Gilead resembles the strict rules that were present in Puritan society: rigid moral codes, modest clothing, banishment of dissenters, and regulation of every aspect of people's lives and relationships. For Atwood, the parallels to Massachusett's Puritans were personal as well as theoretical. She spent several years studying the Puritans at Harvard and she's possibly descended from Mary Webster, a Puritan woman accused of witchcraft who survived her hanging. Atwood is a master storyteller. The details of Gilead, which we've only skimmed the surface of, slowly come into focus through the eyes of its characters, mainly the novel's protagonist Offred, a handmaid in the household of a commander. Before the coup that established Gilead, Offred had a husband, a child, a job, and a normal, middle-class American life. But when the fundamentalist regime comes into power, Offred is denied her identity, separated from her family, and reduced to being, in Offred's words, "a two-legged womb for increasing Gilead's waning population." She initially accepts the loss of her fundamental human rights in the name of stabilizing the new government. But state control soon extends into attempts to control the language, behavior, and thoughts of herself and other individuals. Early on, Offred says, "I wait. I compose myself. My self is a thing I must compose, as one composes a speech." She likens language to the formulation of identity. Her words also acknowledge the possibility of resistance, and it's resistance, the actions of people who dare to break the political, intellectual, and sexual rules, that drives the plot of the Handmaid's Tale. Ultimately, the novel's exploration of the consequences of complacency, and how power can be wielded unfairly, makes Atwood's chilling vision of a dystopian regime ever relevant.

**P529 2017-11-10 The complicated history of surfing - Scott Laderman**

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For some, it's a serious sport. For others, just a way to let loose. But despite its casual association with fun and sun, surfing has a richer and deeper history than many realize. What we today call surfing originated in the Polynesian islands of the Pacific Ocean. We know from various accounts that wave riding was done throughout the Polynesian Pacific, as well as in West Africa and Peru. But it was in the Hawaiian archipelago in particular that surfing advanced the most, was best documented, and, unlike elsewhere in Polynesia, persisted. And for the people of Hawaii, wave sliding was not just a recreational activity, but one with spiritual and social significance. Like much of Hawaiian society, nearly every aspect of surfing was governed by a code of rules and taboos known as kapu. Hawaiians made offerings when selecting a tree to carve, prayed for waves with the help of a kahuna, or an expert priest, and gave thanks after surviving a perilous wipeout. Certain surf breaks were strickly reserved for the elite. But it wasn't just a solemn affair. Surfers competed and wagered on who could ride the farthest, the fastest, or catch the biggest wave with superior skill, granting respect, social status, and romantic success. Though it was later called the sport of kings, Hawaiian men and women of all ages and social classes participated, riding surfboards shaped from koa, breadfruit, or wiliwili trees. Many Hawaiians road alaia boards, which were thin, midsized, and somewhat resemble today's shortboards. Some mounted paipo boards, short, round-nosed boards on which riders typically lay on their stomachs. But only chieftains could ride the massive olo boards, twice as long as today's longboards. Unlike most modern surfboards, all boards were finless, requiring surfers to drag their hands or feet to turn. We don't know exactly when wave sliding was invented, but we know that it had already been practiced in Polynesia for centuries by the time it was described in 1777 by William Anderson, a surgeon on Captain Cook's ship "Resolution." Although Anderson was in awe, most of the American Christian missionaries who arrived in Hawaii several decades later regarded surfing as sinful, and they discouraged it, along with other aspects of native culture. The biggest threat to surfing, however, was the threat to the natives themselves. By 1890, new illnesses introduced by Europeans and Americans had decimated the Hawaiian people, leaving fewer than 40,000 from a pre-contact population that may have exceeded 800,000. At the same time, foreign influence grew with white settlers overthrowing the native monarchy in 1893, and the U.S. annexing the islands five years later. The end of Hawaii's independence coincided with surfing's native-led revival, a revival soon exploited by the American colonizers. But first, some Hawaiians took surfing overseas. In 1907, George Freeth, the so-called Hawaiian Wonder, traveled to the west coast and gave surfing demonstrations in southern California. Then in 1914, Olympic swimmer Duke Kahanamoku made his way to Australia and New Zealand, gliding across the southern Pacific waves and attracting rapt audiences wherever he went. Shortly before Freeth went to California, a South Carolinian named Alexander Hume Ford moved to Hawaii. After learning to surf, he became a champion of the pastime. But Ford may have had unsavory reasons for his enthusiastic efforts to boost the sport. Like many settlers, he wanted Hawaii to become a U.S. state but was worried about its non-white majority of natives and Asian workers. Ford thus promoted surfing to attract white Americans to Hawaii, first as tourists, then as residents. He was helped by numerous writers and filmmakers. Ford's demographic plan would fail miserably. Hawaii became a state in 1959 and remains the most racially diverse state in the country. But the promotion of surfing was a far greater success. Today, surfing is a multi-billion dollar global industry, with tens of millions of enthusiasts worldwide. And though relatively few of these surfers are aware of the once-crucial wave chants or board carving rituals, Hawaiians continue to preserve these traditions nearly washed away by history's waves.

**P530 2017-11-15 What is the tragedy of the commons - Nicholas Amendolare**

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Imagine as a thought experiment that you live in a small village and depend on the local fish pond for food. You share the pond with three other villagers. The pond starts off with a dozen fish, and the fish reproduce. For every two fish, there will be one baby added each night. So, in order to maximize your supply of food, how many fish should you catch each day? Take a moment to think about it. Assume baby fish grow to full size immediately and that the pond begins at full capacity, and ignore factors like the sex of the fish you catch. The answer? One, and it's not just you. The best way to maximize every villager's food supply is for each fisherman to take just one fish each day. Here's how the math works. If each villager takes one fish, there will be eight fish left over night. Each pair of fish produces one baby, and the next day, the pond will be fully restocked with twelve fish. If anyone takes more than one, the number of reproductive pairs drops, and the population won't be able to bounce back. Eventually, the fish in the lake will be gone, leaving all four villagers to starve. This fish pond is just one example of a classic problem called the tragedy of the commons. The phenomenon was first described in a pamphlet by economist William Forster Lloyd in 1833 in a discussion of the overgrazing of cattle on village common areas. More than 100 years later, ecologist Garrett Hardin revived the concept to describe what happens when many individuals all share a limited resource, like grazing land, fishing areas, living space, even clean air. Hardin argued that these situations pit short-term self-interest against the common good, and they end badly for everyone, resulting in overgrazing, overfishing, overpopulation, pollution, and other social and environmental problems. The key feature of a tragedy of the commons is that it provides an opportunity for an individual to benefit him or herself while spreading out any negative effects across the larger population. To see what that means, let's revisit our fish pond. Each individual fisherman is motivated to take as many fish as he can for himself. Meanwhile, any decline in fish reproduction is shared by the entire village. Anxious to avoid losing out to his neighbors, a fisherman will conclude that it's in his best interest to take an extra fish, or two, or three. Unfortunately, this is the same conclusion reached by the other fisherman, and that's the tragedy. Optimizing for the self in the short term isn't optimal for anyone in the long term. That's a simplified example, but the tragedy of the commons plays out in the more complex systems of real life, too. The overuse of antibiotics has led to short-term gains in livestock production and in treating common illnesses, but it's also resulted in the evolution of antibiotic-resistant bacteria, which threaten the entire population. A coal-fired power plant produces cheap electricity for its customers and profits for its owners. These local benefits are helpful in the short term, but pollution from mining and burning coal is spread across the entire atmosphere and sticks around for thousands of years. There are other examples, too. Littering, water shortages, deforestation, traffic jams, even the purchase of bottled water. But human civilization has proven it's capable of doing something remarkable. We form social contracts, we make communal agreements, we elect governments, and we pass laws. All this to save our collective selves from our own individual impulses. It isn't easy, and we certainly don't get it right nearly all of the time. But humans at our best have shown that we can solve these problems and we can continue to do so if we remember Hardin's lesson. When the tragedy of the commons applies, what's good for all of us is good for each of us.

**P531 2017-11-15 Why do you need to get a flu shot every year - Melvin Sanicas**

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All year long, researchers at hundreds of hospitals around the world collect samples from flu patients and send them to top virology experts with one goal: to design the vaccine for the next flu season. But why do we need a new one every year? Vaccines for diseases like mumps and rubella offer a lifetime of protection with two shots early in life. What's so special about the flu? Two factors make the flu a tough target. First, there are more than 100 subtypes of the influenza virus, and the ones in circulation change from season to season. And second, the flu's genetic code allows it to mutate more quickly than many other viruses. The flu spreads by turning a host's own cells into viral production factories. When the virus is engulfed by a host cell, it expels its genetic material, which makes its way to the nucleus. There, cellular machinery that normally copies the host's genes starts replicating viral genes instead, creating more and more copies of the virus. New viruses are repackaged and crammed into the cell until it bursts, sending freshly minted influenza viruses out to infect additional cells. Most viruses follow this script. The trick with the flu is that its genetic material isn't DNA but a similar compound called RNA. And RNA viruses can mutate much faster. When cells synthesize DNA, a built-in proofreader recognizes and corrects mistakes, but the RNA synthesis mechanism doesn't have this fail-safe. If errors creep in, they stick around creating new variants of the virus. Why is this a problem? Because vaccines depend on recognition. The flu vaccine includes some of the same substances, called antigens, found on the surface of the virus itself. The body identifies those fragments as foreign and responds by producing compounds called antibodies, tailor-made to match the antigens. When a vaccinated person encounters the actual virus, the preprogrammed antibodies help the immune system identify the threat and mobilize quickly to prevent an infection. Those antigens are different for every strain of influenza. If vaccination has prepared the immune system for one strain, a different one may still be able to sneak by. Even within the same strain of flu, those rapid genetic mutations can change the surface compounds enough that the antibodies may not recognize them. To make things even more complicated, sometimes two different strains combine to create an entirely new hybrid virus. All of this makes vaccinating for the flu like trying to hit a moving transforming target. That's why scientists are constantly collecting data about which strains are circulating and checking to see how much those strains have mutated from previous years' versions. Twice annually, the World Health Organization pulls together experts to analyze all that data, holding one meeting for each hemisphere. The scientists determine which strains to include in that season's vaccine, picking four for the quadrivalent vaccine in use today. In spite of the flu's evasive maneuvers, in recent years, the group's predictions have been almost always correct. Even when flu strains mutate further, the vaccine is often close enough that a vaccinated person who catches the flu anyway will have a milder and shorter illness than they would otherwise. Vaccination also helps protect other people in the community who may not be medically eligible for the shot by preventing those around them from carrying the virus. This is called herd immunity. The flu shot can't give you the flu. It contains an inactivated virus that isn't capable of making you sick. You might feel tired and achy after getting it, but that's not an infection. It's your normal immune response to the vaccine. Some parts of the world use, instead of a shot, an inhaled vaccine that contains a weakened live virus. This is also safe for the vast majority of people. Only those with impaired immune systems would be at risk, but they're typically not given live vaccines. Meanwhile, scientists are working to develop a universal flu vaccine that would protect against any strain, even mutated ones. But until then, the hunt for next year's vaccine is on.

**P532 2017-11-21 History vs. Che Guevara - Alex Gendler**

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His face is recognized all over the world. The young medical student who became a revolutionary icon. But was Che Guevara a heroic champion of the poor or a ruthless warlord who left a legacy of repression? Order, order. Hey, where have I seen that guy before? Ahem, your Honor, this is Ernesto Che Guevara. In the early 1950s, he left behind a privileged life as a medical student in Argentina to travel through rural Latin America. The poverty and misery he witnessed convinced him that saving lives required more than medicine. So he became a terrorist seeking to violently overthrow the region's governments. What? The region's governments were brutal oligarchies. Colonialism may have formally ended, but elites still controlled all the wealth. American corporations bought up land originally seized from indigenous people and used it for profit and export, even keeping most of it uncultivated while locals starved. Couldn't they vote to change that? Oh, they tried, your Honor. In 1953, Che came to Guatemala under the democratically-elected government of President Árbenz. Árbenz passed reforms to redistribute some of this uncultivated land back to the people while compensating the landowners. But he was overthrown in a CIA-sponsored coup. The military was protecting against the seizure of private property and communist takeover. They were protecting corporate profits and Che saw that they would use the fear of communism to overthrow any government that threatened those profits. So he took the lessons of Guatemala with him to Mexico. There, he met exiled Cuban revolutionaries and decided to help them liberate their country. You mean help Fidel Castro turn a vibrant Cuba into a dictatorship. Dictatorship was what Cuba had before the revolution. Fulgencio Batista was a tyrant who came to power in a military coup. He turned Havana into a luxury playground for foreigners while keeping Cubans mired in poverty and killing thousands in police crackdowns. Even President Kennedy called it the worst example of "economic colonization, humiliation, and exploitation in the world." Whatever Batista's faults, it can't compare to the totalitarian nightmare Castro would create. Forced labor camps, torture of prisoners, no freedom to speak or to leave. But this isn't the trial of Fidel Castro, is it? Che Guevara was instrumental in helping Castro seize power. As a commander in his guerilla army, he unleashed a reign of terror across the countryside, killing any suspected spies or dissenters. He also helped peasants build health clinics and schools, taught them to read, and even recited poetry to them. His harsh discipline was necessary against a much stronger enemy who didn't hesitate to burn entire villages suspected of aiding the rebels. Let's not forget that the new regime held mass executions and killed hundreds of people without trial as soon as they took power in 1959. The executed were officials and collaborators who had tormented the masses under Batista. The people supported this revolutionary justice. Which people? An angry mob crying for blood does not a democracy make. And that's not even mentioning the forced labor camps, arbitrary arrests, and repression of LGBT people that continued long after the revolution. There's a reason people kept risking their lives to flee, often with nothing but the clothes on their backs. So was that all this Che brought to Cuba? Just another violent dictatorship? Not at all. He oversaw land redistribution, helped established universal education, and organized volunteer literacy brigades that raised Cuba's literacy rate to 96%, still one of the highest in the world. Which allowed the government to control what information everyone received. Guevara's idealistic incompetence as Finance Minister caused massive drops in productivity when he replaced worker pay raises with moral certificates. He suppressed all press freedom, declaring that newspapers were instruments of the oligarchy. And it was he who urged Castro to host Soviet nuclear weapons, leading to the Cuban Missile Crisis that brought the world to the brink of destruction. He was a leader, not a bureaucrat. That's why he eventually left to spread the revolution abroad. Which didn't go well. He failed to rally rebels in the Congo and went to Bolivia even when the Soviets disapproved. The Bolivian Government, with the help of the CIA, was able to capture and neutralize this terrorist in 1967, before he could do much damage. While doing plenty of damage themselves in the process. So that was the end of it? Not at all. As Che said, the revolution is immortal. He was publicly mourned in cities all over the world. Not by the Cubans who managed to escape. And his story would inspire young activists for generations to come. Ha. A trendy symbol of rebellion for those who never had to live under his regime. Symbols of revolution may become commodified, but the idea of a more just world remains. Maybe, but I'm not sharing my coffee. Che Guevara was captured and executed by government forces in Bolivia. His remains would not be found for another 30 years. But did he die a hero or had he already become a villain? And should revolutions be judged by their ideals or their outcomes? These are the questions we face when we put history on trial.

**P533 2017-11-22 How do fish make electricity - Eleanor Nelsen**

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In 1800, the explorer Alexander von Humboldt witnessed a swarm of electric eels leap out of the water to defend themselves against oncoming horses. Most people thought the story so unusual that Humboldt made it up. But fish using electricity is more common than you might think; and yes, electric eels are a type of fish. Underwater, where light is scarce, electrical signals offer ways to communicate, navigate, and find—plus, in rare cases, stun—prey. Nearly 350 species of fish have specialized anatomical structures that generate and detect electrical signals. These fish are divided into two groups, depending on how much electricity they produce. Scientists call the first group the weakly electric fish. Structures near their tails called electric organs produce up to a volt of electricity, about two-thirds as much as a AA battery. How does this work? The fish's brain sends a signal through its nervous system to the electric organ, which is filled with stacks of hundreds or thousands of disc-shaped cells called electrocytes. Normally, electrocytes pump out sodium and potassium ions to maintain a positive charge outside and negative charge inside. But when the nerve signal arrives at the electrocyte, it prompts the ion gates to open. Positively charged ions flow back in. Now, one face of the electrocyte is negatively charged outside and positively charged inside. But the far side has the opposite charge pattern. These alternating charges can drive a current, turning the electrocyte into a biological battery. The key to these fish's powers is that nerve signals are coordinated to arrive at each cell at exactly the same time. That makes the stacks of electrocytes act like thousands of batteries in series. The tiny charges from each one add up to an electrical field that can travel several meters. Cells called electroreceptors buried in the skin allow the fish to constantly sense this field and the changes to it caused by the surroundings or other fish. The Peter’s elephantnose fish, for example, has an elongated chin called a schnauzenorgan that's riddled in electroreceptors. That allows it to intercept signals from other fish, judge distances, detect the shape and size of nearby objects, and even determine whether a buried insect is dead or alive. But the elephantnose and other weakly electric fish don't produce enough electricity to attack their prey. That ability belongs to the strongly electric fish, of which there are only a handful of species. The most powerful strongly electric fish is the electric knife fish, more commonly known as the electric eel. Three electric organs span almost its entire two-meter body. Like the weakly electric fish, the electric eel uses its signals to navigate and communicate, but it reserves its strongest electric discharges for hunting using a two-phased attack that susses out and then incapacitates its prey. First, it emits two or three strong pulses, as much as 600 volts. These stimulate the prey's muscles, sending it into spasms and generating waves that reveal its hiding place. Then, a volley of fast, high-voltage discharges causes even more intense muscle contractions. The electric eel can also curl up so that the electric fields generated at each end of the electric organ overlap. The electrical storm eventually exhausts and immobilizes the prey, and the electric eel can swallow its meal alive. The other two strongly electric fish are the electric catfish, which can unleash 350 volts with an electric organ that occupies most of its torso, and the electric ray, with kidney-shaped electric organs on either side of its head that produce as much as 220 volts. There is one mystery in the world of electric fish: why don't they electrocute themselves? It may be that the size of strongly electric fish allows them to withstand their own shocks, or that the current passes out of their bodies too quickly. Some scientists think that special proteins may shield the electric organs, but the truth is, this is one mystery science still hasn't illuminated.

**P534 2017-11-28 Can 100% renewable energy power the world - Federico Rosei and Renzo**

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Every year, the world uses 35 billion barrels of oil. This massive scale of fossil fuel dependence pollutes the Earth and it won't last forever. Scientists estimate that we've consumed about 40% of the world's oil. According to present estimates, at this rate, we'll run out of oil and gas in 50 years or so, and in about a century for coal. On the flip side, we have abundant sun, water, and wind. These are renewable energy sources, meaning that we won't use them up over time. What if we could exchange our fossil fuel dependence for an existence based solely on renewables? We've pondered that question for decades, and yet, renewable energy still only provides about 13% of our needs. That's because reaching 100% requires renewable energy that's inexpensive and accessible. This represents a huge challenge, even if we ignore the politics involved and focus on the science and engineering. We can better understand the problem by understanding how we use energy. Global energy use is a diverse and complex system, and the different elements require their own solutions. But for now, we'll focus on two of the most familiar in everyday life: electricity and liquid fuels. Electricity powers blast furnaces, elevators, computers, and all manner of things in homes, businesses, and manufacturing. Meanwhile, liquid fuels play a crucial role in almost all forms of transportation. Let's consider the electrical portion first. The great news is that our technology is already advanced enough to capture all that energy from renewables, and there's an ample supply. The sun continuously radiates about 173 quadrillion watts of solar energy at the Earth, which is almost 10,000 times our present needs. It's been estimated that a surface that spans several hundred thousand kilometers would be needed to power humanity at our present usage levels. So why don't we build that? Because there are other hurdles in the way, like efficiency and energy transportation. To maximize efficiency, solar plants must be located in areas with lots of sunshine year round, like deserts. But those are far away from densely populated regions where energy demand is high. There are other forms of renewable energy we could draw from, such as hydroelectric, geothermal, and biomasses, but they also have limits based on availability and location. In principle, a connected electrical energy network with power lines crisscrossing the globe would enable us to transport power from where it's generated to where it's needed. But building a system on this scale faces an astronomical price tag. We could lower the cost by developing advanced technologies to capture energy more efficiently. The infrastructure for transporting energy would also have to change drastically. Present-day power lines lose about 6-8% of the energy they carry because wire material dissipates energy through resistance. Longer power lines would mean more energy loss. Superconductors could be one solution. Such materials can transport electricity without dissipation. Unfortunately, they only work if cooled to low temperatures, which requires energy and defeats the purpose. To benefit from that technology, we'd need to discover new superconducting materials that operate at room temperature. And what about the all-important, oil-derived liquid fuels? The scientific challenge there is to store renewable energy in an easily transportable form. Recently, we've gotten better at producing lithium ion batteries, which are lightweight and have high-energy density. But even the best of these store about 2.5 megajoules per kilogram. That's about 20 times less than the energy in one kilogram of gasoline. To be truly competitive, car batteries would have to store much more energy without adding cost. The challenges only increase for bigger vessels, like ships and planes. To power a cross-Atlantic flight for a jet, we'd need a battery weighing about 1,000 tons. This, too, demands a technological leap towards new materials, higher energy density, and better storage. One promising solution would be to find efficient ways to convert solar into chemical energy. This is already happening in labs, but the efficiency is still too low to allow it to reach the market. To find novel solutions, we'll need lots of creativity, innovation, and powerful incentives. The transition towards all-renewable energies is a complex problem involving technology, economics, and politics. Priorities on how to tackle this challenge depend on the specific assumptions we have to make when trying to solve such a multifaceted problem. But there's ample reason to be optimistic that we'll get there. Top scientific minds around the world are working on these problems and making breakthroughs all the time. And many governments and businesses are investing in technologies that harness the energy all around us.

**P535 2017-11-30 Why is Herodotus called “The Father of History” - Mark Robinson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=535)

Giant gold-digging ants, a furious king who orders the sea to be whipped 300 times, and a dolphin that saves a famous poet from drowning. These are just some of the stories from The Histories by Herodotus, an Ancient Greek writer from the 5th century BCE. Not all the events in the text may have happened exactly as Herodotus reported them, but this work revolutionized the way the past was recorded. Before Herodotus, the past was documented as a list of events with little or no attempt to explain their causes beyond accepting things as the will of the gods. Herodotus wanted a deeper, more rational understanding, so he took a new approach: looking at events from both sides to understand the reasons for them. Though he was Greek, Herodotus's hometown of Halicarnassus was part of the Persian Empire. He grew up during a series of wars between the powerful Persians and the smaller Greeks, and decided to find out all he could about the subject. In Herodotus's telling, the Persian Wars began in 499 BCE, when the Athenians assisted a rebellion by Greeks living under Persian rule. In 490, the Persian King, Darius, sent his army to take revenge on Athens. But at the Battle of Marathon, the Athenians won an unexpected victory. Ten years later, the Persians returned, planning to conquer the whole of Greece under the leadership of Darius's son, Xerxes. According to Herodotus, when Xerxes arrived, his million man army was initially opposed by a Greek force led by 300 Spartans at the mountain pass of Thermopylae. At great cost to the Persians, the Spartans and their king, Leonidas, were killed. This heroic defeat has been an inspiration to underdogs ever since. A few weeks later, the Greek navy tricked the Persian fleet into fighting in a narrow sea channel near Athens. The Persians were defeated and Xerxes fled, never to return. To explain how these wars broke out and why the Greeks triumphed, Herodotus collected stories from all around the Mediterranean. He recorded the achievements of both Greeks and non-Greeks before they were lost to the passage of time. The Histories opens with the famous sentence: "Herodotus, of Halicarnassus, here displays his inquiries." By framing the book as an “inquiry,” Herodotus allowed it to contain many different stories, some serious, others less so. He recorded the internal debates of the Persian court but also tales of Egyptian flying snakes and practical advice on how to catch a crocodile. The Greek word for this method of research is "autopsy," meaning "seeing for oneself." Herodotus was the first writer to examine the past by combining the different kinds of evidence he collected: opsis, or eyewitness accounts, akoe, or hearsay, and ta legomena, or tradition. He then used gnome, or reason, to reach conclusions about what actually happened. Many of the book's early readers were actually listeners. The Histories was originally written in 28 sections, each of which took about four hours to read aloud. As the Greeks increased in influence and power, Herodotus's writing and the idea of history spread across the Mediterranean. As the first proper historian, Herodotus wasn't perfect. On occasions, he favored the Greeks over the Persians and was too quick to believe some of the stories that he heard, which made for inaccuracies. However, modern evidence has actually explained some of his apparently extreme claims. For instance, there's a species of marmot in the Himalayas that spreads gold dust while digging. The ancient Persian word for marmot is quite close to the word for ant, so Herodotus may have just fallen prey to a translation error. All in all, for someone who was writing in an entirely new style, Herodotus did remarkably well. History, right down to the present day, has always suffered from the partiality and mistakes of historians. Herodotus’s method and creativity earned him the title that the Roman author Cicero gave him several hundred years later: "The Father of History."

**P536 2017-12-06 How your digestive system works - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=536)

Across the whole planet, humans eat on average between one and 2.7 kilograms of food a day. That's over 365 kilograms a year per person, and more than 28,800 kilograms over the course of a lifetime. And every last scrap makes its way through the digestive system. Comprised of ten organs covering nine meters, and containing over 20 specialized cell types, this is one of the most diverse and complicated systems in the human body. Its parts continuously work in unison to fulfill a singular task: transforming the raw materials of your food into the nutrients and energy that keep you alive. Spanning the entire length of your torso, the digestive system has four main components. First, there's the gastrointestinal tract, a twisting channel that transports your food and has an internal surface area of between 30 and 40 square meters, enough to cover half a badminton court. Second, there's the pancreas, gallbladder, and liver, a trio of organs that break down food using an array of special juices. Third, the body's enzymes, hormones, nerves, and blood all work together to break down food, modulate the digestive process, and deliver its final products. Finally, there's the mesentery, a large stretch of tissue that supports and positions all your digestive organs in the abdomen, enabling them to do their jobs. The digestive process begins before food even hits your tongue. Anticipating a tasty morsel, glands in your mouth start to pump out saliva. We produce about 1.5 liters of this liquid each day. Once inside your mouth, chewing combines with the sloshing saliva to turn food into a moist lump called the bolus. Enzymes present in the saliva break down any starch. Then, your food finds itself at the rim of a 25-centimeter-long tube called the esophagus, down which it must plunge to reach the stomach. Nerves in the surrounding esophageal tissue sense the bolus's presence and trigger peristalsis, a series of defined muscular contractions. That propels the food into the stomach, where it's left at the mercy of the muscular stomach walls, which bound the bolus, breaking it into chunks. Hormones, secreted by cells in the lining, trigger the release of acids and enzyme-rich juices from the stomach wall that start to dissolve the food and break down its proteins. These hormones also alert the pancreas, liver, and gallbladder to produce digestive juices and transfer bile, a yellowish-green liquid that digests fat, in preparation for the next stage. After three hours inside the stomach, the once shapely bolus is now a frothy liquid called chyme, and it's ready to move into the small intestine. The liver sends bile to the gallbladder, which secretes it into the first portion of the small intestine called the duodenum. Here, it dissolves the fats floating in the slurry of chyme so they can be easily digested by the pancreatic and intestinal juices that have leached onto the scene. These enzyme-rich juices break the fat molecules down into fatty acids and glycerol for easier absorption into the body. The enzymes also carry out the final deconstruction of proteins into amino acids and carbohydrates into glucose. This happens in the small intestine's lower regions, the jejunum and ileum, which are coated in millions of tiny projections called villi. These create a huge surface area to maximize molecule absorption and transference into the blood stream. The blood takes them on the final leg of their journey to feed the body's organs and tissues. But it's not over quite yet. Leftover fiber, water, and dead cells sloughed off during digestion make it into the large intestine, also known as the colon. The body drains out most of the remaining fluid through the intestinal wall. What's left is a soft mass called stool. The colon squeezes this byproduct into a pouch called the rectum, where nerves sense it expanding and tell the body when it's time to expel the waste. The byproducts of digestion exit through the anus and the food's long journey, typically lasting between 30 and 40 hours, is finally complete.

**P537 2017-12-06 Who's at risk for colon cancer - Amit H. Sachdev and Frank G. Gress**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=537)

If you were to lay your digestive tract out in a straight line, it would form a tube spanning nearly ten meters. The last 1.5 meters of that are called the colon, or large intestine. Cells in this organ's lining constantly renew themselves, but the genes that moderate this process occasionally go awry, leading to the excessive growth of new cells. That results in small growths or abnormal clumps of cells called polyps. The majority of these polyps won't do any harm, but some can become cancerous when their cells begin to grow and divide rapidly, projecting further into the colon. At that point, they can transform into colon cancer, one of the most prevalent and preventable forms of cancer in the world. That's a slow process: though growth times vary, it often takes around ten years for a small polyp to grow and develop into a cancerous one. We don't know exactly what causes the majority of colon polyps and colon cancers. We do know in general that colon cancer involves the activation of what's called oncogenes in the polyp, and/or the loss of tumor-suppressor genes that usually keep cancer cells in check. Most cells have proto-oncogenes that help them grow. When a proto-oncogene mutates, or there are two many copies of it, it can become a permanently active oncogene with cells that grow out of control. While we don't yet know exactly what underlying factors cause these changes, experts suspect a combination of both environmental and inherited genetic factors. In the worst cases, when cells within polyps divide and spread unchecked, they eventually break through the lining of the colon. Lymph and blood vessels carry those cells all over the body, and they can go on to form tumors. Despite these challenges, there's a solution. We've become extremely good at detecting and removing offending polyps before they can cause cancer. This happens through a process called screening, and when we do it regularly, we can prevent many cases of colon cancer. So, who's at risk? Most cases occur in people aged 50 years or older. This group is considered at average risk for colon cancer or colon polyps. There's also a higher risk group that includes people with personal or family histories of colon polyps or cancer, and those who suffer from inherited genetic syndromes, or inflammatory diseases, like Crohn’s disease and ulcerative colitis. So the best age to initiate screening varies from person to person. If you have access to healthcare, it's best to consult a doctor to find out when you should begin. Screening can be done with various tests. Colonoscopy involves a long, thin, flexible tube that's fitted with a video camera and light at the end and placed internally to examine the colon for polyps. If polyps are found, a doctor can do a polypectomy, a procedure that removes polyps from the colonic wall. Doctors can also then test the polyp for cancerous cells. Colonoscopy is the only test that can be used to both find and remove polyps. There are, however, other useful screening tests, including imaging and at-home tests that can allow patients to examine their stool for small amounts of blood. Occasionally, polyps are too large to be removed during a colonoscopy, in which case, the next step is surgery. If blood and imaging tests then reveal that cancerous cells have spread outside the colon, then a special treatment, like chemotherapy, may also be required to stop the cancer from escalating. We can also take on certain habits to reduce our likelihood of developing colon cancer in the first place. There's evidence that maintaining a healthy weight, not smoking, and being physically active can help. But most importantly, access to healthcare and regular screenings at crucial times in life are the best ways to prevent colon cancer.

**P538 2017-12-06 Why should you read Charles Dickens - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=538)

The starving orphan seeking a second helping of gruel. The spinster wasting away in her tattered wedding dress. The stone-hearted miser plagued by the ghost of Christmas past. More than a century after his death, these remain recognizable figures from the work of Charles Dickens. So striking is his body of work that it gave rise to its own adjective. But what are the features of Dickens's writing that make it so special? Dickens’s fiction brims with anticipation through brooding settings, plot twists, and mysteries. These features of his work kept his audience wanting more. When first published, his stories were serialized, meaning they were released a few chapters at a time in affordable literary journals and only later reprinted as books. This prompted fevered speculation over the cliffhangers and revelations he devised. Serialization not only made fiction available to a wider audience and kept them reading, but increased the hype around the author himself. Dickens became particularly popular for his wit, which he poured into quirky characters and satiric scenarios. His characters exhibit the sheer absurdity of human behavior, and their names often personify traits or social positions, like the downtrodden Bob Cratchit, the groveling Uriah Heep, and the cheery Septimus Crisparkle. Dickens set these colorful characters against intricate social backdrops, which mimic the society he lived in. For instance, he often considered the changes brought about by the Industrial Revolution. During this period, the lower classes experienced sordid working and living conditions. Dickens himself experienced this hardship as a child when he was forced to work in a boot blacking factory after his father was sent to debtors' prison. This influenced his depiction of the Marshalsea prison in Little Dorrit, where the titular character cares for her convict father. Prisons, orphanages, or slums may seem grim settings for a story, but they allowed Dickens to shed light on how his society's most invisible people lived. In Nicholas Nickleby, Nicholas takes a job with the schoolmaster Wackford Squeers. He soon realizes that Squeers is running a scam where he takes unwanted children from their parents for a fee and subjects them to violence and deprivation. Oliver Twist also deals with the plight of children in the care of the state, illustrating the brutal conditions of the workhouse in which Oliver pleads with Mr. Bumble for food. When he flees to London, he becomes ensnared in a criminal underworld. These stories frequently portray Victorian life as grimy, corrupt, and cruel. But Dickens also saw his time as one in which old traditions were fading away. London was becoming the incubator of the modern world through new patterns in industry, trade, and social mobility. Dickens's London is therefore a dualistic space: a harsh world that is simultaneously filled with wonder and possibility. For instance, the enigma of Great Expectations centers around the potential of Pip, an orphan plucked from obscurity by an anonymous benefactor and propelled into high society. In his search for purpose, Pip becomes the victim of other people’s ambitions for him and must negotiate with a shadowy cast of characters. Like many of Dickens’s protagonists, poor Pip's position is constantly destabilized, just one of the reasons why reading Dickens is the best of times for the reader, while being the worst of times for his characters. Dickens typically offered clear resolution by the end of his novels, – with the exception of The Mystery of Edwin Drood. The novel details the disappearance of the orphan Edwin under puzzling circumstances. However, Dickens died before the novel was finished and left no notes resolving the mystery. Readers continue to passionately debate over who Dickens intended as the murderer, and whether Edwin Drood was even murdered in the first place. Throughout many adaptations, literary homages, and the pages of his novels, Dickens’s sparkling language and panoramic worldview continue to resonate. Today, the adjective Dickensian often implies squalid working or living conditions. But to describe a novel as Dickensian is typically high praise, as it suggests a story in which true adventure and discovery occur in the most unexpected places. Although he often explored bleak material, Dickens’s piercing wit never failed to find light in the darkest corners.

**P539 2017-12-13 Why do animals form swarms - Maria R. D'Orsogna**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=539)

When desert locusts are well fed, they're solitary creatures. But when food becomes scarce, hungry, desperate locusts crowd onto small patches of land where they can still find something to eat. Contact between different locusts' hind legs set off a slew of reactions that change their appearance and behavior. Now, instead of shunning their peers, they seek each other out. The locusts eventually start marching and then fly away in large numbers seeking a better habitat. These gigantic swarms can host millions of insects and travel thousands of miles, devastating vegetation and crops. They stay close to each other, but not too close, or they might get eaten by their hungry neighbors. When many individual organisms, like locusts, bacteria, anchovies, or bats, come together and move as one coordinated entity, that's a swarm. From a handful of birds to billions of insects, swarms can be almost any size. But what they have in common is that there's no leader. Members of the swarm interact only with their nearest neighbors or through indirect cues. Each individual follows simple rules: Travel in the same direction as those around you, stay close, and avoid collisions. There are many benefits to traveling in a group like this. Small prey may fool predators by assembling into a swarm that looks like a much bigger organism. And congregating in a large group reduces the chance that any single individual will be captured. Moving in the same direction as your neighbors saves energy by sharing the effort of fighting wind or water resistance. It may even be easier to find a mate in a swarm. Swarming can also allow groups of animals to accomplish tasks they couldn't do individually. When hundreds or millions or organisms follow the same simple rules, sophisticated behavior called swarm intelligence may arise. A single ant can't do much on its own, but an ant colony can solve complex problems, like building a nest and finding the shortest path to a food source. But sometimes, things can go wrong. In a crowd, diseases spread more easily, and some swarming organisms may start eating each other if food is scarce. Even some of the benefits of swarms, like more efficient navigation, can have catastrophic consequences. Army ants are one example. They lay down chemicals called pheromones which signal their neighbors to follow the trail. This is good if the head of the group is marching towards a food source. But occasionally the ants in the front can veer off course. The whole swarm can get caught in a loop following the pheromone trail until they die of exhaustion. Humans are notoriously individualistic, though social, animals. But is there anything we can learn from collective swarm-based organization? When it comes to technology, the answer is definitely yes. Bats can teach drones how to navigate confined spaces without colliding, fish can help design software for safer driving, and insects are inspiring robot teams that can assist search and rescue missions. For swarms of humans, it's perhaps more complicated and depends on the motives and leadership. Swarm behavior in human populations can sometimes manifest as a destructive mob. But collective action can also produce a crowd-sourced scientific breakthrough an artistic expression, or a peaceful global revolution.

**P540 2017-12-18 How does your immune system work - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=540)

A mosquito lands on your arm, injects its chemicals into your skin, and begins to feed. You wouldn’t even know it was there, if not for the red lump that appears, accompanied by a telltale itch. It’s a nuisance, but that bump is an important signal that you’re protected by your immune system, your body’s major safeguard against infection, illness, and disease. This system is a vast network of cells, tissues, and organs that coordinate your body’s defenses against any threats to your health. Without it, you’d be exposed to billions of bacteria, viruses, and toxins that could make something as minor as a paper cut or a seasonal cold fatal. The immune system relies on millions of defensive white blood cells, also known as leukocytes, that originate in our bone marrow. These cells migrate into the bloodstream and the lymphatic system, a network of vessels which helps clear bodily toxins and waste. Our bodies are teeming with leukocytes: there are between 4,000 and 11,000 in every microliter of blood. As they move around, leukocytes work like security personnel, constantly screening the blood, tissues, and organs for suspicious signs. This system mainly relies on cues called antigens. These molecular traces on the surface of pathogens and other foreign substances betray the presence of invaders. As soon as the leukocytes detect them, it takes only minutes for the body’s protective immune response to kick in. Threats to our bodies are hugely variable, so the immune response has to be equally adaptable. That means relying on many different types of leukocytes to tackle threats in different ways. Despite this diversity, we classify leukocytes in two main cellular groups, which coordinate a two-pronged attack. First, phagocytes trigger the immune response by sending macrophages and dendritic cells into the blood. As these circulate, they destroy any foreign cells they encounter, simply by consuming them. That allows phagocytes to identify the antigen on the invaders they just ingested and transmit this information to the second major cell group orchestrating the defense, the lymphocytes. A group of lymphocyte cells called T-cells go in search of infected body cells and swiftly kill them off. Meanwhile, B-cells and helper T-cells use the information gathered from the unique antigens to start producing special proteins called antibodies. This is the pièce de résistance: Each antigen has a unique, matching antibody that can latch onto it like a lock and key, and destroy the invading cells. B-cells can produce millions of these, which then cycle through the body and attack the invaders until the worst of the threat is neutralized. While all of this is going on, familiar symptoms, like high temperatures and swelling, are actually processes designed to aid the immune response. A warmer body makes it harder for bacteria and viruses to reproduce and spread because they’re temperature-sensitive. And when body cells are damaged, they release chemicals that make fluid leak into the surrounding tissues, causing swelling. That also attracts phagocytes, which consume the invaders and the damaged cells. Usually, an immune response will eradicate a threat within a few days. It won’t always stop you from getting ill, but that’s not its purpose. Its actual job is to stop a threat from escalating to dangerous levels inside your body. And through constant surveillance over time, the immune system provides another benefit: it helps us develop long-term immunity. When B- and T-cells identify antigens, they can use that information to recognize invaders in the future. So, when a threat revisits, the cells can swiftly deploy the right antibodies to tackle it before it affects any more cells. That’s how you can develop immunity to certain diseases, like chickenpox. It doesn’t always work so well. Some people have autoimmune diseases, which trick the immune system into attacking the body’s own perfectly healthy cells. No one knows exactly what causes them, but these disorders sabotage the immune system to varying degrees, and underlie problems like arthritis, Type I diabetes, and multiple sclerosis. For most individuals, however, a healthy immune system will successfully fight off an estimated 300 colds and innumerable other potential infections over the course of a lifetime. Without it, those threats would escalate into something far more dangerous. So the next time you catch a cold or scratch a mosquito bite, think of the immune system. We owe it our lives.

**P541 2017-12-20 How to manage your time more effectively (according to machines) - Br**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=541)

In the summer of 1997, NASA's Pathfinder spacecraft landed on the surface of Mars, and began transmitting incredible, iconic images back to Earth. But several days in, something went terribly wrong. The transmissions stopped. Pathfinder was, in effect, procrastinating: keeping itself fully occupied but failing to do its most important work. What was going on? There was a bug, it turned out, in its scheduler. Every operating system has something called the scheduler that tells the CPU how long to work on each task before switching, and what to switch to. Done right, computers move so fluidly between their various responsibilities, they give the illusion of doing everything simultaneously. But we all know what happens when things go wrong. This should give us, if nothing else, some measure of consolation. Even computers get overwhelmed sometimes. Maybe learning about the computer science of scheduling can give us some ideas about our own human struggles with time. One of the first insights is that all the time you spend prioritizing your work is time you aren't spending doing it. For instance, let's say when you check your inbox, you scan all the messages, choosing which is the most important. Once you've dealt with that one, you repeat. Seems sensible, but there's a problem here. This is what's known as a quadratic-time algorithm. With an inbox that's twice as full, these passes will take twice as long and you'll need to do twice as many of them! This means four times the work. The programmers of the operating system Linux encountered a similar problem in 2003. Linux would rank every single one of its tasks in order of importance, and sometimes spent more time ranking tasks than doing them. The programmers’ counterintuitive solution was to replace this full ranking with a limited number of priority “buckets.” The system was less precise about what to do next but more than made up for it by spending more time making progress. So with your emails, insisting on always doing the very most important thing first could lead to a meltdown. Waking up to an inbox three times fuller than normal could take nine times longer to clear. You’d be better off replying in chronological order, or even at random! Surprisingly, sometimes giving up on doing things in the perfect order may be the key to getting them done. Another insight that emerges from computer scheduling has to do with one of the most prevalent features of modern life: interruptions. When a computer goes from one task to another, it has to do what's called a context switch, bookmarking its place in one task, moving old data out of its memory and new data in. Each of these actions comes at a cost. The insight here is that there’s a fundamental tradeoff between productivity and responsiveness. Getting serious work done means minimizing context switches. But being responsive means reacting anytime something comes up. These two principles are fundamentally in tension. Recognizing this tension allows us to decide where we want to strike that balance. The obvious solution is to minimize interruptions. The less obvious one is to group them. If no notification or email requires a response more urgently than once an hour, say, then that’s exactly how often you should check them. No more. In computer science, this idea goes by the name of interrupt coalescing. Rather than dealing with things as they come up – Oh, the mouse was moved? A key was pressed? More of that file downloaded? – the system groups these interruptions together based on how long they can afford to wait. In 2013, interrupt coalescing triggered a massive improvement in laptop battery life. This is because deferring interruptions lets a system check everything at once, then quickly re-enter a low-power state. As with computers, so it is with us. Perhaps adopting a similar approach might allow us users to reclaim our own attention, and give us back one of the things that feels so rare in modern life: rest.

**P542 2018-01-05 The tragic myth of Orpheus and Eurydice - Brendan Pelsue**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=542)

It was the perfect wedding, the guests thought. The groom was Orpheus, the greatest of all poets and musicians. The bride Eurydice, a wood nymph. Anyone could tell the couple was truly and deeply in love. Suddenly, Eurydice stumbled, then fell to the ground. By the time Orpheus reached her side, she was dead, and the snake that had bitten her was slithering away through the grass. Following Eurydice’s funeral, Orpheus was overcome with a grief the human world could not contain, and so he decided he would journey to the land of the dead, a place from which no living creature had ever returned, to rescue his beloved. When Orpheus reached the gates of the underworld, he began to strum his lyre. The music was so beautiful that Cerberus, the three-headed dog who guards the dead, lay down as Orpheus passed. Charon, the ferry captain who charged dead souls to cross the River Styx, was so moved by the music that he brought Orpheus across free of charge. When Orpheus entered the palace of Hades and Persephone, the king and queen of the dead, he began to sing. He sang of his love for Eurydice, and said she had been taken away too soon. The day would come when she, like all living creatures, dwelled in the land of the dead for all eternity, so couldn’t Hades grant her just a few more years on Earth? In the moment after Orpheus finished, all hell stood still. Sisyphus no longer rolled his rock up the hill. Tantalus did not reach for the water he would never be allowed to drink. Even the Furies, the demonic goddesses of vengeance, wept. Hades and Persephone granted Orpheus’s plea, but on one condition. As he climbed back out of the underworld, he must not turn around to see if Eurydice was following behind him. If he did, she would return to the land of the dead forever. Orpheus began to climb. With each step, he worried more and more about whether Eurydice was behind him. He heard nothing— where were her footsteps? Finally, just before he stepped out of the underworld and into the bright light of day, he gave into temptation. Orpheus tried to return to the underworld, but was refused entry. Separated from Eurydice, Orpheus swore never to love another woman again. Instead, he sat in a grove of trees and sang songs of lovers. There was Ganymede, the beautiful boy who Zeus made drink-bearer to the gods. There was Myrrah, who loved her father and was punished for it, and Pygmalion, who sculpted his ideal woman out of ivory, then prayed to Venus until she came to life. And there was Venus herself, whose beautiful Adonis was killed by a wild boar. It was as if Orpheus’s own love and loss had allowed him to see into the hearts of gods and people everywhere. For some, however, poetry was not enough. A group of wild women called the Maenads could not bear the thought that a poet who sang so beautifully of love would not love them. Their jealousy drove them to a frenzy and they destroyed poor Orpheus. The birds, nature’s singers, mourned Orpheus, as did the rivers, who made music as they babbled. The world had lost two great souls. Orpheus and Eurydice had loved each other so deeply that when they were separated, Orpheus had understood the pain and joys of lovers everywhere, and a new art form, the love poem, was born. While the world wept, Orpheus found peace, and his other half, in the underworld. There, to this day, he walks with Eurydice along the banks of the River Styx. Sometimes, they stroll side by side; sometimes, she is in front; and sometimes, he takes the lead, turning to look back at her as often as he likes.

**P543 2018-01-05 What are mini brains - Madeline Lancaster**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=543)

This pencil-eraser-sized mass of cells is something called a brain organoid. It’s a collection of lab-grown neurons and other brain tissue that scientists can use to learn about full-grown human brains. And it can be grown from a sample of your skin cells. Why would we need such a thing? Neuroscientists face a challenge: shielded by our thick skulls and swaddled in layers of protective tissue, the human brain is extremely difficult to observe in action. For centuries, scientists have tried to understand them using autopsies, animal models, and, in recent years, imaging techniques. We’ve learned a lot through all these methods, but they have limitations. Conditions like Alzheimer’s and schizophrenia, and the effect on the human brain of diseases like Zika, continue to hide beyond our view, and our understanding. Enter brain organoids, which function like human brains but aren’t part of an organism. Each one comes from an undifferentiated stem cell, which is a cell that can develop into any tissue in the body, from bone to brain. Scientists can make undifferentiated stem cells from skin cells. That means they can take a skin sample from a person with a particular condition and generate brain organoids from that person. The hardest part of growing a brain organoid, which stumped scientists for years, was finding the perfect combination of sugars, proteins, vitamins, and minerals that would induce the stem cell to develop a neural identity. That was only discovered recently, in 2013. The rest of the process is surprisingly easy. A neural stem cell essentially grows itself, similar to how a seed grows into a plant, all it needs are the brain’s equivalents of soil, water, and sunlight. A special gel to simulate embryonic tissue, a warm incubator set at body temperature, and a bit of motion to mimic blood flow. The stem cell grows into a very small version of an early-developing human brain, complete with neurons that can connect to one another and make simplified neural networks. As mini brains grow, they follow all the steps of fetal brain development. By observing this process, we can learn how our neurons develop, as well as how we end up with so many more of them in our cortex, the part responsible for higher cognition like logic and reasoning, than other species. Being able to grow brains in the lab, even tiny ones, raises ethical questions, like: Can they think for themselves, or develop consciousness? And the answer is no, for several reasons. A brain organoid has the same tissue types as a full-sized brain, but isn’t organized the same way. The organoid is similar to an airplane that’s been taken apart and reassembled at random; you could still study the wings, the engine, and other parts, but the plane could never fly. Similarly, a brain organoid allows us to study different types of brain tissue, but can’t think. And even if mini brains were organized like a real brain, they still wouldn’t be able to reason or develop consciousness. A big part of what makes our brains so smart is their size, and mini brains have only about 100,000 neurons compared to the 86 billion in a full-sized brain. Scientists aren’t likely to grow larger brain organoids anytime soon. Without blood vessels to feed them, their size is limited to one centimeter at most. Finally, mini brains aren’t able to interact with the outside world. We learn by interacting with our environments: receiving inputs through our eyes, ears, and other sensory organs, and reacting in turn. The complex neural networks that underlie conscious thoughts and actions develop from this feedback loop. Without it, the organoids can never form a functional network. There’s nothing quite like the actual human brain, but mini brains are an unprecedented tool for studying everything from development to disease. With luck, these humble organoids can help us discover what makes the human brain unique, and maybe bring us closer to answering the age-old question: what makes us human?

**P544 2018-01-09 The myth of Oisín and the land of eternal youth - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=544)

In a typical hero's journey, the protagonist sets out on an adventure, undergoes great change, and returns in triumph to their point of origin. But in the Irish genre of myth known as Eachtraí, the journey to the other world ends in a point of no return. While there are many different versions of the otherworld in Irish mythology, the most well-known example occurs in the story of Oisín. Oisín was the son of Fionn mac Cumhaill, the leader of a group of pagan warriors known as the Fianna. As Oisín rode with his companions one day, he was visited by the immortal princess Niamh. The two fell instantly in love and Niamh put Oisín onto her white horse and rode with him to the edge of the Irish sea. As they made for the horizon, the riders sunk into a golden haze. They came to the shores of the gleaming kingdom called Tír na nÓg. This was the home of the Tuatha Dé Danann, the people who ruled Ancient Ireland long before Oisín's time. From the point of his arrival, Oisín's every need was met. He married Niamh in a grand ceremony and was welcomed into her family. When he wished to hear music, his ears filled with bewitching tones. When he hungered, golden plates appeared laden with fragrant food. He admired scenes of great beauty, and colors that he had no name for. All around him, the land and the people existed in a state of unmoving perfection. But what Oisín didn't know was that Tír na nÓg was the land of youth, in which time stood still and the people never aged. In his new home, Oisín continued to hunt and explore as he had in Ireland. But in the land of youth, he possessed a strange, new invincibility. At the end of each day of adventuring, Oisín's wounds magically healed themselves as he slept in Niamh's arms. Although glory and pleasure came easily to Oisín in the land of youth, he missed the Fianna and the adventures they had in Ireland. After three years in Tír na nÓg, he was struck by a deep yearning for home. Before he embarked on his journey back, Niamh warned him that he must not alight from his horse to touch the earth with his own feet. When Oisín reached the shores of Ireland, it felt as if a shadow had fallen over the world. On the hill where his father's palace lay, he saw only a ruin strewn with weeds. His calls for his friends and family echoed from derelict walls. Horrified, Oisín rode until he came upon a group of peasants working in the fields. They were struggling to remove a boulder from their land, and forgetting Niamh's warning, Oisín leapt from his horse and rolled it away with his superhuman strength. The crowd's cheers soon turned into shrieks. In place of the youth was an old man whose beard swept the ground and whose legs buckled under him. He cried out for Finn and the Fianna, but the people only recognized these names from the distant past of 300 years before. Time had betrayed Oisín and his return to mortal lands had aged him irreversibly. Throughout Irish folklore, sightings of the land of youth have been reported in the depths of wells, on the brink of the horizon, or in the gloom of caves. But those who know the tale of Oisín tell of another vision, that of a shining princess carried upon the distant waves by a white horse, still hoping for the return of her doomed love.

**P545 2018-01-17 Why is NASA sending a spacecraft to a metal world - Linda T. Elkins-T**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=545)

Somewhere between the orbits of Mars and Jupiter, about 500 million kilometers away from Earth, floats a metallic orb the size of Massachusetts. That’s no moon...it’s 16 Psyche, one of the most massive asteroids in the solar system. And it is the asteroid our droids are looking for. We humans have managed to send robotic spacecraft to all sorts of environments in space – the gas clouds of Saturn and Jupiter, the icy wastes of Europa, and the rocky dunes of Mars. But Psyche’s surface isn’t just hard rock – it’s heavy metal. The asteroid mostly consists of nickel and iron, by far the largest known body with such a composition. But we don’t yet know what it looks like; our best current radar images show a pixelated smudge. That’ll change in 2026, when an unmanned spacecraft sent as part of NASA’s Discovery Program is scheduled to arrive. So why is NASA so interested in Psyche? Are we going to mine all that metal, or build a giant space magnet? Actually, the real reason is right under our feet. The core of the Earth is thought to consist of a solid nickel-iron center with a molten outer layer. But we’re prevented from studying it up close by 2,800 kilometers of solid rock. The deepest we’ve been able to drill is 12 kilometers. Even if we could go further, the pressure at the core is three million times higher than at the surface, with a temperature of 5,000 degrees Celsius. Simply put, a journey to the center of the Earth is out of the question for now. So scientists have had to resort to indirect ways of studying the core, like measuring earthquake waves that pass through it, or studying minerals thought to have formed there. But what if the best way to study Earth’s inner space is by visiting outer space? After all, we have a pretty good idea of how our planets formed. Dust and gas orbiting our young Sun cooled and collided to form a few thousand miniature bodies we call planetesimals. As these continued to orbit, some combined to grow larger, eventually forming our planets. Others experienced impacts that broke them apart into smaller chunks– the asteroids we see today in the belt between Mars and Jupiter. What makes Psyche so special is that it appears to have been a planetesimal well on its way to becoming a planet, with a rocky exterior surrounding a metal core. But its progress was cut short by a series of hit-and-run collisions with other planetesimals that knocked off the rocky crust until only the core remained. Experiencing that many destructive collisions with no additive ones in between is statistically very unlikely, making Psyche an amazingly rare opportunity to study an exposed metallic core. To do that, NASA’s robotic orbiter will be equipped with an array of advanced instruments. A spectrometer will analyze the gamma rays and neutrons produced when Psyche is struck by cosmic rays. Each element in the periodic table releases gamma rays of specific wavelengths, so these measurements will tell us what elements are found on the surface. A magnetometer will measure Psyche’s magnetic field, allowing us to learn more about how Earth’s magnetic field is generated at its core. And of course, an imager will give us a closer look at the surface than ever before. Visiting a whole new kind of world is exciting enough on its own. But the mission to Psyche gives us a unique chance to discover our own planet’s innermost secrets in an orbit far, far away.

**P546 2018-01-19 Ugly history - The 1937 Haitian Massacre - Edward Paulino**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=546)

When historians talk about the atrocities of the 20th century, we often think of those that took place during and between the two World Wars. Along with the Armenian genocide in modern-day Turkey, the Rape of Nanking in China, and Kristallnacht in Germany, another horrific ethnic cleansing campaign occurred on an island between the Atlantic Ocean and Caribbean Sea. The roots of this conflict go back to 1492, when Christopher Columbus stumbled onto the Caribbean island that would come to be named Hispaniola, launching a wave of European colonization. The island’s Taíno natives were decimated by violence and disease and the Europeans imported large numbers of enslaved Africans to toil in profitable sugar plantations. By 1777, the island had become divided between a French-controlled West and a Spanish-controlled East. A mass slave revolt won Haiti its independence from France in 1804 and it became the world’s first black republic. But the new nation paid dearly, shut out of the world economy and saddled with debt by its former masters. Meanwhile, the Dominican Republic would declare independence by first overthrowing Haitian rule of eastern Hispaniola and later Spanish and American colonialism. Despite the long and collaborative history shared by these two countries, many Dominican elites saw Haiti as a racial threat that imperiled political and commercial relations with white western nations. In the years following World War I, the United States occupied both parts of the island. It did so to secure its power in the Western hemisphere by destroying local opposition and installing US-friendly governments. The brutal and racist nature of the US occupation, particularly along the remote Dominican-Haitian border, laid the foundation for bigger atrocities after its withdrawal. In 1930, liberal Dominican president Horacio Vásquez was overthrown by the chief of his army, Rafael Trujillo. Despite being a quarter Haitian himself, Trujillo saw the presence of a bicultural Haitian and Dominican borderland as both a threat to his power and an escape route for political revolutionaries. In a chilling speech on October 2, 1937, he left no doubt about his intentions for the region. Claiming to be protecting Dominican farmers from theft and incursion, Trujillo announced the killing of 300 Haitians along the border and promised that this so-called "remedy" would continue. Over the next few weeks, the Dominican military, acting on Trujillo’s orders, murdered thousands of Haitian men and women, and even their Dominican-born children. The military targeted black Haitians, even though many Dominicans themselves were also dark-skinned. Some accounts say that to distinguish the residents of one country from the other, the killers forced their victims to say the Spanish word for parsley. Dominicans pronounce it perejil, with a trilled Spanish "r." The primary Haitian language, however, is Kreyol, which doesn’t use a trilled r. So if people struggled to say perejil, they were judged to be Haitian and immediately killed. Yet recent scholarship suggests that tests like this weren’t the sole factor used to determine who would be murdered, especially because many of the border residents were bilingual. The Dominican government censored any news of the massacre, while bodies were thrown in ravines, dumped in rivers, or burned to dispose of the evidence. This is why no one knows exactly how many people were murdered, though contemporary estimates range from about 4,000 to 15,000. Yet the extent of the carnage was clear to many observers. As the US Ambassador to the Dominican Republic at the time noted, “The entire northwest of the frontier on the Dajabón side is absolutely devoid of Haitians. Those not slain either fled across the frontier or are still hiding in the bush.” The government tried to disclaim responsibility and blame the killings on vigilante civilians, but Trujillo was condemned internationally. Eventually, the Dominican government was forced to pay only $525,000 in reparations to Haiti, but due to corrupt bureaucracy, barely any of these funds reached survivors or their families. Neither Trujillo nor anyone in his government was ever punished for this crime against humanity. The legacy of the massacre remains a source of tension between the two countries. Activists on both sides of the border have tried to heal the wounds of the past. But the Dominican state has done little, if anything, to officially commemorate the massacre or its victims. Meanwhile, the memory of the Haitian massacre remains a chilling reminder of how power-hungry leaders can manipulate people into turning against their lifelong neighbors.

**P547 2018-01-21 Can you solve the dark coin riddle - Lisa Winer**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=547)

You heard the traveler's tales, you followed the crumbling maps, and now, after a long and dangerous quest, you have some good news and some bad news. The good news is you've managed to locate the legendary dungeon containing the stash of ancient Stygian coins and the eccentric wizard who owns the castle has even generously agreed to let you have them. The bad news is that he's not quite as generous about letting you leave the dungeon, unless you solve his puzzle. The task sounds simple enough. Both faces of each coin bear the fearsome scorpion crest, one in silver, one in gold. And all you have to do is separate them into two piles so that each has the same number of coins facing silver side up. You're about to begin when all of the torches suddenly blow out and you're left in total darkness. There are hundreds of coins in front of you and each one feels the same on both sides. You try to remember where the silver-facing coins were, but it's hopeless. You've lost track. But you do know one thing for certain. When there was still light, you counted exactly 20 silver-side-up coins in the pile. What can you do? Are you doomed to remain in the dungeon with your newfound treasure forever? You're tempted to kick the pile of coins and curse the curiosity that brought you here. But at the last moment, you stop yourself. You just realized there's a surprisingly easy solution. What is it? Pause here if you want to figure it out for yourself. Answer in: 3 Answer in: 2 Answer in: 1 You carefully move aside 20 coins one by one. It doesn't matter which ones: any coins will do, and then flip each one of them over. That's all there is to it. Why does such a simple solution work? Well, it doesn't matter how many coins there are to start with. What matters is that only 20 of the total are facing silver side up. When you take 20 coins in the darkness, you have no way of knowing how many of these silver-facing coins have ended up in your new pile. But let's suppose you got 7 of them. This means that there are 13 silver-facing coins left in the original pile. It also means that the other 13 coins in your new pile are facing gold side up. So what happens when you flip all of the coins in the new pile over? Seven gold-facing coins and 13 silver-facing coins to match the ones in the original pile. It turns out this works no matter how many of the silver-facing coins you grab, whether it's all of them, a few, or none at all. That's because of what's known as complementary events. We know that each coin only has two possible options. If it's not facing silver side up, it must be gold side up, and vice versa, and in any combination of 20 coins, the number of gold-facing and silver-facing coins must add up to 20. We can prove this mathematically using algebra. The number of silver-facing coins remaining in the original pile will always be 20 minus however many you moved to the new pile. And since your new pile also has a total of 20 coins, its number of gold-facing coins will be 20 minus the amount of silver-facing coins you moved. When all the coins in the new pile are flipped, these gold-facing coins become silver-facing coins, so now the number of silver-facing coins in both piles is the same. The gate swings open and you hurry away with your treasure before the wizard changes his mind. At the next crossroads, you flip one of your hard-earned coins to determine the way to your next adventure. But before you go, we have another quick coin riddle for you – one that comes from this video sponsor’s excellent website. Here we have 8 arrangements of coins. You can flip over adjacent pairs of coins as many times as you like. A flip always changes gold to silver, and silver to gold. Can you figure out how to tell, at a glance, which arrangements can be made all gold? You can try an interactive version of this puzzle and confirm your solution on Brilliant’s website. We love Brilliant.org because the site gives you tools to approach problem-solving in one of our favorite ways— by breaking puzzles into smaller pieces or limited cases, and working your way up from there. This way, you're building up a framework for problem solving, instead of just memorizing formulas. You can sign up for Brilliant for free, and if you like riddles a Brilliant.org premium membership will get you access to countless more interactive puzzles. Try it out today by visiting brilliant.org/TedEd and use that link so they know we sent you. The first 833 of you to visit that link will receive 20% off the annual premium subscription fee.

**P548 2018-01-26 What happens during a stroke - Vaibhav Goswami**

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Every two seconds, someone somewhere in the world experiences a stroke. And one out of every six people will have one at some point in their lives. Strokes deprive brain cells of oxygen and are one of the most common causes of death and a leading cause of preventable disability. When someone experiences a stroke, quick medical care is critical, and can often help avoid permanent brain damage. But what causes strokes in the first place? And what can doctors do to treat them? The brain makes up just 2% of your body’s mass but consumes more than 20% of the oxygen in your blood. That oxygen is carried to the brain through a system of arteries. Carotid arteries supply the front of the brain, and vertebral arteries supply the back. These are connected to each other, and divide into smaller and smaller vessels that get billions of neurons the oxygen they need. If the blood flow is interrupted, oxygen delivery stops and brain cells die. There are two ways this can happen. Hemorrhagic strokes are when a perforated vessel allows blood to leak out. But the more common type is the ischemic stroke, when a clot blocks a vessel and brings blood flow to a halt. Where do these clots come from? On rare occasions, a sudden change in heart rhythm prevents the upper chambers of the heart from contracting normally. This slows down blood flow, allowing platelets, clotting factors, and fibrin to stick together. The clot can be carried up towards the arteries and blood vessels supplying the brain until it gets to one it can’t squeeze through. This is called an embolism and it cuts off the oxygen supply to all the cells downstream. The brain doesn't have pain receptors, so you can't feel the blockage itself. But oxygen deprivation slows brain function and can have sudden, noticeable effects. For example, if the affected area is responsible for speech, an individual’s words may be slurred. If the stroke affects a part of the brain that controls muscle movement, it can cause weakness, often just on one side of the body. When this happens, the body will immediately try to compensate by diverting blood flow to the affected area, but this isn’t a perfect solution. Eventually, the oxygen-deprived cells will start to die, leading to brain damage that may be severe or permanent. That’s why it’s important to get medical care as fast as possible. The first line of treatment is an intravenous medication called Tissue Plasminogen Activator, which can break up the blood clot and allow blood to flow again in the compromised artery. If it’s delivered within a few hours, this medication greatly increases the chance of surviving the stroke and avoiding permanent consequences. If Tissue Plasminogen Activator cannot be given because the patient is on certain medications, has history of major bleeding, or the clot is particularly large, doctors can perform a procedure called an endovascular thrombectomy. Using a fluorescent dye that illuminates the blood vessels under a strong x-ray, the physician inserts a long, thin, flexible tube called a catheter into an artery in the leg and maneuvers it all the way to the blockage. A retriever is passed through this catheter. It expands and anchors into the clot when it’s just past it. The catheter then pulls the clot out when it’s removed. These treatments need to be delivered as soon as possible to preserve brain function, which means figuring out fast if someone is having a stroke. So how can you tell? Here are three quick things to try: 1. Ask the person to smile. A crooked mouth or facial drooping can indicate muscle weakness. 2. Ask them to raise their arms. If one drifts downward, that arm weakness is also a sign of a stroke. 3. Ask them to repeat a simple word or phrase. If their speech sounds slurred or strange, it could mean that the language area of their brain is oxygen-deprived. This is sometimes called the FAST test, and the T stands for time. If you see any of those signs, call emergency services right away. Lives may depend on it.

**P549 2018-01-29 How did teeth evolve - Peter S. Ungar**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=549)

You may take them for granted, but your teeth are a marvel. They break up all your food over the course of your life, while being strong enough to withstand breakage themselves. And they’re formed using only the raw materials from the food they grind down in the first place. What’s behind their impressive strength? Teeth rely on an ingenious structure that makes them both hard and tough. Hardness can be thought of as the ability to resist a crack from starting, while toughness is what stops the crack from spreading Very few materials have both properties. For instance, glass is hard but not tough, while leather is tough but not hard. Teeth manage both by having two layers: a hard external cap of enamel, made up almost entirely of a calcium phosphate, and beneath it, a tougher layer of dentin, partly formed from organic fibers that make it flexible. This amazing structure is created by two types of cells: ameloblasts that secrete enamel and odontoblasts that secrete dentin. As they form teeth, odontoblasts move inward, while ameloblasts move out and slough off when they hit the surface. For enamel, this process produces long, thin strands, each about 60 nanometers in diameter. That’s one one-thousandth the width of a human hair. Those are bundled into rods, packed together, tens of thousands per square millimeter, to form the shield-like enamel layer. Once this process is finished, your enamel can’t repair itself again because all the cells that make it are lost, so we’re lucky that enamel can’t be easily destroyed. Odontoblasts use a more complex process, but unlike ameloblasts, they stick around, continuing to secrete dentin throughout your life. Despite the differences in teeth across the mammalian order, the underlying process of tooth growth is the same whether it’s for lions, kangaroos, elephants, or us. What changes is how nature sculpts the shape of the tooth, altering the folding and growth patterns to suit the distinct diets of different species. Cows have flat molar teeth with parallel ridges for grinding tough grasses. Cats have sharp crested molars, like blades, for shearing meat and sinew. Pigs have blunt, thick ones, useful for crushing hard roots and seeds. The myriad molars of modern mammals can be traced back to a common form called “tribosphenic," which first appeared during the dinosaur age. In the 19th Century, paleontologist Edward Drinker Cope developed the basic model for how this form evolved. He hypothesized that it started with a cone-like tooth, as we see in many fishes, amphibians, and reptiles. Small cusps were then added, so the tooth had three in a row, aligned front to back, and connected by crests. Over time, the cusps were pushed out of line to make triangular crowns. Adjacent teeth formed a continuous zigzag of crests for slicing and dicing. A low shelf then formed at the back of each set of teeth, which became a platform for crushing. As Cope realized, the tribosphenic molar served as the jumping-off point for the radiation of specialized forms to follow, each shaped by evolutionary needs. Straighten the crests and remove the shelf, and you’ve got the conveniently bladed teeth of cats and dogs. Remove the front cusp, raise the shelf, and you’ve got our human molars. A few additional tweaks get you a horse or cow tooth. Some details in Cope’s intuitive hypothesis proved wrong. But in the fossil record, there are examples of teeth that look just as he predicted and we can trace the molars of all living mammals back to that primitive form. Today, the ability to consume diverse forms of food enables mammals to survive in habitats ranging from mountain peaks and ocean depths to rainforests and deserts. So the success of our biological class is due in no small measure to the remarkable strength and adaptability of the humble mammalian molar.

**P550 2018-02-02 The myth of Arachne** **- Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=550)

From sailors who were turned into pigs, nymphs that sprouted into trees, and a gaze that converted the beholder to stone, Greek mythology brims with shape-shifters. The powerful gods usually changed their own forms at will, but for mortals, the mutations were often unwanted. One such unnerving transformation befell the spinner Arachne. Arachne was the daughter of a tradesman who spent his days dying cloth the deepest shades of purple. She had a flair for spinning the finest threads, weaving them into flowing fabric, and creating magnificent tapestries. People flocked to watch her hands flying across her loom, as if thread sprung directly from her fingertips. But as praise for her work grew, so did her pride. Arachne could often be heard boasting about her skills, declaring that her talent surpassed anyone else’s—mortal or divine. She refused to see weaving as a gift from the gods. Rather, she flaunted it as her own personal genius. Unfortunately, the goddess of wisdom and crafts, Athena, overheard Arachne making these claims. Planning to teach the ungrateful girl a lesson, Athena disguised herself as an old woman and stole amongst the mortals. She berated Arachne in public— how dare the weaver claim herself greater than the gods? But Arachne only laughed, barely looking up from her loom. Provoked, the old woman threw off her cloak to reveal her true form. If Arachne insisted on defaming the gods, Athena would challenge her to a contest directly. Masking her shock at the appearance of the grey-eyed goddess, Arachne accepted the challenge. Athena drew up her own glittering loom as a great crowd gathered to watch. The weavers began, eyes fixed and shuttles blurring. Athena conjured wisps of cloud from above and slender threads of grass from below in a spectacle of strength. She wove tremendous scenes that showed the power of the gods: Poseidon riding the waves, Zeus firing thunderbolts, and Apollo hurtling across the sky. In Athena’s splendid tapestry, the glory of the gods dwarfed mortal life. But Arachne had no interest in boosting godly egos. Her tapestry showed the gods abusing their power: squabbling amongst themselves, drinking and bragging, and meddling in the lives of mortals. She represented Zeus as a philanderer, transfiguring himself to ensnare women: a swan for Leda, a bull for Europa, a shower of gold for Danae. Arachne then turned to the misdemeanors of other gods, from Pluto’s abduction of Persephone to Bacchus’s wild pursuit of Erigone. Even though she cast the gods in the most unflattering light, Arachne’s work shone with her dazzling skill. Her tapestry was almost alive, filled with movement and lustrous colors that winked triumphantly. When Athena saw Arachne's undeniably better and flagrantly subversive work, she flew into a rage and turned on the human weaver. Arachne’s glee dimmed as she felt her body shrinking and contorting. Her fingers waved wildly as her arms stuck to her sides, and black hair sprouted all over her body. The goddess left Arachne with a single spool of thread unfurling from her belly, a slim reminder of her human talent. For challenging the assumption that the gods were untouchable, Athena had shrunk her adversary into the first spider. To this day, Arachne and her children spin out her penance— or is it undaunted persistence?— in the shadows of giants.

**P551 2018-02-07 The rise and fall of the Inca Empire - Gordon McEwan**

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It was the Western Hemisphere’s largest empire ever, with a population of nearly 10 million subjects. Over an area of more than 900,000 square kilometers, its people built massive administrative centers, temples, and extensive road and canal systems. They did so in an inhospitable, extreme terrain, all without the use of wheels, horses, iron, or even written language. Yet within 100 years of its rise in the fifteenth century, the Inca Empire would be no more. According to legend, the ancestors of the Inca rulers were created by the sun god Inti, and they emerged from a cave called Tambo Toco. Leading four brothers and four sisters was Ayar Manco, who carried a golden staff with instructions to find the place where it would sink into the ground, showing fertile soil. After many adventures and extensive searching, Ayar Manco and his siblings reached the Cuzco Valley, where the staff pierced the ground. After fighting off the fierce local native population, they founded their capital, and Ayar Manco became Manco Capac, the first Sapa Inca, or king of the Incas. Archaeological evidence suggests that the Incas first settled in this valley around 1200 CE. They remained a small kingdom until 1438, when they were nearly overrun by the neighboring Chanka tribe. The Inca king at this time, Viracocha, and his designated heir fled in fear, but one of his other sons remained and successfully rallied the city’s defenses. For his military skill, he became the ninth Inca ruler, assuming the name of Pachacuti, or "Cataclysm." Pachacuti expanded Inca rule throughout the Andes mountains, transforming the kingdom into an empire through extensive reforms. The empire’s territory was reorganized as Tahuantinsuyu, or "four quarters," with four divisions ruled by governors reporting to the king. Although the Inca had no writing, they used a complex system of knotted strings called quipu to record numbers and perhaps other information. A decimal-based bureaucracy enabled systematic and efficient taxation of the empire’s subjects. In return, the empire provided security, infrastructure, and sustenance, with great storehouses containing necessities to be used when needed. Great terraces and irrigation works were built and various crops were grown in at different altitudes to be transported all over the empire. And it was during Pachacuti’s reign that the famous estate of Machu Picchu was constructed. Pachacuti’s son Topa Inca continued the empire’s military expansion, and he eventually became ruler in 1471 CE. By the end of his reign, the empire covered much of western South America. Topa’s son Huayna Capac succeeded him in 1493. But the new ruler’s distant military campaigns strained the social fabric. And in 1524, Huayna Capac was stricken by fever. Spanish conquistadors had arrived in the Caribbean some time before, bringing diseases to which the native peoples had no resistance. Millions died in the outbreak, including Huayna Capac and his designated heir. The vacant throne ignited a civil war between two of the surviving brothers, Atahualpa and Huascar, greatly weakening the empire. In 1532, after finally winning the Inca civil war, Atahualpa and his army encountered the European invaders. Although greatly outnumbered, Francisco Pizarro and his small group of conquistadors stunned the king’s much larger force with guns and horses, neither of which they had seen before. Atahualpa was taken captive and killed about a year later. The Spanish conquerors were awed by the capital of Cuzco. Pizarro described it as so beautiful that “it would be remarkable even in Spain.” Though the capital had fallen and the native population had been destroyed by civil war and disease, some Incas fell back to a new capital at Vilcabamba and resisted for the next 40 years. But by 1572, the Spaniards had destroyed all remaining resistance along with much of the Incas’ physical and cultural legacy. Thus, the great Inca empire fell even faster than it had risen.

**P552 2018-02-13 The coin flip conundrum - Po-Shen Loh**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=552)

When the Wright brothers had to decide who would be the first to fly their new airplane off a sand dune, they flipped a coin. That was fair: we all know there’s an equal chance of getting heads and tails. But what if they had a more complicated contest? What if they flipped coins repeatedly, so that Orville would win as soon as two heads showed up in a row on his coin, and Wilbur would win as soon as heads was immediately followed by tails on his? Would each brother still have had an equal chance to be the first in flight? At first, it may seem they’d still have the same chance of winning. There are four combinations for two consecutive flips. And if you do flip a coin just twice, there’s an equal chance of each one -- 25%. So your intuition might tell you that in any string of coin flips, each combination would have the same shot at appearing first. Unfortunately, you’d be wrong. Wilbur actually has a big advantage in this contest. Imagine our sequence of coin flips as a sort of board game, where every flip determines which path we take. The goal is to get from start to finish. The heads/tails board looks like this. And this is the head/head board. There’s one critical difference. Heads/heads has a move that sends you all the way back to the start that heads/tails doesn’t have. That’s why heads/heads takes longer on average. So we can demonstrate that this is true using probability and algebra to calculate the average number of flips it would take to get each combination. Let’s start with the heads/tails board, and define x to be the average number of flips to advance one step. Focus only on the arrows. It has two identical steps, each with a 50/50 chance of staying in place or moving forward. Option 1: If we stay in place by getting tails, we waste one flip. Since we’re back in the same place, on average we must flip x more times to advance one step. Together with that first flip, this gives an average of x + 1 total flips to advance. Option 2: If we get heads and move forward, then we have taken exactly one total flip to advance one step. We can now combine option 1 and option 2 with their probabilities to get this expression. Solving that for x gives us an average of two moves to advance one step. Since each step is identical, we can multiply by two and arrive at four flips to advance two steps. For heads/heads, the picture isn’t as simple. This time, let y be the average number of flips to move from start to finish. There are two options for the first move, each with 50/50 odds. Option 1 is the same as before, getting tails sends us back to the start, giving an average of y+1 total flips to finish. In Option 2, there are two equally likely cases for the next flip. With heads we’d be done after two flips. But tails would return us to the start. Since we’d return after two flips, we’d then need an average of y+2 flips in total to finish. So our full expression will be this. And solving this equation gives us six flips. So the math calculates that it takes an average of six flips to get heads/heads, and an average of four to get heads/tails. And, in fact, that’s what you’d see if you tested it for yourself enough times. Of course, the Wright brothers didn’t need to work all this out; they only flipped the coin once, and Wilbur won. But it didn’t matter: Wilbur’s flight failed, and Orville made aviation history, instead. Tough luck, Wilbur.

**P553 2018-02-20 The weird and wonderful metamorphosis of the butterfly - Franziska Ba**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=553)

In order to become a butterfly, a caterpillar’s body dissolves almost completely and is rebuilt from its own juices. As inconvenient and even downright dangerous as this process sounds, it’s actually quite common. Butterflies are just a few of the 800,000 insect species that transition from larvae to adults through complete metamorphosis. That’s approximately 85% of insects and 70% of all known animal species. But how exactly does a caterpillar become a butterfly? When a caterpillar hatches from an egg, it has none of a butterfly’s physical traits. It does have groups of cells inside its body called imaginal discs that will eventually become its butterfly parts. For now, these cells remain dormant. Juvenile hormone suppresses their activity, and prevents the caterpillar from beginning metamorphosis too early. Immediately after hatching, the caterpillar begins to feed, building up fat until its rigid skin, called a cuticle, becomes too tight. At this point, a hormone called ecdysone triggers the cuticle to shed, or molt. As the caterpillar grows, it usually molts four times. Then, when it’s nice and plump, the caterpillar’s levels of juvenile hormone drop, which triggers it to stop eating and moving. A final burst of ecdysone prompts the caterpillar’s cells to begin to self-destruct. Soon, the muscles, fat, and other tissues are almost entirely liquefied, though the imaginal discs stay intact and begin to grow. At the same time, a second skin layer called the pupal cuticle forms underneath the first. One more molt exposes the hard exterior of the pupa. Besides the imaginal discs, only a few tissues are spared, including parts of the respiratory system, the heart, some abdominal muscles, and the mushroom bodies of the brain. The caterpillar juice then fuels the development of the imaginal discs into eyes, antennae, legs, wings, genitalia, and other body parts. Once its new body is built, the insect molts one last time, shedding the pupal cuticle. From there, it’s free to fly away a new butterfly. Even after such a dramatic transformation, the butterfly does retain some memories from its caterpillar days. It’s likely the mushroom bodies of the brain carry important knowledge from the caterpillar over to the adult butterfly. How did such an involved developmental process come to be? We don’t know for sure. The leading theory is that the caterpillar is actually a drawn-out version of a life stage that takes place inside the egg for some other insects. According to this hypothesis, over millions of years, the larvae evolved the ability to eat and live outside the egg. Regardless of how complete metamorphosis originated, it’s become part of the life cycles of a dizzying number of insect species. Still, plenty of species get along perfectly well with a simpler developmental process. What survival advantages might complete metamorphosis provide to make up for the added hassle? For one, it keeps larvae and adults from competing for the same habitats and food sources. And while the pupa may seem vulnerable, this immobile stage can actually be a good way to pass parts of the year when food is scarce. To us, a butterfly’s metamorphosis might sound as fantastic as a phoenix rising from its ashes. But these transformations are taking place all around us, all the time. From the Hercules beetle to the honey bee to the garden ant, countless squishy larvae dissolve and emerge as armored, aerodynamic, and nimble adults.

**P554 2018-02-21 The myth of Thor's journey to the land of giants - Scott A. Mellor**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=554)

Thor—son of Odin, god of thunder, and protector of mankind— struggled mightily against his greatest challenge yet: opening a bag of food. It’d all started when Thor, along with his fleet-footed human servant Thjalfi and Loki, the trickster god, set out on a journey to Jotunheim, land of the giants. Along the way, they’d met a giant named Skrymir, who offered to accompany them and even carry their provisions in his bag. But when they made camp, Skrymir dozed off and Thor couldn’t untie the sack. Frustrated and hungry, Thor tried to wake the giant three times by striking his head with his hammer Mjolnir as hard as he could. But each time, Skrymir thought it was only a falling acorn and went back to sleep. The next morning, Skrymir departed and eventually, the travelers reached a massive fortress called Utgard. Inside the long hall, they met the king of giants, Utgard-Loki, who greeted his guests with a challenge: each of them was to prove they were the best at some particular skill. Loki went first, declaring himself the world’s fastest eater. To test him, the king summoned his servant Logi and the two were placed at either end of a long trough stuffed with food. Loki ate his way inward with blinding speed. But when the contestants met in the center, Loki saw that his adversary had not only eaten just as much food, but also the bones and even the trough itself. Next was Thjalfi, who could outrun anything in the wild. The king summoned an ethereal-looking giant named Hugi, who outraced Thjalfi easily. But the boy would not give up and demanded a rematch. This time, Thjalfi finished close behind and the king admitted he’d never seen a human run so fast. Thjalfi tried a third time, running like his life depended on it, but Hugi was even faster than before. Finally, it was Thor’s turn. The king offered him a drinking horn, saying all his men could drain it in two gulps. Thor raised it to his lips and drank the surprisingly cold and salty mead in the longest gulp he could muster. Then a second. Then a third. But the level of the mead in the horn was only slightly lowered. To test Thor’s renowned strength, the king offered a seemingly easy challenge: lift his pet cat off the ground. But this cat was as tall as Thor. Every time he tried to lift it, it arched its back, and straining with all his godly might, he only managed to lift one paw. Enraged, Thor demanded to wrestle any of the giants. The king summoned the giants’ old nursemaid, Elli. Though the woman looked frail, Thor couldn’t overpower her and grew weaker the longer he struggled, until he was brought to one knee. The three companions prepared to leave, disappointed and humbled. But as the king escorted them out, he revealed that nothing in the castle had been what it seemed. Loki lost the eating contest because his opponent Logi was wildfire itself, devouring everything in its path. Thjalfi couldn’t outrun Hugi because Hugi was the embodiment of thought, always faster than action. And even Thor couldn’t defeat Elli, or old age, which weakens everyone eventually. As for the other challenges, they had also been illusions. The drinking horn was filled with the ocean, and Thor had drained enough to cause the tides. The cat was the serpent that encircles the world, and Thor’s efforts shifted the earth. And Skrymir had been Utgard-Loki in disguise, deflecting Thor’s hammer-blows to form valleys in the surrounding mountains. The giant congratulated them on their prowess, which so frightened him he would never allow them in his land again. Thor and his companions failed the challenges presented to them. But in trying to achieve the impossible, they’d pushed themselves harder than ever before and changed the world in ways no one had expected.

**P555 2018-02-22 Can you solve the seven planets riddle - Edwin F. Meyer**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=555)

Your interstellar police squad has tracked a group of dangerous rebels to a cluster of of seven small planets. Now you must apprehend them quickly before their reinforcements arrive. Of course, the rebels won’t just stay put. They’ll try to dodge you by moving from planet to planet. But you have one major advantage. Every hour, your state-of-the-art cruiser can warp between any two planets, while their beat-up smuggling ship can only jump to an adjacent planet in that same time. These rebels don’t like to stay put. Every time they can relocate, they will. Your scouts tell you that the approaching rebel fleet is 10 hours away. You can’t risk letting the rebels escape. Can you devise a sequence for searching the planets that’s guaranteed to catch them in 10 warps or less, no matter what moves they make? Rounding up the rebels won’t be easy. For one, you have no way of knowing which planet they’re on to begin with. And without that information, it’s hard to determine where they’ll move next. So where do you begin? When tackling problems of this kind it often helps to simplify things, so you can better understand their dynamics. Let’s imagine that this cluster has the same arrangement but no outermost planets, leaving only the four in the center. We still don’t know which planet the rebels start on. But there’s one key feature: the third planet is adjacent to all others, which means the rebels either start there and move somewhere else, or start on one of the other planets and have no choice but to move to planet three. Simply checking planet three twice in a row would do the trick. Adding the three outer planet adds a bit more complexity, but the same strategy remains. We want to check the planets in an order that will eventually corner the rebels. And there’s another insight that can help us: each hour, the rebels move from an even-numbered planet to an odd-numbered planet, or vice versa. This gives us a way to simplify the problem by dividing the planets into two subsets, and tackling each one separately. For starters, let’s assume the rebels begin on an even-numbered planet: either two, four, or six. So we’ll search planet two first. If they’re not there, they must have started on either four or six. which means they can move to three, five, or seven. Planet three at the center gives them the most options for their next move, so we’ll want to check there next. If we don’t find them, they must have been at planet five or seven, meaning they’ll next move to four or six. Let’s now search planet four. If they’re not there, they must have gone to the sixth planet and can only flee to three or seven. If we next scour planet three and don’t find them, we know they went to planet seven and are now cornered. They can only move to planet six, where we’ll apprehend them on our fifth search. Of course, this plan only works assuming that the rebels were on an even-numbered planet in the first hour. But what if that assumption was wrong? In that case, they must’ve started on an odd-numbered planet. And because they move to an adjacent planet every hour, their location must alternate between odd and even-numbered planets. This means that if they were on an odd-numbered planet to start, after five moves, they'd be on an even-numbered planet. So if our first five searches missed them because our assumption that they started on an even-numbered planet was wrong, all we have to do now is repeat the sequence! Searching the planets in order two, three, four, three, six, two, three, four, three, six, leaves the rebels nowhere to run. Thanks to your deductive reasoning, order is restored to the galaxy.

**P556 2018-02-22 The science of skin - Emma Bryce**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=556)

Between you and the rest of the world lies an interface that makes up 16% of your physical weight. This is your skin, the largest organ in your body: laid out flat, it would cover close to 1.7 square meters of ground. Its purpose may seem obvious— to keep our insides in. But a look beyond the surface reveals that it plays a surprising number of roles in our lives. First, the basics. Skin is the foundation of the integumentary system, which also incorporates your hair, nails, and specialized glands and nerves. Made up of three layers, the epidermis, dermis, and hypodermis, skin’s thickness varies from 0.5 millimeters at its thinnest and up to four millimeters at its thickest. It also carries out three key functions: protecting, regulating, and sensing the world beyond its limits. On a daily basis, its huge surface processes hundreds, if not thousands, of physical sensations, relying mostly on large, pressure-sensitive skin components called Merkel cells. In your fingertips alone, there are 750 Merkel cells per each square-centimeter of skin, coupled with over 2,500 receptors that give you your sense of touch. This surface is also the body’s first major line of defense. Without it, you’d be a soggy mass of tissue and fluids, fatally exposed to the elements. Skin effectively seals off your insides and also absorbs pressure and shock with flexible collagen that makes up most of its dermal layer. The epidermis is made up mainly of skin cells called keratinocytes that are completely replaced every four weeks. As new cells form at the base of the epidermis, older ones are pushed up. When these cells move upwards, they’re filled with a hardened protein called keratin. Once they reach the surface, they form a tightly-overlapping, waterproof layer that’s difficult for invading microbes to breach. Any harmful microbes that make it into the epidermis will encounter Langerhans cells. This group of protective skin cells detects invaders and communicates their presence to resident immune system T-cells, which react by launching an immune response. A crucial feature of this immune defense is the several thousand species of microorganisms that inhabit the planes, folds, and crevices of your skin. These microbes, which include bacteria and fungi, thrive in the sebum, an oily substance that’s secreted onto the skin’s surface by sebaceous glands nestled inside the dermis. These skin microbes keep the immune system in a state of constant surveillance, ensuring that it’s ready to react if the body really is at risk. Beyond this protective role, your skin is also a sensory organ that helps regulate your body’s temperature, two roles that are closely interlinked. Nerves detect whether your skin is warm or cold and communicate that information to your brain. In return, the brain instructs localized blood vessels to either expand if the body is too warm, releasing heat from the blood through the skin, or to constrict if the body is cold, which retains heat. At any given time, up to 25% of the body's blood is circulating through the dermis, making this process extremely efficient. Under warm conditions, the skin’s sweat glands will secrete sweat via ducts onto the surface, transferring heat out of the body. Hair can also be stimulated to conserve or release body warmth. The average human has 5 million hair follicles embedded everywhere on the body except the palms of your hands and soles of your feet. Ninety to 150,000 of those are on your scalp, where they help shield the large surface area of your head from physical damage and sunburn. When you're cold, tiny muscles called arrector pilli cause hair to stand upright across the body. That’s the phenomenon known as goosebumps and it traps body heat close to your skin. Skin’s vast surface isn’t just a shield; it also enables us to interact and connect with the world. Its multifunctional layer cools us down and keeps us warm. The integumentary system may be many things, but it’s certainly more than skin deep.

**P557 2018-02-23 A day in the life of an ancient Athenian - Robert Garland**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=557)

It’s 427 BCE and the worst internal conflict ever to occur in the ancient Greek world is in its fourth year. The Peloponnesian War is being fought between the city-states of Athens and Sparta, as well as their allies. The Athenians can’t match the formidable Spartan army on land. So they’ve abandoned the countryside and moved inside the walls surrounding their city and port, now provisioned by a superior fleet and extensive maritime empire. The cramped conditions have taken a toll and a recent plague wiped out a third of the population. But city life goes on. Archias and Dexileia live in the center of Athens. As a painter of high-class pottery, Archias is relatively well-off and takes great interest in the city’s affairs. Dexileia, on the other hand, can't participate in politics or own property. The couple are grateful to the gods that three of their four children, a son and two daughters, have survived past infancy. Many parents see daughters as a liability since they require dowries to find husbands. But Archias is confident that his wealth will allow him to make good matches for them without going bankrupt. Like many Athenians, the family owns slaves. Originally from Thrace, they were captured in war. Thratta does most of the housework and helps raise the children. Philon is a paidagôgos, who supervises the son’s education, teaching him reading and writing. Archias is up early because there’s a meeting of the Ekklêsia, the assembly of citizens, taking place at dawn. Before setting out, he burns incense and pours a libation at the small shrine in the courtyard on behalf of his entire household. Dexileia will remain at home all day, teaching her daughters domestic skills. Later, she’ll retire to the inner courtyard for some fresh air. When Archias arrives at the agora, the civic and commercial heart of the city, he finds the square swarming with his fellow citizens, native-born adult males who have completed military training. Attached to the central monument is a noticeboard with the meeting’s agenda. Today, there’s only one item of discussion: what to do with the people of Mytilene, a city on the island of Lesbos where a revolt against Athenian rule has just been put down. The meeting takes place on a hill west of the acropolis known as the Pnyx. The word means “tightly packed," and the crowd of 5,000 citizens makes it clear why. The heralds purify the hill by sprinkling its boundary with pig’s blood and call for order. As everyone sits on benches facing the platform, the presiding officer opens the meeting with the words: “Tis agoreuein bouleutai?” “Who wishes to address the assembly?” One by one, citizens speak, some advising mercy, others bent on vengeance. A motion is proposed to execute all the Mytileneans and enslave their women and children because they betrayed their Athenian allies during a time of war. A majority raises their right hands in favor. Once the meeting’s over, Archias heads back to the agora to buy food and wine. Hundreds have gathered there to discuss the results, many unhappy with the decision. When Archias returns home, he tells Dexileia about the debate. She thinks that killing the innocent as well as the guilty is harsh and counterproductive, and tells him as much. Around dusk, Archias goes to a friend’s house for a symposium. The nine men drink wine and discuss the meeting well into the night. Archias shares his wife’s opinion urging mercy, and his friends eventually agree. Before dawn, something unprecedented happens. Heralds circulate throughout Athens announcing the council has called another meeting. The second debate is equally heated, but a new resolution, to execute only the leaders of the revolt, narrowly passes. Yet there’s a problem – a ship with orders to carry out the first resolution was dispatched the previous day. And so another ship quickly sets sail to countermand the order – a race of democracy against time.

**P558 2018-02-23 Cannibalism in the animal kingdom - Bill Schutt**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=558)

In the deserts of the American Southwest, spadefoot toad tadpoles hatch in tiny oases. Until they develop into toadlets, they can’t survive outside of water, but these ponds are transient and quickly evaporate. The tadpoles are in a race against the clock to grow up before their nurseries disappear. So nearly overnight, some of the brood explode in size. They use their jack-o-lantern teeth and huge jaw muscles to devour their smaller pond mates. Nourished by this extra fuel, they develop quicker, leaving the pond before it can dry out. The spadefoot toad is far from the only animal to eat members of its own species as a normal part of its life cycle. All of these animals do. If that surprises you, you’re in good company. Until recently, scientists thought cannibalism was a rare response to starvation or other extreme stress. Well-known cannibals, like the praying mantis and black widow spider, were considered bizarre exceptions. But now, we know they more or less represent the rule. While it may seem counterproductive for members of the same species to eat each other, cannibalism can promote the survival of the species as a whole by reducing competition, culling the weak, and bolstering the strong. Some species, like the spadefoot toad, cannibalize in response to environmental pressures. Their situation is precarious, but cannibalism for them isn’t a last-ditch attempt to avoid starvation. Rather, it’s a way to more quickly outgrow a stage where they’re especially vulnerable to predation or dangerous environmental conditions. Other species, including many fish, indiscriminately cannibalize each other during foraging behavior. Fish produce large numbers of tiny young, and adults exhibit about as much individual recognition of their offspring as humans do for a handful of raisins. Fish eggs, larvae, and juveniles are easily available, nutrient-rich meals, and with thousands of eggs in a clutch, plenty are still available to hatch after the adults have snacked. Baby fish aren’t just at risk of being cannibalized by adults— siblings eat each other too. Sand tiger shark eggs develop and hatch inside their mother’s oviducts at different times. When the hatchlings run out of yolk from their own eggs, they eat the other eggs and hatchlings until one baby shark from each oviduct remains. When they emerge, the young sharks are well-nourished, experienced predators who stand a better chance of surviving. Even when they aren’t consumed for nutrition, young animals are especially vulnerable to cannibalism. Hamsters, rats, and other rodent mothers will eat some of their young if they’re sick, dead, or simply too numerous to feed. In other mammals, including bears and lions, males will kill offspring sired by another. That’s because childless females become receptive to mating more quickly than if they were caring for a cub. Rather than waste nutritious meat, the males then eat the dead cubs. Meanwhile, cannibalism is less common in birds than in other groups, but certain species will eat diseased or dead hatchlings as a way of disposing of the bodies before they can attract maggots. When adults eat each other, males are cannibalized more often than females, usually during mating and generally because they’re smaller. Male Australian redback spiders mate with much larger females. Rather than scrambling away after mating, the tiny male does a somersault, bringing his abdomen into contact with his mate’s mouthparts. The female showers him with enzyme-rich gut juice and consumes his abdomen. Males not killed in the initial mating crawl back into the fray, often half-eaten, to mate again, after which they’re dispatched to the spider pantry. So not only does the male provide the female with his sperm, but he also provides her with a nutritious meal to better ensure that she’ll survive to pass on his genes. All in all, it’s clear that cannibalism is as much a part of life in the animal kingdom as other, better-recognized behaviors. As we sink our teeth into the evidence of cannibalism in nature, we might ask ourselves, what else have we missed by applying human standards to the natural world?

**P559 2018-03-05 A day in the life of a Roman soldier - Robert Garland**

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The year is 15 CE and the Roman Empire is prospering. Most of the credit will go to the emperor, but this success wouldn’t have been possible without loyal soldiers like Servius Felix. Servius enlisted as a legionary eight years ago at age 18, the son of a poor farmer with few prospects. Unlike the majority of legionaries, he doesn’t gamble, so he’s been able to save most of his wages. He’s even kept his viaticum, the three gold coins he received when he enlisted. If he survives until retirement, he’ll receive several acres of land. And he’s grown rather fond of a girl back home whom he intends to marry. But he’ll have to wait until he completes his 25 years of service before that can happen. And the life of a legionary is dangerous and grueling. Today, Servius’s legion, along with three others, has undertaken a “great march” of 30,000 Roman paces, the equivalent of nearly 36 kilometers. Servius’s armor and weapons, including his gladius, scutum, and two pila, weigh over 20 kilograms. And that’s not counting his backpack, or sarcina, which contains food and all the tools he needs to help build the camp – spade, saw, pickaxe, and basket. Although Servius is exhausted, he won’t sleep much tonight. He’s been assigned the first watch, which means looking after the baggage animals and keeping alert against a possible ambush. After he’s done, he lies awake, dreading the day ahead, which will force him to recall his worst nightmare. At dawn, Servius eats breakfast with his seven tent companions. They’re like a family, all bearing scars from the battles they’ve fought together. Servius is from Italia, but his fellow soldiers hail from all over the empire, which stretches from Syria to Spain. So they’re all far from home in the northern land of Germania. Servius’s legion and three others with him today are under the command of Emperor Tiberius’s nephew Germanicus, named for his father’s military successes against the Germanic tribes. Each legion has close to 5,000 men, divided into cohorts of about 500, further subdivided into centuries of around 80-100 men. Each century is commanded by a centurion. An aquilifer, or eagle-bearer, marches at the head of each legion carrying its eagle standard. The centurions march beside the legionaries belting out orders, “Dex, sin, dex, sin," “Right, left, right, left," starting with the right foot as the left is considered unlucky or sinister. Despite the strict discipline, there’s tension in the air. Last year, some legions in the area revolted, demanding better pay and a cut in the length of service. Only their general’s charisma and negotiating skills prevented wholesale mutiny. Today is a “just march,” only 30 kilometers. As the marshes and forests of Germania lie beyond the empire’s road system the men must build causeways and bridges to make headway— something they’ve recently spent more time doing than fighting. Finally, they arrive at their destination, a place Servius knows too well. It’s a clearing on the outskirts of the Teutoburg Forest, where six years ago, during the reign of the Emperor Augustus, Germanic tribes under their chieftain Arminius ambushed and destroyed three legions. Proceeding along a narrow path, the legions were attacked from forest cover under torrential rain with their escape blocked. It was one of the worst defeats the Romans ever suffered and Augustus never lived it down. Servius was one of the few survivors. Servius still has nightmares of his comrades lying where they fell. But now the army is back to bury the dead with full military honors. As he helps in the task, he can’t help wondering whether the bones he handles belonged to someone he knew. Several times he wants to weep aloud, but he pushes on with the task. The glory of the Empire can go to the crows. All he craves is to retire on a small farm with his wife-to-be, if the gods should spare his life for 17 more years.

**P560 2018-03-05 Why isn't the world covered in poop - Eleanor Slade and Paul Manning**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=560)

Somewhere near you, an animal is defecating. In fact, each day, the animal kingdom produces roughly enough dung to match the volume of water pouring over the Victoria Falls. So why isn’t the planet covered in the stuff? You can thank the humble dung beetle for eating up the excess. Capable of burying 250 times their body weight in a single night, these valiant insects make quick work of an endless stream of feces. Over 7,000 known species of dung beetle run clean-up duty across six continents —everywhere except Antarctica. A dung beetle’s first task is to locate dung. Some live on the anal regions of larger animals, ready to leap off when they defecate. Others sniff out feces that animals leave behind. A pile of elephant dung can attract 4,000 beetles in 15 minutes. So once a beetle finds dung, it must work quickly to secure some of the bounty for itself. Most dung beetle species fall into one of three main groups: rollers, tunnelers, and dwellers. Dung rollers sculpt a ball of dung, and using their back legs, quickly roll it away from competitors. Potential partners jump on the ball, and once the ball-maker has selected their mate, the pair dig their dung ball into the soil. Once it’s been buried, the female lays a single egg within the dung ball. Tunnelers have a different approach. Digging underneath a pat, some drag dung down into the soil and pack it into clumps known as brood balls, dung balls, or dung “sausages,” depending on their shape and size. Male tunnelers sport a spectacular array of horns to fight each other for control of these tunnels, which they then defend until the female’s laid her egg. Some male tunnelers avoid the fray by masquerading as hornless females and sneaking into tunnels to mate while the guardians’ heads are turned. The third group of dung beetles, dwellers, take the most straightforward approach, laying their eggs directly into a dung pat. This makes their offspring more vulnerable to predation than those of the tunnelers and rollers. As the larvae feed, they riddle the dung pat with tunnels, leaving remains that are quickly colonized by bacteria and fungi and weathered away. Inside a tunnel, ball, or pat, once the larvae hatch, they consume the dung before metamorphosing into a pupa and then an adult beetle. Besides clearing dung, the actions of these beetles have considerable ecological importance. For one, they serve as secondary seed dispersers. Dung from monkeys, wild pigs, and other animals is riddled with seeds from the fruits they eat. When beetles bury their dung balls, they inadvertently protect these seeds from predators and increase the likelihood they’ll germinate. The advantage is so great that one South African plant has evolved to produce seeds that look and smell like dung to trick beetles into burying them. Dung beetles also play important roles in agricultural systems. Livestock, like cows and sheep, produce huge amounts of dung, which contains nutrients that can benefit plants. The beetles break up the dung and tunnel it deep into the soil, bringing the nutrients into close contact with plant roots. Their services to farmers have been valued at $380 million a year in the US and £367 million a year in the UK. Dung beetles can even help us battle global warming by reducing greenhouse gas emissions associated with farming. Microbes living in oxygen-poor livestock dung produce methane, a potent greenhouse gas. But beetles oxygenate pats when they tunnel into them, preventing the microbes from producing methane. The dung beetle spreads seeds, helps farmers, and fights climate change —and accomplishes it all simply by doing its business. Maybe next time you come across some dung in the forest or a field, you’ll be tempted to take a closer look.

**P561 2018-03-13 The Cambodian myth of lightning, thunder, and rain - Prumsodun Ok**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=561)

Once, a long time ago, there was a powerful hermit named Lok Ta Moni Eysei. He had three promising students: Moni Mekhala, the brilliant goddess of the seas, Vorachhun, the princely manifestation of the earth, and Ream Eyso, a demon whose heart burned with passionate fire. Lok Ta wished to bestow a gift upon his most deserving student. To determine which of the three that was, he announced a contest: whoever first brought back a glass full of morning dew would be master of this mysterious gift. When dusk came, Vorachhun and Ream Eyso ventured into the forest. They left not one leaf or blade of grass untouched, impatiently shaking the precious fluid into their glasses. When they returned to the hermit’s hut, they found Moni Mekhala sitting patiently with a full glass of morning dew. She had left her shawl out overnight and won the contest by simply wringing out the fabric over her glass. Proud of all his students, and loving them like his own children, Lok Ta surprised all three with gifts. He turned the dew Ream Eyso collected into a diamond axe, Vorachhun’s into a magic dagger, and Moni Mekhala’s into a crystal ball unlike anything ever seen. Soon Ream Eyso grew covetous and decided he must have Mekhala’s prize. He and Vorachhun tried to woo the goddess so they could get the precious gem. But after she rejected their advances and flew off, Ream Eyso resolved to take the crystal ball by force. Ream Eyso flew through the air in search of Moni Mekhala, propelled on by a jealous rage. On his way, he encountered Vorachhun and attacked him, knowing that the righteous prince would never allow him to steal the crystal. The demon gained the upper hand in the heat of battle, and hurled Vorachhun against the side of a mountain. Sure of Vorachhun’s death, Ream Eyso continued his search until he finally found Moni Mekhala. He demanded that she and her friends either submit to him, the most brilliant of Lok Ta’s students and rightful master of the crystal ball, or die like Vorachhun. Mekhala, without fear, refused and flew off into the clouds, hoping to draw the demon away from her friends. Ream Eyso took the bait, ripping through nimbus after nimbus in his crazed pursuit. Once far enough away, Mekhala confronted her pursuer. Ream Eyso made one last demand but the goddess remained unfazed. Enraged, he began to swing his diamond axe. Before he could hurl the weapon, Mekhala threw her crystal into the air. As it climbed the height of the sky, it emitted powerful flashes of lightning that blinded the demon. Ream Eyso let his axe loose in wild desperation. As the weapon flew through the air it cut through clouds, creating deep, rolling peals of thunder. And when the lightning and thunder mixed, precious seeds of water fell from heaven: rain. Mekhala drew close to Ream Eyso, now blind and impotent without his axe. She pondered what she should do to the murderer. Remembering the kindness and love of her teacher, Moni Mekhala chose compassion and flew into the sky. Shortly later, Ream Eyso regained his strength, found his axe, and followed her. Thunder, lightning, and rain continued to dance across the earth. Some drops fell on Vorachhun and revived him, his skin golden like a rice field ready for harvest. Grabbing his magic dagger, he flew into the sky in search of Ream Eyso and Moni Mekhala.

**P562 2018-03-15 Can you solve the buried treasure riddle - Daniel Griller**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=562)

After a massive storm tears through the Hex Archipelago, you find five grizzled survivors in the water. Shivering their timbers, they explain that they’re the former crew of the great pirate Greenbeard, who marooned them after they tried to mutiny. Each was bound up in a different spot on a small island, until the storm washed them out to sea. In gratitude for saving them, they reveal a secret: the island they were on is also where Greenbeard has buried his treasure hoard. But when the sailors try to describe the island, something seems off. All agree it was flat and barren with no prominent features except for some trees. Yet each pirate claims they saw a different number of trees, ranging from two to six. The pirate who saw two trees says the treasure was buried right at his feet. When you fly your hot air balloon over the area to investigate, you see hundreds of small islands, each with exactly six trees. The next storm will be here soon, so you’ll have to hurry and narrow your search. What does the island with Greenbeard’s treasure look like from the sky? And where will the treasure be on that island? Pause here if you want to figure it out for yourself! Answer in 3 Answer in 2 Answer in 1 It might seem like the pirates are delirious from dehydration. But that’s not what’s going on. Remember, each was confined to a separate point on the island, and no two of them could see the same number of trees. That means that for all but one pirate, something was blocking their view. And since there are no other features on the island, that something could only have been other trees. A pirate would see fewer trees when two or more fell along a straight line from their vantage point. So we need to find the island where five different pirates standing in different spots would each see a different number of trees. Virtually every island has a position from which you can see six trees. And on most islands there’s a position where 5 trees can be seen by standing in line with two of them. It turns out that the hardest locations to find are those with fewer visible trees precisely because they require more trees to line up with the viewer’s position. So how can we see just two trees? One way would be if all the trees were lined up in single file, such as on this island. Then, you could stand at the end of the line and see one, stand in the middle and see two, or stand anywhere else and see all six. But there’s no place from which you can see only three, four, or five, so one straight line of trees is out. So what about two lines of trees? So long as the lines aren’t parallel and they intersect over land, there’ll always be a position where the two lines converge from which you could see exactly two trees. And if they’re grouped two and four, or three and three, there are many arrangements in which you could also see three, four, five, and six trees. Fortunately for us, there’s only one island in the archipelago with two non-parallel lines of trees, and it’ll be buried at the intersection of the two lines. You land on this island and dig up a chest containing a massive pile of tree seeds, ready for planting. Was this treasure really worth all that trouble? That’s a matter of perspective.

**P563 2018-03-19 The most successful pirate of all time - Dian Murray**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=563)

At the height of their power, infamous Caribbean pirates like Blackbeard and Henry Morgan commanded as many as ten ships and several hundred men. But their stories pale next to the most successful pirate of all time. Madame Zheng commanded 1800 vessels, made enemies of several empires, and still lived to old age. Madame Zheng began her life as a commoner working on one of the many floating brothels, or flower boats, in the port city of Guangzhou. By 1801, she had attracted the attention of a local pirate captain named Zheng Yi, and the two soon married. Guangzhou’s fishermen had long engaged in small-scale piracy to supplement their meager incomes in the offseason. But a successful peasant uprising in neighboring Vietnam at the end of the 18th century had raised the stakes. The victorious Tây Sơn rebels had unified their country only to face a Chinese invasion and ongoing maritime battles with the Vietnamese rulers they had overthrown. So they commissioned Guangzhou’s pirates to raid the coast and join the fight against their enemies. Serving their Vietnamese patrons turned the Zhengs and other pirates from ragtag gangs aboard single vessels into professional privateer fleets with dozens of ships able to hold their own at sea. In 1802, the Tây Sơn were overthrown and the pirates lost their safe harbor in Vietnam. But instead of scattering, the Zhengs met the crisis by uniting the rival Cantonese pirate groups into a formidable alliance. At its height, the confederation included 70,000 sailors with 800 large junks and nearly 1,000 smaller vessels. Those were organized into six fleets marked by different colored flags. The Zhengs were unlike many other historically-known privateers, such as Henry Morgan or Barbarossa, who acted on behalf of various naval powers. Instead, the Zhengs were now true outlaws, operating without support or approval from any government. Zheng Yi met an untimely end in 1807, but his widow didn’t hesitate to secure their gains. Through skillful diplomacy, Madame Zheng took charge of the confederation, convincing the captains that their best interests lay in continued collaboration. Meanwhile, she appointed Zhang Bao, the young protege of her late husband, as the commander of her most powerful squadron, the Red Flag Fleet. Zhang became not only her right-hand man, but her lover and, soon, her new husband. Madame Zheng consolidated her power through strict military discipline combined with a surprisingly progressive code of laws. Female captives were theoretically protected from sexual assault, and while pirates could take them as wives, mistreatment or infidelity towards them was punishable by death. Under Madame Zheng’s leadership, the pirates greatly increased their power, with 200 cannons and 1300 guns in the Red Flag Fleet alone. Within a few years, they destroyed 63 of Guangdong Province’s 135 military vessels, forcing their commanders to hire more than 30 private junks. Madame Zheng was so feared that Chinese commanders charged with apprehending her spent most of their time ashore, sometimes sabotaging their own vessels to avoid battle at sea. With little to stop them, the pirates were able to mount successful —and often brutal— raids on garrisons, villages, and markets throughout the coast. Using her administrative talents, Madame Zheng established financial offices in cities and villages, allowing her pirates to extract regular protection payments on land and sea alike. This effectively created a state within a state whose influence reached far beyond the South China Sea. At the peak of her power, Madame Zheng’s confederation drove five American schooners to safe harbor near Macao, captured a Portuguese brig, and blockaded a tribute mission from Thailand —all in a single day. But perhaps Madame Zheng’s greatest success lay in knowing when to quit. By 1810, increasing tension between the Red and Black Flag Fleets weakened the confederation from within and rendered it more vulnerable to attack from without. So, when the Chinese government, desperate to stop the raids, offered amnesty in exchange for the pirates’ surrender, Madame Zheng and Zhang Bao agreed, but only on their own terms. Their confederation was successfully and peacefully dismantled in April 1810, while Zhang Bao was allowed to retain 120 junks for personal use and became an officer in the Chinese navy. Now fighting pirates himself, Zhang Bao quickly rose through the ranks of military command, and Madame Zheng enjoyed all the privileges of her husband’s status. After Zhang Bao died in 1822, Madame Zheng returned with their eleven-year-old son to Guangzhou, where she opened a gambling house and quietly lived off the proceeds. She died at the age of 69—an uncommonly peaceful end to a pirate’s life.

**P564 2018-03-22 A simple way to tell insects apart - Anika Hazra**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=564)

A whip-like straw. Powerful, crushing blades. A pointed, piercing tube. There are nearly a million known insect species in the world, but most have one of just five common types of mouthparts. And that’s extremely useful to scientists because when they encounter an unfamiliar insect in the wild, they can learn a lot about it just by examining how it eats. Scientific classification, or taxonomy, is used to organize all living things into seven levels: kingdom, phylum, class, order, family, genus, and species. The features of an insect’s mouthparts can help identify which order it belongs to, while also providing clues about how it evolved and what it feeds on. The chewing mouthpart is the most common. It’s also the most primitive— all other mouthparts are thought to have started out looking like this one before evolving into something different. It features a pair of jaws called mandibles with toothed inner edges that cut up and crush solid foods, like leaves or other insects. You can find this mouthpart on ants from the Hymenoptera order, grasshoppers and crickets of the Orthoptera order, dragonflies of the Odonata order, and beetles of the Coleoptera order. The piercing-sucking mouthpart consists of a long, tube-like structure called a beak. This beak can pierce plant or animal tissue to suck up liquids like sap or blood. It can also secrete saliva with digestive enzymes that liquefy food for easier sucking. Insects in the Hemiptera order have piercing-sucking mouthparts and include bed bugs, cicadas, aphids, and leafhoppers. The siphoning mouthpart, a friendlier version of the piercing and sucking beak, also consists of a long, tube-like structure called a proboscis that works like a straw to suck up nectar from flowers. Insects of the Lepidoptera order— butterflies and moths— keep their proboscises rolled up tightly beneath their heads when they’re not feeding and unfurl them when they come across some sweet nectar. With the sponging mouthpart, there’s yet another tube, this time ending in two spongy lobes that contain many finer tubes called pseudotracheae. The pseudotracheae secrete enzyme-filled saliva and soak up fluids and dissolved foods by capillary action. House flies, fruit flies, and the other non-biting members of the Diptera order are the only insects that use this technique. But, there’s a catch. Biting flies within Diptera, like mosquitoes, horse flies, and deer flies, have a piercing-sucking mouthpart instead of the sponging mouthpart. And finally, the chewing-lapping mouthpart is a combination of mandibles and a proboscis with a tongue-like structure at its tip for lapping up nectar. On this type of mouthpart, the mandibles themselves are not actually used for eating. For bees and wasps, members of the Hymenoptera order, they serve instead as tools for pollen-collecting and wax-molding. Of course, in nature, there are always exceptions to the rules. The juvenile stages of some insects, for example, have completely different kinds of mouths than their adult versions, like caterpillars, which use chewing mouthparts to devour leaves before metamorphosing into butterflies and moths with siphoning mouthparts. Still, mouthpart identification can, for the most part, help scientists—and you —categorize insects. So why not break out a magnifying lens and learn a little more about who’s nibbling your vegetable garden, biting your arm, or just flying by your ear.

**P565 2018-03-22 What causes body odor - Mel Rosenberg**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=565)

A pungent blend of onions, cheese, and cat urine with hints of... is that…wet goat? Most of us don’t need more than one whiff to identify that generally unpleasant, characteristic smell we call body odor. But it’s a surprisingly complex phenomenon influenced by our genetic makeup, age, diet, and hygiene. So what is this odor, exactly? Where does it come from? And can we do anything about it? To start, you just need two things to produce that familiar scent: your armpit’s own secretions and the bacteria that feed on them. Most people associate body odor with sweat, and it’s an important piece of the puzzle. Your body has millions of sweat glands, and they come in two major types: eccrine glands are found all over your skin and secrete mainly water and salt. Apocrine glands, on the other hand, develop at puberty in your armpits and a few other places on your body. The sweat they secrete is full of proteins and fats. By themselves, these secretions are usually odorless. That’s where bacteria come in. Every square centimeter of our bodies is covered with thousands of bacteria. Many microorganisms thrive in moist environments, like our armpits. There, you can find about a million bacteria per square centimeter, one of the highest concentrations anywhere on the skin. Lurking in this throng of microorganisms are species of Corynebacteria, Staphylococci, Micrococci, and others. When these bacteria feed on the proteins and fats in apocrine sweat, they turn the odorless compounds into new ones that can smell very unpleasant. Some of the worst offenders may be sulfur-containing chemicals; those give body odor its oniony aroma. Carboxylic acids are in the mix, too, adding notes of cheese. These molecules waft up from the armpit and can be sucked directly into our noses, where they’re trapped and detected by an array of specialized receptors. Those can recognize odor molecules at concentrations of less than one in a million. So what determines how strong your body odor might be? It depends on the resident microbial populations in your armpit, and the nutrients that your glands provide them with. Your genes help determine what compounds you produce, and in what quantity, so everyone has a slightly different set. In fact, a gene variant that virtually eliminates body odor is common in people of East Asian descent. Adrenaline increases the ratio of apocrine to eccrine sweat, so body odor can be more intense when you’re nervous. Bacterial composition and concentration also varies between individuals and plays a part. Even what you eat can have a small effect on how you smell. So how can we deal with body odor? Washing the armpits with soap and water helps but won’t remove all the bacteria since many are buried in deeper layers of the skin. Deodorants, however, inhibit bacterial activity and mask odors at the same time. Antiperspirants work by forming tiny gel plugs that block sweat glands, drying out the armpits. While we continue to battle body odor, scientists are trying to understand it. We don’t know why the brain often interprets these particular odors as off-putting. But some researchers have proposed that secretions from the armpit could have a positive function, too, like cementing social bonds and providing a means of chemical communication. We don’t know yet if that’s the case. For now, body odor seems to be just another smelly part of the human condition.

**P566 2018-04-05 The rise and fall of the Byzantine Empire - Leonora Neville**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=566)

Most history books will tell you the Roman Empire fell in the fifth century CE. But this would’ve come as a great surprise to the millions of people who lived in the Roman Empire up through the Middle Ages. This medieval Roman Empire, which we usually refer to today as the Byzantine Empire, began in 330 CE. That’s when Constantine, the first Christian emperor, moved the capital of the Roman Empire to a new city called Constantinople, which he founded on the site of the ancient Greek city Byzantion. When the Visigoths sacked Rome in 410 and the Empire’s western provinces were conquered by barbarians, Constantine’s Eastern capital remained the seat of the Roman emperors. There, generations of emperors ruled for the next 11 centuries. Sharing continuity with the classical Roman Empire gave the Byzantine empire a technological and artistic advantage over its neighbors, whom Byzantines considered barbarians. In the ninth century, visitors from beyond the frontier were astonished at the graceful stone arches and domes of the imperial palace in Constantinople. A pair of golden lions flanked the imperial throne. A hidden organ would make the lions roar as guests fell on their knees. Golden birds sung from a nearby golden tree. Medieval Roman engineers even used hydraulic engines to raise the imperial throne high into the air. Other inherited aspects of ancient Roman culture could be seen in emperors’ clothing, from traditional military garb to togas, and in the courts, which continued to use Roman law. Working-class Byzantines would’ve also had similar lives to their Ancient Roman counterparts; many farmed or plied a specific trade, such as ceramics, leatherworking, fishing, weaving, or manufacturing silk. But, of course, the Byzantine Empire didn’t just rest on the laurels of Ancient Rome. Their artists innovated, creating vast mosaics and ornate marble carvings. Their architects constructed numerous churches, one of which, called Hagia Sophia, had a dome so high it was said to be hanging on a chain from heaven. The Empire was also home to great intellectuals such as Anna Komnene. As imperial princess in the 12th century, Anna dedicated her life to philosophy and history. Her account of her father’s reign is historians’ foremost source for Byzantine political history at the time of the first crusade. Another scholar, Leo the Mathematician, invented a system of beacons that ran the width of the empire— what’s now Greece and Turkey. Stretching more than 700 kilometers, this system allowed the edge of the Empire to warn the emperor of invading armies within one hour of sighting them at the border. But their advances couldn’t protect the Empire forever. In 1203, an army of French and Venetian Crusaders made a deal with a man named Alexios Angelos. Alexios was the son of a deposed emperor, and promised the crusaders vast riches and support to help him retake the throne from his uncle. Alexios succeeded, but after a year, the population rebelled and Alexios himself was deposed and killed. So Alexios’s unpaid army turned their aggression on Constantinople. They lit massive fires, which destroyed countless works of ancient and medieval art and literature, leaving about one-third of the population homeless. The city was reclaimed 50 years later by the Roman Emperor Michael Palaiologos, but his restored Empire never regained all the territory the Crusaders had conquered. Finally, in 1453, Ottoman Emperor Mehmed the Conqueror captured Constantinople, bringing a conclusive end to the Roman Empire. Despite the Ottoman conquest, many Greek-speaking inhabitants of the Eastern Mediterranean continued to call themselves Romans until the early 21st century. In fact, it wasn’t until the Renaissance that the term “Byzantine Empire” was first used. For Western Europeans, the Renaissance was about reconnecting with the wisdom of antiquity. And since the existence of a medieval Roman Empire suggested there were Europeans who’d never lost touch with antiquity, Western Europeans wanted to draw clear lines between the ages. To better distinguish the classical, Latin-speaking, pagan Roman Empire from the medieval, Greek-speaking, Christian Roman Empire, scholars renamed the latter group Byzantines. And thus, 100 years after it had fallen, the Byzantine Empire was born.

**P567 2018-04-06 What causes headaches - Dan Kwartler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=567)

In ancient Greece, headaches were considered powerful afflictions. Victims prayed for relief from Asclepius, the god of medicine. And if pain continued, a medical practitioner would perform the best-known remedy— drilling a small hole in the skull to drain supposedly infected blood. This dire technique, called trepanation, often replaced the headache with a more permanent condition. Fortunately, doctors today don’t resort to power tools to cure headaches. But we still have a lot to learn about this ancient ailment. Today, we’ve classified headaches into two camps— primary headaches and secondary headaches. The former are not symptomatic of an underlying disease, injury, or condition; they are the condition. But we’ll come back to them in a minute because while primary headaches account for 50% of reported cases, we actually know much more about secondary headaches. These are caused by other health problems, with triggers ranging from dehydration and caffeine withdrawal to head and neck injury, and heart disease. Doctors have classified over 150 diagnosable types, all with different potential causes, symptoms, and treatments. But we’ll take just one common case —a sinus infection—as an example. The sinuses are a system of cavities that spread behind our foreheads, noses, and upper cheeks. When our sinuses are infected, our immune response heats up the area, roasting the bacteria and inflaming the cavities well past their usual size. The engorged sinuses put pressure on the cranial arteries and veins, as well as muscles in the neck and head. Their pain receptors, called nociceptors, trigger in response, cueing the brain to release a flood of neuropeptides that inflame the cranial blood vessels, swelling and heating up the head. This discomfort, paired with hyper-sensitive head muscles, creates the sore, throbbing pain of a headache. Not all headache pain comes from swelling. Tense muscles and inflamed, sensitive nerves cause varying degrees of discomfort in each headache. But all cases are reactions to some cranial irritant. While the cause is clear in secondary headaches, the origins of primary headaches remain unknown. Scientists are still investigating potential triggers for the three types of primary headaches: recurring, long-lasting migraines; intensely painful, rapid-fire cluster headaches; and, most common of all, the tension headache. As the name suggests, tension headaches are known for creating the sensation of a tight band squeezed around the head. These headaches increase the tenderness of the pericranial muscles, which then painfully pulse with blood and oxygen. Patients report stress, dehydration, and hormone changes as triggers, but these don’t fit the symptoms quite right. For example, in dehydration headaches, the frontal lobe actually shrinks away from the skull, creating forehead swelling that doesn’t match the location of the pain in tension headaches. Scientists have theories for what the actual cause is, ranging from spasming blood vessels to overly sensitive nociceptors, but no one knows for sure. Meanwhile, most headache research is focused on more severe primary headaches. Migraines are recurring headaches, which create a vise-like sensation on the skull that can last from four hours to three days. In 20% of cases, these attacks are intense enough to overload the brain with electrical energy, which hyper-excites sensory nerve endings. This produces hallucinations called auras, which can include seeing flashing lights and geometric patterns and experiencing tingling sensations. Cluster headaches, another primary headache type, cause burning, stabbing bursts of pain behind one eye, leading to a red eye, constricted pupil, and drooping eyelid. What can be done about these conditions, which dramatically affect many people’s quality of life? Tension headaches and most secondary cases can be treated with over-the-counter pain medications, such as anti-inflammatory drugs that reduce cranial swelling. And many secondary headache triggers, like dehydration, eye strain, and stress, can be proactively avoided. Migraines and cluster headaches are more complicated, and we haven’t yet discovered reliable treatments that work for everyone. But thankfully, pharmacologists and neurologists are hard at work cracking these pressing mysteries that weigh so heavily on our minds.

**P568 2018-04-10 The surprising reasons animals play dead - Tierney Thys**

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Imagine you’re being attacked by a ferocious predator. With no chance of escape, you do what any courageous, self-respecting possum would do: curl into an immobile state called catatonia, stick out your tongue, drool, and ooze some foul-smelling liquid from your anal glands. Disgusted, your assailant loosens its grip, decides you’re not the dinner it was looking for, and departs. After 10 minutes, you resurrect and merrily saunter on. From lemurs to lizards, ants to amphibians, sharks to chickens, hundreds of animals "play dead" as a survival tactic. Nicknamed "playing possum" after its star performer, feigning death is also called thanatosis. That’s from Thanatos, the ancient Greek deity of death. But most scientists call it tonic immobility, or TI. How and why TI occurs depends on the species and situation. Spewing stench and adopting odd postures are common and often play important roles. Other animals sacrifice their neighbors: quail chicks that freeze while their kin run amok have a better chance of survival when pursued by a cat. Speaking of cats, feline mothers can pinch the napes of their kittens’ necks and induce another kind of immobility called clipnosis. This keeps their kittens quiet and easy to transport. Most of the physiological mechanisms underlying these theatrics originate in the parasympathetic nervous system, better known for controlling cycles of resting and digesting. In possums, the parasympathetic nervous system causes their heart rates to drop by nearly half, respiration by a third, and body temperatures by more than half a degree Celsius for up to an hour. The neurotransmitter dopamine also plays a part. Flour beetles with low dopamine levels play dead more frequently than those with high levels, and anything blocking dopamine receptor sites can lengthen catatonia. But maintaining a death ruse isn’t easy. The performers are constantly gauging their surroundings for cues on when it’s safe to rise. Chickens, for instance, can sense when a predator’s eyes are upon them. Researchers know this because when they used a stuffed hawk in an experiment, their chicken subjects came out of their catatonia quicker when the hawk’s eyes were averted. Other animals use TI for purposes other than defense. When the sleeper cichlid feels peckish, it sinks to the lake floor and lies motionless, its splotchy coloration making it seem like a rotting carcass. If a small scavenger investigates, this undead trickster strikes. Some animals even feign death as a sexual ploy. Male nursery spiders offer gifts of silk-wrapped insects in hopes of wooing females. But those females are known to eat love-seeking males. By playing dead while the female eagerly devours her snack, these males can cautiously revive and improve their chances of successfully mating. So TI can work to an animal’s advantage, unless someone else knows its secret. California orcas can flip over young great white sharks, inducing TI for so long the immobilized sharks, who must move to respire, essentially suffocate. Humans can also flip sharks into TI. By stroking a shark’s electrically-sensitive snout and gently turning it over, researchers can induce TI that lasts up to 15 minutes. That’s enough time to insert tags, remove hooks, and even perform surgeries. There are risks however: TI can hamper respiration and induce hyperglycemia, a sign of stress. So this technique should only be used when necessary. Humans can also experience TI when they freeze with fear during violent assaults. Recognizing this ancient, involuntary form of self-defense has significant implications when trying to understand why some victims don’t flee or fight in the face of danger. So, studying TI in non-human animals not only helps us better understand some odd behaviors, it can also help us better understand our own, sometimes counterintuitive, responses to violence.

**P569 2018-04-10 Why can't you divide by zero - TED-Ed**

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In the world of math, many strange results are possible when we change the rules. But there’s one rule that most of us have been warned not to break: don’t divide by zero. How can the simple combination of an everyday number and a basic operation cause such problems? Normally, dividing by smaller and smaller numbers gives you bigger and bigger answers. Ten divided by two is five, by one is ten, by one-millionth is 10 million, and so on. So it seems like if you divide by numbers that keep shrinking all the way down to zero, the answer will grow to the largest thing possible. Then, isn’t the answer to 10 divided by zero actually infinity? That may sound plausible. But all we really know is that if we divide 10 by a number that tends towards zero, the answer tends towards infinity. And that’s not the same thing as saying that 10 divided by zero is equal to infinity. Why not? Well, let’s take a closer look at what division really means. Ten divided by two could mean, "How many times must we add two together to make 10,” or, “two times what equals 10?” Dividing by a number is essentially the reverse of multiplying by it, in the following way: if we multiply any number by a given number x, we can ask if there’s a new number we can multiply by afterwards to get back to where we started. If there is, the new number is called the multiplicative inverse of x. For example, if you multiply three by two to get six, you can then multiply by one-half to get back to three. So the multiplicative inverse of two is one-half, and the multiplicative inverse of 10 is one-tenth. As you might notice, the product of any number and its multiplicative inverse is always one. If we want to divide by zero, we need to find its multiplicative inverse, which should be one over zero. This would have to be such a number that multiplying it by zero would give one. But because anything multiplied by zero is still zero, such a number is impossible, so zero has no multiplicative inverse. Does that really settle things, though? After all, mathematicians have broken rules before. For example, for a long time, there was no such thing as taking the square root of negative numbers. But then mathematicians defined the square root of negative one as a new number called i, opening up a whole new mathematical world of complex numbers. So if they can do that, couldn’t we just make up a new rule, say, that the symbol infinity means one over zero, and see what happens? Let's try it, imagining we don’t know anything about infinity already. Based on the definition of a multiplicative inverse, zero times infinity must be equal to one. That means zero times infinity plus zero times infinity should equal two. Now, by the distributive property, the left side of the equation can be rearranged to zero plus zero times infinity. And since zero plus zero is definitely zero, that reduces down to zero times infinity. Unfortunately, we’ve already defined this as equal to one, while the other side of the equation is still telling us it’s equal to two. So, one equals two. Oddly enough, that's not necessarily wrong; it's just not true in our normal world of numbers. There’s still a way it could be mathematically valid, if one, two, and every other number were equal to zero. But having infinity equal to zero is ultimately not all that useful to mathematicians, or anyone else. There actually is something called the Riemann sphere that involves dividing by zero by a different method, but that’s a story for another day. In the meantime, dividing by zero in the most obvious way doesn’t work out so great. But that shouldn’t stop us from living dangerously and experimenting with breaking mathematical rules to see if we can invent fun, new worlds to explore.

**P570 2018-04-16 Why are fish fish-shaped - Lauren Sallan**

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In tropical seas, flying fish leap out of the water, gliding for up to 200 meters using wing-like fins, before dipping back into the sea. In the Indo-Pacific, a hunting sailfish can reach speeds of 110 kilometers per hour. That’s 11 times faster than Olympic swimming champion Michael Phelps. It can then stick up its spiny dorsal fin like a brake, grinding to a dead halt, mid-swim. Each of these physical feats is made possible by a fish’s form, which in most species is a smooth, elongated body, fins, and a tail. These features are shared across thousands of fish species, each introducing its own variations on the theme to survive in unique habitats. What makes these features so commonplace in fish, and what does it reveal about the more than 33,000 fish species that inhabit earth’s rivers, lakes, and seas? Fish can be split into two main groups, according to the type of motion they favor. The first is body and caudal fin driven motion, and most fish species, about 85%, fall into this group. Here, the body and tail are the primary propelling forces, with fins mainly playing a stabilizing and steering role. This configuration suits many open-water species, which need speed, thrust and control for constant, efficient swimming. Eels lie at one extreme of this group. Known as anguilliform swimmers, their entire bodies undulate to generate a wave-like motion. Compared to anguilliform fish, species like salmon and trout, known as subcarangiforms, use about two-thirds of their body mass to generate motion, while carangiform swimmers, such as mackerel, only use about a third. Typically, the less of its mass a fish uses to generate motion, the more streamlined its shape. At the other end of the spectrum from eels are ostraciiform species like boxfish, and thunniform swimmers like tuna. In these fish, the tails, also known as caudal fins, do the work. A tuna’s tail is attached by tendons to multiple muscles in its body. It powers the body like an engine, forcefully catapulting the bullet-like fish to speeds up to 69 kilometers per hour. The second major fish group relies on median and paired fin motion, meaning they’re propelled through the water predominantly by their fins. Fins allow fine-tuned movement at slow speeds, so this propulsion is typically found in fish that have to navigate complex habitats. Bottom-dwelling fishes, like rays, fall into this group; using their huge pectoral fins, they can lift themselves swiftly off the sea floor. That conveniently allows them to inhabit shallow seas without being buffeted about by waves. Similarly, shallow-water flatfish use their entire bodies as one big fin to hoist themselves up off the sand. Ocean sunfish lack tails, so they move around slowly by beating their wing-like median fins instead. Similar movements are shared by many reef species, like the queen angelfish, surgeonfish, and wrasse. Their focus on fins has taken the demand off their bodies, many of which have consequently evolved into unusual and inventive shapes. There are fishes within both groups that seem to be outliers. But if you look closer, you’ll notice that these common traits are disguised. Seahorses, for instance, don’t appear fish-shaped in any conventional way, yet they use their flexible dorsal fins as makeshift tails. A pufferfish may occasionally look more like a lethal balloon, but if it needs to swim rapidly, it’ll retract its spines. Handfish look like they have legs, but really these limb-like structures are fins, modified to help them amble across the sea floor. For fish, motion underpins survival, so it’s become a huge evolutionary driver of form. The widespread features of fish have been maintained across tens of thousands of fish species, not to mention other ocean-dwelling animals, like penguins, dolphins, sea slugs, and squids. And that’s precisely because they’ve proven so successful.

**P571 2018-04-19 How the world's first metro system was built - Christian Wolmar**

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It was the dawn of 1863, and London’s not-yet-opened subway system, the first of its kind in the world, had the city in an uproar. Digging a hole under the city and putting a railroad in it seemed the stuff of dreams. Pub drinkers scoffed at the idea and a local minister accused the railway company of trying to break into hell. Most people simply thought the project, which cost more than 100 million dollars in today’s money, would never work. But it did. On January 10, 1863, 30,000 people ventured underground to travel on the world’s first subway on a four-mile stretch of line in London. After three years of construction and a few setbacks, the Metropolitan Railway was ready for business. The city’s officials were much relieved. They’d been desperate to find a way to reduce the terrible congestion on the roads. London, at the time the world’s largest and most prosperous city, was in a permanent state of gridlock, with carts, costermongers, cows, and commuters jamming the roads. It’d been a Victorian visionary, Charles Pearson, who first thought of putting railways under the ground. He’d lobbied for underground trains throughout the 1840s, but opponents thought the idea was impractical since the railroads at the time only had short tunnels under hills. How could you get a railway through the center of a city? The answer was a simple system called "cut and cover." Workers had to dig a huge trench, construct a tunnel out of brick archways, and then refill the hole over the newly built tunnel. Because this was disruptive and required the demolition of buildings above the tunnels, most of the line went under existing roads. Of course, there were accidents. On one occasion, a heavy rainstorm flooded the nearby sewers and burst through the excavation, delaying the project by several months. But as soon as the Metropolitan Railway opened, Londoners rushed in to ride the new trains. The Metropolitan quickly became a vital part of London’s transport system. Additional lines were soon built, and new suburbs grew around the stations. Big department stores opened next to the railroad, and the railway company even created attractions, like a 30-story Ferris wheel in Earls Court to bring in tourists by train. Within 30 years, London’s subway system covered 80 kilometers, with lines in the center of town running in tunnels, and suburban trains operating on the surface, often on embankments. But London was still growing, and everyone wanted to be connected to the system. By the late 1880s, the city had become too dense with buildings, sewers, and electric cables for the "cut and cover" technique, so a new system had to be devised. Using a machine called the Greathead Shield, a team of just 12 workers could bore through the earth, carving deep underground tunnels through the London clay. These new lines, called tubes, were at varying depths, but usually about 25 meters deeper than the "cut and cover" lines. This meant their construction didn’t disturb the surface, and it was possible to dig under buildings. The first tube line, the City and South London, opened in 1890 and proved so successful that half a dozen more lines were built in the next 20 years. This clever new technology was even used to burrow several lines under London’s river, the Thames. By the early 20th century, Budapest, Berlin, Paris, and New York had all built subways of their own. And today, with more than 160 cities in 55 countries using underground rails to combat congestion, we can thank Charles Pearson and the Metropolitan Railway for getting us started on the right track.

**P572 2018-04-23 The rise and fall of the Assyrian Empire - Marian H Feldman**

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Before the sun never set on the British Empire, before Genghis Khan swept the steppe, before Rome extended its influence to encircle the Mediterranean Sea, there was ancient Assyria. Considered by historians to be the first true empire, Assyria’s innovations laid the groundwork for every superpower that’s followed. At its height, in the 7th century BCE, the Assyrian Empire stretched across modern Iraq, Syria, Lebanon, Israel, and parts of Turkey, Iran, and Egypt. Its wonders included a vast library and large botanical and zoological park. But the story of Assyria’s rise to dominance began many centuries earlier, in the Late Bronze Age, in a city called Ashur. Ashur was a tin and textiles trading center located along the Tigris River in northern Iraq. It shared its name with a god thought to be an embodiment of the city and later of the entire empire. For the administration-minded Assyrians, politics and religion were closely linked. Around 1300 BCE, a high priest named Ashur-uballit I took the title of king and initiated a tradition of military campaigns, effectively transforming Assyria from a city-state to a territorial state. This meant that a single administrative entity oversaw many places, cultures, and peoples. For the next 150 years, Assyria extended its reach and thrived. In the 12th century BCE, a mysterious catastrophe that still bewilders archaeologists caused the Assyrians to lose much of their territory. A few hundred years later, however, Assyrian kings began a new round of conquests. This time, they honed their administrative system into an empire that would last generations. Assyrians were military innovators and merciless conquerors. During their conquests, they used siege tactics and cruel punishments for those who opposed them, including impalement and flaying. The growth of their empire was due, in part, to their strategy of deporting local populations, then shifting them around the empire to fulfill different needs. This broke peoples’ bonds with their homelands and severed loyalties among local groups. Once the Assyrians conquered an area, they built cities connected by well-maintained royal roads. Often, when a new king came to power, he would build a new capital. With each move, new palaces and temples were erected and lavishly decorated. Although kings claimed absolute power, we know that an extensive system of courtiers, provincial officials, and scholars influenced affairs. At least one woman, Sammuramat, ruled the kingdom. Assyrian rulers celebrated their military excursions by having representations of their exploits carved into the walls of their newly built palaces. But despite the picture of a ruthless war state projected by these records, the Assyrian kings were also interested in the cultural traditions of the region, especially those of Babylonia, a separate state to the south. Babylonia had been a cultural leader for millennia, stretching back to the beginning of writing at the end of the 4th millennium BCE. Assyria saw itself as the inheritor and protector of this tradition. Assyrian rulers supported scholars in specialties ranging from medicine to magic, and the capital cities, like Ninevah, were home to elaborate parks and gardens that housed plants and animals from around the empire. One of Assyria’s final rulers, Ashurbanipal, sent scholars throughout Babylonia to gather up and copy ancient literary works. Ashurbanipal’s library took the form of clay tablets inscribed with cuneiform in the languages of Akkadian and Sumerian. The library was lost during the final sack of Ninevah in 612 BCE. But thanks to a 19th century archaeological excavation, many masterpieces of ancient literature, including the Epic of Gilgamesh and the Babylonian Creation Epic, survive today. After centuries of rule, the Assyrian Empire fell to the Babylonians and Medes between 612 and 609 BCE. Yet the innovations that the Assyrians pioneered live on. Their emphasis on constant innovation, efficient administration, and excellent infrastructure set the standard for every empire that’s followed them in the region and across the globe.

**P573 2018-04-24 How to build a dark matter detector - Jenna Saffin**

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More than two kilometers below the surface of northern Ontario, suspended in 345,000 liters of ultra-pure water, there’s a perfect sphere. It contains 3600 kilograms of liquid argon, cooled to -180 degrees Celsius. Scientists continuously monitor this chamber from above ground, looking for a glimmer of light in the darkness. Because down here, deep beneath the Earth’s surface and cocooned in a watery shield, that light would indicate the presence of one of the universe’s greatest mysteries: dark matter. All the matter we can see, planets, stars and galaxies, doesn’t create enough gravitational pull to explain the universe’s larger structure. It’s dark matter, which is estimated to make up 25% of the known universe. But despite its prevalence, so far we haven’t been able to detect it directly. It’s no small challenge. Dark matter was so named because it doesn’t interact with any type of light, visible or otherwise, which means our usual observation tools simply don’t work when trying to observe it. But while dark matter may not be visible in the electromagnetic spectrum, it’s still matter, so we should be able to measure its interactions with other matter. And if our current model of physics is correct, billions of sub-atomic dark matter particles are passing through the Earth every second. Despite the prevalence of dark matter, its interactions are predicted to be rare and extremely weak. To detect these interactions, dark matter experiments need to be incredibly sensitive. With such sensitive equipment, the ever-present background radiation on Earth’s surface would create so much noise in the data that any dark matter particles would be completely overwhelmed. It would be like trying to hear a pin drop on a busy city street. To solve this problem, scientists have had to dig deep into the Earth. Dark matter experiments are set up in specialized underground labs, either in mines or inside mountains. The rock that makes up the Earth’s crust works like a filter, absorbing radiation and stopping disruptive particles. The ultra-pure water in which the detector is suspended adds an additional layer of radiation filtering. This shielding ensures that only the particles scientists are looking for can make their way into the detectors. Once these particles reach an experiment’s inner vessel, scientists have a chance of detecting them. The detector media are chosen because they’re exquisitely sensitive detectors that can be purified extremely well. These could be a liquid noble gas, germanium and silicon crystals, a refrigerant, or other materials. When radiation interacts, it leaves tell-tale signs, such as light or bubbles, which can be picked up by the sensors inside the detector. The detector media are held in a central chamber made of glass or a special type of acrylic. These chambers have to be able to hold the substance inside without interacting with it while withstanding incredible pressure from the water outside. The inner vessel is surrounded by powerful sensors designed to detect even the tiniest blips of light, or the sound vibrations caused by a single bubble. Each sensor records data 24/7, and experiments run for months and years at a time, generating terabytes of data every day. Building dark matter detectors is as much a feat of engineering as it is a feat of physics. By the time an experiment is ready to start collecting data, years or decades of work and investment have already gone into it, to the tune of tens of millions of dollars. As of 2017, no dark matter particles have been directly detected. That’s not entirely surprising. Physicists expect these interactions to be incredibly rare and difficult to detect. In the meantime, scientists continue to develop new technologies and increase detector sensitivity, closing in on where dark matter is hiding. And when they find it, we’ll finally be able to bring the universe’s darkest secrets into the light.

**P574 2018-04-25 How do brain scans work - John Borghi and Elizabeth Waters**

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As far as we know, there’s only one thing in our solar system sophisticated enough to study itself: the human brain. But this self-investigation is incredibly challenging; a living brain is shielded by a thick skull, swaddled in layers of protective tissue, and made up of billions of tiny, connected cells. That’s why it’s so difficult to isolate, observe, and understand diseases like Alzheimer’s. So how do we study living brains without harming their owners? We can use a trio of techniques called EEG, fMRI, and PET. Each measures something different and has its own strengths and weaknesses, and we’ll look at each in turn. First is EEG, or electroencephalography, which measures electrical activity in your brain. As brain cells communicate, they produce waves of electricity. Electrodes placed on the skull pick up these waves, and differences in the signals detected between electrodes provide information about what’s happening. This technique was invented almost 100 years ago, and it’s still used to diagnose conditions like epilepsy and sleep disorders. It’s also used to investigate what areas of the brain are active during learning or paying attention. EEG is non-invasive, relatively inexpensive, and fast: it can measure changes that occur in just milliseconds. Unfortunately, it’s hard to determine exactly where any particular pattern originates. Electrical signals are generated constantly all over the brain and they interact with each other to produce complex patterns. Using more electrodes or sophisticated data-processing algorithms can help. But in the end, while EEG can tell you precisely when certain activity occurs, it can’t tell you precisely where. To do that, you’d need another technique, such as functional magnetic resonance imaging, or fMRI. fMRI measures how quickly oxygen is consumed by brain cells. Active areas of the brain use oxygen more quickly. So watching an fMRI scan while a person completes cognitive or behavioral tasks can provide information about which regions of the brain might be involved. That allows us to study everything from how we see faces to how we understand what we’re feeling. fMRI can pinpoint differences in brain activity to within a few millimeters, but it’s thousands of times slower than EEG. Using the two techniques together can help show when, and where, neural activity is occurring. The third, even more precise, technique is called positron emission tomography and it measures radioactive elements introduced into the brain. That sounds much scarier than it actually is; PET scans, like fMRI and EEG, are completely safe. During a PET scan, a small amount of radioactive material called a tracer is injected into the bloodstream, and doctors monitor its circulation through the brain. By modifying the tracer to bind to specific molecules, researchers can use PET to study the complex chemistry in our brains. It’s useful for studying how drugs affect the brain and detecting diseases like Alzheimer’s. But this technique has the lowest time resolution of all because it takes minutes for the tracer to circulate and changes to show up. These techniques collectively help doctors and scientists connect what happens in the brain with our behavior. But they’re also limited by how much we still don't know. For example, let's say researchers are interested in studying how memory works. After asking 50 participants to memorize a series of images while in MRI scanners, the researchers might analyze the results and discover a number of active brain regions. Making a link between memory and specific parts of the brain is an important step forward. But future research would be necessary to better understand what’s happening in each region, how they work together, and whether the activity is because of their involvement in memory or another process occurring simultaneously. More advanced imaging and analysis technology might one day provide more accurate results and even distinguish the activity of individual neurons. Until then, our brains will keep measuring, analyzing, and innovating in pursuit of that quest to understand one of the most remarkable things we’ve ever encountered.

**P575 2018-04-25 Which is stronger - Glue or tape - Elizabeth Cox**

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The oldest glue in the world is over 8,000 years old and comes from a cave near the Dead Sea. Ancient people used this glue, made from a mixture of animal bone and plant materials, to waterproof baskets and construct utensils. And for thousands of years after, plants and animals were the glue that held human civilization together. Today, we have enough types of tape and glue to build and repair almost anything. But what gives glue and tape their stickiness? And is one stronger than the other? Adhesives can be made from synthetic molecules or natural proteins and carbohydrates like the vegetable starch dextrin, the milk protein casein, and the terpenes in tree resin. In order to work, glue and tape need both adhesive bonds and cohesive bonds. Adhesive bonds occur between an adhesive’s molecules and the molecules of whatever it’s sticking to. Cohesive bonds happen between a glue or tape’s own molecules, holding it together. Most glues consist of adhesive polymers dissolved in a solvent that prevents them from sticking to the inside of the bottle. The strong smell of many glues comes from the solvent, which evaporates when exposed to air. Some glues use water as a solvent, but others use chemicals that can be harmful to inhale. Glues with two or more components that chemically react instead of just drying can create stronger bonds. Both the adhesive and cohesive bonds of glue are strong, but the drying process makes them irreversible. This is why, if a glued surface is broken after it dries, it can’t be reattached without new glue. By contrast, when tape is applied to a surface, it forms weaker, reversible bonds, so you can peel a piece of tape off a surface and use it again. These weak bonds, called Van der Waals forces, can occur between any two materials, but only if they’re extremely close together, closer than the naked eye can see. Tape usually consists of a backing coated with a combination of a rubber or rubber-like "stretchy" component, and a compound called a tackifier. That’s the "sticky" component. A tape’s stickiness is determined by the proportion of elastic component and tackifier, the thickness of adhesive spread onto the backing, and the type of backing material. No chemical reaction occurs when tape is pressed onto a surface. Instead, the soft adhesive flows into the cracks and grooves of the surface. This ability to slide into cracks and then stay in place is called viscoelasticity. Once the viscoelastic adhesive fills these microscopic crevices, it is close enough to form Van der Waals forces. So what’s the world’s strongest adhesive? Well, there’s no one answer. In terms of absolute strength of adhesive bonds, glue is stronger than tape, but no single adhesive works well in all circumstances. Of the glues, cyanoacrylates, or super glues, may form the strongest bonds, but two-component epoxy glues have much higher resistance to heat and shearing, and are compatible with a wider range of surfaces. So, if you wanted to dangle an anvil in the air, super glue might be your best bet. But if you’re doing so over an active volcano, you’d want an epoxy instead. And in order to work at all, glues need enough real estate where surfaces touch. If for some reason you wanted to make a chain of bowling balls, duct tape would be better. Engineers weigh similar, if less absurd, factors all the time. Choosing the right glue to withstand the heat inside an engine is a matter of life and death. And though the strength of duct tape’s adhesive bonds can’t compete with those of epoxy glues, tape does have the advantage of instantaneous stickiness in an emergency. Glue may be necessary to get a rocket to space, but when it comes to extraterrestrial repairs, stick to duct tape: liquid glues don’t work in zero gravity.

**P576 2018-05-01 What causes constipation - Heba Shaheed**

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Visiting the bathroom is part of the daily human experience. But occasionally, constipation strikes, a condition that causes a backup in your digestive system. The food you eat can take several days to exit your body. And for many, constipation can become chronic, meaning regularly passing lumpy hard stools accompanied by straining. What's behind this unsettling phenomenon? Constipation arises in the colon, also known as the large intestine. This muscular organ is split into four sections: the ascending, transverse, descending, and sigmoid colon, which connects with the rectum and anus. The small intestine delivers stool consisting of ingested food, bile, and digestive juices to the large intestine. As this stool moves through the colon, the organ siphons off most of the water it contains, transforming it from liquid to solid. The longer this transmission takes, the more reabsorption occurs, resulting in increasingly solid stool. Once it reaches the sigmoid colon, a final bout of reabsorption occurs before it enters the rectum, distending its walls and telling the internal anal sphincter to relax. This is the point where you can usually decide whether to physically expel or retain the stool. That’s regulated by the pelvic floor muscles, particularly the puborectalis and external anal sphincter. The puborectalis forms a sling-like formation around the rectum called the anorectal angle. And when you voluntarily relax your external anal sphincter, the stool is finally expelled. When you’re constipated, however, a desire to visit the bathroom isn't enough to coax your body into action. Usually there's two factors behind this problem: the stool’s slow movement through the colon and/or pelvic floor dysfunction. In the first, stool moves excessively slowly through the intestines, causing over-absorption of liquid, which makes the stool dry and hard. With pelvic floor dysfunction, stool becomes difficult to eliminate from the rectum because of tightened pelvic floor muscles, or due to a pelvic organ prolapse, usually through childbirth or aging. Both of these problems make the anorectal angle more acute and it becomes difficult to expel waste. To identify constipation precisely, researchers have developed metrics, such as the Bristol Stool Chart. Most people who look at that chart will be able to tell they’ve experienced constipation before. When you’re on the toilet, you should ideally be in a squatting position. With your buttocks firmly on the toilet seat, you can elevate your feet on a stool and lean forwards with a straight back, which straightens the anorectal angle and eases the passage of waste. Going a day without a bowel movement isn’t necessarily cause for alarm. But if you are experiencing chronic constipation, simple dietary and lifestyle changes, like fibrous vegetables, regular exercise, abdominal massage, and 6 to 8 cups of water per day may help restore your daily trip to the toilet.

**P577 2018-05-02 How does hibernation work - Sheena Lee Faherty**

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Onboard the spacecraft, the astronauts preset the timer, enclose themselves in capsules, and fall into a deep hibernation that’ll carry them several hundred years into the future. This is a familiar scene in many sci-fi films, but could humans ever actually hibernate in real life? Researchers interested in this question turn to the animal kingdom, where hibernation is commonplace, occurring in over 200 species that we know of. Take the Arctic ground squirrel. Native to the North American tundra and northern Russia, this animal burrows beneath the permafrost and slips into a state of suspended animation, its body temperature plummeting to a frigid -2.9 degrees Celsius. Others, like the female black bear, can multitask, giving birth and lactating while they’re hibernating through the winter. The fat-tailed dwarf lemur prepares for its long dormancy by gorging on food and storing the majority of its fat reserves in its tail, doubling its body weight. After hibernation, it emerges looking as svelte as ever. So why do these animals go to such extremes? Hibernation is a necessity, a survival tactic for making it through the harsh winter months when dwindling food and water reserves threaten survival. For many years, experts believed hibernation happened only in arctic and temperate environments. But more recently, they’ve discovered animals hibernating even in arid deserts and tropical rainforests. As hibernation kicks in, animals’ heartbeats usually slow to about 1 to 3% of their original speed, like the dwarf lemur’s, which drops from its usual roughly 180 beats per minute to just around four. Breathing also declines dramatically to just one breath every 10 to 21 minutes in the lemur’s case. And black bears, like most hibernators, don’t urinate or defecate the entire hibernation season. Hibernating animals appear to stay alive by having just enough blood and oxygen moving around their bodies. And scans of hibernating animals reveal that their brain activity has just about flat-lined. But hibernation isn’t a long winter’s nap. As far as researchers know, in lemurs and ground squirrels anyway, the animals aren’t even sleeping for most of it. Hibernation is actually made up of regular bouts of reduced metabolic rate and body temperature known as torpor. Animals can be in torpor for a few days to five weeks, after which they resume normal metabolic rate and body temperature for about 24 hours, before going back into torpor again. The phenomenon is known as an interbout arousal, and why it occurs is still a mystery. The behaviors inherent in hibernation, like going five weeks without sleep, or dropping to near-freezing body temperatures would be potentially fatal to non-hibernating species like us. To find out how hibernators are able to do this, researchers turned their attention to those animal’s genomes. So far, they’ve discovered that hibernation is controlled by genes that turn off and on in unique patterns throughout the year, fine-tuning the hibernator’s physiology and behavior. For example, ground squirrel, bear and dwarf lemur studies have revealed that these animals are able to turn on the genes that control fat metabolism precisely when they need to use their fat stores as fuel to survive long periods of fasting. And the genes in question are present in all mammals, which means that researchers could study hibernating mammals to see how their unique control of physiology might help humans. Understanding how hibernators deal with reduced blood flow could lead to better treatments for protecting the brain during a stroke. Figuring out how these animals avoid muscle deterioration might improve the lives of bedridden patients. And studying how hibernating animals control their weight with ease could illuminate the relationship between metabolism and weight gain in humans. And yes, more research in this area might someday make human hibernation a real possibility. Imagine our surprise if the key to intergalactic travel turns out to be ground squirrels, black bears, and dwarf lemurs.

**P578 2018-05-02 How squids outsmart their predators - Carly Anne York**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=578)

In the ocean’s depths, two titans wage battle: the sperm whale and the colossal squid. Sperm whales use echolocation to hunt these squid for food, but even against this gigantic animal, squid can put up an impressive fight. Scientists know this because on the bodies of washed-up whales, they frequently find huge, round suction scars, emblazoned there by large, grasping tentacles. Ranging in size from this giant’s impressive 14 meters to the 2.5 centimeters of the southern pygmy squid, these creatures fall into the group of animals known as cephalopods. There are about 500 squid species worldwide, and they live in all the world’s oceans, making them a reliable food source for whales, dolphins, sharks, seabirds, fish, and even other squid. Indeed, squid themselves are fearsome ocean predators. But their most extraordinary adaptations are those that have evolved to help them thwart their predators. Squid, which can be found mainly in estuarine, deep-sea, and open-water habitats, often swim together in shoals. Being out in the open without anywhere to hide makes them vulnerable, so as a first line of defense, they rely on large, well-developed eyes. In the colossal squid, these are the size of dinner plates, the largest known eyes in the animal kingdom. When it’s dark or the water is murky, however, squid rely on a secondary sensory system, made from thousands of tiny hair cells that are only about twelve microns long and run along their heads and arms. Each of these hair cells is attached to axons in the nervous system. Swimming animals create a wake, so when the hairs on the squid’s body detect this motion, they send a signal to the brain, which helps it determine the direction of the water’s flow. This way, a squid can sense an oncoming predator in even the dimmest waters. Aware of the threat, a squid can then mask itself from a predator. Squid skin contains thousands of tiny organs called chromatophores, each made of black, brown, red or yellow pigments and ringed in muscle. Reflecting cells beneath the chromatophores mirror the squid’s surroundings, enabling it to blend in. So, when the muscles contract, the color of the pigment is exposed, whereas when the muscles relax the colors are hidden. Each of these chromatophores is under the individual control of the squid’s nervous system, so while some expand, others remain contracted. That enables countershading, where the underside of the squid is lighter than the top, to eliminate a silhouette that a predator might spy from below. Some predators, however, like the whales and dolphins, get around this ruse by using sound waves to detect a squid’s camouflaged form. Not to be outfoxed, the squid still has two more tricks up its sleeve. The first involves ink, produced inside its mantle. Squid ink is made mostly of mucus and melanin, which produces its dark coloring. When squid eject the ink, they either use it to make a large smokescreen that completely blocks the predator’s view or a blob that roughly mimics the size and shape of the squid. This creates a phantom form, called a pseudomorph, that tricks the predator into thinking it’s the real squid. As a final touch, squid rely on jet propulsion to rapidly shoot away from their hunters, reaching speeds of up to 25 miles per hour and moving meters away in mere seconds. This makes them Earth’s fastest invertebrates. Some squid species have also developed unique adaptive behaviors. The deep-sea vampire squid, when startled, uses its webbed arms to make a cape it hides behind. The tiny bobtail, on the other hand, tosses sand over its body as it burrows away from prying eyes. The Pacific flying squid uses jet propulsion for another purpose: to launch itself right out of the water. Squids’ inventive adaptations have allowed them to proliferate for over 500 million years. Even now, we’re still uncovering new species. And as we do, we’re bound to discover even more about how these stealthy cephalopods have mastered survival in the deep and unforgiving sea.

**P579 2018-05-03 Can you solve the false positive riddle - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=579)

Mining unobtainium is hard work. The rare mineral appears in only 1% of rocks in the mine. But your friend Tricky Joe has something up his sleeve. The unobtainium detector he’s been perfecting for months is finally ready. The device never fails to detect unobtainium if any is present. Otherwise, it’s still highly reliable, returning accurate readings 90% of the time. On his first day trying it out in the field, the device goes off, and Joe happily places the rock in his cart. As the two of you head back to camp where the ore can be examined, Joe makes you an offer: he’ll sell you the ore for just $200. You know that a piece of unobtanium that size would easily be worth $1000, but any other minerals would be effectively worthless. Should you make the trade? Pause here if you want to figure it out for yourself. Answer in: 3 Answer in: 2 Answer in: 1 Intuitively, it seems like a good deal. Since the detector is correct most of the time, shouldn’t you be able to trust its reading? Unfortunately, no. Here’s why. Imagine the mine has exactly 1,000 pieces of ore. An unobtainium rarity of 1% means that there are only 10 rocks with the precious mineral inside. All 10 would set off the detector. But what about the other 990 rocks without unobtainium? Well, 90% of them, 891 rocks, to be exact, won’t set off anything. But 10%, or 99 rocks, will set off the detector despite not having unobtanium, a result known as a false positive. Why does that matter? Because it means that all in all, 109 rocks will have triggered the detector. And Joe’s rock could be any one of them, from the 10 that contain the mineral to the 99 that don’t, which means the chances of it containing unobtainium are 10 out of 109 – about 9%. And paying $200 for a 9% chance of getting $1000 isn’t great odds. So why is this result so unexpected, and why did Joe’s rock seem like such a sure bet? The key is something called the base rate fallacy. While we’re focused on the relatively high accuracy of the detector, our intuition makes us forget to account for how rare the unobtanium was in the first place. But because the device’s error rate of 10% is still higher than the mineral’s overall occurrence, any time it goes off is still more likely to be a false positive than a real finding. This problem is an example of conditional probability. The answer lies neither in the overall chance of finding unobtainium, nor the overall chance of receiving a false positive reading. This kind of background information that we’re given before anything happens is known as unconditional, or prior probability. What we’re looking for, though, is the chance of finding unobtainium once we know that the device did return a positive reading. This is known as the conditional, or posterior probability, determined once the possibilities have been narrowed down through observation. Many people are confused by the false positive paradox because we have a bias for focusing on specific information over the more general, especially when immediate decisions come into play. And while in many cases it’s better to be safe than sorry, false positives can have real negative consequences. False positives in medical testing are preferable to false negatives, but they can still lead to stress or unnecessary treatment. And false positives in mass surveillance can cause innocent people to be wrongfully arrested, jailed, or worse. As for this case, the one thing you can be positive about is that Tricky Joe is trying to take you for a ride.

**P580 2018-05-07 When will the next ice age happen - Lorraine Lisiecki**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=580)

Twenty thousand years ago, the Earth was a frigid landscape where woolly mammoths roamed. Huge ice sheets, several thousand meters thick, encased parts of North America, Asia, and Europe. We commonly know it as the "Ice Age." But geologists call it the Last Glacial Maximum. That’s because it’s the most recent time that ice reached such a huge extent, and “ice age” is an informal term without a single agreed-upon definition. Over the last million years, there have actually been about 10 different glacial maxima. Throughout Earth’s history, climate has varied greatly. For hundreds of millions of years, the planet had no polar ice caps. Without this ice, the sea level was 70 meters higher. At the other extreme, about 700 million years ago, Earth became almost entirely covered in ice during an event known as “Snowball Earth.” So what causes these massive swings in the planet’s climate? One of the main drivers is atmospheric carbon dioxide, a greenhouse gas that traps heat. Natural processes, such as volcanism, chemical weathering of rocks, and the burial of organic matter, can cause huge changes in carbon dioxide when they continue for millions of years. Over the past million years, carbon dioxide has been relatively low, and repeated glacial maxima have been caused by cycles in Earth’s movement around the sun. As Earth rotates, it wobbles on its axis and its tilt changes, altering the amount of sunlight that strikes different parts of its surface. These wobbles, combined with the planet’s elliptical orbit, cause summer temperatures to vary depending on whether the summer solstice happens when Earth is closer or farther from the sun. Approximately every 100,000 years, these factors align to create dramatically colder conditions that last for millennia. Cool summers that aren’t warm enough to melt the preceding winter’s snow allow ice to accumulate year after year. These ice sheets produce additional cooling by reflecting more solar energy back into space. Simultaneously, cooler conditions transfer carbon dioxide from the atmosphere into the ocean, causing even more cooling and glacier expansion. About 20,000 years ago, these trends reversed when changes in Earth’s orbit increased summer sunshine over the giant ice sheets, and they began to melt. The sea level rose 130 meters and carbon dioxide was released from the ocean back into the atmosphere. By analyzing pollen and marine fossils, geologists can tell that temperatures peaked about 6,000 years ago, before another shift in Earth’s orbit caused renewed cooling. So what’s coming next? Based on the repeated natural cycle seen in the climate record, we’d normally expect the Earth to continue a trend of gradual cooling for the next few thousand years. However, this cooling abruptly reversed about 150 years ago. Why? Carbon dioxide levels in the atmosphere have been rising since the 19th century, when fossil fuel use increased. We know that from studying air bubbles trapped in Antarctic ice. This surge in carbon dioxide also coincides with a global temperature increase of nearly one degree Celsius. Ice cores and atmospheric monitoring stations show us that carbon dioxide levels are rising faster, and to higher levels, than at any point in the last 800,000 years. Computer models forecast another one to four degrees Celsius of warming by 2100, depending on how much additional fossil fuel we burn. What does that mean for the ice currently on Greenland and Antarctica? Past climate changes suggest that even a small warming shift can begin a process of ice melt that continues for thousands of years. By the end of this century, ice melt is expected to raise the sea level by 30 to 100 centimeters, enough to impact many coastal cities and island nations. If a four-degree Celsius warming persisted for several millennia, the sea level could rise by as much as 10 meters. By studying past climates, scientists learn more about what drives the shifts in ice that have shaped our planet for millions of years. Research suggests that by taking action now to reduce carbon dioxide emissions quickly, we still have the opportunity to curb ice loss and save our coastal communities.

**P581 2018-05-09 Why do we sweat - John Murnan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=581)

The finish line's in sight and you put on an extra burst of speed. As your legs pick up the pace, your breathing gets deeper, your heart pounds faster, and sweat pours over your skin. How does this substance suddenly materialize and what exactly is its purpose? There are a number of scenarios that can make us sweat: eating spicy foods, nervousness, and when we're sick. But exercise is probably the most familiar and common. In that case, sweating happens as a response to movement triggered deep inside your cells. As you increase your pace, your muscles work harder, increasing their demand for energy. A process called cellular respiration consumes glucose and oxygen to form ATP, the energy currency of the cell. Much of this process takes place in structures called mitochondria. The more you move, the harder mitochondria work to supply your body with energy. All this work comes at a cost, though. As the cells break down the ATP, they release heat. The heat stimulates temperature sensors throughout your body. Those receptors detect the excess heat being produced by your muscle cells and communicate that information to the hypothalamus, which regulates body temperature. The hypothalamus responds by sending signals out through the sympathetic nervous system to the sweat glands in your skin. These are distributed all over the body with especially high concentrations on the palms of your hands, the soles of your feet, and on your head. When a sweat gland first receives the signal, the fluid surrounding the cells in its coiled base contains high amounts of sodium and chloride. The cells pump these ions into a hollow tube that runs through the sweat gland. Then, because it's saltier inside the tube than outside, water moves into the tube by osmosis. As what's called the primary secretion builds up in the bottom of the tube, water pressure pushes it up into the long straight part of the duct. Before it seeps onto the skin, cells lining the tube will reclaim as much salt as possible so the process can continue. The water in sweat absorbs your body's heat energy and then evaporates off of you when it reaches the surface, which in turn lowers your temperature. This process, known as evaporative cooling, was an important adaptation for our ancestors. This cooling effect isn't only helpful during exercise. We sweat in many other scenarios, too. Eating particularly spicy food makes some people sweat profusely from their faces. That happens because spices trigger the same neural response in the brain that activates temperature receptors, which usually respond to increased heat. Sweating is also part of the fight or flight response stimulated by stressful scenarios, like asking someone on a date or interviewing for a job. This happens because adrenaline stimulates muscle activity and causes blood vessels to widen, two responses that increase heat and trigger the sweating response. And sweating also occurs when we get sick. When we're feverish, we sweat because infections stimulate the hypothalamus to increase muscle activity, which in turn releases more energy as heat. That increases your overall temperature, a protective mechanism that makes your body less habitable for infectious agents. Like with running, sweating helps your body vent that heat. When the fever's over or you've won your race, your temperature receptors sense the decrease in heat and the hypothalamus brings your sweating response to an end. In some cases, like after a run, the hypothalamus also signals to your body that you need to replenish the water that you've oozed out. So, when you're pushing yourself to reach that next goal, you can think of sweat as your body's very own calibrator, enabling you to go that extra mile.

**P582 2018-05-10 Can you solve the wizard standoff riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=582)

You’ve been chosen as a champion to represent your wizarding house in a deadly duel against two rival magic schools. Your opponents are fearsome. From the Newt-niz school, a powerful sorcerer wields a wand that can turn people into fish, but his spell only works 70% of the time. And from the Leib-ton school, an even more powerful enchantress wields a wand that turns people to statues, and it works 90% of the time. Lots are drawn, and you’re chosen to cast the first spell in the duel. The Newt-niz magician will go second, and the Leib-ton enchantress third, after which you’ll repeat casting in that order until only one of you is left. The rules of magic duels are strict, and anyone who casts out of order immediately forfeits the duel. Also, to prevent draws, the rules stipulate that if everyone’s still standing at the end of the first round, you’ll all be turned into cats. Now, you must choose a wand. Your wizarding house presents you with three options: the Bannekar, which binds one target with vines and casts effectively 60% of the time, the Gaussian, which turns one target into a tree and works 80% of the time, and the incredibly rare Noether 9000, which banishes one target to a distant mountaintop and casts perfectly 100% of the time. Your opponents are masters of strategy, as well as sorcery, and you know they’ll make the choices that maximize their own chances of success. Which wand should you choose and what strategy should you employ to have the greatest chance of winning the duel? Pause the video now if you want to figure it out for yourself! Answer in: 3 Answer in: 2 Answer in: 1 You reach for the Noether 9000 first. After all, it makes sense to enter the duel with the most powerful wand. But before you pick it up, you consider what would happen. As the most dangerous wizard, you’d also be the target of the other two magicians, and you’d need to take care of the most dangerous of them first. But afterward, there’s a 70% chance you'd be struck down by the remaining wizard. That’s trouble. Maybe it’s better to take the Gaussian. It works 80% of the time, which means you wouldn’t be a target until the enchantress was incapacitated. But if you succeeded in transforming her, you’d probably be turned into a fish immediately after. If you transformed the sorcerer, the enchantress would almost certainly turn you to stone. It would really be better if you missed. And that’s when you have an idea: what if you took the Gaussian, then missed on purpose? Then, you would wait for the sorcerer to attack the enchantress, and you’d have an 80% chance of winning against the sorcerer. It’s a good idea, but there’s a problem; the sorcerer could also pass his turn and the enchantress, knowing that she couldn’t pass without becoming a cat, would cast her spell on one of you. And since you’re the most dangerous between you and the sorcerer, you’d be the target. And that’s when you see what you really need to do: take the weakest wand, the Bannekar, and miss on purpose. Now the sorcerer knows that he’ll be targeted by the enchantress and he’ll have to try to turn her into a fish to avoid being turned into stone. Seventy percent of the time he’d succeed and you’d have a 60% chance of winning the duel at the beginning of the next round. If he fails, chances are he’ll be turned to stone and you’d still have a 60% chance of winning the duel against the enchantress. There’s a slim 3% chance you’ll all be turned into cats, but when everything’s accounted for, you have better than even odds of winning with this strategy. And that’s the best you can do. Here’s what the probability of winning for the different strategies looks like. Who would’ve thought that the best way to take your shot would be to throw away your shot?

**P583 2018-05-10 How to stay calm under pressure - Noa Kageyama and Pen-Pen Chen**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=583)

Your favorite athlete closes in for a victorious win. The crowd holds its breath, and, at the crucial moment, she misses the shot. That competitor just experienced the phenomenon known as "choking," where despite months, even years, of practice, a person fails right when it matters most. Choking is common in sports, where performance often occurs under intense pressure and depends on key moments. And yet, performance anxiety also haunts public speakers, contestants in spelling bees, and even world-famous musicians. Most people intuitively blame it on their nerves, but why does being nervous undermine expert performance? There are two sets of theories, which both say that primarily, choking under pressure boils down to focus. First, there are the distraction theories. These suggest that performance suffers when the mind is preoccupied with worries, doubts, or fears, instead of focusing its attention on performing the task at hand. When relevant and irrelevant thoughts compete for the same attention, something has to give. The brain can only process so much information at once. Tasks that challenge working memory, the mental “scratch pad” we use to temporarily store phone numbers and grocery lists, are especially vulnerable to pressure. In a 2004 study, a group of university students were asked to perform math problems, some easy, others more complex and memory-intensive. Half the students completed both problem types with nothing at stake, while the others completed them when calm and under pressure. While everyone did well on the easy problems, those who were stressed performed worse on the more difficult, memory-intensive tasks. Explicit monitoring theories make up the second group of explanations for choking under pressure. They’re concerned with how pressure can cause people to overanalyze the task at hand. Here, the logic goes that once a skill becomes automatic, thinking about its precise mechanics interferes with your ability to do it. Tasks we do unconsciously seem to be most vulnerable to this kind of choking. A study on competitive golfers compared their performance when instructed to simply focus on putting as accurately as possible, versus when they were primed to be acutely aware of the mechanics of their putting stroke. Golfers usually perform this action subconsciously, so those who suddenly tuned in to the precise details of their own moves also became worse at making accurate shots. Choking may not be inevitable for everyone though. Research suggests that some are more susceptible than others, especially those who are self-conscious, anxious, and afraid of being judged negatively by others. So, how can we avoid choking when it really counts? First, it helps to practice under stressful conditions. In a study on expert dart players, researchers found that those who hadn’t practiced under stress performed worse when anxious, compared to those who had become accustomed to pressure. Secondly, many performers extol the virtues of a pre-performance routine, whether it’s taking a few deep breaths, repeating a cue word, or doing a rhythmic sequence of movements. Studies on golfing, bowling, and water polo find that short rituals can lead to more consistent and accurate performance under pressure. And thirdly, researchers have shown that having an external focus on the ultimate goal works better than an internal focus, where someone is tuned into the mechanics of what they’re doing. A study of experienced golfers revealed that those who hit chip shots while focused on the flight of the ball performed significantly better than those who focused on the motion of their arms. So, perhaps we can modify that age-old saying: practice, under pressure, with focus, and with that glorious end goal in sight, makes perfect.

**P584 2018-05-11 Are naked mole rats the strangest mammals - Thomas Park**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=584)

What mammal has the social life of an insect, the cold-bloodedness of a reptile, and the metabolism of a plant? Bald and buck-toothed, naked mole rats may not be pretty, but they’re extraordinary. With a lifespan of 30 years, their peculiar traits have evolved over millions of years to make them uniquely suited to survive harsh conditions, especially long periods without oxygen. In the deserts of East Africa, naked mole rats feed on root vegetables. They dig for the roots with teeth that can move independently, like chopsticks. But even with these special teeth, a single naked mole rat doesn’t stand a chance of finding enough food; the roots are large and nutritious, but scattered far and wide. A large workforce has a much better chance, so naked mole rats live in colonies. Similar to ants, bees, and termites, they build giant nests. Housing up to 300 mole rats, these colonies feature complex underground tunnel systems, nest chambers, and community bathrooms. Also like insects, naked mole rats have a rigid social structure. The dominant female, the queen, and two to three males that she chooses, are the only naked mole rats in the colony who have babies. All the other naked mole rats, male and female, are either soldiers, who defend the colony from possible invaders, or workers. Teams of workers are dispatched to hunt for roots, and their harvest feeds the whole colony. Living in a colony helps naked mole rats find enough food, but when so many animals live in the same underground space, oxygen quickly runs out. Mammals need a lot of oxygen; we use it to make the energy that fuels everything from maintaining our body temperatures to our heartbeats to voluntary movements. Without oxygen, we quickly die. In fact, no other mammal could survive the oxygen depletion experienced in a naked mole rat colony. Naked mole rats can thrive in low oxygen in part because they’ve abandoned one of the body functions that requires the most oxygen: thermoregulation. Most mammals are warm-blooded, meaning they have to keep their body temperature consistent. Naked mole rats don’t get enough oxygen to do this. Instead, they’re the only mammals whose body temperature fluctuates with their environment, making them cold-blooded, like reptiles. They also have a special type of hemoglobin, the molecule in the blood that transports oxygen. Their hemoglobin is much stickier for oxygen than ours and can pick oxygen up even when it’s scarce. In response to a real oxygen emergency, naked mole rats enter a state of suspended animation. They stop moving, slow their breathing, and dramatically lower their heart rate. This greatly reduces the amount of energy, and therefore oxygen, they need. At the same time, they begin to metabolize fructose, like a plant. Fructose is a sugar that can be used to make energy without burning oxygen. Usually, mammals metabolize a different sugar called glucose that makes more energy than fructose, but glucose only works when oxygen’s available. Human brain and heart cells have some cellular machinery to use fructose, but not nearly as much as naked mole rats. Naked mole rats are, in fact, the only mammals known to have this ability. While we can hope humans won’t ever need to exclusively live in underground tunnels, there are many situations where we would benefit from needing less oxygen. During heart attacks and other medical emergencies, people often die or sustain debilitating organ damage from oxygen deprivation. Could we replicate the naked mole rat’s use of the fructose pathway for human health? It took millions of years of evolution to bring the behavior of an insect, the temperature regulation of a reptile, and the energy production of a plant together in one little mammal, but maybe, with enough study, we can replicate just a few of their wild adaptations.

**P585 2018-05-11 The journey to Pluto, the farthest world ever explored - Alan Stern**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=585)

On July 4, 2015, a NASA spacecraft called New Horizons was 5 billion kilometers away from Earth. It was only 10 days away from Pluto, after flying for 9.5 years, when it suddenly dropped out of contact. But let’s back up a little. As of 1989, mankind had successfully sent craft to every known planet in the solar system except one—Pluto. You may have heard that astronomers don’t consider Pluto or its brethren to be planets. However, most planetary scientists still do, which is why we're using that terminology here. There’s a limited amount we can learn about Pluto from Earth because it’s so far from us. Pluto, however, is a scientific goldmine. It’s located in a region called the Kuiper Belt, home to many small planets, hundreds of thousands of ancient icy objects, and trillions of comets. This mysterious region holds clues to the formation of our solar system, and it was long, tantalizingly beyond our reach. Until New Horizons. Its objectives: explore Pluto, collect as much scientific data as possible, transmit it back to Earth, then explore farther out in the Kuiper Belt. To achieve this, the New Horizons team outfitted their craft with seven state-of-the-art scientific instruments. Those included Ralph, a set of cameras powerful enough to capture features the size of city blocks in Manhattan from tens of thousands of kilometers away. And REX, designed to use radio waves to measure Pluto’s atmospheric pressure and temperature. All of the onboard equipment had to be built to be both reliable and lightweight because New Horizons had an additional challenge; it had to reach its target as fast as possible. Why? Around 2020, Pluto will reach a point in its orbit where its atmosphere could freeze. And due to the tilt of its axis, more and more of Pluto’s surface is shrouded in darkness every year. Pluto completes a full orbit once every 248 Earth years, so it would be a long wait for the next prime opportunity to visit. To see how New Horizons got to Pluto in time, let’s jump to its launch. Its three rocket stages accelerated New Horizons to such great speeds that it crossed the 400,000 kilometers to the moon in just nine hours. About a year later, the craft reached Jupiter and got what’s called a gravity assist. That’s where it flies close enough to the gas giant to receive a gravitational slingshot effect. New Horizons was then flying at around 50,000 kilometers per hour, as it would for the next eight years to cross the remaining gulf to Pluto. Going at such an astonishing speed meant that slowing down to get into orbit or land would’ve been impossible. That’s why New Horizons was on a flyby mission, where it would get just one chance to scream by Pluto and make its observations. The flyby would have to be fully automated, since at that distance, any signals to guide it from Earth would take 4.5 hours to reach it. So the team loaded the ship’s computer with a series of thousands of commands, called the core load, that would begin to execute when the craft was 6.5 days from Pluto. But when New Horizons was just ten days out, disaster almost struck. Ground control lost contact with the spacecraft. After two nerve-wracking hours, New Horizons came back online, but mission control discovered that its main computer had rebooted, losing the entire core load and other critical data. Without that, it would soon whizz by Pluto with virtually nothing to show for the mission. Alice Bowman, the mission’s Operations Manager, led a team for 72 sleepless hours to get the instructions loaded back into New Horizons in time. Without room for a single error, she and her team pulled it off, and New Horizons began taking and broadcasting breathtaking images. Those observations have revealed a delightfully varied world, with ground fogs, high altitude hazes, possible clouds, canyons, towering mountains, faults, craters, polar caps, glaciers, apparent dune fields, suspected ice volcanoes, evidence for past flowing liquids, and more. One of the most exciting discoveries is the 1000-kilometer-wide Sputnik Planitia glacier. Sputnik Planitia is mainly composed of slowly churning frozen nitrogen, and we’ve never seen anything like it in our solar system. The exploration of Pluto was a great success, but New Horizons isn’t done yet. On January 1, 2019, it’ll break its own record for furthest explored object when it visits a Kuiper Belt Object called 2014 MU69, which is orbiting the sun another billion kilometers farther away than Pluto. The world is holding its breath to see what it’ll find there.

**P586 2018-05-18 Can you solve the penniless pilgrim riddle - Daniel Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=586)

After months of travel, you’ve arrived at Duonia, home to the famous temple that’s the destination of your pilgrimage. Entering from the northwest, you pass through the city gates and the welcome center, where you’re given a map and a brochure. The map reveals that the town consists of 16 blocks, formed by five streets that run west to east, intersecting five more that run north to south. You’re standing on the northernmost street facing east, with the two blocks containing the gate and the welcome center behind you. The temple’s only entrance lies at the very southeast corner. It’s not a long walk, but there’s a problem. As you learn from the brochure, Duonia imposes a unique tax on all visitors, which must be paid when they arrive at their destination within the city. The tax begins at zero, increases by two silver for every block you walk east, and doubles for every block you walk south. However, a recent reform to make the tax fairer halves your total bill for every block you walk north and subtracts two silver for every block you walk west. Just passing through the gate and the welcome center means you already owe four silver. As a pilgrim you carry no money and have no way of earning any. What’s more, the rules of your pilgrimage forbid you from walking over any stretch of ground more than once during your journey— though you can cross your own path. Can you figure out a way to reach the temple without owing any tax or walking the same block twice in any direction? Pause here if you want to figure it out for yourself. Answer in: 3 Answer in: 2 Answer in: 1 You look at the map to consider your options. Walking towards the temple always increases the tax, and walking away decreases it, so it seems like you can never reach it without owing silver. But what happens when you walk around a single block? If you start out owing four silver and go clockwise starting east, your tax bill becomes six, then 12, then 10, then five. If you looped again, you’d owe seven, 14, 12, and six. It seems that each clockwise loop leaves you owing one extra silver. What about a counterclockwise loop then? Starting owing four again and going south first, your bill changes to eight, 10, five, and three. Looping again you’d owe six, eight, four, and two. Each counterclockwise loop actually earns you one silver. That’s because any tax doubled, plus two, halved, and minus two, always ends up one smaller than it started. The key here is that while the different taxes for opposite directions may seem to balance each other out, the order in which they’re applied makes a huge difference. You start off owing four silver, so four counterclockwise loops would get you down to zero. Unfortunately, it’s not that simple, since you can’t walk the same block twice. But there’s another way to reduce your bill: walking one large counterclockwise loop through the city. From your starting position, walk three blocks south. You need to leave the southernmost street clear for the final stretch, so continuing counterclockwise means going east. Walk two blocks to the eastern wall and you owe a whopping 36 silver. But now you can start reducing your bill. Three blocks north and one block west cuts it to 2.5. You can’t go west from here —that would leave you with no way out. So you go one block south, and the remaining three blocks west, leaving you with a debt of -1 silver. And since doubling a negative number still gives you a negative number, walking the three blocks to the south wall means the city owes you eight. Fortunately, that’s exactly enough to get you through the final blocks to the temple. As you enter, you realize what you’ve learned from your pilgrimage: sometimes an indirect route is the best way to reach your destination.

**P587 2018-05-18 What is dust made of - Michael Marder**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=587)

Meet Dermatophagoides farinae. Crawling around on eight legs, this creature has no eyes to appreciate the kaleidoscope of colors around her. She relies on her extraordinary sense of smell to lead her to food and safe places to lay eggs. And she’s smaller than a pinhead. Dermatophagoides farinae is a dust mite. Less than a tenth the size of an ant, a dust mite’s whole world is contained in the dusty film under a bed or in a forgotten corner. This realm is right under our noses, but from our perspective, the tiny specks of brilliant color blend together into a nondescript grey. What are these colorful microscopic particles? What distinguishes the dust in your house from, say, sand on a beach is that it is a mixture of many different ingredients. It can contain grains of sand, dead skin cells, tiny hairs and threads, animal dander, pollen, manmade pollutants, minerals from outer space, and, of course, dust mites. Dust mites eat animal dander, human skin, and some fungi. We shed dead skin cells constantly, and wherever we live, they mix into the household dust. The same goes for our pets: their dander and hairs enter the mix, as do tiny pieces of thread and cotton fibers from our clothes. These components make every household’s dust a unique blend of bits from its particular inhabitants. Household dust also contains substances that blow in from the wider world. Depending on the local geology, finely ground quartz, coal, or volcanic ash might enter the air as atmospheric dust, along with pollen and fungal spores. Industrial activities also contribute cement powder, particles from car tires, and other chemicals to the airborne mix. The combination of these elements can be as unique as a fingerprint. In Spain, where the land is rich in carbonate materials, dust contains 20 times as much calcium as dust in Nigeria, where the geology is quite different. After a particularly violent storm, scientists identified dust from the Sahara Desert thousands of miles away in London, based on its specific composition. In the future, we may be able to pinpoint the origins of dust samples even more specifically, down to a particular neighborhood or even house - something that may be of great help for forensic specialists. In addition to markers of humans, animals, and landscapes, dust also contains particles from further afield. When a star explodes in a distant galaxy, super hot gases vaporize everything nearby. Then, the dust settles; minerals condense out of the gas. Floating out there between planets and galaxies, this extraterrestrial dust contains tiny pieces of extinguished stars and the building blocks of future celestial bodies. Every year, tens of thousands of tons of cosmic dust lands on Earth and mingles with terrestrial minerals. This blend of chemicals, minerals, and intergalactic particles settles out of the air onto surfaces in our homes, mixing with the detritus of each house’s occupants. Stars explode, mountains erode, and buildings, plants, and animals are all slowly but surely pulverized into fine grey powder. We’re all destined to become dust, but it’s also possible that we came from it. Interstellar dust has been found to carry organic compounds through space. It’s possible that billions of years ago, some of these cosmic particles were the seed of life on our little blue planet.

**P588 2018-05-22 How one scientist averted a national health crisis - Andrea Tone**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=588)

In the fall of 1960, Frances Oldham Kelsey was one of the Food and Drug Administration’s newest recruits. Before the year was out, she would begin a fight that would save thousands of lives, though no one knew it at the time. Although she was new to the FDA, Kelsey was no novice as a scientist. After graduating from high school at age 15, she enrolled at McGill University in Montreal and earned both undergraduate and master’s degrees in pharmacology. From there, she applied for a research post at the University of Chicago’s pharmacology department. Her acceptance letter was addressed to Mr. Oldham. Kelsey later joked that had her name been Elizabeth or Mary Jane, her career might have ended there. Fortunately, it didn’t. She earned her doctorate in pharmacology and accepted Chicago’s invitation to stay as faculty, where she undertook pioneering research on drugs and fetal safety. In 1950, she earned an MD, her fourth and final degree. By the time she joined the FDA, Frances Kelsey was one of the most educated, experienced scientists around. Yet, as the newest member of the team, Kelsey was assigned what everyone thought would be an easy review: an application from the US drug company Merrell to sell a drug called thalidomide. Thalidomide was a sedative developed in Germany that was already being widely used in dozens of countries to treat insomnia and workplace stress. Thalidomide’s anti-nausea properties also made it a popular remedy for pregnant women with morning sickness. Reviewing Merrell’s application, Kelsey found its data on thalidomide’s absorption and toxicity inadequate. Today, the FDA classifies drugs based on their safety for a fetus. But in 1960, many experts believed that the placental barrier shielded a fetus from harm. Kelsey's earlier animal-based research demonstrated the opposite: drugs could pass from mother to fetus through the placenta. Like other drug companies at this time, Merrell had not tested its drug on pregnant animals. Kelsey later said Merrell’s evidence for thalidomide’s safety seemed “more like testimonials than the results of well-designed studies.” Kelsey rejected Merrell’s application and asked them to submit a second backed by better evidence. Her FDA colleagues supported this decision. Merrell had expected a quick, affirmative reply so it could launch thalidomide for the holiday season, when sedative sales soar. Instead of supplying Kelsey with the data she requested they first tried to convince her to approve the drug over a series of calls and visits. When these failed to sway her, Merrell executives complained that stubborn and nit-picking Kelsey was the problem, not thalidomide. The FDA backed Kelsey, forcing Merrell to file another application, and another, and another. As Kelsey reviewed and rejected each new application, news of thalidomide’s adverse side effects began to surface. Doctors reported cases of nerve damage in early 1961, and by fall, they’d unmasked a more horrible truth. Thalidomide, widely used by pregnant women, caused severe birth defects. Thousands of babies died in utero, and tens of thousands more were born with extra appendages, shorter limbs, or no limbs at all. In November 1961, thalidomide was pulled from the German market. Nonetheless, Merrell continued trying to get it approved in the US for several months before withdrawing their sixth and final application. While Kelsey wasn’t the only scientist to identify the risks of thalidomide, she sounded the alarm that kept it off the multi-billion-dollar American drug market. As public awareness of the thalidomide tragedy grew, the quiet scientist became a media sensation. Headlines in newspapers and magazines heralded her heroism while a smiling President John F. Kennedy presented her an award on the White House lawn. After the thalidomide scare, Congress passed laws that expanded the FDA’s authority and toughened requirements for new drug applications. Kelsey was tapped to head the agency’s drug investigation branch. Working at the FDA in different capacities into her 90s, Kelsey was able to witness the changes her actions helped inspire. Her visibility may have dimmed since, but her legacy endures. Privileging facts over opinions, and patience over shortcuts, she made evidence-based medicine the foundation of reforms that continue to protect people today.

**P589 2018-05-23 The Irish myth of the Giant's Causeway - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=589)

On the coast of Northern Ireland, a vast plateau of basalt slabs and columns called the Giant’s Causeway stretches into the ocean. The scientific explanation for this is that it’s the result of molten lava contracting and fracturing as it cooled in the wake of a volcanic eruption. But an ancient Irish myth has a different accounting. According to legend, the giant Finn MacCool lived happily on the North Antrim coast with his wife Oonagh. Their only disturbance came from the taunts and threats of the giant Benandonner, or the red man, who lived across the sea in Scotland. The two roared insults and hurled rocks at each other in dramatic shows of strength. Once, Finn tore up a great clump of land and heaved it at his rival, but it fell short of reaching land. Instead, the clump became the Isle of Man, and the crater left from the disturbed earth filled with water to become Lough Neagh. The giants’ tough talk continued, until one day Benandonner challenged Finn to a fight, face to face. And so the Irish giant tossed enough boulders into the sea to create a bridge of stepping stones to the Scottish coast. Finn marched across in a fit of rage. When Scotland loomed before him, he made out the figure of Benandonner from afar. Finn was a substantial size, but at the sight of his colossal enemy thundering towards him, his courage faltered. With one look at Benandonner’s thick neck and crushing fists, Finn turned and ran. Back home, with Benandonner fast approaching, Finn trembled as he described his enemy’s bulk to Oonagh. They knew that if he faced Benandonner head on, he’d be crushed. And so Oonagh hatched a cunning plan - they needed to create an illusion of size, to suggest Finn was a mountain of a man whilst keeping him out of sight. As Benandonner neared the end of the bridge, Oonagh stuffed her husband in a huge cradle. Disguised as an enormous baby, Finn lay quiet as Benandonnner pounded on the door. The house shook as he stepped inside. Oonagh told the enraged visitor that her husband wasn’t home, but welcomed him to sit and eat while he waited. When Benandonner tore into the cakes placed before him, he cried out in pain for he’d shattered his teeth on the metal Oonagh had concealed inside. She told him that this was Finn’s favorite bread, sowing a seed of doubt in Benandonner’s mind that he was any match for his rival. When Finn let out a squawk, Benandonner’s attention was drawn to the gigantic baby in the corner. So hefty was the infant swaddled under piles of blankets, Benandonner shuddered at the thought of what the father would look like. He decided he’d rather not find out. As he fled, Benandonner tore up the rocks connecting the shores, breaking up the causeway. What remains are two identical rock formations: one on the North Antrim coast of Ireland and one at Fingal’s Cave in Scotland, right across the sea.

**P590 2018-05-24 What causes insomnia - Dan Kwartler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=590)

What keeps you up at night? Pondering deep questions? Excitement about a big trip? Or is it stress about unfinished work, an upcoming test, or a dreaded family gathering? For many people, this stress is temporary, as its cause is quickly resolved. But what if the very thing keeping you awake was stress about losing sleep? This seemingly unsolvable loop is at the heart of insomnia, the world’s most common sleep disorder. Almost anything can cause the occasional restless night - a snoring partner, physical pain, or emotional distress. And extreme sleep deprivation like jetlag can throw off your biological clock, wreaking havoc on your sleep schedule. But in most cases, sleep deprivation is short-term. Eventually, exhaustion catches up with all of us. However, some long-term conditions like respiratory disorders, gastrointestinal problems, and many others can overpower fatigue. And as sleepless nights pile up, the bedroom can start to carry associations of restless nights wracked with anxiety. Come bedtime, insomniacs are stressed. So stressed their brains hijack the stress response system, flooding the body with fight-flight-or-freeze chemicals. Cortisol and adrenocorticotropic hormones course through the bloodstream, increasing heart rate and blood pressure, and jolting the body into hyperarousal. In this condition, the brain is hunting for potential threats, making it impossible to ignore any slight discomfort or nighttime noise. And when insomniacs finally do fall asleep, the quality of their rest is compromised. Our brain’s primary source of energy is cerebral glucose, and in healthy sleep, our metabolism slows to conserve this glucose for waking hours. But PET studies show the adrenaline that prevents sleep for insomniacs also speeds up their metabolisms. While they sleep, their bodies are working overtime, burning through the brain’s supply of energy-giving glucose. This symptom of poor sleep leaves insomniacs waking in a state of exhaustion, confusion, and stress, which starts the process all over again. When these cycles of stress and restlessness last several months, they’re diagnosed as chronic insomnia. And while insomnia rarely leads to death, its chemical mechanisms are similar to anxiety attacks found in those experiencing depression and anxiety. So suffering from any one of these conditions increases your risk of experiencing the other two. Fortunately, there are ways to break the cycle of sleeplessness. Managing the stress that leads to hyperarousal is one of our best-understood treatments for insomnia, and good sleep practices can help rebuild your relationship with bedtime. Make sure your bedroom is dark and comfortably cool to minimize “threats” during hyperarousal. Only use your bed for sleeping, and if you’re restless, leave the room and tire yourself out with relaxing activities like reading, meditating, or journaling. Regulate your metabolism by setting consistent resting and waking times to help orient your body’s biological clock. This clock, or circadian rhythm, is also sensitive to light, so avoid bright lights at night to help tell your body that it’s time for sleep. In addition to these practices, some doctors prescribe medication to aid sleep, but there aren’t reliable medications that help in all cases. And over-the-counter sleeping pills can be highly addictive, leading to withdrawal that worsens symptoms. But before seeking any treatment, make sure your sleeplessness is actually due to insomnia. Approximately 8% of patients diagnosed with chronic insomnia are actually suffering from a less common genetic problem called delayed sleep phase disorder, or DSPD. People with DSPD have a circadian rhythm significantly longer than 24 hours, putting their sleeping habits out of sync with traditional sleeping hours. So while they have difficulty falling asleep at a typical bedtime, it’s not due to increased stress. And given the opportunity, they can sleep comfortably on their own delayed schedule. Our sleeping and waking cycle is a delicate balance, and one that’s vital to maintain for our physical and mental wellbeing. For all these reasons, it’s worth putting in some time and effort to sustain a stable bedtime routine, but try not to lose any sleep over it.

**P591 2018-05-25 Can you solve the giant cat army riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=591)

The villainous Dr. Schrödinger has developed a growth ray and intends to create an army of giant cats to terrorize the city. Your team of secret agents has tracked him to his underground lab. You burst in to find… that it’s a trap! Dr. Schrödinger has slipped into the next room to activate his device and disabled the control panel on the way out. Fortunately, your teammates are masters of spy-craft. Agent Delta has hacked into the control panel and managed to reactivate some of its functionality. Meanwhile, Agent Epsilon has searched through surveillance to find the code for the door: 2, 10, 14. All you have to do is enter those numbers and you’ll be free. But there’s a problem. The control panel has only three buttons: one which adds 5 to the display number, one which adds 7, and one which takes the square root. You need to make the display output the numbers 2, 10, and 14, in that order. It’s okay if it outputs different numbers in between, but there’s no way to reset the display, so once you get to 2, you’ll have to continue on to 10 and 14 from there. Not only that, Agent Delta explains that there are other traps built into the panel. If it ever shows the same number more than once, a number greater than 60, or a non-whole number, the room will explode. Right now, the display reads zero, and time is running out. There’s only one way to solve the puzzle, with a few small variations. How will you input the code to escape from Dr. Schrödinger’s lair and save the day? Pause the video now if you want to figure it out for yourself! Answer in: 3 2 1. You look over your options. Adding 5 or 7 increases the number, and the square root button will make it smaller. But there are only a few options where you can use that button: 4 9 16 25, 36, and 49. You’d love to make 4 or 16. Then you could hit the square root button once or twice to get 2. But you can’t make either with just the 5 and 7 buttons. What will you do? You look at the other possible options for numbers you could take the square root of. Nine you can’t reach. Twenty-five and 49 would take you back to 5 or 7, and you can already get to each of those. Thirty-six is your only option. You add 5, 7, 5, 7, 5, 7, and then hit the square root button. Why that series of 5s and 7s? It’s somewhat arbitrary, but you know that you want to avoid 10, 14, and perfect squares, since you’ll need them later. This gets you to 6. Does that help? Looking at your options, you see that 16 is now in your sights. You add 5 twice more to reach it. Then hit square root twice. That gets you to 2. You’re on your way! Now to 10. You can’t get straight there through addition alone, so you’re going to have to reach another square. Taking the square root of 9 or 25 would get you to a good place, but it turns out that 25 is unreachable from 2. So you add 7 to get to 9, then take the square root again. That gets you to 3. Adding 7 again makes 10. Finally, you need to reach 14. Thinking backwards, you imagine where you could be before 14: 7 or 9. But 9 won’t work because you’ve already used 9. However, you could get to 7 by reaching 49 first. You add your way towards it, being careful not to hit any of the numbers you’ve hit so far. You thread your way carefully, adding five 5s and two 7s. Then, square root to 7, and add 7 more. The door opens, and you’re out of the trap. Thanks to your problem-solving skills, your team gets Schrödinger’s cats out of the box in the nick of time. As for Schrödinger, you can be certain of one thing: he’ll be spending quite some time in a box of his own.

**P592 2018-05-29 Why is it so hard to cure ALS - Fernando G. Vieira**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=592)

In 1963, a 21-year-old physicist named Stephen Hawking was diagnosed with a rare neuromuscular disorder called amyotrophic lateral sclerosis, or ALS. Gradually, he lost the ability to walk, use his hands, move his face, and even swallow. But throughout it all, he retained his incredible intellect, and in the more than 50 years that followed, Hawking became one of history’s most accomplished and famous physicists. However, his condition went uncured and he passed away in 2018 at the age of 76. Decades after his diagnosis, ALS still ranks as one of the most complex, mysterious, and devastating diseases to affect humankind. Also called motor neuron disease and Lou Gehrig’s Disease, ALS affects about two out of every 100,000 people worldwide. When a person has ALS, their motor neurons, the cells responsible for all voluntary muscle control in the body, lose function and die. No one knows exactly why or how these cells die and that’s part of what makes ALS so hard to treat. In about 90% of cases, the disease arises suddenly, with no apparent cause. The remaining 10% of cases are hereditary, where a mother or father with ALS passes on a mutated gene to their child. The symptoms typically first appear after age 40. But in some rare cases, like Hawking’s, ALS starts earlier in life. Hawking’s case was also a medical marvel because of how long he lived with ALS. After diagnosis, most people with the disease live between 2 to 5 years before ALS leads to respiratory problems that usually cause death. What wasn’t unusual in Hawking’s case was that his ability to learn, think, and perceive with his senses remained intact. Most people with ALS do not experience impaired cognition. With so much at stake for the 120,000 people who are diagnosed with ALS annually, curing the disease has become one of our most important scientific and medical challenges. Despite the many unknowns, we do have some insight into how ALS impacts the neuromuscular system. ALS affects two types of nerve cells called the upper and lower motor neurons. In a healthy body, the upper motor neurons, which sit in the brain’s cortex, transmit messages from the brain to the lower motor neurons, situated in the spinal cord. Those neurons then transmit the message into muscle fibers, which contract or relax in response, resulting in motion. Every voluntary move we make occurs because of messages transmitted along this pathway. But when motor neurons degenerate in ALS, their ability to transfer messages is disrupted, and that vital signaling system is thrown into chaos. Without their regular cues, the muscles waste away. Precisely what makes the motor neurons degenerate is the prevailing mystery of ALS. In hereditary cases, parents pass genetic mutations on to their children. Even then, ALS involves multiple genes with multiple possible impacts on motor neurons, making the precise triggers hard to pinpoint. When ALS arises sporadically, the list of possible causes grows: toxins, viruses, lifestyle, or other environmental factors may all play roles. And because there are so many elements involved, there’s currently no single test that can determine whether someone has ALS. Nevertheless, our hypotheses on the causes are developing. One prevailing idea is that certain proteins inside the motor neurons aren’t folding correctly, and are instead forming clumps. The misfolded proteins and clumps may spread from cell to cell. This could be clogging up normal cellular processes, like energy and protein production, which keep cells alive. We’ve also learned that along with motor neurons and muscle fibers, ALS could involve other cell types. ALS patients typically have inflammation in their brains and spinal cords. Defective immune cells may also play a role in killing motor neurons. And ALS seems to change the behavior of specific cells that provide support for neurons. These factors highlight the disease’s complexity, but they may also give us a fuller understanding of how it works, opening up new avenues for treatment. And while that may be gradual, we’re making progress all the time. We’re currently developing new drugs, new stem cell therapies to repair damaged cells, and new gene therapies to slow the advancement of the disease. With our growing arsenal of knowledge, we look forward to discoveries that can change the future for people living with ALS.

**P593 2018-05-30 Are there universal expressions of emotion - Sophie Zadeh**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=593)

The 40 or so muscles in the human face can be activated in different combinations to create thousands of expressions. But do these expressions look the same and communicate the same meaning around the world, regardless of culture? Is one person’s smile another’s grimace? Charles Darwin theorized that emotional expression was a common human feature. But he was in the minority. Until the mid-20th century, many researchers believed that the specific ways we show emotion were learned behaviors that varied across cultures. Personality theorist Silvan Tomkins was one of the few to insist otherwise. Tomkins claimed that certain affects— emotional states and their associated facial expressions— were universal. In the 1960s, psychologist Paul Ekman set about testing this theory by examining hundreds of hours of film footage of remote tribes isolated from the modern world. Ekman found the native peoples’ expressions to be not only familiar, but occurring in precisely the situations he would expect. Conversely, he ran tests with tribes who had no prior exposure to Western culture. They were able to correctly match photos of different facial expressions with stories designed to trigger particular feelings. Over the next few decades, further research has corroborated Darwin’s idea that some of our most important emotional expressions are in fact universal. The degrees of expression appropriate to a given situation can, however, vary greatly across cultures. For instance, researchers have studied facial expression in people who are born blind, hypothesizing that if expressions are universal, they would be displayed in the same way as sighted people. In one study, both blind and sighted athletes displayed the same expressions of emotion when winning or losing their matches. Further evidence can be found in our evolutionary relatives. Comparisons of facial expression between humans and non-human mammals have found similarities in the structure and movement of facial muscles. Chimpanzee laughter looks different from ours, but uses some of the same muscle movements. Back in the 60s, Ekman identified six core expressions. Anger is accompanied by lowered eyebrows drawn together, tense and narrowed eyes, and tight lips; disgust, by the lips pulled up and the nose crinkling. In fear, the upper white of the eyes are revealed as the eyebrows raise and the mouth stretches open, while surprise looks similar, but with rounded eyebrows and relaxed lips. Sadness is indicated by the inner corners of the eyebrows being drawn inwards and upwards, drooping eyes, and a downturned mouth. And of course there’s happiness: lips drawn up and back, and raised cheeks causing wrinkling around the eyes. More recently, researchers have proposed additional entries such as contempt, shame, and disapproval, but opinions vary on how distinct boundaries between these categories can be drawn. So if Ekman and other researchers are correct, what makes certain expressions universal? And why are they expressed in these particular ways? Scientists have a lot of theories rooted in our evolutionary history. One is that certain expressions are important for survival. Fear and surprise could signal to others an immediate danger. Studies of humans and some other primates have found that we pay more attention to faces that signal threats over neutral faces, particularly when we’re already on high alert. Expressions also could help improve group fitness by communicating our internal states to those around us. Sadness, for example, signals to the group that something’s wrong. There’s some evidence that expressions might be even more directly linked to our physiology. The fear expression, for instance, could directly improve survival in potentially dangerous situations by letting our eyes absorb more light and our lungs take in more air, preparing us to fight or flee. There’s still much research to be done in understanding emotional expression, particularly as we learn more about the inner workings of the brain. But if you ever find yourself among strangers in a strange land, a friendly smile could go a long way.

**P594 2018-05-30 Would you live on the moon - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=594)

You roll out of bed and leap eight meters across your underground habitat. The greywater from your sink drains into a small greenhouse where your vegetables grow. After suiting up, you head through a transport chute to inspect the generator. Outside, it’s pitch black - just as it’s been for the last 12 days. This isn’t some post-apocalyptic scenario; it’s just another day of life on the moon. And with the European Space Agency’s idea to establish a functioning "moon camp" by the 2020s, that day may be closer than we think. Of course, living on the moon won’t be easy. The camp envisioned is not so much a village as an inhabited research base similar to those in places like Antarctica. But there are far greater obstacles to living on the moon than just cold weather. The biggest is cosmic radiation. Unlike the Earth, the moon has no atmosphere and no magnetic field. A person on its surface can receive over 400 times the maximum safe dosage of heavy ion radiation, enough to be fatal within ten hours, even in a spacesuit. The first step would likely involve robots and 3D printers constructing covered habitats from lunar soil, or building shelters inside caves formed by lava tubes from the moon’s volcanic past. But what would the inhabitants live on? Supplies would need to be transported from Earth at first. Growing plants requires greenhouse soil and air rich in carbon dioxide, a gas that’s rare on the moon, but could be synthesized from recycled materials. A water treatment plant could be supplied by ice mined from the polar regions using a specialized drill that can bore two meters beneath the lunar surface. Friendly bacteria and viruses necessary to the human microbiome and immune system would also have to be imported or synthesized on site. And lunar inhabitants would have to exercise for hours a day to maintain bone and muscle mass. That’s because the moon’s gravity is just one-sixth that of the Earth, and the everyday strain of working against gravity is part of what keeps our bodies healthy. It might seem strange to go to all this trouble to build a base on a dead rock we’ve already visited. But NASA’s Apollo missions only explored small portions of the moon. We’ve made many discoveries since then, such as ice near the poles and particles of solar wind gases that date back billions of years. They collectively show that the moon has much more to teach us about the history of our solar system. A radio telescope on its far side could observe the cosmos, shielded from the Earth’s electromagnetic interference. And the lunar surface is rich in minerals, like silicon, aluminum, and magnesium, creating great economic potential for mining. But the biggest benefit of the moon camp may not lie on the moon but beyond it. With the nearest possibly habitable world light-years away, and the International Space Station to be retired in about a decade, a moon base would be our first foothold towards becoming an interplanetary species. And proposals such as the Deep Space Gateway envision launching future missions from lunar orbit. The smaller gravitational pull would require less fuel to overcome, allowing for larger ships and more cargo. Meanwhile, the base on the surface could serve as a testing ground for future space operations, a refueling station, and a supply depot all in one. With Europe, Russia, China, and the US expressing interest in the project, the moon camp may come to involve the space agencies of all major nations, as well as private companies. Within a few decades, the moon may be bustling with mining operations, research stations, and tourist routes alongside a construction yard under an orbiting space port. We may have already visited the moon, but now we’re closer than ever to making it part of humanity’s home.

**P595 2018-05-31 Can you solve the Mondrian squares riddle - Gordon Hamilton**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=595)

Dutch artist Piet Mondrian’s abstract, rectangular paintings inspired mathematicians to create a two-fold challenge. First, we must completely cover a square canvas with non-overlapping rectangles. All must be unique, so if we use a 1x4, we can’t use a 4x1 in another spot, but a 2x2 rectangle would be fine. Let’s try that. Say we have a canvas measuring 4x4. We can’t chop it directly in half, since that would give us identical rectangles of 2x4. But the next closest option - 3x4 and 1x4 - works. That was easy, but we’re not done yet. Now take the area of the largest rectangle, and subtract the area of the smallest. The result is our score, and the goal is to get as low a score as possible. Here, the largest area is 12 and the smallest is 4, giving us a score of 8. Since we didn’t try to go for a low score that time, we can probably do better. Let’s keep our 1x4 while breaking the 3x4 into a 3x3 and a 3x1. Now our score is 9 minus 3, or 6. Still not optimal, but better. With such a small canvas, there are only a few options. But let’s see what happens when the canvas gets bigger. Try out an 8x8; what’s the lowest score you can get? Pause here if you want to figure it out yourself. Answer in: 3 Answer in: 2 Answer in: 1 To get our bearings, we can start as before: dividing the canvas roughly in two. That gives us a 5x8 rectangle with area 40 and a 3x8 with area 24, for a score of 16. That’s pretty bad. Dividing that 5x8 into a 5x5 and a 5x3 leaves us with a score of 10. Better, but still not great. We could just keep dividing the biggest rectangle. But that would leave us with increasingly tiny rectangles, which would increase the range between the largest and smallest. What we really want is for all our rectangles to fall within a small range of area values. And since the total area of the canvas is 64, the areas need to add up to that. Let’s make a list of possible rectangles and areas. To improve on our previous score, we can try to pick a range of values spanning 9 or less and adding up to 64. You’ll notice that some values are left out because rectangles like 1x13 or 2x9 won’t fit on the canvas. You might also realize that if you use one of the rectangles with an odd area like 5, 9, or 15, you need to use another odd-value rectangle to get an even sum. With all that in mind, let’s see what works. Starting with area 20 or more puts us over the limit too quickly. But we can get to 64 using rectangles in the 14-18 range, leaving out 15. Unfortunately, there’s no way to make them fit. Using the 2x7 leaves a gap that can only be filled by a rectangle with a width of 1. Going lower, the next range that works is 8 to 14, leaving out the 3x3 square. This time, the pieces fit. That’s a score of 6. Can we do even better? No. We can get the same score by throwing out the 2x7 and 1x8 and replacing them with a 3x3, 1x7, and 1x6. But if we go any lower down the list, the numbers become so small that we’d need a wider range of sizes to cover the canvas, which would increase the score. There’s no trick or formula here – just a bit of intuition. It's more art than science. And for larger grids, expert mathematicians aren’t sure whether they’ve found the lowest possible scores. So how would you divide a 4x4, 10x10, or 32x32 canvas? Give it a try and post your results in the comments.

**P596 2018-06-04 Did the Amazons really exist - Adrienne Mayor**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=596)

Since the time of Homer, ancient stories told of fierce warriors dwelling beyond the Mediterranean world, striking fear into the mightiest empires of antiquity. Their exploits were recounted by many epic poets. They fought in the legendary Trojan War and their grand army invaded Athens. Jason and the Argonauts passed by their shores, barely avoiding their deadly arrows. These formidable fighters faced off against the greatest champions of myth: Heracles, Theseus, and Achilles. And every single one of these warriors was a woman. The war-loving Amazons, "the equals of men" in courage and skill, were familiar to everyone in ancient Greece. Amazon battle scenes decorated the Parthenon on the Athenian Acropolis; paintings and statues of Amazons adorned temples and public spaces. Little girls played with Amazon dolls, and Amazons were a favorite subject on Greek vase paintings. In Greek art and literature, they were depicted as daring and desirable, but also terrifying and deadly, and doomed to die at the hands of Greek heroes. Were Amazons merely figures of myth, or something more? It was long assumed that they were imaginary, like the cyclops and centaurs. But curiously enough, stories from ancient Egypt, Persia, the Middle East, Central Asia, India, and China also featured Amazon-like warrior women. And Amazons were described in ancient historical accounts, not just myths. Writers like Herodotus, Plato, and Strabo never doubted their existence. So who were the real women warriors known as Amazons? Ancient historians located the Amazon homeland in Scythia, the vast territory stretching from the Black Sea across the steppes of Central Asia. This immense region was populated by nomadic tribes whose lives centered on horses, archery, and warfare. Their culture flourished for about 1,000 years beginning around 800 BC. Feared by Greeks, Persians, and the Chinese, the Scythians left no written records. But we can find clues in how their neighbors described them, as well as in archaeology. Scythians' ancestors were the first to ride horses and they invented the recurve bow. And, because a female mounted archer could be as fast and as deadly as a male, all children were trained to ride and shoot. Women hunted and fought alongside men, using the same weapons. The harsh landscape and their nomadic lifestyle created its own form of equality. This amazed the ancient Greeks, whose women led restricted indoor lives. The earliest stories of the Scythians, and Amazons, may have been exaggerated rumors. But as the Greeks began to trade around the Black Sea and further east, their portrayals became more realistic. Early depictions of Amazons showed them with Greek weapons and armor. But in later representations, they wielded bows and battle-axes, rode horses, and wore pointed caps and patterned trousers characteristic of steppe nomads. Until recently, no one was sure how strong the links were between Scythians and the Amazons of Greek myth. But recent archaeological discoveries have provided ample evidence. More than 1,000 ancient Scythian kurgans, or burial mounds, have been excavated, containing skeletons and weapons. Archaeologists had previously assumed that weapons could only belong to male warriors. But modern DNA analysis so far has revealed that about 300 skeletons buried with weapons belong to females ranging in age from 10 to 45, and more are being found every year. The women's skeletons show battle injuries: ribs slashed by swords, skulls bashed by battle-axes, and arrows embedded in bones. In classical art and writings, the fearsome Amazons were always portrayed as brave and heroic. In male-dominated classical Greece, however, the very idea of strong women who gloried in freedom and war aroused mixed feelings. And yet, the Greeks were also drawn to egalitarian ideals. Is it possible that the mythic realm of thrilling Amazon tales was a way to imagine women and men as equal companions?

**P597 2018-06-04 How much of what you see is a hallucination - Elizabeth Cox**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=597)

An elderly woman named Rosalie was sitting in her nursing home when her room suddenly burst to life with twirling fabrics. Through the elaborate drapings, she could make out animals, children, and costumed characters. Rosalie was alarmed, not by the intrusion, but because she knew this entourage was an extremely detailed hallucination. Her cognitive function was excellent, and she had not taken any medications that might cause hallucinations. Strangest of all, had a real-life crowd of circus performers burst into her room, she wouldn’t have been able to see them: she was completely blind. Rosalie had developed a condition known as Charles Bonnet Syndrome, in which patients with either impaired vision or total blindness suddenly hallucinate whole scenes in vivid color. These hallucinations appear suddenly, and can last for mere minutes or recur for years. We still don’t fully understand what causes them to come and go, or why certain patients develop them when others don’t. We do know from fMRI studies that these hallucinations activate the same brain areas as sight, areas that are not activated by imagination. Many other hallucinations, including smells, sights, and sounds, also involve the same brain areas as real sensory experiences. Because of this, the cerebral cortex is thought to play a part in hallucinations. This thin layer of grey matter covers the entire cerebrum, with different areas processing information from each of our senses. But even in people with completely unimpaired senses, the brain constructs the world we perceive from incomplete information. For example, our eyes have blind spots where the optic nerve blocks part of the retina. When the visual cortex processes light into coherent images, it fills in these blind spots with information from the surrounding area. Occasionally, we might notice a glitch, but most of the time we’re none the wiser. When the visual cortex is deprived of input from the eyes, even temporarily, the brain still tries to create a coherent picture, but the limits of its abilities become a lot more obvious. The full-blown hallucinations of Charles Bonnet Syndrome are one example. Because Charles Bonnet Syndrome only occurs in people who had normal vision and then lost their sight, not those who were born blind, scientists think the brain uses remembered images to compensate for the lack of new visual input. And the same is true for other senses. People with hearing loss often hallucinate music or voices, sometimes as elaborate as the cacophony of an entire marching band. In addition to sensory deprivation, recreational and therapeutic drugs, conditions like epilepsy and narcolepsy, and psychiatric disorders like schizophrenia, are a few of the many known causes of hallucinations, and we’re still finding new ones. Some of the most notorious hallucinations are associated with drugs like LSD and psilocybin. Their hallmark effects include the sensation that dry objects are wet and that surfaces are breathing. At higher doses, the visual world can appear to melt, dissolve into swirls, or burst into fractal-like patterns. Evidence suggests these drugs also act on the cerebral cortex. But while visual impairment typically only causes visual hallucinations, and hearing loss auditory ones, substances like LSD cause perceptual disturbances across all the senses. That’s likely because they activate receptors in a broad range of brain areas, including the cortical regions for all the senses. LSD and psilocybin both function like serotonin in the brain, binding directly to one type of serotonin receptor in particular. While serotonin’s role in the brain is complex and poorly understood, it likely plays an important part in integrating information from the eyes, nose, ears, and other sensory organs. So one theory is that LSD and psilocybin cause hallucinations by disrupting the signaling involved in sensory integration. Hallucinations associated with schizophrenia may share a similar mechanism with those caused by LSD and psilocybin. Patients with schizophrenia often have elevated levels of serotonin in the brain. And antipsychotic drugs relieve symptoms of schizophrenia by blocking the same serotonin receptors LSD and psilocybin bind to. And, in some cases, these drugs can even relieve the hallucinations of patients with Charles Bonnet Syndrome. We’re still a long way from understanding all the different causes and interconnected mechanisms of hallucinations. But it’s clear that hallucinatory experiences are much more closely tied to ordinary perception than we once thought. And by studying hallucinations, we stand to learn a great deal about how our brains construct the world we see, hear, smell, and touch. As we learn more, we’ll likely come to appreciate just how subjective and individual each person’s island universe of perception really is.

**P598 2018-06-06 The psychology of post-traumatic stress disorder - Joelle Rabow Malet**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=598)

Many of us will experience some kind of trauma during our lifetime. Sometimes, we escape with no long-term effects. But for millions of us, those experiences linger, causing symptoms like flashbacks, nightmares, and negative thoughts that interfere with everyday life. This phenomenon, called post-traumatic stress disorder, or PTSD, isn’t a personal failing; rather, it’s a treatable malfunction of certain biological mechanisms that allow us to cope with dangerous experiences. To understand PTSD, we first need to understand how the brain processes a wide range of ordeals, including the death of a loved one, domestic violence, injury or illness, abuse, rape, war, car accidents, and natural disasters. These events can bring on feelings of danger and helplessness, which activate the brain’s alarm system, known as the “fight-flight-freeze” response. When this alarm sounds, the hypothalamic, pituitary, and adrenal systems, known as the HPA axis, work together to send signals to the autonomic nervous system. That’s the network that communicates with adrenal glands and internal organs to help regulate functions like heart rate, digestion, and respiration. These signals start a chemical cascade that floods the body with several different stress hormones, causing physiological changes that prepare the body to defend itself. Our heart rate speeds up, breathing quickens, and muscles tense. Even after a crisis is over, escalated levels of stress hormones may last for days, contributing to jittery feelings, nightmares, and other symptoms. For most people, these experiences disappear within a few days to two weeks as their hormone levels stabilize. But a small percentage of those who experience trauma have persistent problems —sometimes vanishing temporarily only to resurface months later. We don’t completely understand what’s happening in the brain, but one theory is that the stress hormone cortisol may be continuously activating the “fight-flight-freeze” response while reducing overall brain functioning, leading to a number of negative symptoms. These symptoms often fall into four categories: intrusive thoughts, like dreams and flashbacks, avoiding reminders of the trauma, negative thoughts and feelings, like fear, anger, and guilt, and “reactive” symptoms like irritability and difficulty sleeping. Not everyone has all these symptoms, or experiences them to the same extent and intensity. When problems last more than a month, PTSD is often diagnosed. Genetics, on-going overwhelming stress, and many risk factors like preexisting mental illnesses or lack of emotional support, likely play a role in determining who will experience PTSD. But the underlying cause is still a medical mystery. A major challenge of coping with PTSD is sensitivity to triggers, physical and emotional stimuli that the brain associates with the original trauma. These can be everyday sensations that aren’t inherently dangerous but prompt powerful physical and emotional reactions. For example, the smell of a campfire could evoke the memory of being trapped in a burning house. For someone with PTSD, that memory activates the same neurochemical cascade as the original event. That then stirs up the same feelings of panic and helplessness as if they’re experiencing the trauma all over again. Trying to avoid these triggers, which are sometimes unpredictable, can lead to isolation. That can leave people feeling invalidated, ignored, or misunderstood, like a pause button has been pushed on their lives while the rest of the world continues around them. But, there are options. If you think you might be suffering from PTSD, the first step is an evaluation with a mental health professional who can direct you towards the many resources available. Psychotherapy can be very effective for PTSD, helping patients better understand their triggers. And certain medications can make symptoms more manageable, as can self- care practices, like mindfulness and regular exercise. What if you notice signs of PTSD in a friend or family member? Social support, acceptance, and empathy are key to helping and recovery. Let them know you believe their account of what they’re experiencing, and that you don’t blame them for their reactions. If they’re open to it, encourage them to seek evaluation and treatment. PTSD has been called “the hidden wound” because it comes without outward physical signs. But even if it’s an invisible disorder, it doesn’t have to be a silent one.

**P599 2018-06-15 Why don’t poisonous animals poison themselves - Rebecca D. Tarvin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=599)

One fine day, when Charles Darwin was still a student at Cambridge, the budding naturalist tore some old bark off a tree and found two rare beetles underneath. He’d just taken one beetle in each hand when he spotted a third beetle. Stashing one of the insects in his mouth for safekeeping, he reached for the new specimen – when a sudden spray of hot, bitter fluid scalded his tongue. Darwin’s assailant was the bombardier beetle. It’s one of thousands of animal species, like frogs, jellyfish, salamanders, and snakes, that use toxic chemicals to defend themselves – in this case, by spewing poisonous liquid from glands in its abdomen. But why doesn’t this caustic substance, ejected at 100 degrees Celsius, hurt the beetle itself? In fact, how do any toxic animals survive their own secretions? The answer is that they use one of two basic strategies: securely storing these compounds or evolving resistance to them. Bombardier beetles use the first approach. They store ingredients for their poison in two separate chambers. When they’re threatened, the valve between the chambers opens and the substances combine in a violent chemical reaction that sends a corrosive spray shooting out of the glands, passing through a hardened chamber that protects the beetle’s internal tissues. Similarly, jellyfish package their venom safely in harpoon-like structures called nematocysts. And venomous snakes store their flesh-eating, blood-clotting compounds in specialized compartments that only have one exit: through the fangs and into their prey or predator. Snakes also employ the second strategy: built-in biochemical resistance. Rattlesnakes and other types of vipers manufacture special proteins that bind and inactivate venom components in the blood. Meanwhile, poison dart frogs have also evolved resistance to their own toxins, but through a different mechanism. These tiny animals defend themselves using hundreds of bitter-tasting compounds called alkaloids that they accumulate from consuming small arthropods like mites and ants. One of their most potent alkaloids is the chemical epibatidine, which binds to the same receptors in the brain as nicotine but is at least ten times stronger. An amount barely heavier than a grain of sugar would kill you. So what prevents poison frogs from poisoning themselves? Think of the molecular target of a neurotoxic alkaloid as a lock, and the alkaloid itself as the key. When the toxic key slides into the lock, it sets off a cascade of chemical and electrical signals that can cause paralysis, unconsciousness, and eventually death. But if you change the shape of the lock, the key can’t fit. For poison dart frogs and many other animals with neurotoxic defenses, a few genetic changes alter the structure of the alkaloid-binding site just enough to keep the neurotoxin from exerting its adverse effects. Poisonous and venomous animals aren’t the only ones that can develop this resistance: their predators and prey can, too. The garter snake, which dines on neurotoxic salamanders, has evolved resistance to salamander toxins through some of the same genetic changes as the salamanders themselves. That means that only the most toxic salamanders can avoid being eaten— and only the most resistant snakes will survive the meal. The result is that the genes providing the highest resistance and toxicity will be passed on in greatest quantities to the next generations. As toxicity ramps up, resistance does too, in an evolutionary arms race that plays out over millions of years. This pattern appears over and over again. Grasshopper mice resist painful venom from scorpion prey through genetic changes in their nervous systems. Horned lizards readily consume harvester ants, resisting their envenomed sting with specialized blood plasma. And sea slugs eat jellyfish nematocysts, prevent their activation with compounds in their mucus, and repurpose them for their own defenses. The bombardier beetle is no exception: the toads that swallow them can tolerate the caustic spray that Darwin found so distasteful. Most of the beetles are spit up hours later, amazingly alive and well. But how do the toads survive the experience? That is still a mystery.

**P600 2018-06-18 The science of hearing - Douglas L. Oliver**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=600)

You hear the gentle lap of waves, the distant cawing of a seagull. But then an annoying whine interrupts the peace, getting closer, and closer, and closer. Until...whack! You dispatch the offending mosquito, and calm is restored. How did you detect that noise from afar and target its maker with such precision? The ability to recognize sounds and identify their location is possible thanks to the auditory system. That’s comprised of two main parts: the ear and the brain. The ear’s task is to convert sound energy into neural signals; the brain’s is to receive and process the information those signals contain. To understand how that works, we can follow a sound on its journey into the ear. The source of a sound creates vibrations that travel as waves of pressure through particles in air, liquids, or solids. But our inner ear, called the cochlea, is actually filled with saltwater-like fluids. So, the first problem to solve is how to convert those sound waves, wherever they’re coming from, into waves in the fluid. The solution is the eardrum, or tympanic membrane, and the tiny bones of the middle ear. Those convert the large movements of the eardrum into pressure waves in the fluid of the cochlea. When sound enters the ear canal, it hits the eardrum and makes it vibrate like the head of a drum. The vibrating eardrum jerks a bone called the hammer, which hits the anvil and moves the third bone called the stapes. Its motion pushes the fluid within the long chambers of the cochlea. Once there, the sound vibrations have finally been converted into vibrations of a fluid, and they travel like a wave from one end of the cochlea to the other. A surface called the basilar membrane runs the length of the cochlea. It’s lined with hair cells that have specialized components called stereocilia, which move with the vibrations of the cochlear fluid and the basilar membrane. This movement triggers a signal that travels through the hair cell, into the auditory nerve, then onward to the brain, which interprets it as a specific sound. When a sound makes the basilar membrane vibrate, not every hair cell moves - only selected ones, depending on the frequency of the sound. This comes down to some fine engineering. At one end, the basilar membrane is stiff, vibrating only in response to short wavelength, high-frequency sounds. The other is more flexible, vibrating only in the presence of longer wavelength, low-frequency sounds. So, the noises made by the seagull and mosquito vibrate different locations on the basilar membrane, like playing different keys on a piano. But that’s not all that’s going on. The brain still has another important task to fulfill: identifying where a sound is coming from. For that, it compares the sounds coming into the two ears to locate the source in space. A sound from directly in front of you will reach both your ears at the same time. You’ll also hear it at the same intensity in each ear. However, a low-frequency sound coming from one side will reach the near ear microseconds before the far one. And high-frequency sounds will sound more intense to the near ear because they’re blocked from the far ear by your head. These strands of information reach special parts of the brainstem that analyze time and intensity differences between your ears. They send the results of their analysis up to the auditory cortex. Now, the brain has all the information it needs: the patterns of activity that tell us what the sound is, and information about where it is in space. Not everyone has normal hearing. Hearing loss is the third most common chronic disease in the world. Exposure to loud noises and some drugs can kill hair cells, preventing signals from traveling from the ear to the brain. Diseases like osteosclerosis freeze the tiny bones in the ear so they no longer vibrate. And with tinnitus, the brain does strange things to make us think there’s a sound when there isn’t one. But when it does work, our hearing is an incredible, elegant system. Our ears enclose a fine-tuned piece of biological machinery that converts the cacophony of vibrations in the air around us into precisely tuned electrical impulses that distinguish claps, taps, sighs, and flies.

**P601 2018-06-19 What is the coldest thing in the world - Lina Marieth Hoyos**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=601)

The coldest materials in the world aren’t in Antarctica. They’re not at the top of Mount Everest or buried in a glacier. They’re in physics labs: clouds of gases held just fractions of a degree above absolute zero. That’s 395 million times colder than your refrigerator, 100 million times colder than liquid nitrogen, and 4 million times colder than outer space. Temperatures this low give scientists a window into the inner workings of matter, and allow engineers to build incredibly sensitive instruments that tell us more about everything from our exact position on the planet to what’s happening in the farthest reaches of the universe. How do we create such extreme temperatures? In short, by slowing down moving particles. When we’re talking about temperature, what we’re really talking about is motion. The atoms that make up solids, liquids, and gases are moving all the time. When atoms are moving more rapidly, we perceive that matter as hot. When they’re moving more slowly, we perceive it as cold. To make a hot object or gas cold in everyday life, we place it in a colder environment, like a refrigerator. Some of the atomic motion in the hot object is transferred to the surroundings, and it cools down. But there’s a limit to this: even outer space is too warm to create ultra-low temperatures. So instead, scientists figured out a way to slow the atoms down directly – with a laser beam. Under most circumstances, the energy in a laser beam heats things up. But used in a very precise way, the beam’s momentum can stall moving atoms, cooling them down. That’s what happens in a device called a magneto-optical trap. Atoms are injected into a vacuum chamber, and a magnetic field draws them towards the center. A laser beam aimed at the middle of the chamber is tuned to just the right frequency that an atom moving towards it will absorb a photon of the laser beam and slow down. The slow down effect comes from the transfer of momentum between the atom and the photon. A total of six beams, in a perpendicular arrangement, ensure that atoms traveling in all directions will be intercepted. At the center, where the beams intersect, the atoms move sluggishly, as if trapped in a thick liquid — an effect the researchers who invented it described as “optical molasses.” A magneto-optical trap like this can cool atoms down to just a few microkelvins — about -273 degrees Celsius. This technique was developed in the 1980s, and the scientists who'd contributed to it won the Nobel Prize in Physics in 1997 for the discovery. Since then, laser cooling has been improved to reach even lower temperatures. But why would you want to cool atoms down that much? First of all, cold atoms can make very good detectors. With so little energy, they’re incredibly sensitive to fluctuations in the environment. So they’re used in devices that find underground oil and mineral deposits, and they also make highly accurate atomic clocks, like the ones used in global positioning satellites. Secondly, cold atoms hold enormous potential for probing the frontiers of physics. Their extreme sensitivity makes them candidates to be used to detect gravitational waves in future space-based detectors. They’re also useful for the study of atomic and subatomic phenomena, which requires measuring incredibly tiny fluctuations in the energy of atoms. Those are drowned out at normal temperatures, when atoms speed around at hundreds of meters per second. Laser cooling can slow atoms to just a few centimeters per second— enough for the motion caused by atomic quantum effects to become obvious. Ultracold atoms have already allowed scientists to study phenomena like Bose-Einstein condensation, in which atoms are cooled almost to absolute zero and become a rare new state of matter. So as researchers continue in their quest to understand the laws of physics and unravel the mysteries of the universe, they’ll do so with the help of the very coldest atoms in it.

**P602 2018-06-25 Why does your voice change as you get older - Shaylin A. Schundler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=602)

In the mid-16th century, Italians were captivated by a type of male singer whose incredible range contained notes previously thought impossible for adult men. However, this gift came at a high price. To prevent their voices from breaking, these singers had been castrated before puberty, halting the hormonal processes that would deepen their voices. Known as castrati, their light, angelic voices were renowned throughout Europe, until the cruel procedure that created them was outlawed in the 1800s. Though stunting vocal growth can produce an extraordinary musical range, naturally developing voices are already capable of incredible variety. And as we age, our bodies undergo two major changes which explore that range. So how exactly does our voice box work, and what causes these shifts in speech? The specific sound of a speaking voice is the result of many anatomical variables, but it’s mostly determined by the age and health of our vocal cords and the size of our larynxes. The larynx is a complex system of muscle and cartilage that supports and moves the vocal cords, or, as they’re more accurately known, the vocal folds. Strung between the thyroid and arytenoid cartilages, these two muscles form an elastic curtain that opens and shuts across the trachea, the tube that carries air through the throat. The folds are apart when we’re breathing, but when we speak, they slam shut. Our lungs push air against the closed folds, blowing them open and vibrating the tissue to produce sound. Unlike the deliberate focus required for playing an external instrument, we effortlessly change notes as we speak. By pushing air faster or slower, we change the frequency and amplitude of these vibrations, which respectively translate to the pitch and volume of our voices. Rapid and small vibrations create high-pitched, quiet tones, while slow, large vibrations produce deep, bellowing rumbles. Finally, by moving the laryngeal muscles between the cartilages, we can stretch and contract those folds to intuitively play our internal instruments. This process is the same from your first words to your last, but as you age, your larynx ages too. During puberty, the first major shift starts, as your voice begins to deepen. This happens when your larynx grows in size, elongating the vocal folds and opening up more room for them to vibrate. These longer folds have slower, larger vibrations, which result in a lower baseline pitch. This growth is especially dramatic in many males, whose high testosterone levels lead first to voice cracks, and then to deeper, more booming voices, and laryngeal protrusions called Adam’s apples. Another vocal development during puberty occurs when the homogenous tissue covering the folds specializes into three distinct functional layers: a central muscle, a layer of stiff collagen wrapped in stretchy elastin fibers, and an outer layer of mucus membrane. These layers add nuance and depth to the voice, giving it a distinct timbre that sets it apart from its pre-pubescent tones. After puberty, most people’s voices remain more or less the same for about 50 years. But we all use our voices differently, and eventually we experience the symptoms associated with aging larynxes, known as presbyphonia. First, the collagen in our folds stiffens and the surrounding elastin fibers atrophy and decay. This decreased flexibility increases the pitch of older voices. But for people who have experienced the hormonal effects of menopause, the higher pitch is countered and outweighed by swollen vocal folds. The folds' increased mass slows their vibrations, resulting in deeper voices. All these symptoms are further complicated by having fewer healthy laryngeal nerve endings, which reduces precise muscle control and causes breathy or rough voices. Ultimately, these anatomical changes are just a few of the factors that can affect your voice. But when kept in good condition, your voice box is a finely tuned instrument, capable of operatic arias, moody monologues, and stirring speeches.

**P603 2018-06-26 History vs. Augustus - Peta Greenfield & Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=603)

His reign marked the beginning of one of history’s greatest empires and the end of one of its first republics. Was Rome’s first emperor a visionary leader who guaranteed his civilization’s place in history or a tyrant who destroyed its core values? Find out in History versus Augustus. Order, order. The defendant today is Gaius Octavius? Gaius Julius Caesar/Augustus... Do we have the wrong guy? No, your Honor. Gaius Octavius, born in 63 BCE, was the grand-nephew of Julius Caesar. He became Gaius Julius Caesar upon being named his great-uncle’s adoptive son and heir. And he gained the title Augustus in 27 BCE when the Senate granted him additional honors. You mean when he established sole authority and became emperor of Rome. Is that bad? Didn’t every place have some king or emperor back then? Actually, your Honor, the Roman people had overthrown their kings centuries before to establish a republic, a government meant to serve the people, not the privilege of a ruling family. And it was Octavius who destroyed this tradition. Octavius was a model public servant. At 16, he was elected to the College of Pontiffs that supervised religious worship. He fought for Rome in Hispania alongside his great-uncle Caesar and took up the responsibility of avenging Caesar’s death when the corrupt oligarchs in the Senate betrayed and murdered him. Caesar had been a power-hungry tyrant who tried to make himself a king while consorting with his Egyptian queen Cleopatra. After his death, Octavius joined his general Mark Antony in starting a civil war that tore Rome apart, then stabbed his ally in the back to increase his own power. Antony was a fool. He waged a disastrous campaign in Parthia and plotted to turn Roman territories into personal kingdoms for himself and Cleopatra. Isn’t that what Caesar had been accused of? Well... So Octavius destroyed Antony for trying to become a king and then became one himself? That’s right. You can see the megalomania even in his adopted title – "The Illustrious One." That was a religious honorific. And Augustus didn’t seek power for his own sake. As winner of the civil war and commander of the most troops, it was his duty to restore law and order to Rome so that other factions didn’t continue fighting. He didn’t restore the law - he made it subordinate to him! Not true. Augustus worked to restore the Senate’s prestige, improved food security for the lower classes, and relinquished control of the army when he resigned his consul post. Mere optics. He used his military influence and personal wealth to stack the Senate in his favor, while retaining the powers of a tribune and the right to celebrate military triumphs. He kept control of provinces with the most legions. And if that wasn’t enough, he assumed the consul position twice more to promote his grandchildren. He was clearly trying to establish a dynasty. But what did he do with all that power? Glad you asked, your Honor. Augustus’s accomplishments were almost too many to name. He established consistent taxation for all provinces, ending private exploitation by local tax officials. He personally financed a network of roads and employed couriers so news and troops could travel easily throughout the realm. And it was under Augustus that many of Rome’s famous public buildings were constructed. The writers of the time were nearly unanimous in praising his rule. Did the writers have any other choice? Augustus exiled plenty of people on vague charges, including Ovid, one of Rome’s greatest poets. And you forgot to mention the intrusive laws regarding citizens’ personal lives – punishing adultery, restricting marriage between social classes, even penalties for remaining unmarried. He was trying to improve the citizenry and instill discipline. And he succeeded. His legacy speaks for itself: 40 years of internal stability, a professional army that expanded Rome’s frontiers in all directions, and a government still remembered as a model of civic virtue. His legacy was an empire that would go on to wage endless conquest until it collapsed, and a tradition of military autocracy. Any time a dictator in a general’s uniform commits atrocities while claiming to act on behalf of "the people," we have Augustus Caesar to thank. So you’re saying Augustus was a good emperor, and you’re saying there’s no such thing? We’re used to celebrating historical leaders for their achievements and victories. But to ask whether an individual should have such power in the first place is to put history itself on trial.

**P604 2018-06-26 How exactly does binary code work - José Américo N L F de Freitas**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=604)

Imagine trying to use words to describe every scene in a film, every note in your favorite song, or every street in your town. Now imagine trying to do it using only the numbers 1 and 0. Every time you use the Internet to watch a movie, listen to music, or check directions, that’s exactly what your device is doing, using the language of binary code. Computers use binary because it's a reliable way of storing data. For example, a computer's main memory is made of transistors that switch between either high or low voltage levels, such as 5 volts and 0 volts. Voltages sometimes oscillate, but since there are only two options, a value of 1 volt would still be read as "low." That reading is done by the computer’s processor, which uses the transistors’ states to control other computer devices according to software instructions. The genius of this system is that a given binary sequence doesn't have a pre-determined meaning on its own. Instead, each type of data is encoded in binary according to a separate set of rules. Let’s take numbers. In normal decimal notation, each digit is multiplied by 10 raised to the value of its position, starting from zero on the right. So 84 in decimal form is 4x10⁰ + 8x10¹. Binary number notation works similarly, but with each position based on 2 raised to some power. So 84 would be written as follows: Meanwhile, letters are interpreted based on standard rules like UTF-8, which assigns each character to a specific group of 8-digit binary strings. In this case, 01010100 corresponds to the letter T. So, how can you know whether a given instance of this sequence is supposed to mean T or 84? Well, you can’t from seeing the string alone – just as you can’t tell what the sound "da" means from hearing it in isolation. You need context to tell whether you're hearing Russian, Spanish, or English. And you need similar context to tell whether you’re looking at binary numbers or binary text. Binary code is also used for far more complex types of data. Each frame of this video, for instance, is made of hundreds of thousands of pixels. In color images, every pixel is represented by three binary sequences that correspond to the primary colors. Each sequence encodes a number that determines the intensity of that particular color. Then, a video driver program transmits this information to the millions of liquid crystals in your screen to make all the different hues you see now. The sound in this video is also stored in binary, with the help of a technique called pulse code modulation. Continuous sound waves are digitized by taking "snapshots" of their amplitudes every few milliseconds. These are recorded as numbers in the form of binary strings, with as many as 44,000 for every second of sound. When they’re read by your computer’s audio software, the numbers determine how quickly the coils in your speakers should vibrate to create sounds of different frequencies. All of this requires billions and billions of bits. But that amount can be reduced through clever compression formats. For example, if a picture has 30 adjacent pixels of green space, they can be recorded as "30 green" instead of coding each pixel separately - a process known as run-length encoding. These compressed formats are themselves written in binary code. So is binary the end-all-be-all of computing? Not necessarily. There’s been research into ternary computers, with circuits in three possible states, and even quantum computers, whose circuits can be in multiple states simultaneously. But so far, none of these has provided as much physical stability for data storage and transmission. So for now, everything you see, hear, and read through your screen comes to you as the result of a simple "true" or "false" choice, made billions of times over.

**P605 2018-06-26 The myth of Hercules - 12 labors in 8-bits - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=605)

Hercules, son of Zeus and champion of humankind, gazed in horror as he realized he had just committed the most unspeakable crime imaginable. The goddess Hera, who hated Hercules for being born of her husband’s adultery, had stricken him with a temporary curse of madness. And his own family were the casualties. Consumed by grief, Hercules sought out the Oracle of Delphi, who told him the path to atonement lay with his cousin, King Eurystheus of Tiryns, a favorite of Hera’s. Eurystheus hoped to humiliate Hercules with ten impossible tasks that pitted him against invincible monsters and unfathomable forces. Instead, the king set the stage for an epic series of adventures that would come to be known as the Labors of Hercules. The first labor was to slay the Nemean Lion, who kidnapped women and devoured warriors. Its golden fur was impervious to arrows, but Hercules cornered the lion in its dark cave, stunned it with a club, and strangled it with his bare hands. He found no tool sharp enough to skin the beast, until the goddess Athena suggested using one of its own claws. Hercules returned to Tiryns wearing the lion’s hide, frightening King Eurystheus so much that he hid in a wine jar. From then on, Hercules was ordered to present his trophies at a safe distance. The second target was the Lernaean Hydra, a giant serpent with many heads. Hercules fought fiercely, but every time he cut one head off, two more grew in its place. The battle was hopeless until his nephew Iolaus thought to cauterize the necks with fire, keeping the heads from regrowing. The dead serpent’s remains became the Hydra constellation. Instead of slaying a beast, Hercules next had to catch one, alive. The Ceryneian Hind was a female deer so fast it could outrun an arrow. Hercules tracked it for a year, finally trapping it in the northern land of Hyperborea. The animal turned out to be sacred to Artemis, goddess of the hunt, and Hercules swore to return it. When Eurystheus saw the hind, he demanded to keep it instead, but as soon as Hercules let go, the animal ran to its mistress. Thus, Hercules completed his task without breaking his promise. The fourth mission was to capture the Erymanthian boar, which had ravaged many fields. Advised by the wise centaur Chiron, Hercules trapped it by chasing it into thick snow. For the fifth task, there were no animals, just their leftovers. The stables where King Augeas kept his hundreds of divine cattle had not been maintained in ages. Hercules promised to clean them in one day if he could keep one-tenth of the livestock. Augeas expected the hero to fail. Instead, Hercules dug massive trenches, rerouting two nearby rivers to flow through the stables until they were spotless. Next came three more beastly foes, each requiring a clever strategy to defeat. The carnivorous Stymphalian birds nested in an impenetrable swamp, but Hercules used Athena’s special rattle to frighten them into the air, at which point he shot them down. No mortal could stand before the Cretan bull’s mad rampage, but a chokehold from behind did the trick. And the mad King Diomedes, who had trained his horses to devour his guests, got a taste of his own medicine when Hercules wrestled him into his own stables. The ensuing feast calmed the beasts enough for Hercules to bind their mouths. But the ninth labor involved someone more dangerous than any beast, Hippolyta, Queen of the Amazons. Hercules was to retrieve the belt given to her by her father Ares, the god of war. He sailed to the Amazon land of Themyscira prepared for battle, but the queen was so impressed with the hero and his exploits that she gave the belt willingly. For his tenth labor, Hercules had to steal a herd of magical red cattle from Geryon, a giant with three heads and three bodies. On his way, Hercules was so annoyed by the Libyan desert heat that he shot an arrow at the Sun. The sun god Helios admired the hero’s strength and lent his chariot for the journey to the island of Erytheia. There, Hercules fought off Geryon’s herdsman and his two-headed dog, before killing the giant himself. That should have been the end. But Eurystheus announced that two labors hadn’t counted: the Hydra, because Iolaus had helped Hercules kill it, and the stables, because he’d accepted payment. And so, the hero set about his eleventh task, obtaining golden apples from the garden of the Hesperides nymphs. Hercules began by catching the Old Man of the Sea and holding the shape-shifting water-god until he revealed the garden’s location. Once there, the hero found the titan Atlas holding up the heavens. Hercules offered to take his place if Atlas would retrieve the apples. Atlas eagerly complied, but Hercules then tricked him into trading places again, escaping with apples in hand. The twelfth and final task was to bring back Cerberus, the three-headed hound guarding the underworld. Helped by Hermes and Athena, Hercules descended and met Hades himself. The lord of the dead allowed Hercules to take the beast if he could do it without weapons, which he achieved by grabbing all three of its heads at once. When he presented the hound to a horrified Eurystheus, the king finally declared the hero’s service complete. After 12 years of toil, Hercules had redeemed the tragic deaths of his family and earned a place in the divine pantheon. But his victory held an even deeper importance. In overcoming the chaotic and monstrous forces of the world, the hero swept away what remained of the Titans’ primordial order, reshaping it into one where humanity could thrive. Through his labors, Hercules tamed the world’s madness by atoning for his own.

**P606 2018-06-27 A day in the life of an ancient Egyptian doctor - Elizabeth Cox**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=606)

It’s another sweltering morning in Memphis, Egypt. As the sunlight brightens the Nile, Peseshet checks her supplies. Honey, garlic, cumin, acacia leaves, cedar oil. She’s well stocked with the essentials she needs to treat her patients. Peseshet is a swnw, or a doctor. In order to become one, she had to train as a scribe and study the medical papyri stored at the Per Ankh, the House of Life. Now, she teaches her own students there. Before teaching, Peseshet has a patient to see. One of the workers at the temple construction site has injured his arm. When Peseshet arrives, the laborer’s arm is clearly broken, and worse, the fracture is a sed, with multiple bone fragments. Peseshet binds and immobilizes the injury. Her next stop is the House of Life. On her way, a woman intercepts Peseshet in the street. The woman’s son has been stung by a scorpion. Peseshet has seen many similar stings and knows exactly what to do. She must say an incantation to cast the poison out. She begins to recite the spell, invoking Serqet, patron of physicians and goddess of venomous creatures. Peseshet recites the spell as if she is Serqet. This commanding approach has the greatest chance at success. After she utters the last line, she tries to cut the poison out with a knife for good measure. Peseshet packs up to leave, but the woman has another question. She wants to find out if she is pregnant. Peseshet explains her fail-safe pregnancy test: plant two seeds: one barley, one emmer. Then, urinate on the seeds every day. If the plants grow, she’s pregnant. A barley seedling predicts a baby boy, while emmer foretells a girl. Peseshet also recommends a prayer to Hathor, goddess of fertility. When Peseshet finally arrives at the House of Life, she runs into the doctor-priest Isesi. She greets Isesi politely, but she thinks priests are very full of themselves. She doesn’t envy Isesi’s role as neru pehut, which directly translates to herdsman of the anus to the royal family, or, guardian of the royal anus. Inside, the House of Life is bustling as usual with scribes, priests, doctors, and students. Papyri containing all kinds of records, not just medical information, are stored here. Peseshet’s son Akhethetep is hard at work copying documents as part of his training to become a scribe. He’s a particularly promising student, but he was admitted to study because Peseshet is a scribe, as was her father before her. Without family in the profession, it’s very difficult for boys, and impossible for girls, to pursue this education. Peseshet oversees all the female swnws and swnws-in-training in Memphis. The men have their own overseer, as the male doctors won’t answer to a woman. Today, Peseshet teaches anatomy. She quizzes her students on the metu, the body’s vessels that transport blood, air, urine, and even bad spirits. Peseshet is preparing to leave when a pale, thin woman accosts her at the door and begs to be examined. The woman has a huge, sore lump under her arm. Peseshet probes the growth and finds it cool to the touch and hard like an unripe hemat fruit. She has read about ailments like this, but never seen one. For this tumor there is no treatment, medicine or spell. All the texts give the same advice: do nothing. After delivering the bad news, Peseshet goes outside. She lingers on the steps of the House of Life, admiring the city at dusk. In spite of all her hard work, there will always be patients she can’t help, like the woman with the tumor. They linger with her, but Peseshet has no time to dwell. In a few short weeks, the Nile’s annual flooding will begin, bringing life to the soil for the next year’s harvest and a whole new crop of patients.

**P607 2018-06-27 How the Normans changed the history of Europe - Mark Robinson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=607)

In the year 1066, 7000 Norman infantry and knights sailed in warships across the English Channel. Their target: England, home to more than a million people. Theirs was a short voyage with massive consequences. And around the same period of time, other groups of Normans were setting forth all across Europe, going on adventures that would reverberate throughout that continent’s history. So who were these warriors and how did they leave their mark so far and wide? Our story begins over 200 years earlier, when Vikings began to settle on the shores of northern France as part of a great Scandinavian exodus across northern Europe. The French locals called these invaders Normans, named for the direction they came from. Eventually, Charles, the king of the Franks, negotiated peace with the Viking leader Rollo in 911, granting him a stretch of land along France’s northern coast that came to be known as Normandy. The Normans proved adaptable to their newly settled life. They married Frankish women, adopted the French language, and soon started converting from Norse paganism to Christianity. But though they adapted, they maintained the warrior tradition and conquering spirit of their Viking forebears. Before long, ambitious Norman knights were looking for new challenges. The Normans’ best-known achievement was their conquest of England. In 1066, William, the Duke of Normandy, disputed the claim of the new English king, Harold Godwinson. Soon after landing in England, William and his knights met Harold’s army near the town of Hastings. The climactic moment in the battle is immortalized in the 70-meter-long Bayeux Tapestry, where an arrow striking Harold in the eye seals the Norman victory. William consolidated his gains with a huge castle-building campaign and a reorganization of English society. He lived up to his nickname "William the Conqueror" through a massive survey known as the Domesday Book, which recorded the population and ownership of every piece of land in England. Norman French became the language of the new royal court, while commoners continued to speak Anglo-Saxon. Over time, the two merged to give us the English we know today, though the divide between lords and peasants can still be felt in synonym pairs such as cow and beef. By the end of the 12th century, the Normans had further expanded into Wales, Scotland, and Ireland. Meanwhile, independent groups of Norman knights traveled to the Mediterranean, inspired by tales of pilgrims returning from Jerusalem. There, they threw themselves into a tangled mass of conflicts among the established powers all over that region. They became highly prized mercenaries, and during one of these battles, they made the first recorded heavy cavalry charge with couched lances, a devastating tactic that soon became standard in medieval warfare. The Normans were also central to the First Crusade of 1095-99, a bloody conflict that re-established Christian control in certain parts of the Middle East. But the Normans did more than just fight. As a result of their victories, leaders like William Iron-Arm and Robert the Crafty secured lands throughout Southern Italy, eventually merging them to form the Kingdom of Sicily in 1130. Under Roger II, the kingdom became a beacon of multicultural tolerance in a world torn apart by religious and civil wars. Muslim Arab poets and scholars served in the royal court alongside Byzantine Greek sailors and architects. Arabic remained an official language along with Latin, Greek, and Norman French. The world’s geographical knowledge was compiled in The Book of Roger, whose maps of the known world would remain the most accurate available for 300 years. And the churches built in Palermo combined Latin-style architecture, Arab ceilings, and Byzantine domes, all decorated with exquisite golden mosaics. So if the Normans were so successful, why aren’t they still around? In fact, this was a key part of their success: not just ruling the societies they conquered, but becoming part of them. Although the Normans eventually disappeared as a distinct group, their contributions remained. And today, from the castles and cathedrals that dot Europe’s landscape to wherever the English language is spoken, the Norman legacy lives on.

**P608 2018-07-11 Zen kōans - unsolvable enigmas designed to break your brain - Puqun L**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=608)

How do we explain the unexplainable? This question has inspired numerous myths, religious practices, and scientific inquiries. But Zen Buddhists practicing throughout China from the 9th to 13th century asked a different question – why do we need an explanation? For these monks, blindly seeking answers was a vice to overcome, and learning to accept the mysteries of existence was the true path to enlightenment. But fighting the urge to explain the unexplainable can be difficult. So to help practice living with these mysteries, the meditating monks used a collection of roughly 1,700 bewildering and ambiguous philosophical thought experiments called kōans. The name, originally gong-an in Chinese, translates to “public record or case." But unlike real-world court cases, kōans were intentionally incomprehensible. They were surprising, surreal, and frequently contradicted themselves. On the surface, they contained a proverb about the Zen Buddhist monastic code - such as living without physical or mental attachments, avoiding binary thinking, and realizing one’s true “Buddha-nature." But by framing those lessons as illogical anecdotes, they became tests to help practicing monks learn to live with ambiguity and paradox. By puzzling through these confusing “cases," meditating monks could both internalize and practice Buddhist teachings. Hopefully, they would let go of the search for one true answer and trigger a spiritual breakthrough. Since these are intentionally unexplainable, it would be misguided to try and decipher these stories ourselves. But like the monks before us, we can puzzle over them together, and investigate just how resistant they are to simple explanations. Consider this kōan illustrating the practice of no-attachment. Two monks, Tanzan and Ekido, are traveling together down a muddy road. Ahead they see an attractive traveler, unable to cross the muddy path. Tanzan politely offers his help, carrying the traveler on his back across the street, and placing her down without a word. Ekido was shocked. According to monastic law, monks were not supposed to go near women, let alone touch a beautiful stranger. After miles of walking, Ekido could no longer restrain himself. “How could you carry that woman?” Tanzan smiled, “I left the traveler there. Are you still carrying her?” Like all kōans, this story has numerous interpretations. But one popular reading suggests that despite never having physically carried the traveler, Ekido broke monastic law by mentally "clinging to" the woman. This type of conflict – examining the grey area between the letter of the law and the spirit of the law – was common in kōans. In addition to exploring ambiguity, kōans often ridiculed characters claiming total understanding of the world around them. One such example finds three monks debating a temple flag rippling in the wind. The first monk refers to the flag as a moving banner, while the second monk insists that they are not seeing the flag move, but rather the wind blowing. They argue back and forth, until finally, a third monk intervenes, “It is not the flag moving, nor the wind blowing, but rather the movement of your minds!” One interpretation of this kōan plays on the supposed wisdom of the arguing monks – the first asserting the importance of the observable world, the second favoring deeper knowledge we can infer from that world. But each monk’s commitment to his own “answer” blinds him to the other’s insight, and in doing so, defies an essential Buddhist ideal: abolishing binary thinking. The third monk identifies their conflict as a perceptual one – both arguing monks fail to see the larger picture. Of course, all these interpretations only hint at how to wrestle with these kōans. Neither the wisdom from practicing monks before us, nor the supposedly wise characters in these stories can resolve them for you. That’s because the purpose of these kōans isn’t reaching a simple solution. It’s the very act of struggling with these paradoxical puzzles which challenge our desire for resolution, and our understanding of understanding itself.

**P609 2018-07-12 Did ancient Troy really exist - Einav Zamir Dembin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=609)

When Homer’s Iliad was first written down in the 8th century BCE, the story of the Trojan war was already an old one. From existing oral tradition, audiences knew the tales of the long siege, the epic duels outside the city walls, and the cunning trick that finally won the war. In the end, the magnificent city was burned to the ground, never to rise again. But had it ever existed? By the time the field of archaeology began to take shape in the 19th century, many were skeptical, considering the epic to be pure fiction, a founding myth imagining a bygone heroic era. But some scholars believed that behind the superhuman feats and divine miracles there must have been a grain of historical truth - a war that was really fought, and a place where it happened. Frank Calvert was one such believer. He had spent his youth traveling and learning about ancient civilizations before accompanying his brother Frederick on a diplomatic mission to the northwest Anatolian region of Çanakkale. It was here that Homer described the Greek encampment at the mouth of the Scamander river. And it was here that fate brought Frank into contact with a journalist and geologist named Charles Maclaren. Locals and travelers had long speculated that Troy might’ve stood on one of the surrounding hilltops. But Maclaren had been one of the first to publish a detailed topographical study of the area. He believed he had found the site – a 32-meter mound known by the name Hisarlık, derived from the Turkish word for “fortress.” Soon after meeting with him in 1847, the Calverts bought 2,000 acres of farmland that included part of the hill. Before they could explore any further, the Crimean War broke out and forestalled their archaeological ambitions for several years. After the war’s end, Frank Calvert began to survey the site, but lacked the funds for a full excavation. This was where the wealthy German businessman and amateur archaeologist Heinrich Schliemann came in. At Calvert’s invitation, Schliemann visited the grounds in 1868, and decided to excavate. Eager to find the ancient city, Schliemann tore massive trenches all the way to the base of the hill. There, he uncovered a hoard of precious artifacts, jewelry, and metalwork, including two diadems and a copper shield. Schliemann took full credit for the discovery, announcing that he had found Troy and the treasure of its king Priam. But the real treasure was elsewhere. When later archaeologists studied the site, they realized that the mound consisted of no less than nine cities, each built atop the ruins of the last. The layer Schliemann had uncovered dated back to the Mycenaean Age, more than 1,000 years too early for Homer. But inside the mound was indeed evidence for a city that had thrived during the Bronze Age, with charred stone, broken arrowheads, and damaged human skeletons suggesting a violent end. It was Troy VII, contained in the middle layers and now ravaged for a second time by Schliemann’s careless excavation. The settlement, spanning some 200,000 square meters and home to as many as 10,000 people, thrived until around 1180 BCE. Its position at the southern entrance of the Dardanelles strait would’ve made a formidable strategic location for both defense and trade. Most importantly, there are the remains of a massive fortification wall – perhaps the very same one from which Priam and Hector once watched the Greeks approach. Of course, it’s difficult to be certain that these ruins are the true remains of ancient Troy, and scholars still dispute whether the Trojan War as described by Homer ever happened. Yet the evidence is strong enough that UNESCO has labelled Hisarlık the archeological site of Troy. Regardless of its identity, thanks to persistence, a bit of faith, and a lot of research, archaeologists are bringing the long-buried secrets of an ancient, lost city to light.

**P610 2018-07-13 The breathtaking courage of Harriet Tubman - Janell Hobson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=610)

Escaping slavery; risking everything to save her family; leading a military raid; championing the cause of women’s suffrage; these are just a handful of the accomplishments of one of America’s most courageous heroes. Harriet Tubman was born Araminta Ross in Dorchester County, Maryland, in the early 1820s. Born into chattel slavery, Araminta, or Minty, was the fifth of nine children. Two of Minty’s older sisters were sold to a chain gang. Even as a small child, Minty was hired out to different owners, who subjected her to whippings and punishment. Young Minty’s life changed forever on an errand to a neighborhood store. There, an overseer threw a two-pound weight at a fugitive enslaved person, missed, and struck Minty instead. Her injury caused her to experience sleeping spells, which we know of today as narcolepsy, for the rest of her life. Minty’s owner tried to sell her, but there were no buyers for an enslaved person who fell into sleeping spells. She was instead put to work with her father, Ben Ross, who taught her how to lumber. Lumbering increased Minty’s physical strength and put her in touch with free black sailors who shipped the wood to the North. From them, Minty learned about the secret communications that occurred along trade routes, information that would prove invaluable later in her life. In this mixed atmosphere of free and enslaved blacks working side by side, Minty met John Tubman, a free black man she married in 1844. After marriage, she renamed herself Harriet, after her mother. Harriet Tubman’s owner died in 1849. When his widow planned to sell off her enslaved human beings, Harriet feared she would be sold away from everyone she loved. She had heard of an “underground railroad," a secret network of safe houses, boat captains, and wagon drivers willing to harbor fugitive enslaved people on their way north. So Tubman fled with two of her brothers, Ben and Harry. They eventually turned back, fearing they were lost. But in one of her sleeping spells, Harriet dreamed that she could fly like a bird. Looking down below, she saw the path to liberation. And in the autumn of 1849, she set out on her own, following the North Star to Pennsylvania, and to freedom. Tubman returned to the South 13 times to free her niece, brothers, parents, and many others. She earned the nickname Black Moses and worked diligently with fellow abolitionists to help enslaved people escape, first to the North, and later to Canada. Harriet Tubman worked as a Union army nurse, scout, and spy during the Civil War. In 1863, she became the first woman in United States history to plan and lead a military raid, liberating nearly 700 enslaved persons in South Carolina. After the war, the 13th Amendment to the U.S. Constitution legally abolished slavery, while the 14th expanded citizenship and the 15th gave voting rights to formerly enslaved black men. But she was undaunted, and she persisted. She raised funds for formerly enslaved persons and helped build schools and a hospital on their behalf. In 1888, Tubman became more active in the fight for women’s right to vote. In 1896, she appeared at the founding convention of the National Association of Colored Women in Washington D.C. and later at a woman’s suffrage meeting in Rochester, New York. There she told the audience: “I was a conductor on the Underground Railroad, and I can say what many others cannot. I never ran my train off the track, and I never lost a passenger.” As her fame grew, various friends and allies helped her in the fight to collect a veteran’s pension for her service in the Union Army. In 1899, she was finally granted $20 a month. In a fitting twist of fate, the United States Treasury announced in 2016 that Tubman’s image will appear on a redesigned twenty dollar bill. Harriet Tubman died on March 10, 1913. Even on her deathbed at age 91, she kept the freedom of her people in mind. Her final words were: "I go away to prepare a place for you.”

**P611 2018-07-14 How can you change someone's mind (hint - facts aren't always enough)**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=611)

Three people are at a dinner party. Paul, who’s married, is looking at Linda. Meanwhile, Linda is looking at John, who’s not married. Is someone who’s married looking at someone who’s not married? Take a moment to think about it. Most people answer that there’s not enough information to tell. And most people are wrong. Linda must be either married or not married—there are no other options. So in either scenario, someone married is looking at someone who’s not married. When presented with the explanation, most people change their minds and accept the correct answer, despite being very confident in their first responses. Now let’s look at another case. A 2005 study by Brendan Nyhan and Jason Reifler examined American attitudes regarding the justifications for the Iraq War. Researchers presented participants with a news article that showed no weapons of mass destruction had been found. Yet many participants not only continued to believe that WMDs had been found, but they even became more convinced of their original views. So why do arguments change people’s minds in some cases and backfire in others? Arguments are more convincing when they rest on a good knowledge of the audience, taking into account what the audience believes, who they trust, and what they value. Mathematical and logical arguments like the dinner party brainteaser work because even when people reach different conclusions, they’re starting from the same set of shared beliefs. In 1931, a young, unknown mathematician named Kurt Gödel presented a proof that a logically complete system of mathematics was impossible. Despite upending decades of work by brilliant mathematicians like Bertrand Russell and David Hilbert, the proof was accepted because it relied on axioms that everyone in the field already agreed on. Of course, many disagreements involve different beliefs that can’t simply be reconciled through logic. When these beliefs involve outside information, the issue often comes down to what sources and authorities people trust. One study asked people to estimate several statistics related to the scope of climate change. Participants were asked questions, such as “how many of the years between 1995 and 2006 were one of the hottest 12 years since 1850?” After providing their answers, they were presented with data from the Intergovernmental Panel on Climate Change, in this case showing that the answer was 11 of the 12 years. Being provided with these reliable statistics from a trusted official source made people more likely to accept the reality that the earth is warming. Finally, for disagreements that can’t be definitively settled with statistics or evidence, making a convincing argument may depend on engaging the audience’s values. For example, researchers have conducted a number of studies where they’ve asked people of different political backgrounds to rank their values. Liberals in these studies, on average, rank fairness— here meaning whether everyone is treated in the same way—above loyalty. In later studies, researchers attempted to convince liberals to support military spending with a variety of arguments. Arguments based on fairness— like that the military provides employment and education to people from disadvantaged backgrounds— were more convincing than arguments based on loyalty— such as that the military unifies a nation. These three elements— beliefs, trusted sources, and values— may seem like a simple formula for finding agreement and consensus. The problem is that our initial inclination is to think of arguments that rely on our own beliefs, trusted sources, and values. And even when we don’t, it can be challenging to correctly identify what’s held dear by people who don’t already agree with us. The best way to find out is simply to talk to them. In the course of discussion, you’ll be exposed to counter-arguments and rebuttals. These can help you make your own arguments and reasoning more convincing and sometimes, you may even end up being the one changing your mind.

**P612 2018-07-20 What really happened to the Library of Alexandria - Elizabeth Cox**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=612)

2,300 years ago, the rulers of Alexandria set out to fulfill one of humanity’s most audacious goals: to collect all the knowledge in the world under one roof. In its prime, the Library of Alexandria housed an unprecedented number of scrolls and attracted some of the Greek world’s greatest minds. But by the end of the 5th century CE, the great library had vanished. Many believed it was destroyed in a catastrophic fire. The truth of the library’s rise and fall is much more complex. The idea for the library came from Alexander the Great. After establishing himself as a conqueror, the former student of Aristotle turned his attention to building an empire of knowledge headquartered in his namesake city. He died before construction began, but his successor, Ptolemy I, executed Alexander’s plans for a museum and library. Located in the royal district of the city, the Library of Alexandria may have been built with grand Hellenistic columns, native Egyptian influences, or a unique blend of the two--there are no surviving accounts of its architecture. We do know it had lecture halls, classrooms, and, of course, shelves. As soon as the building was complete, Ptolemy I began to fill it with primarily Greek and Egyptian scrolls. He invited scholars to live and study in Alexandria at his expense. The library grew as they contributed their own manuscripts, but the rulers of Alexandria still wanted a copy of every book in the world. Luckily, Alexandria was a hub for ships traveling through the Mediterranean. Ptolemy III instituted a policy requiring any ship that docked in Alexandria to turn over its books for copying. Once the Library’s scribes had duplicated the texts, they kept the originals and sent the copies back to the ships. Hired book hunters also scoured the Mediterranean in search of new texts, and the rulers of Alexandria attempted to quash rivals by ending all exports of the Egyptian papyrus used to make scrolls. These efforts brought hundreds of thousands of books to Alexandria. As the library grew, it became possible to find information on more subjects than ever before, but also much more difficult to find information on any specific subject. Luckily, a scholar named Callimachus of Cyrene set to work on a solution, creating the pinakes, a 120-volume catalog of the library’s contents, the first of its kind. Using the pinakes, others were able to navigate the Library’s swelling collection. They made some astounding discoveries. 1,600 years before Columbus set sail, Eratosthenes not only realized the earth was round, but calculated its circumference and diameter within a few miles of their actual size. Heron of Alexandria created the world’s first steam engine over a thousand years before it was finally reinvented during the Industrial Revolution. For about 300 years after its founding in 283 BCE, the library thrived. But then, in 48 BCE, Julius Caesar laid siege to Alexandria and set the ships in the harbor on fire. For years, scholars believed the library burned as the blaze spread into the city. It's possible the fire destroyed part of the sprawling collection, but we know from ancient writings that scholars continued to visit the library for centuries after the siege. Ultimately, the library slowly disappeared as the city changed from Greek, to Roman, Christian, and eventually Muslim hands. Each new set of rulers viewed its contents as a threat rather than a source of pride. In 415 CE, the Christian rulers even had a mathematician named Hypatia murdered for studying the library’s ancient Greek texts, which they viewed as blasphemous. Though the Library of Alexandria and its countless texts are long gone, we’re still grappling with the best ways to collect, access, and preserve our knowledge. There’s more information available today and more advanced technology to preserve it, though we can’t know for sure that our digital archives will be more resistant to destruction than Alexandria’s ink and paper scrolls. And even if our reservoirs of knowledge are physically secure, they will still have to resist the more insidious forces that tore the library apart: fear of knowledge, and the arrogant belief that the past is obsolete. The difference is that, this time, we know what to prepare for.

**P613 2018-07-24 Can you solve the rogue AI riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=613)

A hostile artificial intelligence called NIM has taken over the world’s computers. You’re the only person skilled enough to shut it down, and you’ll only have one chance. You’ve broken into NIM’s secret lab, and now you’re floating in a raft on top of 25 stories of electrified water. You’ve rigged up a remote that can lower the water level by ejecting it from grates in the sides of the room. If you can lower the water level to 0, you can hit the manual override, shut NIM off, and save the day. However, the AI knows that you’re here, and it can lower the water level, too, by sucking it through a trapdoor at the bottom of the lab. If NIM is the one to lower the water level to 0, you’ll be sucked out of the lab, resulting in a failed mission. Control over water drainage alternates between you and NIM, and neither can skip a turn. Each of you can lower the water level by exactly 1, 3, or 4 stories at a time. Whoever gets the level exactly to 0 on their turn will win this deadly duel. Note that neither of you can lower the water below 0; if the water level is at 2, then the only move is to lower the water level 1 story. You know that NIM has already computed all possible outcomes of the contest, and will play in a way that maximizes its chance of success. You go first. How can you survive and shut off the artificial intelligence? Pause here if you want to figure it out for yourself. Answer in: 3 Answer in: 2 Answer in: 1 You can’t leave anything up to chance - NIM will take any advantage it can get. And you’ll need to have a response to any possible move it makes. The trick here is to start from where you want to end and work backwards. You want to be the one to lower the water level to 0, which means you need the water level to be at 1, 3, or 4 when control switches to you. If the water level were at 2, your only option would be to lower it 1 story, which would lead to NIM making the winning move. If we color code the water levels, we can see a simple principle at play: there are “losing” levels like 2, where no matter what whoever starts their turn there does, they’ll lose. And there are winning levels, where whoever starts their turn there can either win or leave their opponent with a losing level. So not only are 1, 3, and 4 winning levels, but so are 5 and 6, since you can send your opponent to 2 from there. What about 7? From 7, all possible moves would send your opponent to a winning level, making this another losing level. And we can continue up the lab in this way. If you start your turn 1, 3, or 4 levels above a losing level, then you’re at a winning level. Otherwise, you’re destined to lose. You could continue like this all the way to level 25. But as a shortcut, you might notice that levels 8 through 11 are colored identically to 1 through 4. Since a level’s color is determined by the levels 1, 3, and 4 stories below it, this means that level 12 will be the same color as level 5, 13 will match 6, 14 will match 7, and so on, In particular, the losing levels will always be multiple of 7, and two greater than multiples of 7. Now, from your original starting level of 25, you have to make sure your opponent starts on a losing level every single turn— if NIM starts on a winning level even once, it’s game over for you. So your only choice on turn 1 is to lower the water level by 4 stories. No matter what the AI does, you can continue giving it losing levels until you reach 0 and trigger the manual override. And with that, the crisis is averted. Now, back to a less stressful kind of surfing.

**P614 2018-07-25 How do cigarettes affect the body - Krishna Sudhir**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=614)

Cigarettes aren’t good for us. That’s hardly news--we’ve known about the dangers of smoking for decades. But how exactly do cigarettes harm us? Let’s look at what happens as their ingredients make their way through our bodies, and how we benefit physically when we finally give up smoking. With each inhalation, smoke brings its more than 5,000 chemical substances into contact with the body’s tissues. From the start, tar, a black, resinous material, begins to coat the teeth and gums, damaging tooth enamel, and eventually causing decay. Over time, smoke also damages nerve-endings in the nose, causing loss of smell. Inside the airways and lungs, smoke increases the likelihood of infections, as well as chronic diseases like bronchitis and emphysema. It does this by damaging the cilia, tiny hairlike structures whose job it is to keep the airways clean. It then fills the alveoli, tiny air sacs that enable the exchange of oxygen and carbon dioxide between the lungs and blood. A toxic gas called carbon monoxide crosses that membrane into the blood, binding to hemoglobin and displacing the oxygen it would usually have transported around the body. That’s one of the reasons smoking can lead to oxygen deprivation and shortness of breath. Within about 10 seconds, the bloodstream carries a stimulant called nicotine to the brain, triggering the release of dopamine and other neurotransmitters including endorphins that create the pleasurable sensations which make smoking highly addictive. Nicotine and other chemicals from the cigarette simultaneously cause constriction of blood vessels and damage their delicate endothelial lining, restricting blood flow. These vascular effects lead to thickening of blood vessel walls and enhance blood platelet stickiness, increasing the likelihood that clots will form and trigger heart attacks and strokes. Many of the chemicals inside cigarettes can trigger dangerous mutations in the body’s DNA that make cancers form. Additionally, ingredients like arsenic and nickel may disrupt the process of DNA repair, thus compromising the body’s ability to fight many cancers. In fact, about one of every three cancer deaths in the United States is caused by smoking. And it’s not just lung cancer. Smoking can cause cancer in multiple tissues and organs, as well as damaged eyesight and weakened bones. It makes it harder for women to get pregnant. And in men, it can cause erectile dysfunction. But for those who quit smoking, there’s a huge positive upside with almost immediate and long-lasting physical benefits. Just 20 minutes after a smoker’s final cigarette, their heart rate and blood pressure begin to return to normal. After 12 hours, carbon monoxide levels stabilize, increasing the blood’s oxygen-carrying capacity. A day after ceasing, heart attack risk begins to decrease as blood pressure and heart rates normalize. After two days, the nerve endings responsible for smell and taste start to recover. Lungs become healthier after about one month, with less coughing and shortness of breath. The delicate hair-like cilia in the airways and lungs start recovering within weeks, and are restored after 9 months, improving resistance to infection. By the one-year anniversary of quitting, heart disease risk plummets to half as blood vessel function improves. Five years in, the chance of a clot forming dramatically declines, and the risk of stroke continues to reduce. After ten years, the chances of developing fatal lung cancer go down by 50%, probably because the body’s ability to repair DNA is once again restored. Fifteen years in, the likelihood of developing coronary heart disease is essentially the same as that of a non-smoker. There’s no point pretending this is all easy to achieve. Quitting can lead to anxiety and depression, resulting from nicotine withdrawal. But fortunately, such effects are usually temporary. And quitting is getting easier, thanks to a growing arsenal of tools. Nicotine replacement therapy through gum, skin patches, lozenges, and sprays may help wean smokers off cigarettes. They work by stimulating nicotine receptors in the brain and thus preventing withdrawal symptoms, without the addition of other harmful chemicals. Counselling and support groups, cognitive behavioral therapy, and moderate intensity exercise also help smokers stay cigarette-free. That’s good news, since quitting puts you and your body on the path back to health.

**P615 2018-07-25 What would happen if every human suddenly disappeared - Dan Kwartler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=615)

Human beings are everywhere. With settlements on every continent, we can be found in the most isolated corners of Earth’s jungles, oceans, and tundras. Our impact is so profound, most scientists believe humanity has left a permanent mark on Earth’s geological record. So what would happen if suddenly, every human on Earth disappeared? With no one maintaining them, some of our creations backfire immediately. Hours after we disappear, oil refineries malfunction, producing month-long blazes at plants like the ones in western India, the southern United States, and South Korea. In underground rail systems like those in London, Moscow, and New York City, hundreds of drainage pumps are abandoned, flooding the tunnels in just three days. By the end of the first week, most emergency generators have shut down, and once the fires have gone out, the earth goes dark for the first time in centuries. After the first catastrophic month, changes come more gradually. Within 20 years, sidewalks have been torn apart by weeds and tree roots. Around this time, flooded tunnels erode the streets above into urban rivers. In temperate climates, the cycle of seasons freezes and thaws these waterways, cracking pavement and concrete foundations. Leaking pipes cause the same reaction in concrete buildings, and within 200 winters, most skyscrapers buckle and tumble down. In cities built in river deltas like Houston, these buildings eventually wash away completely - filling nearby tributaries with crushed concrete. Rural and suburban areas decay more slowly, but in largely unsurprising ways. Leaks, mold, bug and rodent infestations - all the usual enemies of the homeowner- now go uncontested. Within 75 years, most houses' supporting beams have rotted and sagged, and the resulting collapsed heap is now home to local rodents and lizards. But in this post-human world, “local” has a new meaning. Our cities are full of imported plants, which now run wild across their adopted homes. Water hyacinth coat the waterways of Shanghai in a thick green carpet. Poisonous giant hogweeds overgrow the banks of London’s Thames River. Chinese Ailanthus trees burst through New York City streets. And as sunken skyscrapers add crumbled concrete to the new forest floor, the soil acidity plummets, potentially allowing new plant life to thrive. This post-human biodiversity extends into the animal kingdom, as well. Animals follow the unchecked spread of native and non-native plants, venturing into new habitats with the help of our leftover bridges. In general, our infrastructure saves some animals and dooms others. Cockroaches continue to thrive in their native tropical habitats, but without our heating systems, their urban cousins likely freeze and die out in just two winters. And most domesticated animals are unable to survive without us – save for a handful of resourceful pigs, dogs, and feral housecats. Conversely, the reduced light pollution saves over a billion birds each year whose migrations were disrupted by blinking communication tower lights and high-tension wires. And mosquitos multiply endlessly in one of their favorite manmade nurseries – rubber tires, which last for almost a thousand years. As fauna and flora flourish, Earth’s climate slowly recovers from millennia of human impact. Within 35,000 years, the plant cycle removes the last traces of lead left by the Industrial Revolution from Earth’s soil, and it may take up to 65,000 years beyond that for CO2 to return pre-human levels. But even after several million years, humanity’s legacy lives on. Carved in unyielding granite, America’s Mt. Rushmore survives for 7.2 million years. The chemical composition of our bronze sculptures keeps them recognizable for over 10 million. And buried deep underground, the remnants of cities built on floodplains have been preserved in time as a kind of technofossil. Eventually, these traces, too, will be wiped from the planet’s surface. Humanity hasn’t always been here, and we won’t be here forever. But by investigating the world without us, perhaps we can learn more about the world we live in now.

**P616 2018-07-25 Why is Aristophanes called 'The Father of Comedy' - Mark Robinson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=616)

At the annual Athenian drama festival in 426 BC, a comic play called The Babylonians, written by a young poet named Aristophanes, was awarded first prize. But the play’s depiction of Athens’ conduct during the Peloponnesian War was so controversial that afterwards, a politician named Kleon took Aristophanes to court for "slandering the people of Athens in the presence of foreigners." Aristophanes struck back two years later with a play called The Knights. In it, he openly mocked Kleon, ending with Kleon’s character working as a lowly sausage seller outside the city gates. This style of satire was a consequence of the unrestricted democracy of 5th century Athens and is now called "Old Comedy." Aristophanes’ plays, the world’s earliest surviving comic dramas, are stuffed full of parodies, songs, sexual jokes, and surreal fantasy. They often use wild situations, like a hero flying to heaven on a dung beetle, or a net cast over a house to keep the owner’s father trapped inside, in order to subvert audience expectations. And they’ve shaped how comedy’s been written and performed ever since. The word "comedy" comes from the Ancient Greek "komos," – revel, and "oide," – singing, and it differed from its companion art form, "tragedy" in many ways. Where ancient Athenian tragedies dealt with the downfall of the high and mighty, their comedies usually ended happily. And where tragedy almost always borrowed stories from legend, comedy addressed current events. Aristophanes’ comedies celebrated ordinary people and attacked the powerful. His targets were arrogant politicians, war-mongering generals, and self-important intellectuals, exactly the people who sat in the front row of the theatre, where everyone could see their reactions. As a result, they were referred to as komoidoumenoi: "those made fun of in comedy." Aristophanes’ vicious and often obscene mockery held these leaders to account, testing their commitment to the city. One issue, in particular, inspired much of Aristophanes’ work: the Peloponnesian War between Athens and Sparta. In Peace, written in 421 BC, a middle-aged Athenian frees the embodiment of peace from a cave, where she’d been exiled by profiteering politicians. Then, in the aftermath of a crushing naval defeat for Athens in 411 BC, Aristophanes wrote "Lysistrata." In this play, the women of Athens grow sick of war and go on a sex strike until their husbands make peace. Other plays use similarly fantastic scenarios to skewer topical situations, such as in "Clouds," where Aristophanes mocked fashionable philosophical thinking. The hero Strepsiades enrolls in Socrates’s new philosophical school, where he learns how to prove that wrong is right and that a debt is not a debt. No matter how outlandish these plays get, the heroes always prevail in the end. Aristophanes also became the master of the parabasis, a comic technique where actors address the audience directly, often praising the playwright or making topical comments and jokes. For example, in "Birds," the Chorus takes the role of different birds and threatens the Athenian judges that if their play doesn’t win first prize, they’ll defecate on them as they walk around the city. Perhaps the judges didn’t appreciate the joke, as the play came in second. By exploring new ideas and encouraging self-criticism in Athenian society, Aristophanes not only mocked his fellow citizens, but he shaped the nature of comedy itself. Hailed by some scholars as the father of comedy, his fingerprints are visible upon comic techniques everywhere, from slapstick to double acts to impersonations to political satire. Through the praise of free speech and the celebration of ordinary heroes, his plays made his audience think while they laughed. And his retort to Kleon in 425 BC still resonates today: “I’m a comedian, so I’ll speak about justice, no matter how hard it sounds to your ears.”

**P617 2018-07-25 Why should you read Edgar Allan Poe - Scott Peeples**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=617)

A high forehead topped by disheveled black hair, a sickly pallor, and a look of deep intelligence and deeper exhaustion in his dark, sunken eyes. Edgar Allan Poe’s image is not just instantly recognizable – it’s perfectly suited to his reputation. From the prisoner strapped under a descending pendulum blade, to a raven who refuses to leave the narrator’s chamber, Poe’s macabre and innovative stories of gothic horror have left a timeless mark on literature. But just what is it that makes Edgar Allan Poe one of the greatest American authors? After all, horror was a popular genre of the period, with many practitioners. Yet Poe stood out thanks to his careful attention to form and style. As a literary critic, he identified two cardinal rules for the short story form: it must be short enough to read in one sitting, and every word must contribute to its purpose. By mastering these rules, Poe commands the reader’s attention and rewards them with an intense and singular experience – what Poe called the unity of effect. Though often frightening, this effect goes far beyond fear. Poe’s stories use violence and horror to explore the paradoxes and mysteries of love, grief, and guilt, while resisting simple interpretations or clear moral messages. And while they often hint at supernatural elements, the true darkness they explore is the human mind and its propensity for self-destruction. In “The Tell-Tale Heart,” a ghastly murder is juxtaposed with the killer’s tender empathy towards the victim – a connection that soon returns to haunt him. The title character of "Ligeia" returns from the dead through the corpse of her husband’s second wife – or at least the opium-addicted narrator thinks she does. And when the protagonist of “William Wilson” violently confronts a man he believes has been following him, he might just be staring at his own image in a mirror. Through his pioneering use of unreliable narrators, Poe turns readers into active participants who must decide when a storyteller might be misinterpreting or even lying about the events they’re relating. Although he’s best known for his short horror stories, Poe was actually one of the most versatile and experimental writers of the nineteenth century. He invented the detective story as we know it, with “The Murders in the Rue Morgue,” followed by “The Mystery of Marie Roget” and “The Purloined Letter.” All three feature the original armchair detective, C. Auguste Dupin, who uses his genius and unusual powers of observation and deduction to solve crimes that baffle the police. Poe also wrote satires of social and literary trends, and hoaxes that in some cases anticipated science fiction. Those included an account of a balloon voyage to the moon, and a report of a dying patient put into a hypnotic trance so he could speak from the other side. Poe even wrote an adventure novel about a voyage to the South Pole and a treatise on astrophysics, all while he worked as an editor, producing hundreds of pages of book reviews and literary theory. An appreciation of Poe’s career wouldn’t be complete without his poetry: haunting and hypnotic. His best-known poems are songs of grief, or in his words, “mournful and never-ending remembrance.” “The Raven,” in which the speaker projects his grief onto a bird who merely repeats a single sound, made Poe famous. But despite his literary success, Poe lived in poverty throughout his career, and his personal life was often as dark as his writing. He was haunted by the loss of his mother and his wife, who both died of tuberculosis at the age of 24. Poe struggled with alcoholism and frequently antagonized other popular writers. Much of his fame came from posthumous – and very loose – adaptations of his work. And yet, if he could’ve known how much pleasure and inspiration his writing would bring to generations of readers and writers alike, perhaps it may have brought a smile to that famously brooding visage.

**P618 2018-07-27 Can you solve the Leonardo da Vinci riddle - Tanya Khovanova**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=618)

You’ve found Leonardo Da Vinci’s secret vault, secured by a series of combination locks. Fortunately, your treasure map has three codes: 1210, 3211000, and… hmm. The last one appears to be missing. Looks like you’re gonna have to figure it out on your own. There’s something those first two numbers have in common: they’re what’s called autobiographical numbers. This is a special type of number whose structure describes itself. Each of an autobiographical number’s digits indicates how many times the digit corresponding to that position occurs within the number. The first digit indicates the quantity of zeroes, the second digit indicates the number of ones, the third digit the number of twos, and so on until the end. The last lock takes a 10 digit number, and it just so happens that there’s exactly one ten-digit autobiographical number. What is it? Pause here if you want to figure it out for yourself! Answer in: 3 Answer in: 2 Answer in: 1 Blindly trying different combinations would take forever. So let’s analyze the autobiographical numbers we already have to see what kinds of patterns we can find. By adding all the digits in 1210 together, we get 4 – the total number of digits. This makes sense since each individual digit tells us the number of times a specific digit occurs within the total. So the digits in our ten-digit autobiographical number must add up to ten. This tells us another important thing – the number can’t have too many large digits. For example, if it included a 6 and a 7, then some digit would have to appear 6 times, and another digit 7 times– making more than 10 digits. We can conclude that there can be no more than one digit greater than 5 in the entire sequence. So out of the four digits 6, 7, 8, and 9, only one – if any-- will make the cut. And there will be zeroes in the positions corresponding to the numbers that aren’t used. So now we know that our number must contain at least three zeroes – which also means that the leading digit must be 3 or greater. Now, while this first digit counts the number of zeroes, every digit after it counts how many times a particular non-zero digit occurs. If we add together all the digits besides the first one – and remember, zeroes don’t increase the sum – we get a count of how many non-zero digits appear in the sequence, including that leading digit. For example, if we try this with the first code, we get 2 plus 1 equals 3 digits. Now, if we subtract one, we have a count of how many non-zero digits there are after the first digit – two, in our example. Why go through all that? Well, we now know something important: the total quantity of non-zero digits that occur after the first digit is equal to the sum of these digits, minus one. And how can you get a distribution where the sum is exactly 1 greater than the number of non-zero positive integers being added together? The only way is for one of the addends to be a 2, and the rest 1s. How many 1s? Turns out there can only be two – any more would require additional digits like 3 or 4 to count them. So now we have the leading digit of 3 or greater counting the zeroes, a 2 counting the 1s, and two 1s – one to count the 2s and another to count the leading digit. And speaking of that, it’s time to find out what the leading digit is. Since we know that the 2 and the double 1s have a sum of 4, we can subtract that from 10 to get 6. Now it’s just a matter of putting them all in place: 6 zeroes, 2 ones, 1 two, 0 threes, 0 fours, 0 fives, 1 six, 0 sevens, 0 eights, and 0 nines. The safe swings open, and inside you find... Da Vinci’s long-lost autobiography.

**P619 2018-07-31 The fascinating history of cemeteries - Keith Eggener**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=619)

Spindly trees, rusted gates, crumbling stone, a solitary mourner— these things come to mind when we think of cemeteries. But not so long ago, many burial grounds were lively places, with blooming gardens and crowds of people strolling among the headstones. How did our cemeteries become what they are today? Some have been around for centuries, like the world’s largest, Wadi al-Salaam, where more than five million people are buried. But most of the places we’d recognize as cemeteries are much younger. In fact, for much of human history, we didn’t bury our dead at all. Our ancient ancestors had many other ways of parting with the dead loved ones. Some were left in caves, others in trees or on mountaintops. Still others were sunk in lakes, put out to sea, ritually cannibalized, or cremated. All of these practices, though some may seem strange today, were ways of venerating the dead. By contrast, the first known burials about 120,000 years ago were likely reserved for transgressors, excluding them from the usual rites intended to honor the dead. But the first burials revealed some advantages over other practices: they protected bodies from scavengers and the elements, while shielding loved ones from the sight of decay. These benefits may have shifted ancient people’s thinking toward graves designed to honor the dead, and burial became more common. Sometimes, these graves contained practical or ritual objects, suggesting belief in an afterlife Communal burials first appeared in North Africa and West Asia around 10 to 15,000 years ago, around the same time as the first permanent settlements in these areas. These burial grounds created permanent places to commemorate the dead. The nomadic Scythians littered the steppes with grave mounds known as kurgans. The Etruscans built expansive necropoles, their grid-patterned streets lined with tombs. In Rome, subterranean catacombs housed both cremation urns and intact remains. The word cemetery, or “sleeping chamber,” was first used by ancient Greeks, who built tombs in graveyards at the edges of their cities. In medieval European cities, Christian churchyards provided rare, open spaces that accommodated the dead, but also hosted markets, fairs, and other events. Farmers even grazed cattle in them, believing graveyard grass made for sweeter milk. As cities grew during the industrial revolution, large suburban cemeteries replaced smaller urban churchyards. Cemeteries like the 110-acre Père-Lachaise in Paris or the 72-acre Mt. Auburn in Cambridge, Massachusetts were lushly landscaped gardens filled with sculpted stones and ornate tombs. Once a luxury reserved for the rich and powerful, individually marked graves became available to the middle and working classes. People visited cemeteries for funerals, but also for anniversaries, holidays, or simply an afternoon outdoors. By the late 19th century, as more public parks and botanical gardens appeared, cemeteries began to lose visitors. Today, many old cemeteries are lonely places. Some are luring visitors back with tours, concerts, and other attractions. But even as we revive old cemeteries, we’re rethinking the future of burial. Cities like London, New York, and Hong Kong are running out of burial space. Even in places where space isn’t so tight, cemeteries permanently occupy land that can’t be otherwise cultivated or developed. Traditional burial consumes materials like metal, stone, and concrete, and can pollute soil and groundwater with toxic chemicals. With increasing awareness of the environmental costs, people are seeking alternatives. Many are turning to cremation and related practices. Along with these more conventional practices, people can now have their remains shot into space, used to fertilize a tree, or made into jewelry, fireworks, and even tattoo ink. In the future, options like these may replace burial completely. Cemeteries may be our most familiar monuments to the departed, but they’re just one step in our ever-evolving process of remembering and honoring the dead.

**P620 2018-08-01 Everything you need to know to read “The Canterbury Tales” - Iseult G**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=620)

A portly Miller, barely sober enough to sit on his horse, rambles on about the flighty wife of a crotchety old carpenter and the scholar she takes as her lover. To get some time alone together, the scholar and the wife play various tricks that involve feigning madness, staging a biblical flood, and exposing themselves in public. But the parish clerk is also lusting after the wife, and comes by every night to sing outside her house. This becomes so tiresome that she tries to scare him away by hanging her rear end out the window for him to kiss. When this appears not to work, her scholar decides to try farting in the same position, but this time, the clerk is waiting with a red-hot poker. This might all sound like a bawdy joke, but it’s part of one of the most esteemed works of English literature ever created: The Canterbury Tales, which seamlessly blends the lofty and the lowly. The work consists of 24 stories, each told by one of Chaucer’s spirited characters. Narrators include familiar Medieval figures such as a Knight, a Clerk, and a Nun, and the less recognizable Reeve, and Mancible, and others. The Tales are written in Middle English, which often looks entirely different from the language spoken today. It was used between the 12th and 15th centuries, and evolved from Old English due to increased contact with European romantic languages after the Norman Conquest of 1066. Most of the Middle English alphabet is still familiar today, with the inclusion of a few archaic symbols, such as yogh, which denotes the y, j, or gh sound. The loquacious cast of the Tales first meet at the Tabard Inn in Southwark. They have a journey in common: a pilgrimage to Canterbury to visit the shrine of St. Thomas Beckett, a martyred archbishop who was murdered in his own Cathedral. Eager and nosy for some personal details, the host of the Inn proposes a competition: whoever tells the best tale will be treated to dinner. If not for their pilgrimage, many of these figures would never have had the chance to interact. This is because Medieval society followed a feudal system that divided the clergy and nobility from the working classes, made up of peasants and serfs. By Chaucer’s time, a professional class of merchants and intellectuals had also emerged. Chaucer spent most of his life as a government official during the Hundred Years' War, traveling throughout Italy and France, as well as his native England. This may have influenced the panoramic vision of his work, and in the Tales, no level of society is above mockery. Chaucer uses the quirks of the characters’ language – the ribald humor of the Cook, the solemn prose of the Parson, and the lofty notions of the Squire – to satirize their worldviews. The varied dialects, genres, and literary tropes also make the work a vivid record of the different ways Medieval audiences entertained themselves. For instance, the Knight’s tale of courtly love, chivalry, and destiny riffs on romance, while the tales of working-class narrators are generally comedies filled with scatological language, sexual deviance, and slapstick. This variation includes something for everyone, and that’s one reason why readers continue to delight in the work in both Middle English and translation. While the narrative runs to over 17,000 lines, it's apparently unfinished, as the prologue ambitiously introduces 29 pilgrims and promises four stories apiece, and the innkeeper never crowns a victor. It’s possible that Chaucer was so caught up in his sumptuous creations that he delayed picking a winner - or perhaps he was so fond of each character that he just couldn’t choose. Whatever the reason, this means that every reader is free to judge; the question of who wins is up to you.

**P621 2018-08-06 Why should you read 'One Hundred Years of Solitude' - Francisco Díez-**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=621)

One day in 1965, while driving to Acapulco for a vacation with his family, Colombian journalist Gabriel García Márquez abruptly turned his car around, asked his wife to take care of the family’s finances for the coming months, and returned home. The beginning of a new book had suddenly come to him: “Many years later, as he faced the firing squad, Colonel Aureliano Buendía was to remember that distant afternoon when his father took him to discover ice.” Over the next eighteen months, those words would blossom into One Hundred Years of Solitude. A novel that would go on to bring Latin American literature to the forefront of the global imagination, earning García Márquez the 1982 Nobel Prize for Literature. What makes One Hundred Years of Solitude so remarkable? The novel chronicles the fortunes and misfortunes of the Buendía family over seven generations. With its lush, detailed sentences, large cast of characters, and tangled narrative, One Hundred Years of Solitude is not an easy book to read. But it’s a deeply rewarding one, with an epic assortment of intense romances, civil war, political intrigue, globe-trotting adventurers, and more characters named Aureliano than you’d think possible. Yet this is no mere historical drama. One Hundred Years of Solitude is one of the most famous examples of a literary genre known as magical realism. Here, supernatural events or abilities are described in a realistic and matter-of-fact tone, while the real events of human life and history reveal themselves to be full of fantastical absurdity. Surreal phenomena within the fictional village of Macondo intertwine seamlessly with events taking place in the real country of Colombia. The settlement begins in a mythical state of isolation, but is gradually exposed to the outside world, facing multiple calamities along the way. As years pass, characters grow old and die, only to return as ghosts, or to be seemingly reincarnated in the next generation. When the American fruit company comes to town, so does a romantic mechanic who is always followed by yellow butterflies. A young woman up and floats away. Although the novel moves forward through subsequent generations, time moves in an almost cyclical manner. Many characters have similar names and features to their forebears, whose mistakes they often repeat. Strange prophecies and visits from mysterious gypsies give way to the skirmishes and firing squads of repeated civil wars. An American fruit company opens a plantation near the village and ends up massacring thousands of striking workers, mirroring the real-life ‘Banana Massacre’ of 1928. Combined with the novel’s magical realism, this produces a sense of history as a downward spiral the characters seem powerless to escape. Beneath the magic is a story about the pattern of Colombian and Latin American history from colonial times onward. This is a history that the author experienced firsthand. Gabriel García Márquez grew up in a Colombia torn apart by civil conflict between its Conservative and Liberal political parties. He also lived in an autocratic Mexico and covered the 1958 Venezuelan coup d’état as a journalist. But perhaps his biggest influences were his maternal grandparents. Nicolás Ricardo Márquez was a decorated veteran of the Thousand Days War whose accounts of the rebellion against Colombia's conservative government led Gabriel García Márquez to a socialist outlook. Meanwhile, Doña Tranquilina Iguarán Cotes’ omnipresent superstition became the foundation of One Hundred Years of Solitude’s style. Their small house in Aracataca where the author spent his childhood formed the main inspiration for Macondo. With One Hundred Years of Solitude, Gabriel García Márquez found a unique way to capture the unique history of Latin America. He was able to depict the strange reality of living in a post-colonial society, forced to relive the tragedies of the past. In spite of all this fatalism, the novel still holds hope. At his Nobel Lecture, García Marquez reflected on Latin America’s long history of civil strife and rampant iniquity. Yet he ended the speech by affirming the possibility of building a better world, to quote, “where no one will be able to decide for others how they die, where love will prove true and happiness be possible, and where the races condemned to one hundred years of solitude will have, at last and forever, a second chance on earth."

**P623 2018-08-10 What is the universe expanding into - Sajan Saini**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=623)

The universe began its cosmic life in a big bang nearly fourteen billion years ago, and has been expanding ever since. But what is it expanding into? That's a complicated question. Here's why: Einstein's equations of general relativity describe space and time as a kind of inter-connected fabric for the universe. This means that what we know of as space and time exist only as part of the universe and not beyond it. Now, when everyday objects expand, they move out into more space. But if there is no such thing as space to expand into, what does expanding even mean? In 1929 Edwin Hubble's astronomy observations gave us a definitive answer. His survey of the night sky found all faraway galaxies recede, or move away, from the Earth. Moreover, the further the galaxy, the faster it recedes. How can we interpret this? Consider a loaf of raisin bread rising in the oven. The batter rises by the same amount in between each and every raisin. If we think of raisins as a stand-in for galaxies, and batter as the space between them, we can imagine that the stretching or expansion of intergalactic space will make the galaxies recede from each other, and for any galaxy, its faraway neighbors will recede a larger distance than the nearby ones in the same amount of time. Sure enough, the equations of general relativity predict a cosmic tug-of-war between gravity and expansion. It's only in the dark void between galaxies where expansion wins out, and space stretches. So there's our answer. The universe is expanding unto itself. That said, cosmologists are pushing the limits of mathematical models to speculate on what, if anything, exists beyond our spacetime. These aren't wild guesses, but hypotheses that tackle kinks in the scientific theory of the Big Bang. The Big Bang predicts matter to be distributed evenly across the universe, as a sparse gas --but then, how did galaxies and stars come to be? The inflationary model describes a brief era of incredibly rapid expansion that relates quantum fluctuations in the energy of the early universe, to the formation of clumps of gas that eventually led to galaxies. If we accept this paradigm, it may also imply our universe represents one region in a greater cosmic reality that undergoes endless, eternal inflation. We know nothing of this speculative inflating reality, save for the mathematical prediction that its endless expansion may be driven by an unstable quantum energy state. In many local regions, however, the energy may settle by random chance into a stable state, stopping inflation and forming bubble universes. Each bubble universe —ours being one of them —would be described by its own Big Bang and laws of physics. Our universe would be part of a greater multiverse, in which the fantastic rate of eternal inflation makes it impossible for us to encounter a neighbor universe. The Big Bang also predicts that in the early, hot universe, our fundamental forces may unify into one super-force. Mathematical string theories suggest descriptions of this unification, in addition to a fundamental structure for sub-atomic quarks and electrons. In these proposed models, vibrating strings are the building blocks of the universe. Competing models for strings have now been consolidated into a unified description, and suggest these structures may interact with massive, higher dimensional surfaces called branes. Our universe may be contained within one such brane, floating in an unknown higher dimensional place, playfully named “the bulk,” or hyperspace. Other branes—containing other types of universes—may co-exist in hyperspace, and neighboring branes may even share certain fundamental forces like gravity. Both eternal inflation and branes describe a multiverse, but while universes in eternal inflation are isolated, brane universes could bump into each other. An echo of such a collision may appear in the cosmic microwave background —a soup of radiation throughout our universe, that’s a relic from an early Big Bang era. So far, though, we’ve found no such cosmic echo. Some suspect these differing multiverse hypotheses may eventually coalesce into a common description, or be replaced by something else. As it stands now, they’re speculative explorations of mathematical models. While these models are inspired and guided by many scientific experiments, there are very few objective experiments to directly test them, yet. Until the next Edwin Hubble comes along, scientists will likely be left to argue about the elegance of their competing models… and continue to dream about what, if anything, lies beyond our universe.

**P624 2018-08-13 Can you solve the rebel supplies riddle - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=624)

You’re overseeing the delivery of crucial supplies to a rebel base deep in the heart of enemy territory. To get past Imperial customs, all packages must follow a strict protocol: if a box is marked with an even number on the bottom, it must be sealed with a red top. The boxes are already being loaded onto the transport when you receive an urgent message. One of the four boxes was sealed incorrectly, but they lost track of which one. All the boxes are still on the conveyor belt. Two are facing down: one marked with a four, and one with a seven. The other two are facing up: one with a black top, another with a red one. You know that any violation of the protocol will get the entire shipment confiscated and put your allies in grave danger. But any boxes you pull off for inspection won’t make it onto this delivery run, depriving the rebels of critically needed supplies. The transport leaves in a few moments, with or without its cargo. Which box or boxes should you grab off the conveyor belt? Pause the video now if you want to figure it out for yourself! Answer in: 3 Answer in: 2 Answer in: 1 It may seem like you need to inspect all four boxes to see what’s on the other side of each. But in fact, only two of them matter. Let’s look at the protocol again. All it says is that even-numbered boxes must have a red top. It doesn’t say anything about odd-numbered boxes, so we can just ignore the box marked with a seven. What about the box with a red top? Don’t we need to check that the number on the bottom is even? As it turns out, we don’t. The protocol says that if a box has an even number, then it should have a red top. It doesn’t say that only boxes with even numbers can have red tops, or that a box with a red top must have an even number. The requirement only goes in one direction. So we don’t need to check the box with the red lid. We do, however, need to check the one with the black lid, to make sure it wasn’t incorrectly placed on an even-numbered box. If you initially assumed the rules imply a symmetrical match between the number on the box and the type of lid, you’re not alone. That error is so common, we even have a name for it: affirming the consequent, or the fallacy of the converse. This fallacy wrongly assumes that just because a certain condition is necessary for a given result, it must also be sufficient for it. For instance, having an atmosphere is a necessary condition for being a habitable planet. But this doesn’t mean that it’s a sufficient condition – planets like Venus have atmospheres but lack other criteria for habitability. If that still seems hard to wrap your head around, let’s look at a slightly different problem. Imagine the boxes contain groceries. You see one marked for shipment to a steakhouse and one to a vegetarian restaurant. Then you see two more boxes turned upside down: one labeled as containing meat, and another as containing onions. Which ones do you need to check? Well, it’s easy – make sure the meat isn’t being shipped to the vegetarian restaurant, and that the box going there doesn’t contain meat. The onions can go to either place, and the box bound for the steakhouse can contain either product. Why does this scenario seem easier? Formally, it’s the same problem – two possible conditions for the top of the box, and two for the bottom. But in this case, they’re based on familiar real-world needs, and we easily understand that while vegetarians only eat vegetables, they’re not the only ones who do so. In the original problem, the rules seemed more arbitrary, and when they’re abstracted that way, the logical connections become harder to see. In your case, you’ve managed to get enough supplies through to enable the resistance to fight another day. And you did it by thinking outside the box – both sides of it.

**P625 2018-08-17 Is fire a solid, a liquid, or a gas - Elizabeth Cox**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=625)

Sitting around a campfire, you can feel its heat, smell the woody smoke, and hear it crackle. If you get too close, it burns your eyes and stings your nostrils. You could stare at the bright flames forever as they twist and flicker in endless incarnations. But what exactly are you looking at? The flames are obviously not solid, nor are they liquid. Mingling with the air, they’re more like a gas, but more visible--and more fleeting. And on a scientific level, fire differs from gas because gases can exist in the same state indefinitely while fires always burn out eventually. One misconception is that fire is a plasma, the fourth state of matter in which atoms are stripped of their electrons. Like fire and unlike the other kinds of matter, plasmas don’t exist in a stable state on earth. They only form when gas is exposed to an electric field or superheated to temperatures of thousands or tens of thousands of degrees. By contrast, fuels like wood and paper burn at a few hundred degrees —far below the threshold of what's usually considered a plasma. So if fire isn’t a solid, liquid, gas, or a plasma, what does that leave? It turns out fire isn’t actually matter at all. Instead, it’s our sensory experience of a chemical reaction called combustion. In a way, fire is like the leaves changing color in fall, the smell of fruit as it ripens, or a firefly’s blinking light. All of these are sensory clues that a chemical reaction is taking place. What differs about fire is that it engages a lot of our senses at the same time, creating the kind of vivid experience we expect to come from a physical thing. Combustion creates that sensory experience using fuel, heat, and oxygen. In a campfire, when the logs are heated to their ignition temperature, the walls of their cells decompose, releasing sugars and other molecules into the air. These molecules then react with airborne oxygen to create carbon dioxide and water. At the same time, any trapped water in the logs vaporizes, expands, ruptures the wood around it, and escapes with a satisfying crackle. As the fire heats up, the carbon dioxide and water vapor created by combustion expand. Now that they’re less dense, they rise in a thinning column. Gravity causes this expansion and rising, which gives flames their characteristic taper. Without gravity, molecules don’t separate by density and the flames have a totally different shape. We can see all of this because combustion also generates light. Molecules emit light when heated, and the color of the light depends on the temperature of the molecules. The hottest flames are white or blue. The type of molecules in a fire can also influence flame color. For instance, any unreacted carbon atoms from the logs form little clumps of soot that rise into the flames and emit the yellow-orange light we associate with a campfire. Substances like copper, calcium chloride, and potassium chloride can add their own characteristic hues to the mix. Besides colorful flames, fire also continues to generate heat as it burns. This heat sustains the flames by keeping the fuel at or above ignition temperature. Eventually, though, even the hottest fires run out of fuel or oxygen. Then, those twisting flames give a final hiss and disappear with a wisp of smoke as if they were never there at all.

**P626 2018-08-21 Does stress affect your memory - Elizabeth Cox**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=626)

You spend weeks studying for an important test. On the big day, you wait nervously as your teacher hands it out. You’re working your way through, when you’re asked to define ‘ataraxia.’ You know you’ve seen it before, but your mind goes blank. What just happened? The answer lies in the complex relationship between stress and memory. There are many types and degrees of stress and different kinds of memory, but we’re going to focus on how short-term stress impacts your memory for facts. To start, it helps to understand how this kind of memory works. Facts you read, hear, or study become memories through a process with three main steps. First comes acquisition: the moment you encounter a new piece of information. Each sensory experience activates a unique set of brain areas. In order to become lasting memories, these sensory experiences have to be consolidated by the hippocampus, influenced by the amygdala, which emphasizes experiences associated with strong emotions. The hippocampus then encodes memories, probably by strengthening the synaptic connections stimulated during the original sensory experience. Once a memory has been encoded, it can be remembered, or retrieved, later. Memories are stored all over the brain, and it’s likely the prefrontal cortex that signals for their retrieval. So how does stress affect each of these stages? In the first two stages, moderate stress can actually help experiences enter your memory. Your brain responds to stressful stimuli by releasing hormones known as corticosteroids, which activate a process of threat-detection and threat-response in the amygdala. The amygdala prompts your hippocampus to consolidate the stress-inducing experience into a memory. Meanwhile, the flood of corticosteroids from stress stimulates your hippocampus, also prompting memory consolidation. But even though some stress can be helpful, extreme and chronic stress can have the opposite effect. Researchers have tested this by injecting rats directly with stress hormones. As they gradually increased the dose of corticosteroids, the rats’ performance on memory tests increased at first, but dropped off at higher doses. In humans, we see a similar positive effect with moderate stress. But that only appears when the stress is related to the memory task— so while time pressure might help you memorize a list, having a friend scare you will not. And the weeks, months, or even years of sustained corticosteroids that result from chronic stress can damage the hippocampus and decrease your ability to form new memories. It would be nice if some stress also helped us remember facts, but unfortunately, the opposite is true. The act of remembering relies on the prefrontal cortex, which governs thought, attention, and reasoning. When corticosteroids stimulate the amygdala, the amygdala inhibits, or lessens the activity of, the prefrontal cortex. The reason for this inhibition is so the fight/flight/freeze response can overrule slower, more reasoned thought in a dangerous situation. But that can also have the unfortunate effect of making your mind go blank during a test. And then the act of trying to remember can itself be a stressor, leading to a vicious cycle of more corticosteroid release and an even smaller chance of remembering. So what can you do to turn stress to your advantage and stay calm and collected when it matters the most? First, if you know a stressful situation like a test is coming, try preparing in conditions similar to the stressful environment. Novelty can be a stressor. Completing practice questions under time pressure, or seated at a desk rather than on a couch, can make your stress response to these circumstances less sensitive during the test itself. Exercise is another useful tool. Increasing your heart and breathing rate is linked to chemical changes in your brain that help reduce anxiety and increase your sense of well-being. Regular exercise is also widely thought to improve sleeping patterns, which comes in handy the night before a test. And on the actual test day, try taking deep breaths to counteract your body’s flight/fight/freeze response. Deep breathing exercises have shown measurable reduction in test anxiety in groups ranging from third graders to nursing students. So the next time you find your mind going blank at a critical moment, take a few deep breaths until you remember ataraxia: a state of calmness, free from anxiety.

**P627 2018-08-21 What is imposter syndrome and how can you combat it - Elizabeth Cox**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=627)

Even after writing eleven books and winning several prestigious awards, Maya Angelou couldn’t escape the nagging doubt that she hadn’t really earned her accomplishments. Albert Einstein experienced something similar: he described himself as an “involuntary swindler” whose work didn’t deserve as much attention as it had received. Accomplishments at the level of Angelou’s or Einstein’s are rare, but their feeling of fraudulence is extremely common. Why can’t so many of us shake feelings that we haven’t earned our accomplishments, or that our ideas and skills aren’t worthy of others’ attention? Psychologist Pauline Rose Clance was the first to study this unwarranted sense of insecurity. In her work as a therapist, she noticed many of her undergraduate patients shared a concern: though they had high grades, they didn’t believe they deserved their spots at the university. Some even believed their acceptance had been an admissions error. While Clance knew these fears were unfounded, she could also remember feeling the exact same way in graduate school. She and her patients experienced something that goes by a number of names-- imposter phenomenon, imposter experience, and imposter syndrome. Together with colleague Suzanne Imes, Clance first studied imposterism in female college students and faculty. Their work established pervasive feelings of fraudulence in this group. Since that first study, the same thing has been established across gender, race, age, and a huge range of occupations, though it may be more prevalent and disproportionately affect the experiences of underrepresented or disadvantaged groups. To call it a syndrome is to downplay how universal it is. It's not a disease or an abnormality, and it isn’t necessarily tied to depression, anxiety, or self-esteem. Where do these feelings of fraudulence come from? People who are highly skilled or accomplished tend to think others are just as skilled. This can spiral into feelings that they don’t deserve accolades and opportunities over other people. And as Angelou and Einstein experienced, there’s often no threshold of accomplishment that puts these feelings to rest. Feelings of imposterism aren’t restricted to highly skilled individuals, either. Everyone is susceptible to a phenomenon known as pluralistic ignorance, where we each doubt ourselves privately, but believe we’re alone in thinking that way because no one else voices their doubts. Since it’s tough to really know how hard our peers work, how difficult they find certain tasks, or how much they doubt themselves, there’s no easy way to dismiss feelings that we’re less capable than the people around us. Intense feelings of imposterism can prevent people from sharing their great ideas or applying for jobs and programs where they’d excel. At least so far, the most surefire way to combat imposter syndrome is to talk about it. Many people suffering from imposter syndrome are afraid that if they ask about their performance, their fears will be confirmed. And even when they receive positive feedback, it often fails to ease feelings of fraudulence. But on the other hand, hearing that an advisor or mentor has experienced feelings of imposterism can help relieve those feelings. The same goes for peers. Even simply finding out there’s a term for these feelings can be an incredible relief. Once you’re aware of the phenomenon, you can combat your own imposter syndrome by collecting and revisiting positive feedback. One scientist who kept blaming herself for problems in her lab started to document the causes every time something went wrong. Eventually, she realized most of the problems came from equipment failure, and came to recognize her own competence. We may never be able to banish these feelings entirely, but we can have open conversations about academic or professional challenges. With increasing awareness of how common these experiences are, perhaps we can feel freer to be frank about our feelings and build confidence in some simple truths: you have talent, you are capable, and you belong.

**P628 2018-08-22 Is there any truth to the King Arthur legends - Alan Lupack**

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“Here lies Arthur, king who was, and king who will be.” So reads the inscription on King Arthur’s gravestone in Thomas Malory’s Le Morte d’Arthur. Writing in the 15th century, Malory couldn’t have known how prophetic this inscription would turn out to be. King Arthur has risen again and again in our collective imagination, along with his retinue of knights, Guinevere, the Round Table, Camelot, and of course, Excalibur. But where do these stories come from, and is there any truth to them? King Arthur as we know him is a creation of the later Middle Ages, but his legend actually has its roots in Celtic poetry from an earlier time: the Saxon invasions of Britain. After the Romans left Britain in 410 CE, Saxon invaders from what’s now Germany and Denmark quickly capitalized on the vulnerability of the abandoned territory. The inhabitants of Britain fought fiercely against the invaders through several centuries of turmoil. There are hardly any written records from this time, so it’s difficult to reconstruct an accurate history. However, surviving poetry from the era gives us some clues. One of the poems, The Gododdin, contains the very first reference to Arthur, though Arthur himself doesn’t actually appear in it. It says a different warrior, named Gwawrddur, was skilled at slaying his enemies, but was no Arthur. That’s not much to go on, but whoever this Arthur was, he must’ve been the gold standard of warriors. Whether he ruled anyone, or even lived at all is, unfortunately, less clear. Despite this uncertainty, references to Arthur caught the attention of an aspiring historian hundreds of years later. In 1130, Geoffrey of Monmouth was a lowly cleric with grand ambitions. Using Celtic and Latin sources, he spent years creating a lengthy chronicle titled, "The History of the Kings of Britain." The centerpiece of this tome was King Arthur. History is a generous term for Geoffrey’s account. Writing six hundred years after the Saxon invasions, he cobbled together fragments of myth and poetry to compensate for the almost complete lack of official records. A few of his sources contained mentions of Arthur, and some others were realistic accounts of battles and places. But many featured mythic heroes fighting long odds with the help of magical swords and sorcery. Geoffrey blended them all: A magical sword called Caledfwlch and a Roman fortress called Caerleon appeared in his source material, so Geoffrey’s Arthur ruled from Caerleon and wielded Caliburnus, the Latin translation of Caledfwlch. Geoffrey even added a wise counselor named Merlin, based on the Celtic bard Myrrdin, to Arthur’s story. If Arthur did live, he would likely have been a military leader, but a castle-bound king better fit Geoffrey’s regal history. Geoffrey’s chronicle got the attention he’d hoped for, and was soon translated from Latin into French by the poet Wace around 1155 CE. Wace added another centerpiece of Arthurian lore to Geoffrey’s sword, castle, and wizard: the Round Table. He wrote that Arthur had the table constructed so that all guests in his court would be equally placed, and none could boast that he had the highest position at the table. After reading Wace’s translation, another French poet, Chrétien de Troyes, wrote a series of romances that catapulted Arthur’s story to fame. He introduced tales of individual knights like Lancelot and Gawain, and mixed elements of romance in with the adventures. He conceived Arthur, Lancelot, and Guinevere’s love triangle. In addition to interpersonal intrigue, he also introduced the Holy Grail. Chrétien probably based his Grail’s powers on magical objects in Celtic mythology. He lived in the middle of the Crusades, and others imposed the preoccupations of the time on the Grail, casting it as a powerful relic from the crucifixion. Numerous adaptations in French and other languages followed from Chrétien’s work. In the course of these retellings, Caerleon became Camelot, and Caliburnus was rechristened Excalibur. In the 15th century, Sir Thomas Malory synthesized these stories in Le Morte D’arthur, the basis of many modern accounts of King Arthur. In the thousand years since Arthur first appeared in a Celtic poem, his story has transformed over and over to reflect the concerns of his chroniclers and their audiences. And we’re still rewriting and adapting the legend today. Whether or not the man ever lived, loved, reigned, or adventured, it’s undeniable that the character has achieved immortality.

**P629 2018-08-28 What’s a smartphone made of - Kim Preshoff**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=629)

As of 2018, there are around 2.5 billion smartphone users in the world. If we broke open all their newest phones, which are just a fraction of the total that’ve been built, and split them into their component parts, that would produce around 85,000 kilograms of gold, 875,000 of silver, and 40 million kilograms of copper. How did this precious cache get into our phones, and can we reclaim it? Gold, silver, and copper are actually just a few of the 70 or so chemical elements that make up the average smartphone. These can be divided into different groups, two of the most critical being rare earth elements and precious metals. Rare earths are a selection of 17 elements that are actually common in Earth’s crust and are found in many areas across the world in low concentrations. These elements have a huge range of magnetic, phosphorescent, and conductive properties that make them crucial to modern technologies. In fact, of the 17 types of rare earth metals, phones and other electronics may contain up to 16. In smartphones, these create the screen and color display, aid conductivity, and produce the signature vibrations, amongst other things. And yet, crucial as they are, extracting these elements from the earth is linked to some disturbing environmental impacts. Rare earth elements can often be found, but in many areas, it’s not economically feasible to extract them due to low concentrations. Much of the time, extracting them requires a method called open pit mining that exposes vast areas of land. This form of mining destroys huge swaths of natural habitats, and causes air and water pollution, threatening the health of nearby communities. Another group of ingredients in smartphones comes with similar environmental risks: these are metals such as copper, silver, palladium, aluminum, platinum, tungsten, tin, lead, and gold. We also mine magnesium, lithium, silica, and potassium to make phones, and all of it is associated with vast habitat destruction, as well as air and water pollution. Mining comes with worrying social problems, too, like large-scale human and animal displacement to make way for industrial operations, and frequently, poor working conditions for laborers. Lastly, phone production also requires petroleum, one of the main drivers of climate change. That entwines our smartphones inextricably with this growing planetary conundrum. And, what’s more, the ingredients we mine to make our phones aren’t infinite. One day, they’ll simply run out, and we haven’t yet discovered effective replacements for some. Despite this, the number of smartphones is on a steady increase; by 2019 it’s predicted that there’ll be close to 3 billion in use. This means that reclaiming the bounty within our phones is swiftly becoming a necessity. So, if you have an old phone, you might want to consider your options before throwing it away. To minimize waste, you could donate it to a charity for reuse, take it to an e-waste recycling facility, or look for a company that refurbishes old models. However, even recycling companies need our scrutiny. Just as the production of smartphones comes with social and environmental problems, dismantling them does too. E-waste is sometimes intentionally exported to countries where labor is cheap but working conditions are poor. Vast workforces, often made up of women and children, may be underpaid, lack the training to safely disassemble phones, and be exposed to elements like lead and mercury, which can permanently damage their nervous systems. Phone waste can also end up in huge dump sites, leaching toxic chemicals into the soil and water, mirroring the problems of the mines where the elements originated. A phone is much more than it appears to be on the surface. It’s an assemblage of elements from multiple countries, linked to impacts that are unfolding on a global scale. So, until someone invents a completely sustainable smartphone, we’ll need to come to terms with how this technology affects widespread places and people.

**P630 2018-09-04 What causes heartburn - Rusha Modi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=630)

Just between your chest and abdomen is where you’ll find one of the most important muscles you probably didn't know you had: the lower esophageal sphincter, or LES. When functioning properly, this ring of tissue plays a crucial role in helping us eat. But when the LES malfunctions, it becomes the main player in heartburn --a searing, sometimes sour-tasting chest-spasm that many people will experience at some point in their lives. We know that humans have been battling heartburn for hundreds, if not thousands of years. But recently the incidence has risen, making it a common stomach complaint worldwide. When the symptoms of heartburn become more more regular and intense —such as twice a week or more-- it’s diagnosed as Gastroesophageal Reflux Disease, or GERD. But what causes this problem, and how can it be stopped? Heartburn starts in an area called the gastroesophageal junction, where the LES resides. This smooth, muscular ring of the LES is moderated by an intricate tree of nerve roots that connect to the brain, the heart, and the lungs. After food enters the stomach from the esophagus, the muscle’s task is to stop it from surging back up again. The LES contracts, squeezing the stomach entrance and creating a high pressure zone that prevents digestive acids from seeping out. But if the LES relaxes at the wrong moment or gradually weakens, it becomes like a faulty, ill-fitting lid, causing the area to depressurize. That allows burning stomach acid-- and even chunks of food--to spurt into the esophagus, sometimes going as far up as the mouth. The cause of all this internal drama has long been put down to diet. Foods like caffeine and peppermint contain ingredients that may have a relaxing affect on the LES, which makes it incapable of doing its job. Other acidic foods, like citrus and tomatoes, can worsen irritation of the esophagus when they leach out with stomach acid. Carbonated beverages can similarly bubble up in the stomach, forcing open the valve. But researchers have discovered that food isn’t the only trigger. Smoking poses a risk, because the nicotine in cigarettes relaxes the LES. Consuming excessive amounts of alcohol may have a similar effect. Pregnant women often experience more heartburn due to the pressure of a growing baby on their stomachs. and the levels of certain hormones in their bodies. Obesity can cause hernias that disrupt the anti-reflux barrier of the gastroesophageal junction that normally protects against heartburn. Numerous medications, including those for asthma, high blood pressure, birth control, and depression can also have unintended effects on the LES. An occasional bout of heartburn isn't necessarily something to worry about. But, if heartburn starts happening regularly, it can weaken the LES muscle over time, letting more and more acid escape. And if it goes untreated, this can cause bigger problems. Over time, constant acid leakage from heartburn may form scar tissue which narrows the esophageal tube, making it harder to swallow food. Ongoing reflux can also damage the cells lining the esophagus--a rare condition called Barrett’s esophagus, which can elevate the risk of esophageal cancer. Luckily, heartburn is often treatable with a range of medicines that can help neutralize or reduce stomach acid. In extreme cases, some people have surgery to tighten the LES to minimize their distress. But we can often stop heartburn before it reaches that point. Reducing the consumption of certain foods, not smoking, and maintaining a healthy weight can all dramatically reduce reflux. With proper care we can help our LES’s keep the chemical fountain of our stomachs in proper order and avoid having to feel the burn.

**P631 2018-09-12 Can you solve the alien probe riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=631)

The discovery of an alien monolith on planet RH-1729 has scientists across the world racing to unlock its mysteries. Your engineering team has developed an elegant probe to study it. The probe is a collection of 27 cube modules capable of running all the scientific tests necessary to analyze the monolith. The modules can self-assemble into a large 3x3x3 cube, with each individual module placed anywhere in the cube, and at any orientation. It can also break itself apart and reassemble into any other orientation. Now comes your job. The probe will need a special protective coating for each of the extreme environments it passes through. The red coating will seal it against the cold of deep space, the purple coating will protect it from the intense heat as it enters the atmosphere of RH-1729, and the green coating will shield it from the alien planet’s electric storms. You can apply the coatings to each of the faces of all 27 of the cubic modules in any way you like, but each face can only take a single color coating. You need to figure out how you can apply the colors so the cubes can re-assemble themselves to show only red, then purple, then green. How can you apply the colored coatings to the 27 cubes so the probe will be able to make the trip? Pause here if you want to figure it out yourself. You can start by painting the outside of the complete cube red, since you’ll need that regardless. Then you can break it into 27 pieces, and look at what you have. There are 8 corner cubes, which each have three red faces, 12 edge cubes, which have two red faces, 6 face cubes, which have 1 red face, and a single center cube, which has no red faces. You’ve painted a total of 54 faces red at this point, so you’ll need the same number of faces for the green and purple cubes, too. When you’re done, you’ll have painted 54 faces red, 54 faces green, and 54 faces purple. That’s 162 faces, which is precisely how many the cubes have in total. So there’s no margin for waste. If there’s any way to do this, it’ll probably be highly symmetrical. Maybe you can use that to help you. You look at the center cube. You’d better paint it half green and half purple, so you can use it as a corner for each of those cubes, and not waste a single face. There’ll need to be center cubes with no green and no purple too. So you take 2 corner cubes from the red cube and paint the 3 blank faces of 1 purple, and the 3 blank faces of the other green. Now you’ve got the 6 face cubes that each have 1 face painted red. That leaves 5 empty faces on each. You can split them in half. In the first group, you paint 3 faces green and 2 faces purple; In the second group, paint 3 faces purple and 2 green. Counting on symmetry, you replicate these piles again with the colors rearranged. That gives you 6 with 1 green face, 6 with 1 red face, and 6 with 1 purple face. Counting up what you’ve completely painted, you see 8 corner cubes in each color, 6 edge cubes in each color, 6 face cubes in each color, and 1 center cube. That means you just need 6 more edge cubes in green and purple. And there are exactly 6 cubes left, each with 4 empty faces. You paint 2 faces of each green and 2 faces of each purple. And now you have a cube that’s perfectly painted to make an incredible trip. It rearranges itself to be red in deep space, purple as it enters RH-1729’s atmosphere, and green when it flies through the electric storms. As it reaches the monolith, you realize you’ve achieved something humans have dreamt of for eons: alien contact.

**P632 2018-09-14 Could the Earth be swallowed by a black hole - Fabio Pacucci**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=632)

From asteroids capable of destroying entire species, to gamma-ray bursts and supernovae that could exterminate life on Earth, outer space has no shortage of forces that could wreak havoc on our tiny planet. But there’s something in space that seems more terrifying than any of these – something that wipes out everything it comes near. Could the Earth be swallowed by a black hole? A black hole is an object so dense that space and time around it are inescapably modified, warped into an infinite sink. Nothing, not even light, can move fast enough to escape a black hole’s gravitational pull once it passes a certain boundary, known as the event horizon. Thus, a black hole is like a cosmic vacuum cleaner with infinite capacity, gobbling up everything in its path, and letting nothing out. To determine whether a black hole could swallow the Earth, we first have to figure out where they are. But since they don’t emit light, how’s that possible? Fortunately, we’re able to observe their effect on the space around them. When matter approaches a black hole, the immense gravitational field accelerates it to high speed. This emits an enormous amount of light. And for objects too far away to be sucked in, the massive gravitational force still affects their orbits. If we observe several stars orbiting around an apparently empty point, a black hole could be leading the dance. Similarly, light that passes close enough to an event horizon will be deflected in a phenomenon known as gravitational lensing. Most of the black holes that we’ve found can be thought of as two main types. The smaller ones, called stellar mass black holes, have a mass up to 100 times larger than that of our sun. They’re formed when a massive star consumes all its nuclear fuel and its core collapses. We’ve observed several of these objects as close as 3000 light-years away, and there could be up to 100 million small black holes just in the Milky Way galaxy. So should we be worried? Probably not. Despite their large mass, stellar black holes only have a radius of around 300 kilometers or less, making the chances of a direct hit with us miniscule. Although because their gravitational fields can affect a planet from a large distance, they could be dangerous even without a direct collision. If a typical stellar-mass black hole were to pass in the region of Neptune, the orbit of the Earth would be considerably modified, with dire results. Still, the combination of how small they are and how vast the galaxy is means that stellar black holes don’t give us much to worry about. But we still have to meet the second type: supermassive black holes. These have masses millions or billions times greater than that of our sun and have event horizons that could span billions of kilometers. These giants have grown to immense proportions by swallowing matter and merging with other black holes. Unlike their stellar cousins, supermassive black holes aren’t wandering through space. Instead, they lie at the center of galaxies, including our own. Our solar system is in a stable orbit around a supermassive black hole that resides at the center of the Milky Way, at a safe distance of 25,000 light-years. But that could change. If our galaxy collides with another, the Earth could be thrown towards the galactic center, close enough to the supermassive black hole to be eventually swallowed up. In fact, a collision with the Andromeda Galaxy is predicted to happen 4 billion years from now, which may not be great news for our home planet. But before we judge them too harshly, black holes aren’t simply agents of destruction. They played a crucial role in the formation of galaxies, the building blocks of our universe. Far from being shadowy characters in the cosmic play, black holes have fundamentally contributed in making the universe a bright and astonishing place.

**P633 2018-09-14 Why should you read 'Waiting For Godot' - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=633)

A shabby man named Estragon, sits near a tree at dusk and struggles to remove his boot. He’s soon joined by his friend Vladimir, who reminds his anxious companion that they must wait here for someone called Godot. So begins a vexing cycle in which the two debate when Godot will come, why they’re waiting, and whether they’re even at the right tree. From here, Waiting for Godot only gets stranger - but it’s considered a play that changed the face of modern drama. Written by Samuel Beckett between 1949 and 1955, it offers a simple but stirring question - what should the characters do? Estragon: Don’t let's do anything. It's safer. Vladimir: Let’s wait and see what he says. Estragon: Who? Vladimir: Godot. Estragon: Good idea. Such cryptic dialogue and circular reasoning are key features of the Theatre of the Absurd, a movement which emerged after the Second World War and found artists struggling to find meaning in devastation. The absurdists deconstructed plot, character and language to question their meaning and share their profound uncertainty on stage. While this may sound grim, the absurd blends its hopelessness with humor. This is reflected in Beckett’s unique approach to genre in Waiting for Godot, which he branded “a tragicomedy in two acts." Tragically, the characters are locked in an existential conundrum: they wait in vain for an unknown figure to give them a sense of purpose, but their only sense of purpose comes from the act of waiting, While they wait, they sink into boredom, express religious dread and contemplate suicide. But comically, there is a jagged humor to their predicament, which comes across in their language and movements. Their interactions are filled with bizarre wordplay, repetition and double entendres, as well as physical clowning, singing and dancing, and frantically swapping their hats. It’s often unclear whether the audience is supposed to laugh or cry - or whether Beckett saw any difference between the two. Born in Dublin, Beckett studied English, French and Italian before moving to Paris, where he spent most of his life writing theatre, poetry and prose. While Beckett had a lifelong love of language, he also made space for silence by incorporating gaps, pauses and moments of emptiness into his work. This was a key feature of his trademark uneven tempo and black humor, which became popular throughout the Theatre of the Absurd. He also cultivated a mysterious persona, and refused to confirm or deny any speculations about the meaning of his work. This kept audiences guessing, increasing their fascination with his surreal worlds and enigmatic characters. The lack of any clear meaning makes Godot endlessly open to interpretation. Critics have offered countless readings of the play, resulting in a cycle of ambiguity and speculation that mirrors the plot of the drama itself. It's been read as an allegory of the Cold War, the French Resistance, and Britain’s colonization of Ireland. The dynamic of the two protagonists has also sparked intense debate. They’ve been read as survivors of the apocalypse, an aging couple, two impotent friends, and even as personifications of Freud’s ego and id. Famously, Beckett said the only thing he could be sure of was that Vladimir and Estragon were "wearing bowler hats." Like the critical speculation and maddening plot, their language often goes in circles as the two bicker and banter, lose their train of thought, and pick up right where they left off: Vladimir: We could start all over again perhaps Estragon: That should be easy Vladimir: It’s the start that’s difficult Estragon: You can start from anything Vladimir: Yes, but you have to decide. Beckett reminds us that just like our daily lives, the world onstage doesn’t always make sense. It can explore both reality and illusion, the familiar and the strange. And although a tidy narrative still appeals, the best theatre keeps us thinking – and waiting.

**P634 2018-09-17 History through the eyes of a chicken - Chris A. Kniesly**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=634)

The annals of Ancient Egyptian king Thutmose III described a marvelous foreign bird that “gives birth daily.” Zoroastrians viewed them as spirits whose cries told of the cosmic struggle between darkness and light. Romans brought them on their military campaigns to foretell the success of future battles. And today, this bird still occupies an important, though much less honorable position – on our dinner plates. The modern chicken is descended primarily from the Red Junglefowl, and partially from three other closely related species, all native to India and Southeast Asia. The region’s bamboo plants produce massive amounts of fruit just once every few decades. Junglefowls’ ability to lay eggs daily may have evolved to take advantage of these rare feasts, increasing their population when food was abundant. This was something humans could exploit on a consistent basis, and the birds’ weak flight capabilities and limited need for space made them easy to capture and contain. The earliest domesticated chickens, dating at least back to 7,000 years ago, weren’t bred for food, but for something considered less savory today. The aggressiveness of breeding males, armed with natural leg spurs, made cockfighting a popular entertainment. By the second millennium BCE, chickens had spread from the Indus Valley to China and the Middle East to occupy royal menageries and to be used in religious rituals. But it was in Egypt where the next chapter in the bird’s history began. When a hen naturally incubates eggs, she will stop laying new ones and sit on a “clutch” of 6 or more eggs for 21 days. By the middle of the 1st millennium BCE, the Egyptians had learned to artificially incubate chicken eggs by placing them in baskets over hot ashes. That freed up hens to continue laying daily, and what had been a royal delicacy or religious offering became a common meal. Around the same time as Egyptians were incubating eggs, Phoenician merchants introduced chickens to Europe, where they quickly became an essential part of European livestock. However, for a long time, the chicken’s revered status continued to exist alongside its culinary one. The Ancient Greeks used fighting roosters as inspirational examples for young soldiers. The Romans consulted chickens as oracles. And as late as the 7th Century, the chicken was considered a symbol for Christianity. Over the next few centuries, chickens accompanied humans wherever they went, spreading throughout the world through trade, conquest, and colonization. After the Opium Wars, Chinese breeds were brought to England and crossed with local chickens. This gave rise to a phenomenon called “Hen Fever” or “The Fancy”, with farmers all over Europe striving to breed new varieties with particular combinations of traits. This trend also caught the attention of a certain Charles Darwin, who wondered if a similar selective breeding process occurred in nature. Darwin would observe hundreds of chickens while finalizing his historic work introducing the theory of Evolution. But the chicken’s greatest contribution to science was yet to come. In the early 20th century, a trio of British scientists conducted extensive crossbreeding of chickens, building on Gregor Mendel’s studies of genetic inheritance. With their high genetic diversity, many distinct traits, and only 7 months between generations, chickens were the perfect subject. This work resulted in the famous Punnett Square, used to show the genotypes that would result from breeding a given pairing. Since then, numerous breeding initiatives have made chickens bigger and meatier, and allowed them to lay more eggs than ever. Meanwhile, chicken production has shifted to an industrial, factory-like model, with birds raised in spaces with a footprint no larger than a sheet of paper. And while there’s been a shift towards free-range farming due to animal rights and environmental concerns, most of the world’s more than 22 billion chickens today are factory farmed. From gladiators and gifts to the gods, to traveling companions and research subjects, chickens have played many roles over the centuries. And though they may not have come before the proverbial egg, chickens’ fascinating history tells us a great deal about our own.

**P635 2018-09-17 The fascinating science behind phantom limbs - Joshua W. Pate**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=635)

The vast majority of people who’ve lost a limb can still feel it— not as a memory or vague shape, but in complete lifelike detail. They can flex their phantom fingers and sometimes even feel the chafe of a watchband or the throb of an ingrown toenail. And astonishingly enough, occasionally even people born without a limb can feel a phantom. So what causes phantom limb sensations? The accuracy of these apparitions suggests that we have a map of the body in our brains. And the fact that it’s possible for someone who’s never had a limb to feel one implies we are born with at least the beginnings of this map. But one thing sets the phantoms that appear after amputation apart from their flesh and blood predecessors: the vast majority of them are painful. To fully understand phantom limbs and phantom pain, we have to consider the entire pathway from limb to brain. Our limbs are full of sensory neurons responsible for everything from the textures we feel with our fingertips to our understanding of where our bodies are in space. Neural pathways carry this sensory input through the spinal cord and up to the brain. Since so much of this path lies outside the limb itself, most of it remains behind after an amputation. But the loss of a limb alters the way signals travel at every step of the pathway. At the site of an amputation, severed nerve endings can thicken and become more sensitive, transmitting distress signals even in response to mild pressure. Under normal circumstances, these signals would be curtailed in the dorsal horn of the spinal cord. For reasons we don’t fully understand, after an amputation, there is a loss of this inhibitory control in the dorsal horn, and signals can intensify. Once they pass through the spinal cord, sensory signals reach the brain. There, the somatosensory cortex processes them. The entire body is mapped in this cortex. Sensitive body parts with many nerve endings, like the lips and hands, are represented by the largest areas. The cortical homunculus is a model of the human body with proportions based on the size of each body part’s representation in the cortex, The amount of cortex devoted to a specific body part can grow or shrink based on how much sensory input the brain receives from that body part. For example, representation of the left hand is larger in violinists than in non-violinists. The brain also increases cortical representation when a body part is injured in order to heighten sensations that alert us to danger. This increased representation can lead to phantom pain. The cortical map is also most likely responsible for the feeling of body parts that are no longer there, because they still have representation in the brain. Over time, this representation may shrink and the phantom limb may shrink with it. But phantom limb sensations don’t necessarily disappear on their own. Treatment for phantom pain usually requires a combination of physical therapy, medications for pain management, prosthetics, and time. A technique called mirror box therapy can be very helpful in developing the range of motion and reducing pain in the phantom limb. The patient places the phantom limb into a box behind a mirror and the intact limb in front of the mirror. This tricks the brain into seeing the phantom rather than just feeling it. Scientists are developing virtual reality treatments that make the experience of mirror box therapy even more lifelike. Prosthetics can also create a similar effect— many patients report pain primarily when they remove their prosthetics at night. And phantom limbs may in turn help patients conceptualize prosthetics as extensions of their bodies and manipulate them intuitively. There are still many questions about phantom limbs. We don’t know why some amputees escape the pain typically associated with these apparitions, or why some don’t have phantoms at all. And further research into phantom limbs isn’t just applicable to the people who experience them. A deeper understanding of these apparitions will give us insight into the work our brains do every day to build the world as we perceive it. They’re an important reminder that the realities we experience are, in fact, subjective.

**P636 2018-09-20 What if cracks in concrete could fix themselves - Congrui Jin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=636)

Concrete is the most widely used construction material in the world. It can be found in swathes of city pavements, bridges that span vast rivers, and the tallest skyscrapers on earth. But this sturdy substance does have a weakness: it’s prone to catastrophic cracking that costs tens of billions of dollars to repair each year. But what if we could avoid that problem, by creating concrete that heals itself? This idea isn’t as far-fetched as it may seem. It boils down to an understanding of how concrete forms, and how to exploit that process to our benefit. Concrete is a combination of coarse stone and sand particles, called aggregates, that mix with cement, a powdered blend of clay and limestone. When water gets added to this mix, the cement forms a paste and coats the aggregates, quickly hardening through a chemical reaction called hydration. Eventually, the resulting material grows strong enough to prop up buildings that climb hundreds of meters into the sky. While people have been using a variety of recipes to produce cement for over 4,000 years, concrete itself has a surprisingly short lifespan. After 20 to 30 years, natural processes like concrete shrinkage, excessive freezing and thawing, and heavy loads can trigger cracking. And it’s not just big breaks that count: tiny cracks can be just as dangerous. Concrete is often used as a secondary support around steel reinforcements. In this concrete, even small cracks can channel water, oxygen, and carbon dioxide that corrode the steel and lead to disastrous collapse. On structures like bridges and highways that are constantly in use, detecting these problems before they lead to catastrophe becomes a huge and costly challenge. But not doing so would also endanger thousands of lives. Fortunately, we’re already experimenting with ways this material could start fixing itself. And some of these solutions are inspired by concrete’s natural self-healing mechanism. When water enters these tiny cracks, it hydrates the concrete’s calcium oxide. The resulting calcium hydroxide reacts with carbon dioxide in the air, starting a process called autogenous healing, where microscopic calcium carbonate crystals form and gradually fill the gap. Unfortunately, these crystals can only do so much, healing cracks that are less than 0.3mm wide. Material scientists have figured out how to heal cracks up to twice that size by adding hidden glue into the concrete mix. If we put adhesive-filled fibers and tubes into the mixture, they’ll snap open when a crack forms, releasing their sticky contents and sealing the gap. But adhesive chemicals often behave very differently from concrete, and over time, these adhesives can lead to even worse cracks. So perhaps the best way to heal large cracks is to give concrete the tools to help itself. Scientists have discovered that some bacteria and fungi can produce minerals, including the calcium carbonate found in autogenous healing. Experimental blends of concrete include these bacterial or fungal spores alongside nutrients in their concrete mix, where they could lie dormant for hundreds of years. When cracks finally appear and water trickles into the concrete, the spores germinate, grow, and consume the nutrient soup that surrounds them, modifying their local environment to create the perfect conditions for calcium carbonate to grow. These crystals gradually fill the gaps, and after roughly three weeks, the hard-working microbes can completely repair cracks up to almost 1mm wide. When the cracks seal, the bacteria or fungi will make spores and go dormant once more— ready to start a new cycle of self-healing when cracks form again. Although this technique has been studied extensively, we still have a ways to go before incorporating it in the global production of concrete. But, these spores have huge potential to make concrete more resilient and long-lasting— which could drastically reduce the financial and environmental cost of concrete production. Eventually, these microorganisms may force us to reconsider the way we think about our cities, bringing our inanimate concrete jungles to life.

**P637 2018-09-26 The princess who rewrote history - Leonora Neville**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=637)

Alexios Komnenos, Byzantine emperor, led his army to meet the Scythian hordes in battle. For good luck, he carried one of the holiest relics in Christendom: the veil that had belonged to the Virgin Mary. Unfortunately, it didn’t help. Not only was his army defeated, but as they fled, the Emperor was stabbed in the buttocks. To make matters worse, a strong wind made the relic too heavy to carry, so he stashed it in some bushes as he escaped. But even as he fled, he managed to slay some Scythians and rescue a few comrades. At least, this is how Alexios' daughter Anna recounted the story, writing nearly 60 years later. She spent the last decade of her long life creating a 500-page history of her father’s reign called The Alexiad. Written in Greek, the book was modeled after ancient Greek epics and historical writings. But Anna had a different, trickier task than the writers in these traditions: as a princess writing about her own family, she had to balance her loyalty to her kin with her obligation to portray events accurately, navigating issues like Alexios’s embarrassing stab to the buttocks. A lifetime of study and participation in her father’s government prepared Anna for this undertaking. Anna was born in 1083, shortly after her father seized control of the Roman Empire following a decade of brutal civil wars and revolts. The empire was deep in decline when he came to power, and threatened from all sides: by the Seljuk Turks in the East, the Normans in the West, and Scythian raiders to the north. Over the course of Anna’s childhood and adolescence, Alexios fought constant military campaigns to secure the frontiers of his empire, even striking up an uneasy alliance with the Crusaders. Meanwhile in Constantinople, Anna fought her own battle. She was expected to study subjects considered proper for a Byzantine princess, like courtly etiquette and the Bible, but preferred classical myth and philosophy. To access this material, she had to learn to read and speak Ancient Greek, by studying secretly at night. Eventually her parents realized how serious she was, and provided her with tutors. Anna expanded her studies to classical literature, rhetoric, history, philosophy, mathematics, astronomy, and medicine. One scholar even complained that her constant requests for more Aristotle commentaries were wearing out his eyes. At age fifteen, Anna married Nikephoros Bryennios to quell old conflicts between their families and strengthen Alexios’s reign. Fortunately, Anna and Nikephoros ended up sharing many intellectual interests, hosting and debating the leading scholars of the day. Meanwhile, Alexios’s military excursions began to pay off, restoring many of the empire’s former territories. As her father aged, Anna and her husband helped her parents with their imperial duties. During this time, Anna reportedly advocated for just treatment of the people in their disputes with the government. After Alexios’s death, Anna’s brother John ascended to the throne and Anna turned back to philosophy and scholarship. Her husband had written a history arguing that his grandfather would have made a better emperor than Alexios, but Anna disagreed. She began working on the Alexiad, which made the case for her father's merits as emperor. Spanning the late 11th and early 12th centuries of Byzantine history, the Alexiad recounts the tumultuous events of Alexios’s reign, and Anna’s own reactions to those events, like bursting into tears at the thought of the deaths of her parents and husband. She may have included these emotional passages in hopes that they would make her writing more palatable to a society that believed women shouldn't write about battles and empires. While her loyalty to her father was evident in her favorable account of his reign, she also included criticism and her opinions of events. In the centuries after her death, Anna’s Alexiad was copied over and over, and remains an invaluable eyewitness account of Alexios’s reign today. And through her epic historical narrative, Anna Komnene secured her own place in history.

**P638 2018-09-27 Can you solve the killer robo-ants riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=638)

The good news is that your experimental robo-ants are a success! The bad news is that you accidentally just gave them the ability to shoot deadly lasers …and you can’t turn it off. You have five minutes to stop them before the lasers go online. Until then, all of your robo-ants will walk inside their habitat at a speed of exactly 1 meter per minute. If they bump into each other or hit a dead end, they’ll instantly turn around and walk back the way they came. When five minutes are up, they’ll turn on their lasers, break free, and stream out into the world, carving a path of destruction as they go. Your one chance to stop them is to insert the two emergency vacuum nozzles into the habitat and suck the ants up before they break free. The nozzles can press into any one location in the habitat through a membrane covering its front side, and any ants that walk past will be sucked up and deactivated. You can’t move the nozzles once they’re placed without leaving a hole that the robo-ants would pour out of, so choosing the right spots will be key. The habitat is made out of meter-long tubes. When the robots reach an intersection, they will pick randomly whether to go left, right, or forward. They only go backward if they hit hit another robo-ant or a dead end. Unfortunately, there are hundreds of them inside the habitat, and if even one escapes, it’ll do a lot of damage. With just less than five minutes remaining, where should you place the 2 vacuum nozzles to suck up all the robo-ants? Pause the video now if you want to figure it out for yourself. Answer in: 3 Answer in: 2 Answer in: 1 With robo-ants ricocheting all over the habitat, it might seem impossible to stop them before they break free. But this situation is simpler than it seems. Here's why. Imagine just two robo-ants crawling toward each other. When they collide, they immediately reverse directions. And what would that sequence of events look like if they crawled past each other instead? It would look exactly the same before and after their collision, but with their positions swapped. This is true every time a pair of robo-ants meet. Because the identities of individual ants don’t matter, you just need to figure out where you should put the nozzles to capture any single ant walking without interruption for less than 5 minutes, starting from any point in the habitat. That’s much easier to conceptualize and solve. Placing the nozzles at intersections where three or four tubes meet seems like your best bet since that’s where the robo-ants might otherwise change directions and miss your nozzles. There are only four intersections… which two should you pick? The top right intersection has to be one of them. If it isn’t, an ant crawling down from this intersection toward the dead end would crawl for four minutes to get back to the intersection, and then go in any of three directions, walking for at least another minute. Once you’ve placed a nozzle in the top right, the only other choice that has a chance to work is the bottom left. To see that this works, imagine an ant anywhere else in the habitat. Worst case scenario, the ant would start right next to the vacuum nozzle, marching away from it. But in all those worst cases, the ant would march for at most 4 meters before being sucked up into the vacuum. No other choice of two intersection points is guaranteed to get all the robo-ants within five minutes. Having vacuumed them all up, you’ve averted a major crisis. Before you mess with robo-ants again, you’ll want to have a robo-anteater ready. And wouldn’t it be cool if it could fly and breathe fire? There’s no way that could go wrong!

**P639 2018-10-01 Why can't some birds fly -** **Gillian Gibb**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=639)

In the lush rainforests of Australia, birds roost in the low branches and amble across the forest floor, enjoying the shade and tropical fruits. But the jungle isn’t theirs alone. A dingo is prowling in the shadows, and fruit won’t satisfy his appetite. The birds flee to safety all but the cassowary, who can’t clear the ground on her puny wings. Instead, she attacks, sending the dingo running for cover with one swipe of her razor-sharp toe claws. The cassowary is one of approximately 60 living species of flightless birds. These earthbound avians live all over the world, from the Australian outback to the African savanna to Antarctic shores. They include some species of duck and all species of penguin, secretive swamp dwellers and speedy ostriches, giant emus, and tiny kiwis. Though the common ancestor of all modern birds could fly, many different bird species have independently lost their flight. Flight can have incredible benefits, especially for escaping predators, hunting, and traveling long distances. But it also has high costs: it consumes huge amounts of energy and limits body size and weight. A bird that doesn’t fly conserves energy, so it may be able to survive on a scarcer or less nutrient-rich food source than one that flies. The Takahe of New Zealand, for example, lives almost entirely on the soft base of alpine grasses. For birds that nest or feed on the ground, this predisposition to flightlessness can be even stronger. When a bird species doesn’t face specific pressures to fly, it can stop flying in as quickly as a few generations. Then, over thousands or millions of years, the birds’ bodies change to match this new behavior. Their bones, once hollow to minimize weight, become dense. Their sturdy feathers turn to fluff. Their wings shrink, and in some cases disappear entirely. And the keel-like protrusion on their sternums, where the flight muscles attach, shrinks or disappears, except in penguins, who repurpose their flight muscles and keels for swimming. Most often, flightlessness evolves after a bird species flies to an island where there are no predators. As long as these predator-free circumstances last, the birds thrive, but they are vulnerable to changes in their environment. For instance, human settlers bring dogs, cats, and stowaway rodents to islands. These animals often prey on flightless birds and can drive them to extinction. In New Zealand, stoats introduced by European settlers have threatened many native species of flightless bird. Some have gone extinct while others are endangered. So in spite of the energy-saving advantages of flightlessness, many flightless bird species have only a short run before going the way of the dodo. But a few flightless birds have survived on mainlands alongside predators aplenty. Unlike most small flightless species that come and go quickly, these giants have been flightless for tens of millions of years. Their ancestors appeared around the same time as the first small mammals, and they were probably able to survive because they were evolving— and growing—at the same time as their mammalian predators. Most of these birds, like emus and ostriches, ballooned in size, weighing hundreds of pounds more than wings can lift. Their legs grew thick, their feet sturdy, and newly developed thigh muscles turned them into formidable runners. Though they no longer use them to fly, many of these birds repurpose their wings for other means. They can be spotted tucking their heads beneath them for warmth, flashing them at prospective mates, sheltering eggs with them, or even using them to steer as they charge across the plains. They may be flightless, but they’re still winging it.

**P640 2018-10-06 Why should you read 'Don Quixote' - Ilan Stavans**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=640)

Mounting his skinny steed, the protagonist of Don Quixote charges an army of giants. In his eyes, it is his duty to vanquish these behemoths in the name of his beloved lady, Dulcinea. However, this act of valor is ill conceived. As his squire Sancho Panza explains to him time and again, these aren’t giants; they are merely windmills. Don Quixote is undeterred, but his piercing lance is soon caught in their sails. Never discouraged, the knight stands proudly, and becomes even more convinced of his mission. This sequence encapsulates much of what is loved about Don Quixote, the epic, illogical, and soulful tale of Alonso Quijano, who becomes the clumsy but valiant Don Quixote of la Mancha, known as the Knight of the Sorrowful Countenance. Originally published in two volumes, the narrative follows Don Quixote as he travels through central and northern Spain fighting the forces of evil. Despite Don Quixote’s lofty imagination, his creator, Miguel de Cervantes, could never have imagined his book would become the best-selling novel of all time. Barring 5 years as a soldier, and 5 more enslaved by pirates, Cervantes spent most of his life as a struggling poet and playwright. It wasn’t until his late 50’s that he published his greatest creation: an epic satire of chivalry novels. At this time, medieval books chronicling the adventures of knights and their moral code dominated European culture. While Cervantes was a fan, he was weary of these repetitive tomes, which focused more on listing heroic feats than character development. To challenge them, he wrote Don Quixote, the story of a hidalgo, or idle nobleman, who spends his days and nights reading chivalry novels. Driven mad by these stories, he fashions himself a champion for the downtrodden. Everyone in his village tries to convince him to give up his lunacy, going so far as to burn some of the lurid books in his personal library. But Don Quixote is unstoppable. He dresses up in old shining armor, mounts his skinny horse, and leaves his village in search of glory. Cervantes’ novel unfolds as a collection of episodes detailing the mishaps of the valiant knight. Yet unlike the chivalry books and perhaps all other prior fiction, Cervantes’ story deeply investigates the protagonist’s inner life. Don Quixote matures as the narrative develops, undergoing a noticeable transformation. This literary revelation has led many scholars to call Don Quixote the first modern novel. And this character development doesn’t happen in isolation. Early on, Don Quixote is joined by a villager-turned-squire named Sancho Panza. Sancho and Don Quixote are a study in opposites: with one as the grounded realist to the other’s idealism. Their lively, evolving friendship is often credited as the original hero and sidekick duo, inspiring centuries of fictional partnerships. Don Quixote was a huge success. Numerous editions were published across Europe in the seventeenth century. Even in the Americas, where the Church banned all novels for being sinful distractions, audiences were known to enjoy pirated editions. The book was so well received that readers clamored for more. After a rival author attempted to cash in on a fake follow-up, Cervantes released the official sequel in response. Now published alongside the first volume as a completed text, this second volume picks up where the original left off, only now Don Quixote and Sancho have become folk heroes. Just as in real-life, Cervantes included his novel’s success in the world of his characters. This unconventional meta-awareness created philosophical complexity, as the knight and his squire ponder the meaning of their story. Unfortunately, Cervantes had sold the book’s publishing rights for very little. He died rich in fame alone. But his treatise on the power of creativity and individualism has inspired art, literature, popular culture, and even political revolution. Don Quixote argues that our imagination greatly informs our actions, making us capable of change, and, indeed, making us human.

**P641 2018-10-09 Does time exist - Andrew Zimmerman Jones**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=641)

The earliest time measurements were observations of cycles of the natural world, using patterns of changes from day to night and season to season to build calendars. More precise time-keeping, like sundials and mechanical clocks, eventually came along to put time in more convenient boxes. But what exactly is it that we’re measuring? Is time something that physically exists, or is it just in our heads? At first the answer seems obvious— of course time exists; it constantly unfolds all around us, and it’s hard to imagine the universe without it. But our understanding of time started getting complicated thanks to Einstein. His theory of relativity tells us that time passes for everyone, but doesn’t always pass at the same rate for people in different situations, like those travelling close to the speed of light or orbiting a supermassive black hole. Einstein resolved the malleability of time by combining it with space to define space-time, which can bend, but behaves in consistent, predictable ways. Einstein’s theory seemed to confirm that time is woven into the very fabric of the universe. But there’s a big question it didn’t fully resolve: why is it we can move through space in any direction, but through time in only one? No matter what we do, the past is always, stubbornly, behind us. This is called the arrow of time. When a drop of food coloring is dropped into a glass of water, we instinctively know that the coloring will drift out from the drop, eventually filling the glass. Imagine watching the opposite happen. Here, we’d recognize time as unfolding backwards. We live in a universe where the food coloring spreads out in the water, not a universe where it collects together. In physics, this is described by the Second Law of Thermodynamics, which says that systems will gain disorder, or entropy, over time. Systems in our universe move from order to disorder, and it is that property of the universe that defines the direction of time’s arrow. So if time is such a fundamental property, it should be in our most fundamental equations describing the universe, right? We currently have two sets of equations that govern physics. General relativity describes the behavior of very large things, while quantum physics explains the very small. One of the biggest goals in theoretical physics over the last half century has been reconciling the two into one fundamental “theory of everything." There have been many attempts —none yet proven— and they treat time in different ways. Oddly enough, one contender called the Wheeler-DeWitt equation, doesn’t include time at all. Like all current theories of everything, that equation is speculative. But as a thought experiment, if it or a similarly time-starved equation turned out to be true, would that mean that time doesn’t exist, at the most fundamental level? Could time just be some sort of illusion generated by the limitations of the way we perceive the universe? We don’t yet know, but maybe that’s the wrong way of thinking about it. Instead of asking if time exists as a fundamental property, maybe it could exist as an emergent one. Emergent properties are things that don’t exist in individual pieces of a system, but do exist for the system as a whole. Each individual water molecule doesn’t have a tide, but the whole ocean does. A movie creates change through time by using a series of still images that appear to have a fluid, continuous change between them. Flipping through the images fast enough, our brains perceive the passage of time from the sequence of still images. No individual frame of the movie changes or contains the passage of time, but it’s a property that comes out of how the pieces are strung together. The movement is real, yet also an illusion. Could the physics of time somehow be a similar illusion? Physicists are still exploring these and other questions, so we’re far from a complete explanation. At least for the moment.

**P642 2018-10-09 How rollercoasters affect your body - Brian D. Avery**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=642)

In the summer of 1895, crowds flooded the Coney Island boardwalk to see the latest marvel of roller coaster technology: the Flip Flap Railway. This was America’s first-ever looping coaster – but its thrilling flip came at a price. The ride caused numerous cases of severe whiplash, neck injury and even ejections, all due to its signature loop. Today, coasters can pull off far more exciting tricks, without resorting to the “thrill” of a hospital visit. But what exactly are roller coasters doing to your body, and how have they managed to get scarier and safer at the same time? At the center of every roller coaster design is gravity. Unlike cars or transit trains, most coasters are propelled around their tracks almost entirely by gravitational energy. After the coaster crests the initial lift hill, it begins an expertly engineered cycle – building potential energy on ascents and expending kinetic energy on descents. This rhythm repeats throughout the ride, acting out the coaster engineer’s choreographed dance of gravitational energy. But there’s a key variable in this cycle that wasn’t always so carefully considered: you. In the days of the Flip-Flap, ride designers were most concerned with coasters getting stuck somewhere along the track. This led early builders to overcompensate, hurling trains down hills and pulling on the brakes when they reached the station. But as gravity affects the cars, it also affects the passengers. And under the intense conditions of a coaster, gravity’s effects are multiplied. There’s a common unit used by jet pilots, astronauts, and coaster designers called “g force”. One G force is the familiar tug of gravity you feel when standing on Earth – this is the force of Earth’s gravitational pull on our bodies. But as riders accelerate and decelerate, they experience more or less gravitational force. Modern ride designers know that the body can handle up to roughly 5 Gs, but the Flip-Flap and its contemporaries routinely reached up to 12 Gs. At those levels of gravitational pressure, blood is sent flying from your brain to your feet, leading to light-headedness or blackouts as the brain struggles to stay conscious. And oxygen deprivation in the retinal cells impairs their ability to process light, causing greyed out vision or temporary blindness. If the riders are upside down, blood can flood the skull, causing a bout of crimson vision called a “redout”. Conversely, negative G’s create weightlessness. Within the body, short-term weightlessness is mostly harmless. It can contribute to a rider’s motion sickness by suspending the fluid in their inner ears which coordinates balance. But the bigger potential danger – and thrill – comes from what ride designers call airtime. This is when riders typically experience seat separation, and, without the proper precautions, ejection. The numerous belts and harnesses of modern coasters have largely solved this issue, but the passenger’s ever-changing position can make it difficult to determine what needs to be strapped down. Fortunately, modern ride designers are well aware of what your body, and the coaster, can handle. Coaster engineers play these competing forces against each other, to relieve periods of intense pressure with periods of no pressure at all. And since a quick transition from positive to negative G-force can result in whiplash, headaches, and back and neck pain, they avoid the extreme changes in speed and direction so common in thrill rides of old. Modern rides are also much sturdier, closely considering the amount of gravity they need to withstand. At 5 G’s, your body feels 5 times heavier; so if you weigh 100lbs, you’d exert the weight of 500 lbs on the coaster. Engineers have to account for the multiplied weight of every passenger when designing a coaster’s supports. Still, these rides aren’t for everyone. The floods of adrenaline, light-headedness, and motion sickness aren’t going anywhere soon. But today’s redundant restraints, 3D modeling and simulation software have made roller coasters safer and more thrilling than ever. Our precise knowledge about the limits of the human body have helped us build coasters that are faster, taller, and loopier – and all without going off the rails.

**P643 2018-10-17 Can you solve the stolen rubies riddle - Dennis Shasha**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=643)

One of the kingdom’s most prosperous merchants has been exposed for his corrupt dealings. Nearly all of his riches are invested in a collection of 30 exquisite Burmese rubies, and the crowd in the square is clamoring for their confiscation to reimburse his victims. But the scoundrel and his allies at court have made a convincing case that at least some of his wealth was obtained legitimately, and through good service to the crown. The king ponders for a minute and announces his judgment. Because there’s no way to know which portion of the rubies were bought with ill-gotten wealth, the fine will be determined through a game of wits between the merchant and the king’s most clever advisor – you. You’re both told the rules in advance. The merchant will be allowed to discreetly divide his rubies among three boxes, which will then be placed in front of you. You will be given three cards, and must write a number between 1 and 30 on each, before putting a card in front of each of the boxes. The boxes will then all be opened. For each box, you will receive exactly as many rubies as the number written on the corresponding card, if the box has that many. But if your number is greater than the number of rubies actually there, the scoundrel gets to keep the entire box. The king puts just two constraints on how the scoundrel distributes his rubies. Each box must contain at least two rubies and one of the boxes must contain exactly six more rubies than another— but you won’t know which boxes those are. After a few minutes of deliberation, the merchant hides the gems, and the boxes are brought in front of you. Which numbers should you choose in order to guarantee the largest possible fine for the scoundrel and the greatest compensation for his victims? Pause the video now if you want to figure it out for yourself. Answer in 3 Answer in 2 Answer in 1 You don’t want to overshoot by being too greedy. But there is a way you can guarantee to get more than half of the scoundrel’s stash. The situation resembles an adversarial game like chess – only here you can’t see the opponent’s position. To figure out the minimum number of rubies you’re guaranteed to win, you need to look for the worst case scenario, as if the merchant already knew your move and could arrange the rubies to minimize your winnings. Because you have no way of knowing which boxes will have more or fewer rubies, you should pick the same number for each. Suppose you write three 9’s. The scoundrel might have allocated the rubies as 8, 14 and 8. In that case, you’d receive 9 from the middle box and no others. On the other hand, you can be sure that at least two boxes have a minimum of 8 rubies. Here’s why. We’ll start by assuming the opposite, that two boxes have 7 or fewer. Those could not be the two that differ by 6, because every box must have at least 2 rubies. In that case, the third box would have at most 13 rubies—that’s 7 plus 6. Add up all three of those boxes, and the most that could equal is 27. Since that’s less than 30, this scenario isn’t possible. You now know, by what’s called a proof by contradiction, that two of the boxes have 8 or more rubies. If you ask for 8 from all three boxes you’ll receive at least 16— and that’s the best you can guarantee, as you can see by thinking again about the 8, 14, 8 scenario. You’ve recovered more than half the scoundrel’s fortune as restitution for the public. And though he’s managed to hold on to some of his rubies, his fortune has definitely lost some of its shine.

**P644 2018-10-26 Can you solve the giant iron riddle - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=644)

The family of giants you work for is throwing a fancy dinner party, and they all want to look their best. But there’s a problem – the elder giant’s favorite shirt is wrinkled! To fix it, you’ll need to power up… the Giant Iron. The iron needs two giant batteries to work. You just had 4 working ones and 4 dead ones in separate piles, but it looks like the baby giant mixed them all up. You need to get the iron working and press the giant shirt, fast – or you’ll end up being the main course tonight! How can you test the batteries so that you’re guaranteed to get a working pair in 7 tries or less? Pause the video now if you want to figure it out for yourself Answer in 3 Answer in 2 Answer in 1 You could, of course, take all eight batteries and begin testing the 28 possible combinations. You might get lucky within the first few tries. But if you don’t, moving the giant batteries that many times will take way too long. You can’t rely on luck – you need to assume the worst possibility and plan accordingly. However, you don’t actually need to test every possible combination. Remember – there are four good batteries in total, meaning that any pile of six you choose will have at least two good batteries in it. That doesn’t help you right away, since testing all six batteries could still take as many as 15 tries. But it does give you a clue to the solution – dividing the batteries into smaller subsets narrows down the possible results. So instead of six batteries, let’s take any three. This group has a total of three possible combinations. Since both batteries have to be working for the iron to power up, a single failure can’t tell you whether both batteries are dead, or just one. But if all three combinations fail, then you’ll know this group has either one good battery, or none at all. Now you can set those three aside and repeat the process for another three batteries. You might get a match, but if every combination fails again, you’ll know this set can have no more than one good battery. That would leave only two batteries untried. Since there are four good batteries in total and you’ve only accounted for two so far, both of these remaining ones must be good. Dividing the batteries into sets of 3, 3, and 2 is guaranteed to get a working result in 7 tries or less, no matter what order you test the piles in. With no time to spare, the iron comes to life, and you manage to get the shirt flawlessly ironed. The pleased elder and his family show up to the party dressed to the nines … well, almost.

**P645 2018-10-29 How far would you have to go to escape gravity - Rene Laufer**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=645)

More than six thousand light years from the surface of the earth, a rapidly spinning neutron star called the Black Widow pulsar blasts its companion brown dwarf star with radiation as the two orbit each other every 9 hours. Standing on our own planet, you might think you’re just an observer of this violent ballet. But in fact, both stars are pulling you towards them. And you’re pulling back, connected across trillions of kilometers by gravity. Gravity is the attractive force between two objects with mass— any two objects with mass. Which means that every object in the universe attracts every other object: every star, black hole, human being, smartphone, and atom are all constantly pulling on each other. So why don’t we feel pulled in billions of different directions? Two reasons: mass and distance. The original equation describing the gravitational force between two objects was written by Isaac Newton in 1687. Scientists’ understanding of gravity has evolved since then, but Newton’s Law of Universal Gravitation is still a good approximation in most situations. It goes like this: the gravitational force between two objects is equal to the mass of one times the mass of the other, multiplied by a very small number called the gravitational constant, and divided by the distance between them, squared. If you doubled the mass of one of the objects, the force between them would double, too. If the distance between them doubled, the force would be one-fourth as strong. The gravitational force between you and the Earth pulls you towards its center, a force you experience as your weight. Let’s say this force is about 800 Newtons when you’re standing at sea level. If you traveled to the Dead Sea, the force would increase by a tiny fraction of a percent. And if you climbed to the top of Mount Everest, the force would decrease— but again, by a minuscule amount. Traveling higher would make a bigger dent in gravity’s influence, but you won’t escape it. Gravity is generated by variations in the curvature of spacetime— the three dimensions of space plus time— which bend around any object that has mass. Gravity from Earth reaches the International Space Station, 400 kilometers above the earth, with almost its original intensity. If the space station was stationary on top of a giant column, you’d still experience ninety percent of the gravitational force there that you do on the ground. Astronauts just experience weightlessness because the space station is constantly falling towards earth. Fortunately, it’s orbiting the planet fast enough that it never hits the ground. By the time you made it to the surface of the moon, around 400,000 kilometers away, Earth’s gravitational pull would be less than 0.03 percent of what you feel on earth. The only gravity you’d be aware of would be the moon’s, which is about one sixth as strong as the earth’s. Travel farther still and Earth’s gravitational pull on you will continue to decrease, but never drop to zero. Even safely tethered to the Earth, we’re subject to the faint tug of distant celestial bodies and nearby earthly ones. The Sun exerts a force of about half a Newton on you. If you’re a few meters away from a smartphone, you'll experience a mutual force of a few piconewtons. That’s about the same as the gravitational pull between you and the Andromeda Galaxy, which is 2.5 million light years away but about a trillion times as massive as the sun. But when it comes to escaping gravity, there’s a loophole. If all the mass around us is pulling on us all the time, how would Earth’s gravity change if you tunneled deep below the surface, assuming you could do so without being cooked or crushed? If you hollowed out the center of a perfectly spherical Earth— which it isn’t, but let’s just say it were— you’d experience an identical pull from all sides. And you’d be suspended, weightless, only encountering the tiny pulls from other celestial bodies. So you could escape the Earth’s gravity in such a thought experiment— but only by heading straight into it.

**P646 2018-10-31 Can you solve the secret werewolf riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=646)

You’re on the trail of a werewolf that’s been terrorizing your town. After months of detective work, you’ve narrowed your suspects to one of five people: the mayor, the tailor, the baker, the grocer, or the carpenter. You’ve invited them to dinner with a simple plan: you’ll slip a square of a rare werewolf antidote into each of their dinners. Unfortunately, your pet goat just ate four of the squares, and you only have one left. Luckily, the remaining square is 50 grams, and the minimum effective dose is 10 grams. If you can precisely divide the square into fifths you’ll have just enough antidote for everyone. You’ll have to use a laser-cutting tool to cut up the square; every other means available to you isn’t precise enough. There are 8 points that can act as starting or ending points for each cut. To use the device, you’ll have to input pairs of points that tell the laser where to begin and end each cut, and then the laser executes all the cuts simultaneously. It’s okay to cut the square into as many pieces as you want, as long as you can group them into 10 gram portions. But you can’t fold the square or alter it otherwise, and you only get one shot at using the laser cutter. The full moon is rising, and in a moment someone will transform and tear you all apart unless you can cure them first. How can you divide the antidote into perfect fifths, cure the secret werewolf, and save everyone? Pause the video now if you want to figure it out for yourself. Answer in 3 Answer in 2 Answer in 1 When it comes to puzzles that involve cutting and rearranging, it’s often helpful to actually take a piece of paper and try cutting it up to see what you can get. If we cut BF and DH we’d get fourths, but we need fifths. Maybe there’s a way to shave a bit off of a quarter to get exactly one fifth. Cutting BE looks good at first, but that last cut takes a off a quarter of a quarter, leaving us with a portion of 3/16: just smaller than a fifth, and not enough to cure a werewolf. What if we started with BE instead? That would also give us a quarter. And is there a way to shave just a bit more off? Both DG and CH look promising. If we make one more cut, from A to F, we may start to notice something. With these four cuts—from B to E, D to G, F to A, and H to C—we’ve got four triangles and a square in the middle. But the pieces that make each triangle can also be rearranged to make a square identical to the middle one. This means that we’ve split the antidote into perfect fifths! What’s interesting about this sort of problem is that while it’s possible to solve it by starting from the geometry, it’s actually easier to start experimenting and see where that gets you. That wouldn’t be as viable if the square had, say, 24 cut points, but with just 8 there are only so many reasonable options. You secretly dose each of the townspeople as the full moon emerges in the sky. And just as you do, a terrible transformation begins. Then, just as suddenly, it reverses. Your measurements were perfect, and the people and animals of the town can rest a little easier.

**P647 2018-11-05 History vs. Henry VIII - Mark Robinson and Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=647)

He was a powerful king whose break with the church of Rome would forever change the course of English history. But was he a charismatic reformer or a bullying tyrant? Find out on History versus Henry VIII. Judge: Order, order. Now, who do we have here? Looks like quite the dashing fellow. Defense: Indeed, your honour. This is Henry VIII, the acclaimed king who reformed England's religion and government and set it on course to becoming a modern nation. Prosecutor: I beg to differ. This is a cruel, impulsive, and extravagant king who had as little regard for his people as he did for his six wives. Judge: Six wives? Defense: Your honor, Henry's first marriage was arranged for him when he was only a child. He only married Catherine of Aragon to strengthen England’s alliance with Spain. Prosecutor: An alliance he was willing to toss aside with no regard for the nation. Defense: Henry had every regard for the nation. It was imperative to secure the Tudor dynasty by producing a male heir – something Catherine failed to do in over twenty years of marriage. Prosecutor: It takes two to make an heir, your honor. Defense: Ahem. Regardless, England needed a new queen to ensure stability, but the Pope refused to annul the union and let the king remarry. Judge: Sounds like quite a pickle. Can’t argue with the Pope. Prosecutor: And yet that’s exactly what the king decided to do. He uprooted the country’s religious foundations and broke the Church of England away from Rome, leading to centuries of strife. Defense: All Henry did was give the Church honest domestic leadership. He freed his subjects from the corrupt Roman Catholic establishment. And by rejecting the more radical changes of the Protestant reformation, he allowed his people to preserve most of their religious traditions. Prosecutor: Objection! The Church had been a beloved and popular institution that brought comfort and charity to the masses. Thanks to Henry, church property was seized; hospitals closed, and precious monastic libraries lost forever, all to enrich the Crown. Defense: Some of the funds were used to build new cathedrals and open secular schools. And it was necessary for England to bring its affairs under its own control rather than Rome’s. Prosecutor: You mean under Henry’s control. Defense: Not true. All of the king’s major reforms went through Parliament. No other country of the time allowed its people such a say in government. Prosecutor: He used Parliament as a rubber stamp for his own personal will. Meanwhile he ruled like a tyrant, executing those he suspected of disloyalty. Among his victims were the great statesman and philosopher Thomas More – once his close friend and advisor – and Anne Boleyn, the new queen Henry had torn the country apart to marry. Judge: He executed his own wife? Defense: That…wasn’t King Henry’s initiative. She was accused of treason in a power struggle with the King’s minister, Thomas Cromwell. Prosecutor: The trial was a sham and she wouldn’t have been convicted without Henry’s approval. Besides, he wasn’t too upset by the outcome - he married Jane Seymour just 11 days later! Defense: A marriage that, I note, succeeded in producing a male heir and guaranteeing a stable succession… though the new queen tragically died in childbirth. Prosecutor: This tragedy didn’t deter him from an ill conceived fourth marriage to Anne of Cleves, which Henry then annulled on a whim and used as an excuse to execute Cromwell. As if that weren’t enough, he then married Catherine Howard – a cousin of Anne Boleyn – before having her executed too. Defense: She was engaged in adultery to which she confessed! Regardless, Henry’s final marriage to Catherine Parr was actually very successful. Prosecutor: His sixth! It only goes to show he was an intemperate king who allowed faction and intrigue to rule his court, concerned only with his own pleasure and grandiosity. Defense: That grandiosity was part of the king’s role as a model for his people. He was a learned scholar and musician who generously patronized the arts, as well as being an imposing warrior and sportsman. And the lavish tournaments he hosted enhanced England’s reputation on the world stage. Prosecutor: And yet both his foreign and domestic policies were a disaster. His campaigns in France and his brutal invasion of Scotland drained the treasury, and his attempt to pay for it by debasing the coinage led to constant inflation. The lords and landowners responded by removing access to common pastures and turning the peasant population into beggars. Defense: Beggars who would soon become yeomen farmers. The enclosures made farming more efficient, and created a labor surplus that laid the foundation for the Industrial Revolution. England would never have become the great power that it did without them …and without Henry. Judge: Well, I think no matter what, we can all agree he looks great in that portrait. A devout believer who broke with the Church. A man of learning who executed scholars. A king who brought stability to the throne, but used it to promote his own glory, Henry VIII embodied all the contradictions of monarchy on the verge of the modern era. But separating the ruler from the myth is all part of putting history on trial.

**P648 2018-11-05 The myth of Sisyphus - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=648)

Whether it’s being chained to a burning wheel, turned into a spider, or having an eagle eat one’s liver, Greek mythology is filled with stories of the gods inflicting gruesome horrors on mortals who angered them. Yet one of their most famous punishments is not remembered for its outrageous cruelty, but for its disturbing familiarity. Sisyphus was the first king of Ephyra, now known as Corinth. Although a clever ruler who made his city prosperous, he was also a devious tyrant who seduced his niece and killed visitors to show off his power. This violation of the sacred hospitality tradition greatly angered the gods. But Sisyphus may still have avoided punishment if it hadn’t been for his reckless confidence. The trouble began when Zeus kidnapped the nymph Aegina, carrying her away in the form of a massive eagle. Aegina’s father, the river god Asopus, pursued their trail to Ephyra, where he encountered Sisyphus. In exchange for the god making a spring inside the city, the king told Asopus which way Zeus had taken the girl. When Zeus found out, he was so furious that he ordered Thanatos, or Death, to chain Sisyphus in the underworld so he couldn’t cause any more problems. But Sisyphus lived up to his crafty reputation. As he was about to be imprisoned, the king asked Thanatos to show him how the chains worked – and quickly bound him instead, before escaping back among the living. With Thanatos trapped, no one could die, and the world was thrown into chaos. Things only returned to normal when the god of war Ares, upset that battles were no longer fun, freed Thanatos from his chains. Sisyphus knew his reckoning was at hand. But he had another trick up his sleeve. Before dying, he asked his wife Merope to throw his body in the public square, from where it eventually washed up on the shores of the river Styx. Now back among the dead, Sisyphus approached Persephone, queen of the Underworld, and complained that his wife had disrespected him by not giving him a proper burial. Persephone granted him permission to go back to the land of living and punish Merope, on the condition that he would return when he was done. Of course, Sisyphus refused to keep his promise, now having twice escaped death by tricking the gods. There wouldn’t be a third time, as the messenger Hermes dragged Sisyphus back to Hades. The king had thought he was more clever than the gods, but Zeus would have the last laugh. Sisyphus’s punishment was a straightforward task – rolling a massive boulder up a hill. But just as he approached the top, the rock would roll all the way back down, forcing him to start over …and over, and over, for all eternity. Historians have suggested that the tale of Sisyphus may stem from ancient myths about the rising and setting sun, or other natural cycles. But the vivid image of someone condemned to endlessly repeat a futile task has resonated as an allegory about the human condition. In his classic essay The Myth of Sisyphus, existentialist philosopher Albert Camus compared the punishment to humanity’s futile search for meaning and truth in a meaningless and indifferent universe. Instead of despairing, Camus imagined Sisyphus defiantly meeting his fate as he walks down the hill to begin rolling the rock again. And even if the daily struggles of our lives sometimes seem equally repetitive and absurd, we still give them significance and value by embracing them as our own.

**P649 2018-11-05 What’s the smallest thing in the universe - Jonathan Butterworth**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=649)

If you were to take any everyday object, say a coffee cup, and break it in half, then in half again, and keep carrying on, where would you end up? Could you keep on going forever? Or would you find a set of indivisible building blocks out of which everything is made? Physicists have found the latter- that matter is made of fundamental particles, the smallest things in the universe. Particles interact with each other according to a theory called the “Standard Model”. The Standard Model is a remarkably elegant encapsulation of the strange quantum world of indivisible, infinitely small particles. It also covers the forces that govern how particles move, interact, and bind together to give shape to the world around us. So how does it work? Zooming in on the fragments of the cup, we see molecules, made of atoms bound up together. A molecule is the smallest unit of any chemical compound. An atom is the smallest unit of any element in the periodic table. But the atom is not the smallest unit of matter. Experiments found that each atom has a tiny, dense nucleus, surrounded by a cloud of even tinier electrons. The electron is, as far as we know, one of the fundamental, indivisible building blocks of the universe. It was the first Standard Model particle ever discovered. Electrons are bound to an atom’s nucleus by electromagnetism. They attract each other by exchanging particles called photons, which are quanta of light that carry the electromagnetic force, one of the fundamental forces of the Standard Model. The nucleus has more secrets to reveal, as it contains protons and neutrons. Though once thought to be fundamental particles on their own, in 1968 physicists found that protons and neutrons are actually made of quarks, which are indivisible. A proton contains two “up” quarks and one “down” quark. A neutron contains two down quarks and one up. The nucleus is held together by the strong force, another fundamental force of the Standard Model. Just as photons carry the electromagnetic force, particles called gluons carry the strong force. Electrons, together with up and down quarks, seem to be all we need to build atoms and therefore describe normal matter. However, high energy experiments reveal that there are actually six quarks– down & up, strange & charm, and bottom & top - and they come in a wide range of masses. The same was found for electrons, which have heavier siblings called the muon and the tau. Why are there three (and only three) different versions of each of these particles? This remains a mystery. These heavy particles are only produced, for very brief moments, in high energy collisions, and are not seen in everyday life. This is because they decay very quickly into the lighter particles. Such decays involve the exchange of force-carrying particles, called the W and Z, which – unlike the photon – have mass. They carry the weak force, the final force of the Standard Model. This same force allows protons and neutrons to transform into each other, a vital part of the fusion interactions that drive the Sun. To observe the W and Z directly, we needed the high energy collisions provided by particle accelerators. There’s another kind of Standard Model particle, called neutrinos. These only interact with other particles through the weak force. Trillions of neutrinos, many generated by the sun, fly through us every second. Measurements of weak interactions found that there are different kinds of neutrinos associated with the electron, muon, and tau. All these particles also have antimatter versions, which have the opposite charge but are otherwise identical. Matter and antimatter particles are produced in pairs in high-energy collisions, and they annihilate each other when they meet. The final particle of the Standard Model is the Higgs boson – a quantum ripple in the background energy field of the universe. Interacting with this field is how all the fundamental matter particles acquire mass, according to the Standard Model. The ATLAS Experiment on the Large Hadron Collider is studying the Standard Model in-depth. By taking precise measurements of the particles and forces that make up the universe, ATLAS physicists can look for answers to mysteries not explained by the Standard Model. For example, how does gravity fit in? What is the real relationship between force carriers and matter particles? How can we describe “Dark Matter”, which makes up most of the mass in the universe but remains unaccounted for? While the Standard Model provides a beautiful explanation for the world around us, there is still a universe’s worth of mysteries left to explore.

**P650 2018-11-13 The life cycle of a neutron star - David Lunney**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=650)

About once every century, a massive star somewhere in our galaxy runs out of fuel. This happens after millions of years of heat and pressure have fused the star’s hydrogen into heavier elements like helium, carbon, and nitrogen— all the way to iron. No longer able to produce sufficient energy to maintain its structure, it collapses under its own gravitational pressure and explodes in a supernova. The star shoots most of its innards into space, seeding the galaxy with heavy elements. But what this cataclysmic eruption leaves behind might be even more remarkable: a ball of matter so dense that atomic electrons collapse from their quantum orbits into the depths of atomic nuclei. The death of that star is the birth of a neutron star: one of the densest known objects in the universe, and a laboratory for the strange physics of supercondensed matter. But what is a neutron star? Think of a compact ball inside of which protons and electrons fuse into neutrons and form a frictionless liquid called a superfluid— surrounded by a crust. This material is incredibly dense – the equivalent of the mass of a fully-loaded container ship squeezed into a human hair, or the mass of Mount Everest in a space of a sugar cube. Deeper in the crust, the neutron superfluid forms different phases that physicists call “nuclear pasta,” as it’s squeezed from lasagna to spaghetti-like shapes. The massive precursors to neutron stars often spin. When they collapse, stars that are typically millions of kilometers wide compress down to neutron stars that are only about 25 kilometers across. But the original star’s angular momentum is preserved. So for the same reason that a figure skater’s spin accelerates when they bring in their arms, the neutron star spins much more rapidly than its parent. The fastest neutron star on record rotates over 700 times every second, which means that a point on its surface whirls through space at more than a fifth of the speed of light. Neutron stars also have the strongest magnetic field of any known object. This magnetic concentration forms vortexes that radiate beams from the magnetic poles. Since the poles aren’t always aligned with the rotational axis of the star, the beams spin like lighthouse beacons, which appear to blink when viewed from Earth. We call those pulsars. The detection of one of these tantalizing flashing signals by astrophysicist Jocelyn Bell in 1967 was in fact the way we indirectly discovered neutron stars in the first place. An aging neutron star’s furious rotation slows over a period of billions of years as it radiates away its energy in the form of electromagnetic and gravity waves. But not all neutron stars disappear so quietly. For example, we’ve observed binary systems where a neutron star co-orbits another star. A neutron star can feed on a lighter companion, gorging on its more loosely bound atmosphere before eventually collapsing cataclysmically into a black hole. While many stars exist as binary systems, only a small percentage of those end up as neutron-star binaries, where two neutron stars circle each other in a waltz doomed to end as a merger. When they finally collide, they send gravity waves through space-time like ripples from a stone thrown into a calm lake. Einstein’s theory of General Relativity predicted this phenomenon over 100 years ago, but it wasn't directly verified until 2017, when gravitational-wave observatories LIGO and VIRGO observed a neutron star collision. Other telescopes picked up a burst of gamma rays and a flash of light, and, later, x-rays and radio signals, all from the same impact. That became the most studied event in the history of astronomy. It yielded a treasure trove of data that’s helped pin down the speed of gravity, bolster important theories in astrophysics, and provide evidence for the origin of heavy elements like gold and platinum. Neutron stars haven’t given up all their secrets yet. LIGO and VIRGO are being upgraded to detect more collisions. That’ll help us learn what else the spectacular demise of these dense, pulsating, spinning magnets can tell us about the universe.

**P651 2018-11-13 Why is meningitis so dangerous - Melvin Sanicas**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=651)

In 1987, tens of thousands of people gathered in Saudi Arabia for the annual Hajj pilgrimage. But what started out as a celebration led to a health crisis: just a few days after the pilgrimage, more than 2,000 cases of meningitis broke out spreading across Saudi Arabia and the rest of the world. The outbreak was so fierce that it was believed to have sparked a wave of deadly meningitis epidemics that ultimately infected tens of thousands of people worldwide. Meningitis is the inflammation of the meninges, three tissue layers responsible for protecting the brain and spinal cord. What makes meningitis so dangerous compared to other diseases is the sheer speed with which it invades a person’s body. In the worst cases, it causes death within a day. Fortunately, that’s rare for patients who receive early medical treatment. The disease primarily comes in three forms: fungal, viral, and bacterial-- the last being the most deadly by far, and what we’ll focus on. People usually contract bacterial meningitis by breathing in tiny particles of mucus and saliva that spray into the air when an infected person sneezes or coughs. It can also be transmitted through kissing, or sharing cigarettes, toothbrushes or utensils. Some people can be infected and carry the disease without showing symptoms or getting sick, which helps the disease spread quickly to others. Once the bacteria enter the nose, mouth, and throat, they cross the surrounding membranes and enter the bloodstream. From there, bacteria have rapid access to the body’s tissues --including a membrane called the blood-brain barrier. This is made of a tight mesh of cells which separate blood vessels from the brain, and block everything except for a specific set of particles, including water molecules and some gases. But in ways that scientists are still trying to understand, meningitis bacteria can trick the barrier into letting them through. Inside the brain, the bacteria swiftly infect the meninges. This triggers inflammation as the body’s immune response kicks into overdrive, bringing on fever and intense headaches. As swelling in the meninges worsens, the neck begins to stiffen. Swelling in the brain disrupts its normal function-- causing symptoms like hearing loss and extreme light sensitivity. As pressure increases in the cranium, it may also make the person confused-- one of the hallmarks of the disease. A few hours in, the rapidly multiplying bacteria start to release toxins, leading to septicemia, also known as blood poisoning. This breaks down blood vessels, letting blood seep out and form what starts out looking like a rash, and evolves into big discoloured blots beneath the skin. At the same time, these toxins burn through oxygen in the blood, reducing the amount that gets to major organs like the lungs and kidneys. That increases the chance of organ shut down --and alongside spreading septicemia, threatens death. That all sounds scary, but doctors are so good at treating meningitis that a visit to the hospital can drastically reduce an adult’s risk of dying from it. The longer it’s left untreated, though, the more likely it will lead to lasting damage. If declining oxygen levels cause cell death in extreme parts of the body --like fingers, toes, arms and legs-- the risk of amputation goes up. And if bacterial toxins accumulate in the brain and trigger cell death, meningitis could also cause long-term brain damage and memory loss. So fast treatment, or better yet, prevention, is critical. That's why most countries have vaccines that defend against the disease in its deadliest forms. Those are usually given to the people who are most at risk--like young children, people with weak immune systems, or people who gather in large groups where an outbreak of meningitis could potentially happen. In addition to those gatherings, meningitis is most common in a region called the meningitis belt that stretches across Africa, though cases do happen all over the world. If you’re concerned that you or someone you know may have meningitis, get to the doctor as soon as possible; quick action could save your life.

**P652 2018-11-15 Who decides what art means - Hayley Levitt**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=652)

Imagine you and a friend are strolling through an art exhibit and a striking painting catches your eye. The vibrant red appears to you as a symbol of love, but your friend is convinced it's a symbol of war. And where you see stars in a romantic sky, your friend interprets global warming-inducing pollutants. To settle the debate, you turn to the internet, where you read that the painting is a replica of the artist's first-grade art project: Red was her favorite color and the silver dots are fairies. You now know the exact intentions that led to the creation of this work. Are you wrong to have enjoyed it as something the artist didn’t intend? Do you enjoy it less now that you know the truth? Just how much should the artist's intention affect your interpretation of the painting? It's a question that's been tossed around by philosophers and art critics for decades, with no consensus in sight. In the mid-20th century, literary critic W.K. Wimsatt and philosopher Monroe Beardsley argued that artistic intention was irrelevant. They called this the Intentional Fallacy: the belief that valuing an artist's intentions was misguided. Their argument was twofold: First, the artists we study are no longer living, never recorded their intentions, or are simply unavailable to answer questions about their work. Second, even if there were a bounty of relevant information, Wimsatt and Beardsley believed it would distract us from the qualities of the work itself. They compared art to a dessert: When you taste a pudding, the chef's intentions don't affect whether you enjoy its flavor or texture. All that matters, they said, is that the pudding "works." Of course, what "works" for one person might not "work" for another. And since different interpretations appeal to different people, the silver dots in our painting could be reasonably interpreted as fairies, stars, or pollutants. By Wimsatt and Beardsley's logic, the artist's interpretation of her own work would just be one among many equally acceptable possibilities. If you find this problematic, you might be more in line with Steven Knapp and Walter Benn Michaels, two literary theorists who rejected the Intentional Fallacy. They argued that an artist's intended meaning was not just one possible interpretation, but the only possible interpretation. For example, suppose you're walking along a beach and come across a series of marks in the sand that spell out a verse of poetry. Knapp and Michaels believed the poem would lose all meaning if you discovered these marks were not the work of a human being, but an odd coincidence produced by the waves. They believed an intentional creator is what makes the poem subject to understanding at all. Other thinkers advocate for a middle ground, suggesting that intention is just one piece in a larger puzzle. Contemporary philosopher Noel Carroll took this stance, arguing that an artist's intentions are relevant to their audience the same way a speaker's intentions are relevant to the person they’re engaging in conversation. To understand how intentions function in conversation, Carroll said to imagine someone holding a cigarette and asking for a match. You respond by handing them a lighter, gathering that their motivation is to light their cigarette. The words they used to ask the question are important, but the intentions behind the question dictate your understanding and ultimately, your response. So which end of this spectrum do you lean towards? Do you, like Wimsatt and Beardsley, believe that when it comes to art, the proof should be in the pudding? Or do you think that an artist's plans and motivations for their work affect its meaning? Artistic interpretation is a complex web that will probably never offer a definitive answer.

**P653 2018-11-15 Why should you read 'A Midsummer Night's Dream' - Iseult Gillespie**

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a group of youths sneak into the woods, where they take mind-altering substances, switch it up romantically, and brush up against creatures from another dimension. "A Midsummer’s Night’s Dream" sees Shakespeare get psychedelic – and the result is a treat in the theatre and on the page. First performed in the 1590's, this play is one of Shakespeare’s friskiest works, filled with trickery, madness and magic. Set over the course of one night, Midsummer progresses at a rollicking pace. The plot is structured around patterns of collision and dissolution, where characters from different worlds are thrown together and torn apart. Shakespeare uses these patterns to mock the characters’ self-obsession and question authority with a comic twist. The action is set in Ancient Greece, but like many of Shakespeare’s plays it reflects his contemporary concerns. The magical setting of the woods at night disrupts the boundaries between separate groups, with bizarre results. Here, the bard plays with the rigid class system of his own time, taking three distinct groups and turning their society upside-down in a world where no mortal is in control. The play opens with young Hermia raging at her father Egeus and Theseus, the King of Athens, who have forbidden her to marry her lover Lysander. Hermia has no interest in her father's choice for her of Demetrius – but her best friend Helena definitely does. Furious at their elders, Hermia and Lysander elope under cover of darkness, with Demetrius in hot pursuit. This is further complicated by Helena’s decision to follow them all into the woods, in the hope of winning Demetrius’ heart. At this point, the woods are getting crowded, as the lovers are sharing the space with a group of “rude mechanicals”— a troupe of workers drunkenly rehearsing a play, led by the jovial Nick Bottom. Unbeknownst to them, the humans have entered into the world of the fairies. Despite their magical splendor, Oberon and Titania, the king and queen of the fairies, have their own romantic problems. Furious at his inability to control Titania, the jealous Oberon commands the trickster Puck to squeeze the juice of a magical flower over her eyes. When she wakes up, she’ll fall in love with the first thing she sees. On his mission, Puck gleefully sprinkles the juice over the eyes of the napping Demetrius and Lysander, and transforms Bottom’s head into that of a donkey for good measure. As eyes flicker open, a night of chaos commences that includes broken hearts, mistaken identity, and transformations. Out of all the characters, Bottom probably fares the best – when the bewitched Titania lays eyes on him, she calls on her fairies to lavish him with wine and treasures and sweeps the transfigured donkeyman off his feet: “pluck the wings from painted butterflies/ To fan the moonbeams from his sleeping eyes. Nod to him, elves, and do him courtesies.” While magic is the catalyst to the action, the play reflects the real drama of the things we do for love – and the nonsensical behavior of the people under its spell. The moon overlooks the action “like a silver bow,” signifying erratic behavior, the dark side of love, and the bewitching allure of a world where the usual rules don’t apply. Although the characters eventually come to their senses, "A Midsummer Night's Dream" raises the question of how much agency we have over our own daily lives. But it’s not the more realistically rendered lovers, rulers or workers who have the last word, but the impish Puck who queries whether we can ever truly trust what we see: If we shadows have offended, Think but this and all is mended: That you have but slumbered here While these visions did appear. And in so doing, he evokes the effect of entering into the magical world of great theatre that plays with the boundary between illusion and reality – and dramatizes the possibility that life is but a dream.

**P654 2018-11-19 Inside the killer whale matriarchy - Darren Croft**

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Off the rugged coast of the pacific northwest, pods of killer whales inhabit the frigid waters. Each family is able to survive here thanks mainly to one member, its most knowledgeable hunter: the grandmother. These matriarchs can live eighty years or more, while most males die off in their thirties. Though killer whales inhabit every major ocean, until recently we knew very little about them. The details of their lives eluded scientists until an organization called the Center for Whale Research began studying a single population near Washington State and British Columbia in 1976. Thanks to their ongoing work, we’ve learned a great deal about these whales, known as the Southern Residents. And the more we learn, the more this population’s elders’ vital role comes into focus. Each grandmother starts her life as a calf born into her mother’s family group, or matriline. The family does everything together, hunting and playing, even communicating through their own unique set of calls. Both sons and daughters spend their entire lives with their mothers’ families. That doesn’t mean a young whale only interacts with her relatives. Besides their own special calls, her matriline shares a dialect with nearby families, and they socialize regularly. Once a female reaches age fifteen or so, these meetings become opportunities to mate with males from other groups. The relationships don’t go much beyond mating— she and her calves stay with her family, while the male returns to his own mother. Until approximately age forty, she gives birth every 6 years on average. Then, she goes through menopause— which is almost unheard of in the animal kingdom. In fact, humans, killer whales and a few other whales are the only species whose females continue to live for years after they stop reproducing. After menopause, grandmothers take the lead hunting for salmon, the Southern Residents’ main food source. Most of the winter they forage offshore, supplementing salmon with other fish. But when the salmon head towards shore in droves to spawn, the killer whales follow. The matriarch shows the younger whales where to find the most fertile fishing grounds. She also shares up to 90% of the salmon she catches. With each passing year, her contributions become more vital: overfishing and habitat destruction have decimated salmon populations, putting the whales at near-constant risk of starvation. These grandmothers’ expertise can mean the difference between life and death for their families– but why do they stop having calves? It’s almost always advantageous for a female to continue reproducing, even if she also cares for her existing children and grandchildren. A couple unique circumstances change this equation for killer whales. The fact that neither sons or daughters leave their families of origin is extremely rare— in almost all animal species, one or both sexes disperse. This means that as a female killer whale ages, a greater percentage of her family consists of her children and grandchildren, while more distant relatives die off. Because older females are more closely related to the group than younger females, they do best to invest in the family as a whole, whereas younger females should invest in reproducing. In the killer whale’s environment, every new calf is another mouth to feed on limited, shared resources. An older female can further her genes without burdening her family by supporting her adult sons, who sire calves other families will raise. This might be why the females have evolved to stop reproducing entirely in middle age. Even with the grandmothers’ contributions, the Southern Resident killer whales are critically endangered, largely due to a decline in salmon. We urgently need to invest in restoring salmon populations to save them from extinction. In the long term, we’ll need more studies like the Center for Whale Research’s. What we’ve learned about the Southern Residents may not hold true for other groups. By studying other populations closely, we might uncover more startling adaptations, and anticipate their vulnerabilities to human interference before their survival is at risk.

**P655 2018-11-19 The dangerous race for the South Pole - Elizabeth Leane**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=655)

Roald Amundsen had spent nearly two years preparing his Arctic expedition. He had secured funding from the Norwegian Crown and hand-picked a trusted crew. He’d even received the blessing of the famed explorer Fridtjof Nansen, along with the use of his ship, Fram, specially constructed to withstand the ice. Now, with the voyage departing, he had one final announcement to his shipmates: They were going to head in the opposite direction. By the early 20th century, nearly every region of the globe had been visited and mapped, with only two key locations remaining: the North Pole, deep in the frozen waters of the Arctic region, and the South Pole, nestled within a recently discovered icy continent in the vast Antarctic Ocean. A veteran of several expeditions, Amundsen had long dreamed of reaching the North Pole. But in 1909, amidst his preparations, news came that the American explorers Frederick Cook and Robert Peary had staked rival claims to the achievement. Instead of abandoning the planned voyage, Amundsen decided to alter its course to what he called “the last great problem.” But Amundsen’s crew weren’t the only ones kept in the dark. British naval officer Robert F. Scott had already visited the Antarctic, and was leading his own South Pole expedition. Now, as Scott’s ship Terra Nova reached Melbourne in 1910, he was greeted with the news that Amundsen was also heading south. Reluctantly, Scott found himself pitted against the Norwegian in what the newspapers called a ‘race to the Pole.’ Yet if it was a race, it was a strange one. The expeditions left at different times from different locations, and they had very different plans for the journey. Amundsen was focused solely on reaching the Pole. Informed by his Arctic exploration, he drew on both Inuit and Norwegian experience, arriving with a small team of men and more than a hundred dogs. His explorers were clothed in sealskin and furs, as well as specially designed skis and boots. But Scott's venture was more complicated. Launching an extensive scientific research expedition, he traveled with over three times more men than Amundsen, alongside over 30 dogs, 19 Siberian ponies, and three state-of-the-art motorized sledges. But these additional tools and bodies weighed down the ship as it battled the storms of the southern ocean. And as they finally began to lay supplies, they found both their ponies and motor-sledges ineffective in the harsh ice and snow. In the spring of 1911, after waiting out the long polar night, both parties began the journey south. Scott’s team traveled over the Beardmore Glacier, following the path of Ernest Shackleton's earlier attempt to reach the pole. But although this course had been documented, it proved slow and laborious. Meanwhile, despite an initial false start, Amundsen’s five-man team made good time using a previously uncharted route through the same Transantarctic Mountains. They stayed ahead of Scott’s team, and on December 14, arrived first at their desolate destination. To avoid the ambiguity that surrounded Cook and Peary’s North Pole claims, Amundsen’s team traversed the area in a grid to make sure they covered the Pole’s location. Along with flags and a tent marker, they left a letter for Scott, which would not be found until over a month later. But when Scott’s party finally reached the pole, losing the ‘race’ was the least of their problems. On the way back towards the camp, two of the five men succumbed to frostbite starvation, and exhaustion. The remaining explorers hoped for a prearranged rendezvous with a team sent from their base, but due to a series of mishaps, misjudgements and miscommunications, their rescue never arrived. Their remains, along with Scott’s diary, would not be found until spring. Today, scientists from various countries live and work at Antarctic research stations. But the journeys of these early explorers are not forgotten. Despite their divergent fates, they are forever joined in history, and in the name of the research base that marks the South Pole.

**P656 2018-11-26 A brie(f) history of cheese - Paul Kindstedt**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=656)

Before empires and royalty, before pottery and writing, before metal tools and weapons – there was cheese. As early as 8000 BCE, the earliest Neolithic farmers living in the Fertile Crescent began a legacy of cheesemaking almost as old as civilization itself. The rise of agriculture led to domesticated sheep and goats, which ancient farmers harvested for milk. But when left in warm conditions for several hours, that fresh milk began to sour. Its lactic acids caused proteins to coagulate, binding into soft clumps. Upon discovering this strange transformation, the farmers drained the remaining liquid – later named whey – and found the yellowish globs could be eaten fresh as a soft, spreadable meal. These clumps, or curds, became the building blocks of cheese, which would eventually be aged, pressed, ripened, and whizzed into a diverse cornucopia of dairy delights. The discovery of cheese gave Neolithic people an enormous survival advantage. Milk was rich with essential proteins, fats, and minerals. But it also contained high quantities of lactose – a sugar which is difficult to process for many ancient and modern stomachs. Cheese, however, could provide all of milk’s advantages with much less lactose. And since it could be preserved and stockpiled, these essential nutrients could be eaten throughout scarce famines and long winters. Some 7th millennium BCE pottery fragments found in Turkey still contain telltale residues of the cheese and butter they held. By the end of the Bronze Age, cheese was a standard commodity in maritime trade throughout the eastern Mediterranean. In the densely populated city-states of Mesopotamia, cheese became a staple of culinary and religious life. Some of the earliest known writing includes administrative records of cheese quotas, listing a variety of cheeses for different rituals and populations across Mesopotamia. Records from nearby civilizations in Turkey also reference rennet. This animal byproduct, produced in the stomachs of certain mammals, can accelerate and control coagulation. Eventually this sophisticated cheesemaking tool spread around the globe, giving way to a wide variety of new, harder cheeses. And though some conservative food cultures rejected the dairy delicacy, many more embraced cheese, and quickly added their own local flavors. Nomadic Mongolians used yaks’ milk to create hard, sundried wedges of Byaslag. Egyptians enjoyed goats’ milk cottage cheese, straining the whey with reed mats. In South Asia, milk was coagulated with a variety of food acids, such as lemon juice, vinegar, or yogurt and then hung to dry into loafs of paneer. This soft mild cheese could be added to curries and sauces, or simply fried as a quick vegetarian dish. The Greeks produced bricks of salty brined feta cheese, alongside a harder variety similar to today’s pecorino romano. This grating cheese was produced in Sicily and used in dishes all across the Mediterranean. Under Roman rule, “dry cheese” or “caseus aridus,” became an essential ration for the nearly 500,000 soldiers guarding the vast borders of the Roman Empire. And when the Western Roman Empire collapsed, cheesemaking continued to evolve in the manors that dotted the medieval European countryside. In the hundreds of Benedictine monasteries scattered across Europe, medieval monks experimented endlessly with different types of milk, cheesemaking practices, and aging processes that led to many of today’s popular cheeses. Parmesan, Roquefort, Munster and several Swiss types were all refined and perfected by these cheesemaking clergymen. In the Alps, Swiss cheesemaking was particularly successful – producing a myriad of cow’s milk cheeses. By the end of the 14th century, Alpine cheese from the Gruyere region of Switzerland had become so profitable that a neighboring state invaded the Gruyere highlands to take control of the growing cheese trade. Cheese remained popular through the Renaissance, and the Industrial Revolution took production out of the monastery and into machinery. Today, the world produces roughly 22 billion kilograms of cheese a year, shipped and consumed around the globe. But 10,000 years after its invention, local farms are still following in the footsteps of their Neolithic ancestors, hand crafting one of humanity’s oldest and favorite foods.

**P657 2018-11-27 Why should you read Kurt Vonnegut -** **Mia Nacamulli**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=657)

Billy Pilgrim can’t sleep because he knows aliens will arrive to abduct him in one hour. He knows the aliens are coming because he has become “unstuck” in time, causing him to experience events out of chronological order. Over the course of Kurt Vonnegut’s Slaughterhouse-five, he hops back and forth between a childhood trip to the Grand Canyon, his life as a middle-aged optometrist, his captivity in an intergalactic zoo, the humiliations he endured as a war prisoner, and more. The title of Slaughterhouse-five and much of its source material came from Vonnegut’s own experiences in World War II. As a prisoner of war, he lived in a former slaughterhouse in Dresden, where he took refuge in an underground meat locker while Allied forces bombed the city. When he and the other prisoners finally emerged, they found Dresden utterly demolished. After the war, Vonnegut tried to make sense of human behavior by studying an unusual aspect of anthropology: the shapes of stories, which he insisted were just as interesting as the shapes of pots or spearheads. To find the shape, he graphed the main character’s fortune from the beginning to the end of a story. The zany curves he generated revealed common types of fairy tales and myths that echo through many cultures. But this shape can be the most interesting of all. In a story like this, it’s impossible to distinguish the character’s good fortune from the bad. Vonnegut thought this kind of story was the truest to real life, in which we are all the victims of a series of accidents, unable to predict how events will impact us long term. He found the tidy, satisfying arcs of many stories at odds with this reality, and he set out to explore the ambiguity between good and bad fortune in his own work. When Vonnegut ditched clear-cut fortunes, he also abandoned straightforward chronology. Instead of proceeding tidily from beginning to end, in his stories “All moments, past, present and future always have existed, always will exist.” Tralfamadorians, the aliens who crop up in many of his books, see all moments at once. They “can see where each star has been and where it is going, so that the heavens are filled with rarefied, luminous spaghetti.” But although they can see all of time, they don’t try to change the course of events. While the Trafalmadorians may be at peace with their lack of agency, Vonnegut’s human characters are still getting used to it. In The Sirens of Titan, when they seek the meaning of life in the vastness of the universe, they find nothing but “empty heroics, low comedy, and pointless death.” Then, from their vantage point within a “chrono-synclastic infundibulum,” a man and his dog see devastating futures for their earthly counterparts, but can’t change the course of events. Though there aren’t easy answers available, they eventually conclude that the purpose of life is “to love whoever is around to be loved.” In Cat’s Cradle, Vonnegut’s characters turn to a different source of meaning: Bokonism, a religion based on harmless lies that all its adherents recognize as lies. Though they’re aware of Bokonism’s lies, they live their lives by these tenets anyway, and in so doing develop some genuine hope. They join together in groups called Karasses, which consist of people we “find by accident but […] stick with by choice”— cosmically linked around a shared purpose. These are not to be confused with Granfalloons, groups of people who appoint significance to actually meaningless associations, like where you grew up, political parties, and even entire nations. Though he held a bleak view of the human condition, Vonnegut believed strongly that “we are all here to help each other get through this thing, whatever it is." We might get pooped and demoralized, but Vonnegut interspersed his grim assessments with more than a few morsels of hope. His fictional alter ego, Kilgore Trout, supplied this parable: two yeast sat “discussing the possible purposes of life as they ate sugar and suffocated in their own excrement. Because of their limited intelligence, they never came close to guessing that they were making champagne.” In spite of his insistence that we’re all here to fart around, in spite of his deep concerns about the course of human existence, Vonnegut also advanced the possibility, however slim, that we might end up making something good. And if that isn’t nice, what is?

**P658 2018-11-28 Can you solve the time travel riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=658)

Your internship in Professor Ramsey’s physics lab has been amazing. Until, that is, the professor accidentally stepped through a time portal. You’ve got just a minute to jump through the portal to save him before it closes and leaves him stranded in history. Once you’re through it, the portal will close, and your only way back will be to create a new one using the chrono-nodules from your lab. Activated nodules connect to each other via red or blue tachyon entanglement. Activate more nodules and they’ll connect to all other nodules in the area. As soon as a red or blue triangle is created with a nodule at each point, it opens a doorway through time that will take you back to the present. But the color of each individual connection manifests at random, and there’s no way to choose or change its color. And there’s one more problem: each individual nodule creates a temporal instability that raises the chances the portal might collapse as you go through it. So the fewer you bring, the better. The portal’s about to close. What’s the minimum number of nodules you need to bring to be certain you’ll create a red or blue triangle and get back to the present? Pause here if you want to figure it out for yourself! Answer in: 3 Answer in: 2 Answer in: 1 This question is so rich that an entire branch of mathematics known as Ramsey Theory developed from it. Ramsey Theory is home to some famously difficult problems. This one isn’t easy, but it can be handled if you approach it systematically. Imagine you brought just three nodules. Would that be enough? No - for example, you might have two blue and one red connection, and be stuck in the past forever. Would four nodules be enough? No - there are many arrangements here that don’t give a blue or red triangle. What about five? It turns out there is an arrangement of connections that avoids creating a blue or red triangle. These smaller triangles don’t count because they don’t have a nodule at each corner. However, six nodules will always create a blue triangle or a red triangle. Here’s how we can prove that without sorting through every possible case. Imagine activating the sixth nodule, and consider how it might connect to the other five. It could do so in one of six ways: with five red connections, five blue connections, or some mix of red and blue. Notice that every possibility has at least three connections of the same color coming from this nodule. Let’s look at just the nodules on the other end of those same three color connections. If the connections were blue, then any additional blue connection between those three would give us a blue triangle. So the only way we could get in trouble is if all the connections between them were red. But those three red connections would give us a red triangle. No matter what happens, we’ll get a red or a blue triangle, and open our doorway. On the other hand, if the original three connections were all red instead of blue, the same argument still works, with all the colors flipped. In other words, no matter how the connections are colored, six nodules will always create a red or blue triangle and a doorway leading home. So you grab six nodules and jump through the portal. You were hoping your internship would give you valuable life experience. Turns out, that didn’t take much time.

**P659 2018-11-29 From slave to rebel gladiator - The life of Spartacus - Fiona Radford**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=659)

As the warrior slept, a snake coiled around his face. Instead of a threat, his wife saw an omen– a fearsome power that would lead her husband to either glory or doom. For now, however, he was only a slave – one of millions taken from the territories conquered by Rome to work the mines, till the fields, or fight for the crowd’s entertainment. A nomadic Thracian from what is now Bulgaria, he had served in the Roman Army but was imprisoned for desertion. His name was Spartacus. Spartacus had been brought to Capua by Batiatus, a lanista, or trainer of gladiators. And life at the ludus, or gladiator school, was unforgiving. New recruits were forced to swear an oath “to be burned, to be bound, to be beaten, and to be killed by the sword,” and to obey their master’s will without question. But even harsh discipline couldn’t break Spartacus’s spirit. In 73 BCE, Spartacus led 73 other slaves to seize knives and skewers from the kitchen and fight their way out, hijacking a wagon of gladiator equipment along the way. They were done fighting for others– now, they fought for their freedom. When the news reached Rome, the Senate was too busy with wars in Spain and the Pontic Empire to worry about some unruly slaves. Unconcerned, praetor Claudius Glaber took an army of three thousand men to the rebel’s refuge at Mount Vesuvius, and blocked off the only passage up the mountain. All that remained was to wait and starve them out– or so he thought. In the dead of night, the rebels lowered themselves down the cliffside on ropes made from vines, and flanked Glaber’s unguarded camp. Thus began the legend of Rome’s defiant gladiator. As news of the rebellion spread, its ranks swelled with escaped slaves, deserting soldiers, and hungry peasants. Many were untrained, but Spartacus’s clever tactics transformed them into an effective guerrilla force. A second Roman expedition led by praetor Varinius, was ambushed while the officer bathed. To elude the remaining Roman forces, the rebels used their enemy’s corpses as decoy guards, stealing Varinius’s own horse to aid their escape. Thanks to his inspiring victories and policy of distributing spoils equally, Spartacus continued attracting followers, and gained control of villages where new weapons could be forged. The Romans soon realized they were no longer facing ragtag fugitives, and in the spring of 72 BCE, the Senate retaliated with the full force of two legions. The rebels left victorious, but many lives were lost in the battle, including Spartacus’ lieutenant Crixus. To honor him, Spartacus held funeral games, forcing his Roman prisoners to play the role his fellow rebels had once endured. By the end of 72 BCE, Spartacus’ army was a massive force of roughly 120,000 members. But those numbers proved difficult to manage. With the path to the Alps clear, Spartacus wanted to march beyond Rome’s borders, where his followers would be free. But his vast army had grown brash. Many wanted to continue pillaging, while others dreamed of marching on Rome itself. In the end, the rebel army turned south– forgoing what would be their last chance at freedom. Meanwhile, Marcus Licinius Crassus had assumed control of the war. As Rome’s wealthiest citizen, he pursued Spartacus with eight new legions, eventually trapping the rebels in the toe of Italy. After failed attempts to build rafts, and a stinging betrayal by local pirates, the rebels made a desperate run to break through Crassus’s lines– but it was no use. Roman reinforcements were returning from the Pontic wars, and the rebels’ ranks and spirits were broken. In 71 BCE, they made their last stand. Spartacus nearly managed to reach Crassus before being cut down by centurions. His army was destroyed, and 6000 captives were crucified along the Appian Way– a haunting demonstration of Roman authority. Crassus won the war, but it is not his legacy which echoes through the centuries. Thousands of years later, the name of the slave who made the world’s mightiest empire tremble has become synonymous with freedom– and the courage to fight for it.

**P660 2018-12-03 Are we running out of clean water - Balsher Singh Sidhu**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=660)

From space, our planet appears to be more ocean than Earth. But despite the water covering 71% of the planet’s surface, more than half the world’s population endures extreme water scarcity for at least one month a year. And current estimates predict that by 2040, up to 20 more countries could be experiencing water shortages. Taken together, these bleak statistics raise a startling question: are we running out of clean water? Well yes, and no. At a planetary scale, Earth can’t run out of freshwater thanks to the water cycle, a system that continuously produces and recycles water, morphing it from vapour, to liquid, to ice as it circulates around the globe. So this isn’t really a question of how much water there is, but of how much of it is accessible to us. 97% of earth’s liquid is saltwater, too loaded with minerals for humans to drink or use in agriculture. Of the remaining 3% of potentially usable freshwater, more than two-thirds is frozen in ice caps and glaciers. That leaves less than 1% available for sustaining all life on Earth, spread across our planet in rivers, lakes, underground aquifers, ground ice and permafrost. It’s these sources of water that are being rapidly depleted by humans, but slowly replenished by rain and snowfall. And this limited supply isn’t distributed evenly around the globe. Diverse climates and geography provide some regions with more rainfall and natural water sources, while other areas have geographic features that make transporting water much more difficult. And supplying the infrastructure and energy it would take to move water across these regions is extremely expensive. In many of these water-poor areas, as well as some with greater access to water, humanity is guzzling up the local water supply faster than it can be replenished. And when more quickly renewed sources can’t meet the demand, we start pumping it out of our finite underground reserves. Of Earth’s 37 major underground reservoirs, 21 are on track to be irreversibly emptied. So while it’s true that our planet isn’t actually losing water, we are depleting the water sources we rely on at an unsustainable pace. This might seem surprising – after all, on average, people only drink about two liters of water a day. But water plays a hidden role in our daily lives, and in that same 24 hours, most people will actually consume an estimated 3000 liters of water. In fact, household water – which we use to drink, cook, and clean – accounts for only 3.6% of humanity’s water consumption. Another 4.4% goes to the wide range of factories which make the products we buy each day. But the remaining 92% of our water consumption is all spent on a single industry: agriculture. Our farms drain the equivalent of 3.3 billion Olympic-sized swimming pools every year, all of it swallowed up by crops and livestock to feed Earth’s growing population. Agriculture currently covers 37% of Earth’s land area, posing the biggest threat to our regional water supplies. And yet, it’s also a necessity. So how do we limit agriculture’s thirst while still feeding those who rely on it? Farmers are already finding ingenious ways to reduce their impact, like using special irrigation techniques to grow “more crop per drop”, and breeding new crops that are less thirsty. Other industries are following suit, adopting production processes that reuse and recycle water. On a personal level, reducing food waste is the first step to reducing water use, since one-third of the food that leaves farms is currently wasted or thrown away. You might also want to consider eating less water-intensive foods like shelled nuts and red meat. Adopting a vegetarian lifestyle could reduce up to one third of your water footprint. Our planet may never run out of water, but it doesn’t have to for individuals to go thirsty. Solving this local problem requires a global solution, and small day-to-day decisions can affect reservoirs around the world.

**P661 2018-12-04 Can animals be deceptive - Eldridge Adams**

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A male firefly glows above a field on a summer’s night, emitting a series of enticing flashes. He hopes a nearby female will respond with her own lightshow and mate with him. Sadly for this male, it won’t turn out quite the way he plans. A female from a different species mimics his pulsing patterns: by tricking the male with her promise of partnership, she lures him in– and turns him into an easy meal. He’s been deceived. Behavioral biologists have identified three defining hallmarks of deception by non-human animals: it must mislead the receiver, the deceiver must benefit, and it can’t simply be an accident. In this case we know that the predatory firefly’s signal isn’t an accident because she flexibly adjusts her flash pattern to match males of different species. Based on this definition, where is animal deception seen in nature? Camouflage is a good starting point– and one of the most familiar examples of animal trickery. The leaf-tailed gecko and the octopus fool viewers by blending into the surfaces on which they rest. Other animals use mimicry to protect themselves. Harmless scarlet kingsnakes have evolved red, yellow, and black patterns resembling those of the venomous eastern coral snake to benefit from the protective warnings these markings convey. Even some plants use mimicry: there are orchids that look and smell like female wasps to attract hapless males, who end up pollinating the plant. Some of these animals benefit by having fixed characteristics that are evolutionary suited to their environments. But in other cases, the deceiver seems to anticipate the reactions of other animals and to adjust its behavior accordingly. Sensing a threat, the octopus will rapidly change its colors to match its surroundings. Dwarf chameleons color-match their environments more closely when they see a bird predator rather than a snake– birds, after all, have better color vision. One of the more fascinating examples of animal deception comes from the fork-tailed drongo. This bird sits atop tall trees in the Kalahari Desert, surveying the landscape for predators and calling when it senses a threat. That sends meerkats, pied babblers, and others dashing for cover. But the drongo will also sound a false alarm when those other species have captured prey. As the meerkats and babblers flee, the drongo swoops down to steal their catches. This tactic works about half the time– and it provides drongos with much of their food. There are fewer solid cases of animals using signals to trick members of their own species, but that happens too. Consider the mantis shrimp. Like other crustaceans, it molts as it grows, which leaves its soft body vulnerable to attack. But it’s still driven to protect its home against rivals. So it has become a masterful bluffer. Despite being fragile, a newly molted shrimp is actually more likely to threaten intruders, spreading the large limbs it usually uses to strike or stab its opponents. And that works – bluffers are more likely to keep their homes than non-bluffers. In its softened condition, a mantis shrimp couldn’t withstand a fight– which is why we can be confident that its behavior is a bluff. Biologists have even noticed that its bluffs are tactical: newly molted mantis shrimp are more likely to bluff against smaller rivals, who are especially likely to be driven away. It would seem that instead of just threatening reflexively, the mantis shrimp is swiftly gauging the situation and predicting others’ behavior, to get the best result. So we know that animals can deceive, but do they do so with intent? That’s a difficult question, and many scientists think we'll never be able to answer it. We can't observe animals’ internal thoughts. But we don’t need to know what an animal is thinking in order to detect deception. By watching behavior and its outcomes, we learn that animals manipulate predators, prey, and rivals, and that their capacity for deception can be surprisingly complex.

**P662 2018-12-05 How Thor got his hammer - Scott A. Mellor**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=662)

Loki the mischief-maker, was writhing uncomfortably in Thor’s iron grip. The previous night, while the rest of the gods slept, he’d snuck up on Thor’s wife Sif and shorn off her beautiful hair. It’d seemed like a funny prank at the time, but now Thor was about to break every bone in his body. Loki had to think of some way to fix what he’d done. Yet who could replace Sif’s matchless hair, golden like a field of summer wheat? The dwarves! – their legendary smiths could make anything. So Loki rushed to their realm, deep within the mountains of the earth. Even before he arrived, the wily Loki was already scheming how he would get the dwarves to do his bidding. He decided that his best bet was to pit two families against each other. He first visited the masterful sons of Ivaldi. He told them that their rivals, a pair of brothers named Brokk and Eitri, had claimed that they were the best craftsmen in the world and were determined to prove it in a competition. The rules were that each family had to create three gifts for the gods, including, for the Ivaldis, golden hair. Then Loki visited Brokk and Eitri, and told them the same thing, only now claiming that the sons of Ivaldi had issued the challenge. But Brokk and Eitri couldn’t be fooled so easily, and only agreed to participate if Loki put his own head on the line. Literally—if Brokk and Eitri won, Loki would forfeit his head to them. Loki had no choice but to agree, and to save himself had to find a way to make sure the sons of Ivaldi emerged victorious. Both sets of dwarves got to work. Eitri set Brokk to man the bellows and told him not to stop for any reason, or the treasures would be ruined. Soon a strange black fly flew into the room. As a piece of pigskin was placed in the forge, the fly stung Brokk’s hand, but he didn’t flinch. Next, while Eitri worked a block of gold, the fly bit Brokk on the neck. The dwarf carried on. Finally, Eitri placed a piece of iron in the furnace. This time the fly landed right on Brokk’s eyelid and bit as hard as it could. And for just a split second, Brokk’s hand left the bellows. That’s all it took; their final treasure hadn’t stayed in the fire long enough. Loki now reappeared in his normal form, overjoyed by their failure, and accompanied the dwarves to present their treasures to the gods. First, Loki presented the treasures from the sons of Ivaldi. Their golden hair bound to Sif’s head and continued to grow, leaving her even more radiant than before. Next, for Odin the all-father, a magnificent spear that could pierce through anything. And finally a small cloth that unfolded into a mighty ship built for Freyr, god of the harvest. Then Brokk presented the treasures made by him and his brother. For Freyr they’d forged a golden-bristled boar who’d pull Freyr’s chariot across the sky faster than any mount. For Odin, a golden arm ring which would make eight more identical rings on every ninth night. And for Thor, a hammer called Mjolnir. Its handle was too short, and Loki smirked at the obvious defect. But then Brokk revealed its abilities. Mjolnir would never shatter, never miss its mark and always return to Thor’s hand when thrown. Despite the short handle, the gods all agreed this was the finest gift of all. Remembering what was at stake, Loki tried to flee, but Thor reached him first. But before the dwarves could have their due, clever Loki pointed out that they had won the rights to his head, but not his neck, and thus had no right to cut it. All begrudgingly admitted the truth in that, but Brokk would have the last laugh. Taking his brother’s awl, he pierced it through Loki’s lips and sewed his mouth shut, so the trickster god could no longer spread his malicious deceit. Yet the irony was not lost on the gods. For it was Loki’s deceit that had brought them these fine treasures and given Thor the hammer for which he’s still known today.

**P663 2018-12-06 The truth about electroconvulsive therapy (ECT) - Helen M. Farrell**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=663)

In 1982, a young nurse was suffering from severe, unrelenting depression. She couldn’t work, socialize, or even concentrate well enough to read the newspaper. One treatment changed everything. After two courses of electroconvulsive therapy, or ECT, her symptoms lifted. She went back to work, then on to graduate school, where she earned high grades. At first, she talked openly about her life changing treatment. But as she realized many people had an extremely negative impression of ECT, she stopped sharing her experience. ECT carried a deep stigma, leftover from a history that bears little resemblance to the modern procedure. The therapy was first used in medicine in 1938. In its early years, doctors administered a strong electrical current to the brain, causing a whole-body seizure during which patients might bite their tongues or even break bones. Modern ECT is very different. While a patient is under general anesthesia, electrodes deliver a series of mild electrical pulses to the brain. This causes huge numbers of neurons to fire in unison: a brief, controlled seizure. A muscle relaxant keeps spasms from spreading to the rest of his body. The only physical indication of the electricity flooding the brain is a twitching foot. The treatment lasts for about a minute, and most patients are able to resume normal activities about an hour after each session. ECT is commonly used to treat severe cases of major depression or bipolar disorder in patients who haven’t responded to other therapies, or who have had adverse reactions to medication. Half or more of those who undergo treatment experience an improvement in their symptoms. Most patients treated with ECT have two or three sessions per week for several weeks. Some begin to notice an improvement in their symptoms after just one session, while others take longer to respond. Patients often continue less frequent treatments for several months to a year, and some need occasional maintenance sessions for the rest of their lives. Modern ECT is much safer than it used to be, but patients can still experience side effects. They may feel achy, fatigued, or nauseated right after treatment. Some have trouble remembering what happened right before a session— for example, what they had for dinner the previous evening. Rarely, they might have trouble remembering up to weeks and months before. For most patients, this memory loss does improve over time. What's fascinating is that despite its proven track record, we still don't know exactly why ECT works. Neurons in the brain communicate via electrical signals, which influence our brain chemistry, contributing to mood and behavior. The flood of electrical activity sparked by ECT alters that chemistry. For example, ECT triggers the release of certain neurotransmitters, molecules that help carry signals between neurons and influence mental health. ECT also stimulates the flow of hormones that may help reduce symptoms of depression. Interestingly, ECT maintenance works better when paired with medication, even in patients who were resistant to medication before. As we come to a better understanding of the brain, we’ll likely be able to make ECT even more effective. In 1995, more than a decade after her first course of ECT, the nurse decided to publish an account of her experience. Because of the stigma surrounding the treatment, she worried that doing so might negatively impact her personal and professional life, but she knew ECT could make a difference for patients when all else failed. Though misperceptions about ECT persist, accounts like hers have helped make doctors and patients alike aware of the treatment’s life changing potential.

**P664 2018-12-07 Can you solve the multiplying rabbits riddle - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=664)

After years of experiments, you’ve finally created the pets of the future– nano-rabbits! They’re tiny, they’re fuzzy… and they multiply faster than the eye can see. In your lab there are 36 habitat cells, arranged in an inverted pyramid, with 8 cells in the top row. The first has one rabbit, the second has two, and so on, with eight rabbits in the last one. The other rows of cells are empty… for now. The rabbits are hermaphroditic, and each rabbit in a given cell will breed once with every rabbit in the horizontally adjacent cells, producing exactly one offspring each time. The newborn rabbits will drop into the cell directly below the two cells of its parents, and within minutes will mature and reproduce in turn. Each cell can hold 10^80 nano-rabbits – that’s a 1 followed by 80 zeros – before they break free and overrun the world. Your calculations have given you a 46-digit number for the count of rabbits in the bottom cell– plenty of room to spare. But just as you pull the lever to start the experiment, your assistant runs in with terrible news. A rival lab has sabotaged your code so that all the zeros at the end of your results got cut off. That means you don’t actually know if the bottom cell will be able to hold all the rabbits – and the reproduction is already underway! To make matters worse, your devices and calculators are all malfunctioning, so you only have a few minutes to work it out by hand. How many trailing zeros should there be at the end of the count of rabbits in the bottom habitat? And do you need to pull the emergency shut-down lever? Pause the video now if you want to figure it out for yourself. Answer in 3 Answer in 2 Answer in 1 There isn’t enough time to calculate the exact number of rabbits in the final cell. The good news is we don’t need to. All we need to figure out is how many trailing zeros it has. But how can we know how many trailing zeros a number has without calculating the number itself? What we do know is that we arrive at the number of rabbits in the bottom cell through a process of multiplication – literally. The number of rabbits in each cell is the product of the number of rabbits in each of the two cells above it. And there are only two ways to get numbers with trailing zeros through multiplication: either multiplying a number ending in 5 by any even number, or by multiplying numbers that have trailing zeroes themselves. Let’s calculate the number of rabbits in the second row and see what patterns emerge. Two of the numbers have trailing zeros – 20 rabbits in the fourth cell and 30 in the fifth cell. But there are no numbers ending in 5. And since the only way to get a number ending in 5 through multiplication is by starting with a number ending in 5, there won’t be any more down the line either. That means we only need to worry about the numbers that have trailing zeros themselves. And a neat trick to figure out the amount of trailing zeros in a product is to count and add the trailing zeros in each of the factors – for example, 10 x 100 = 1,000. So let’s take the numbers in the fourth and fifth cells and multiply down from there. 20 and 30 each have one zero, so the product of both cells will have two trailing zeros, while the product of either cell and an adjacent non-zero-ending cell will have only one. When we continue all the way down, we end up with 35 zeros in the bottom cell. And if you’re not too stressed about the potential nano-rabbit apocalypse, you might notice that counting the zeros this way forms part of Pascal’s triangle. Adding those 35 zeros to the 46 digit number we had before yields an 81 digit number – too big for the habitat to contain! You rush over and pull the emergency switch just as the seventh generation of rabbits was about to mature – hare-raisingly close to disaster.

**P665 2018-12-11 Can you solve the troll’s paradox riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=665)

You’ve discovered a doorway to another realm, and now you and your brother are off exploring the wonderful world of Paradoxica. Fantastically paradoxical creatures crawl, run, and fly around you. And then you see the troll. It’s catching all the creatures in an enormous net. You bravely step forward and demand it let them go. The troll laughs. “If you’re such a fan of paradoxes,” it says, “then I’ll make you an offer. If you say something true, I’ll release all these creatures." You’re about to say, “You are a troll,” but before you can, the troll grabs your brother. “If you say something false,” he continues, “then I’ll release your brother." Your statement can only be a single sentence. And as you can see, I hate paradoxes more than anything. If you try to cheat by saying something paradoxical, like, ‘this statement is false,’ then I'll eat your brother and the creatures." What true/false statement can you say to force the troll to free your brother and the paradoxical creatures? [Pause the video now if you want to figure it out for yourself!] Answer in: 3 Answer in: 2 Answer in: 1 This seems like an impossible situation, but incredibly, you can say something that will force the troll to release all its prisoners. This is an example of coercive logic, invented by the great logician and puzzle creator Raymond Smullyan. The trick Smullyan came up with involves saying a statement whose truth or falseness depends on what you want the troll to do. Your statement still has to be carefully crafted. For example, if you were to say, “You are going to free the creatures and my brother,” the troll could respond, “that’s false… I’m only going to free your brother.” Similarly, if you said, “You will free the paradoxes,” the troll could say, “That’s true,” and free the paradoxes. But watch what happens if you say, “You will free my brother.” The statement can’t be false, because if it were, the troll, by its own rules, would have to free your brother. That would make the statement paradoxically true and false. But the troll hates paradoxes and would never willingly create one. So his only option is for the statement to be true. If “you will free my brother” is true, then the troll has to release your brother. And by its own rules, the troll has to free the creatures as well, since you said a true statement. By wielding just 5 words like a logical scalpel, you’ve forced the troll to free all its prisoners. As the troll stomps off in anger, the paradoxes cheer you for winning them their freedom, and promise to lead you to the treasure at the top of the stairs. If you can reach it.

**P666 2018-12-13 A day in the life of a Mongolian queen - Anne F. Broadbridge**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=666)

As dawn breaks over a moveable city of ten thousand yurts, Queen Boraqchin is in for a rude awakening. A rogue sheep has slipped past her servants and guards and bolted into her yurt, where he springs into bed and bleats in her ear. Although she’s the formidable khatun of the Golden Horde, a huge kingdom in the Mongolian Empire, Boraqchin has a hands-on approach to ruling. She’s been married to Batu Khan, the fearsome grandson of Genghis Khan himself, since she was fifteen – and while her husband is out on his raids, she juggles the duties of flocks, family and empire at home. This makes her the manager – and the mover – of a city of thousands. Twice a year, Boraqchin moves the city between two seasonal camping grounds. This ensures constant water and lush grass in summer, and protection from harsh winds in winter. The whole operation requires weeks of strict planning, liaising with the other camps in her domain, strategic delegation – and the patience to move at the speed of dawdling animals. Today is moving day, and she’ll have to direct throngs of her ladies, commanders, slaves and animals up the river Volga for the summer. As Boraqchin steps outside, she’s greeted by a commotion – her unwanted visitor is now running circles around her stewards. They’re attempting to stow her possessions securely into wagons. Boraqchin orders them to get it under control – but she’s the only one quick enough to catch the stray. She next supervises her ladies who are unpinning her yurt and lifting it onto its custom wagon. It requires a team of twenty oxen to pull, and Boraqchin wouldn’t trust anyone to steer it but herself. Next, Boraqchin and her woolly companion meet with the guards. She orders them to keep close watch on her husband's special reception yurt and port-able throne during the journey. They’ll also act as outriders, and she tells them how to secure the route, surround her for safety – and keep the animals in check. But when the sheep finally breaks free and makes for the fields, the guards can barely keep up as it scampers through crowds packing up their yurts. Exasperated, Boraqchin rides down to the pastures herself. When she gets there, she catches sight of the troublesome sheep wriggling into the middle of a flock. When she follows him in, he’s nestled next to a ewe, his mother. She’s pregnant, and seems to be in pain. With a start, Boraqchin realizes that this ewe’s impending delivery has been forgotten in the flurry of moving day. There’s no time to find a shepherd – instead, Boraqchin rolls up her sleeves, greases her arm and helps the ewe give birth to two new additions to the empire. Leaving the lambs and their mother, Boraqchin dashes back to the camp. Here the final touches have been put to packing, and vehicles are starting to line up. This vast procession starts with the queen and two hundred wagons filled with her treasures. Next up are the junior wives and crew, then the concubines – and this is only Boraqchin's camp. After this comes the second imperial camp led by another senior wife, then two more camps, also led by wives. Boraqchin has been checking in with them for weeks to ensure a smooth departure and orderly queue. But they only make up the royal portion of the line – behind them winds the entire civilian city, which includes holy men with portable chapels and mosques, families, tradesmen, and shepherds. Finally, Boraqchin settles into her wagon. It’ll take weeks to reach their destination – but over the course of the journey, she’ll keep everyone expertly in check – from her proud children and attentive subjects, to the most meandering sheep at the back of line.

**P667 2018-12-13 The history of the world according to cats - Eva-Maria Geigl**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=667)

On May 27th, 1941, the German battleship Bismarck sank in a fierce firefight, leaving only 118 of her 2,200 crew members alive. But when a British destroyer came to collect the prisoners, they found an unexpected survivor - a black and white cat clinging to a floating plank. For the next several months this cat hunted rats and raised British morale - until a sudden torpedo strike shattered the hull and sank the ship. But, miraculously, not the cat. Nicknamed Unsinkable Sam, he rode to Gibraltar with the rescued crew and served as a ship cat on three more vessels – one of which also sank - before retiring to the Belfast Home for Sailors. Many may not think of cats as serviceable sailors, or cooperative companions of any kind. But cats have been working alongside humans for thousands of years - helping us just as often as we help them. So how did these solitary creatures go from wild predator to naval officer to sofa sidekick? The domestication of the modern house cat can be traced back to more than 10,000 years ago in the Fertile Crescent, at the start of the Neolithic era. People were learning to bend nature to their will, producing much more food than farmers could eat at one time. These Neolithic farmers stored their excess grain in large pits and short, clay silos. But these stores of food attracted hordes of rodents, as well as their predator, Felis silvestris lybica - the wildcat found across North Africa and Southwest Asia. These wildcats were fast, fierce, carnivorous hunters. And they were remarkably similar in size and appearance to today’s domestic cats. The main differences being that ancient wildcats were more muscular, had striped coats, and were less social towards other cats and humans. The abundance of prey in rodent-infested granaries drew in these typically solitary animals. And as the wildcats learned to tolerate the presence of humans and other cats during mealtime, we think that farmers likewise tolerated the cats in exchange for free pest control. The relationship was so beneficial that the cats migrated with Neolithic farmers from Anatolia into Europe and the Mediterranean. Vermin were a major scourge of the seven seas. They ate provisions and gnawed at lines of rope, so cats had long since become essential sailing companions. Around the same time these Anatolian globe trotting cats set sail, the Egyptians domesticated their own local cats. Revered for their ability to dispatch venomous snakes, catch birds, and kill rats, domestic cats became important to Egyptian religious culture. They gained immortality in frescos, hieroglyphs, statues, and even tombs, mummified alongside their owners. Egyptian ship cats cruised the Nile, holding poisonous river snakes at bay. And after graduating to larger vessels, they too began to migrate from port to port. During the time of the Roman Empire, ships traveling between India and Egypt carried the lineage of the central Asian wildcat F. s. ornata. Centuries later, in the Middle Ages, Egyptian cats voyaged up to the Baltic Sea on the ships of Viking seafarers. And both the Near Eastern and North African wildcats – probably tamed at this point -- continued to travel across Europe, eventually setting sail for Australia and the Americas. Today, most house cats have descended from either the Near Eastern or the Egyptian lineage of F.s.lybica. But close analysis of the genomes and coat patterns of modern cats tells us that unlike dogs, which have undergone centuries of selective breeding, modern cats are genetically very similar to ancient cats. And apart from making them more social and docile, we’ve done little to alter their natural behaviors. In other words, cats today are more or less as they’ve always been: Wild animals. Fierce hunters. Creatures that don’t see us as their keepers. And given our long history together, they might not be wrong.

**P668 2018-12-17 Why should you read “Fahrenheit 451” - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=668)

“It was a pleasure to burn. It was a special pleasure to see things eaten, to see things blackened and changed.” Fahrenheit 451 opens in a blissful blaze - and before long, we learn what’s going up in flames. Ray Bradbury’s novel imagines a world where books are banned from all areas of life - and possessing, let alone reading them, is forbidden. The protagonist, Montag, is a fireman responsible for destroying what remains. But as his pleasure gives way to doubt, the story raises critical questions of how to preserve one’s mind in a society where free will, self-expression, and curiosity are under fire. In Montag’s world, mass media has a monopoly on information, erasing almost all ability for independent thought. On the subway, ads blast out of the walls. At home, Montag’s wife Mildred listens to the radio around the clock, and three of their parlor walls are plastered with screens. At work, the smell of kerosene hangs over Montag’s colleagues, who smoke and set their mechanical hound after rats to pass the time. When the alarm sounds they surge out in salamander-shaped vehicles, sometimes to burn whole libraries to the ground. But as he sets tomes ablaze day after day like “black butterflies,” Montag’s mind occasionally wanders to the contraband that lies hidden in his home. Gradually, he begins to question the basis of his work. Montag realizes he’s always felt uneasy - but has lacked the descriptive words to express his feelings in a society where even uttering the phrase “once upon a time” can be fatal. Fahrenheit 451 depicts a world governed by surveillance, robotics, and virtual reality- a vision that proved remarkably prescient, but also spoke to the concerns of the time. The novel was published in 1953, at the height of the Cold War. This era kindled widespread paranoia and fear throughout Bradbury’s home country of the United States, amplified by the suppression of information and brutal government investigations. In particular, this witch hunt mentality targeted artists and writers who were suspected of Communist sympathies. Bradbury was alarmed at this cultural crackdown. He believed it set a dangerous precedent for further censorship, and was reminded of the destruction of the Library of Alexandria and the book-burning of Fascist regimes. He explored these chilling connections in Fahrenheit 451, titled after the temperature at which paper burns. The accuracy of that temperature has been called into question, but that doesn’t diminish the novel’s standing as a masterpiece of dystopian fiction. Dystopian fiction as a genre amplifies troubling features of the world around us and imagines the consequences of taking them to an extreme. In many dystopian stories, the government imposes constrictions onto unwilling subjects. But in Fahrenheit 451, Montag learns that it was the apathy of the masses that gave rise to the current regime. The government merely capitalized on short attention spans and the appetite for mindless entertainment, reducing the circulation of ideas to ash. As culture disappears, imagination and self-expression follow. Even the way people talk is short-circuited - such as when Montag’s boss Captain Beatty describes the acceleration of mass culture: "Speed up the film, Montag, quick. Click? Pic? Look, Eye, Now, Flick, Here, There, Swift, Pace, Up, Down, In, Out, Why, How, Who, What, Where, Eh? Uh! Bang! Smack! Wallop, Bing, Bong, Boom! Digest-digests, digest-digest-digests. Politics? One column, two sentences, a headline! Then, in mid-air, all vanishes!" In this barren world, Montag learns how difficult it is to resist when there's nothing left to hold on to. Altogether, Fahrenheit 451 is a portrait of independent thought on the brink of extinction - and a parable about a society which is complicit in its own combustion.

**P669 2018-12-18 Can you survive nuclear fallout -** **Brooke Buddemeier and Jessica S. W**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=669)

The full scope of a nuclear detonation is almost unimaginable. Hopefully, no one will ever experience another of these catastrophic incidents. But there is a scientifically supported plan of action that could save hundreds of thousands of lives in the area surrounding a nuclear explosion. So what is this plan, and what exactly would it protect us from? To create their destructive blast, these weapons harness the power of nuclear fission– in which an atom’s nucleus is split in two. This process produces an incredible amount of energy, and in some materials the neutrons produced by one fission are absorbed by nearby atoms, splitting additional nuclei. These chain reactions can produce a range of explosive yields, but let’s consider an explosion equivalent to 10,000 tons of TNT. An explosion like this would create a fireball capable of decimating a few city blocks and a shockwave damaging buildings several kilometers away. There is tragically nothing that can be done to save those in the fireball’s radius. However, for those in the shockwave and beyond, our scientifically supported protocol could be life saving. And though it may sound surprising, the best way to stay protected before, during, and after a nuclear detonation, is getting inside. Similar to protecting yourself from tornadoes or hurricanes, getting and staying inside a sturdy building would offer protection from the explosion’s shockwave, heat, and radiation. The shockwave of energy would travel several kilometers beyond the fireball’s radius in the first few seconds. Sturdy buildings within that range should be able to withstand the shockwave, and staying in the centers and basements of these buildings also helps provide protection from heat and flying objects. Finding shelter is especially important if the fireball occurs close to the earth, as it will pull thousands of tons of dirt and debris several kilometers into the atmosphere. As the fireball cools, unstable atoms created by the nuclear fission mix with the debris to produce the most dangerous long-term effect of a nuclear detonation: radioactive particles called fallout. These sand-sized particles emit ionizing radiation, capable of separating electrons from molecules and atoms. Exposure to massive amounts of this radiation can result in cell damage, radiation burns, radiation sickness, cancer, and even death. Created several kilometers up, dangerous concentrations of this material would be driven by upper atmospheric winds, potentially leading to hazardous levels of fallout in areas up to tens of kilometers downwind. Thankfully, the same buildings that offer protection from the blast are even better at guarding against fallout. Radiation is reduced as it travels through space and mass. So while a broken window and sealed window both have the same minimal effect on radiation, thick layers of steel, concrete, and packed earth can offer serious protection. And since fallout gives off half of its energy in the first hour and 80% in the first day, staying inside for 24 hours could dramatically improve the odds of avoiding the most serious effects of radiation. Following the blast there would be at least 15 minutes to find shelter before the fallout begins. Since the most hazardous fallout particles are the heaviest, they sink through the air and collect on streets and rooftops, making ideal shelters underground or in the middle of high-rise buildings. But if someone were to get caught in the fallout, there are still measures they could take. After finding a safe space, they should remove their shoes and outer layers, wash any exposed skin, and store the contaminated clothing far away. Once inside, plan on staying there for at least 24 hours. If the shelter is poor, or someone inside needs urgent medical attention, try seeking outside help after an hour. But ideally, stay inside and stay tuned for more information from first responders. While electric power, cell service, and Internet would be down, most radios would likely survive. So listen in for emergency responders to determine the safest course forward. Nuclear weapons are some of the most powerful tools of destruction on Earth, and it may seem naive to put faith in these straightforward protective measures. But studies and simulations have repeatedly shown the benefits of getting inside. So while we’ll hopefully never need to, remember to Get Inside, Stay Inside, and Stay Tuned.

**P670 2018-12-20 How CRISPR lets you edit DNA - Andrea M. Henle**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=670)

From the smallest single-celled organism to the largest creatures on earth, every living thing is defined by its genes. The DNA contained in our genes acts like an instruction manual for our cells. Four building blocks called bases are strung together in precise sequences, which tell the cell how to behave and form the basis for our every trait. But with recent advancements in gene editing tools, scientists can change an organism’s fundamental features in record time. They can engineer drought-resistant crops and create apples that don’t brown. They might even prevent the spread of infectious outbreaks and develop cures for genetic diseases. CRISPR is the fastest, easiest, and cheapest of the gene editing tools responsible for this new wave of science. But where did this medical marvel come from? How does it work? And what can it do? Surprisingly, CRISPR is actually a natural process that’s long functioned as a bacterial immune system. Originally found defending single-celled bacteria and archaea against invading viruses, naturally occurring CRISPR uses two main components. The first are short snippets of repetitive DNA sequences called “clustered regularly interspaced short palindromic repeats,” or simply, CRISPRs. The second are Cas, or “CRISPR-associated” proteins which chop up DNA like molecular scissors. When a virus invades a bacterium, Cas proteins cut out a segment of the viral DNA to stitch into the bacterium’s CRISPR region, capturing a chemical snapshot of the infection. Those viral codes are then copied into short pieces of RNA. This molecule plays many roles in our cells, but in the case of CRISPR, RNA binds to a special protein called Cas9. The resulting complexes act like scouts, latching onto free-floating genetic material and searching for a match to the virus. If the virus invades again, the scout complex recognizes it immediately, and Cas9 swiftly destroys the viral DNA. Lots of bacteria have this type of defense mechanism. But in 2012, scientists figured out how to hijack CRISPR to target not just viral DNA, but any DNA in almost any organism. With the right tools, this viral immune system becomes a precise gene-editing tool, which can alter DNA and change specific genes almost as easily as fixing a typo. Here’s how it works in the lab: scientists design a “guide” RNA to match the gene they want to edit, and attach it to Cas9. Like the viral RNA in the CRISPR immune system, the guide RNA directs Cas9 to the target gene, and the protein’s molecular scissors snip the DNA. This is the key to CRISPR’s power: just by injecting Cas9 bound to a short piece of custom guide RNA scientists can edit practically any gene in the genome. Once the DNA is cut, the cell will try to repair it. Typically, proteins called nucleases trim the broken ends and join them back together. But this type of repair process, called nonhomologous end joining, is prone to mistakes and can lead to extra or missing bases. The resulting gene is often unusable and turned off. However, if scientists add a separate sequence of template DNA to their CRISPR cocktail, cellular proteins can perform a different DNA repair process, called homology directed repair. This template DNA is used as a blueprint to guide the rebuilding process, repairing a defective gene or even inserting a completely new one. The ability to fix DNA errors means that CRISPR could potentially create new treatments for diseases linked to specific genetic errors, like cystic fibrosis or sickle cell anemia. And since it’s not limited to humans, the applications are almost endless. CRISPR could create plants that yield larger fruit, mosquitoes that can’t transmit malaria, or even reprogram drug-resistant cancer cells. It’s also a powerful tool for studying the genome, allowing scientists to watch what happens when genes are turned off or changed within an organism. CRISPR isn’t perfect yet. It doesn’t always make just the intended changes, and since it’s difficult to predict the long-term implications of a CRISPR edit, this technology raises big ethical questions. It’s up to us to decide the best course forward as CRISPR leaves single-celled organisms behind and heads into labs, farms, hospitals, and organisms around the world.

**P671 2018-12-20 How do ocean currents work - Jennifer Verduin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=671)

In 1992, a cargo ship carrying bath toys got caught in a storm. Shipping containers washed overboard, and the waves swept 28,000 rubber ducks and other toys into the North Pacific. But they didn’t stick together. Quite the opposite– the ducks have since washed up all over the world, and researchers have used their paths to chart a better understanding of ocean currents. Ocean currents are driven by a range of sources: the wind, tides, changes in water density, and the rotation of the Earth. The topography of the ocean floor and the shoreline modifies those motions, causing currents to speed up, slow down, or change direction. Ocean currents fall into two main categories: surface currents and deep ocean currents. Surface currents control the motion of the top 10 percent of the ocean’s water, while deep-ocean currents mobilize the other 90 percent. Though they have different causes, surface and deep ocean currents influence each other in an intricate dance that keeps the entire ocean moving. Near the shore, surface currents are driven by both the wind and tides, which draw water back and forth as the water level falls and rises. Meanwhile, in the open ocean, wind is the major force behind surface currents. As wind blows over the ocean, it drags the top layers of water along with it. That moving water pulls on the layers underneath, and those pull on the ones beneath them. In fact, water as deep as 400 meters is still affected by the wind at the ocean’s surface. If you zoom out to look at the patterns of surface currents all over the earth, you’ll see that they form big loops called gyres, which travel clockwise in the northern hemisphere and counter-clockwise in the southern hemisphere. That’s because of the way the Earth’s rotation affects the wind patterns that give rise to these currents. If the earth didn’t rotate, air and water would simply move back and forth between low pressure at the equator and high pressure at the poles. But as the earth spins, air moving from the equator to the North Pole is deflected eastward, and air moving back down is deflected westward. The mirror image happens in the southern hemisphere, so that the major streams of wind form loop-like patterns around the ocean basins. This is called the Coriolis Effect. The winds push the ocean beneath them into the same rotating gyres. And because water holds onto heat more effectively than air, these currents help redistribute warmth around the globe. Unlike surface currents, deep ocean currents are driven primarily by changes in the density of seawater. As water moves towards the North Pole, it gets colder. It also has a higher concentration of salt, because the ice crystals that form trap water while leaving salt behind. This cold, salty water is more dense, so it sinks, and warmer surface water takes its place, setting up a vertical current called thermohaline circulation. Thermohaline circulation of deep water and wind-driven surface currents combine to form a winding loop called the Global Conveyor Belt. As water moves from the depths of the ocean to the surface, it carries nutrients that nourish the microorganisms which form the base of many ocean food chains. The global conveyor belt is the longest current in the world, snaking all around the globe. But it only moves a few centimeters per second. It could take a drop of water a thousand years to make the full trip. However, rising sea temperatures are causing the conveyor belt to seemingly slow down. Models show this causing havoc with weather systems on both sides of the Atlantic, and no one knows what would happen if it continues to slow or if it stopped altogether. The only way we’ll be able to forecast correctly and prepare accordingly will be to continue to study currents and the powerful forces that shape them.

**P672 2018-12-21 How one journalist risked her life to hold murderers accountable - Ch**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=672)

In March of 1892, three Black grocery store owners in Memphis, Tennessee, were murdered by a mob of white men. Lynchings like these were happening all over the American South, often without any subsequent legal investigation or consequences for the murderers. But this time, a young journalist and friend of the victims set out to expose the truth about these killings. Her reports would shock the nation and launch her career as an investigative journalist, civic leader, and civil rights advocate. Her name was Ida B. Wells. Ida Bell Wells was born into slavery in Holly Springs, Mississippi on July 16, 1862, several months before the Emancipation Proclamation released her and her family. After losing both parents and a brother to yellow fever at the age of 16, she supported her five remaining siblings by working as a schoolteacher in Memphis, Tennessee. During this time, she began working as a journalist. Writing under the pen name “Iola,” by the early 1890s she gained a reputation as a clear voice against racial injustice and become co-owner and editor of the Memphis Free Speech and Headlight newspaper. She had no shortage of material: in the decades following the Civil War, Southern whites attempted to reassert their power by committing crimes against Black people including suppressing their votes, vandalizing their businesses, and even murdering them. After the murder of her friends, Wells launched an investigation into lynching. She analyzed specific cases through newspaper reports and police records, and interviewed people who had lost friends and family to lynch mobs. She risked her life to get this information. As a Black person investigating racially motivated murders, she enraged many of the same southern white men involved in lynchings. Her bravery paid off. Most whites had claimed and subsequently reported that lynchings were responses to criminal acts by Black people. But that was not usually the case. Through her research, Wells showed that these murders were actually a deliberate, brutal tactic to control or punish black people who competed with whites. Her friends, for example, had been lynched when their grocery store became popular enough to divert business from a white competitor. Wells published her findings in 1892. In response, a white mob destroyed her newspaper presses. She was out of town when they struck, but they threatened to kill her if she ever returned to Memphis. So she traveled to New York, where that same year she re-published her research in a pamphlet titled Southern Horrors: Lynch Law in All Its Phases. In 1895, after settling in Chicago, she built on Southern Horrors in a longer piece called The Red Record. Her careful documentation of the horrors of lynching and impassioned public speeches drew international attention. Wells used her newfound fame to amplify her message. She traveled to Europe, where she rallied European outrage against racial violence in the American South in hopes that the US government and public would follow their example. Back in the US, she didn’t hesitate to confront powerful organizations, fighting the segregationist policies of the YMCA and leading a delegation to the White House to protest discriminatory workplace practices. She did all this while disenfranchised herself. Women didn’t win the right to vote until Wells was in her late 50s. And even then, the vote was primarily extended to white women only. Wells was a key player in the battle for voting inclusion, starting a Black women’s suffrage organization in Chicago. But in spite of her deep commitment to women’s rights, she clashed with white leaders of the movement. During a march for women’s suffrage in Washington D.C., she ignored the organizers’ attempt to placate Southern bigotry by placing Black women in the back, and marched up front alongside the white women. She also chafed with other civil rights leaders, who saw her as a dangerous radical. She insisted on airing, in full detail, the atrocities taking place in the South, while others thought doing so would be counterproductive to negotiations with white politicians. Although she participated in the founding of the NAACP, she was soon sidelined from the organization. Wells’ unwillingness to compromise any aspect of her vision of justice shined a light on the weak points of the various rights movements, and ultimately made them stronger— but also made it difficult for her to find a place within them. She was ahead of her time, waging a tireless struggle for equality and justice decades before many had even begun to imagine it possible.

**P673 2019-01-03 Can you solve the vampire hunter riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=673)

The greatest challenge a vampire hunter can take on is to bring sunlight into a vampire's lair. You’ve stealthily descended into the darkness of a vampire cave, setting a sequence of mirrors as you go. When the sun reaches the right angle in the sky, a focused beam of light will ricochet along the mirrors, strike your diffuser, and illuminate the great chamber where the vampires sleep. You set the final mirror and sneak through an opening in the corner of the great chamber. The diffuser must be wall-mounted, but the walls are crowded with coffins, which you don’t dare disturb. The only open spots are in the other three corners of the room. The light will enter through the southwest corner at a 45 degree angle and bounce off the perfectly smooth metallic walls until it hits one of the other three corners. But which corner will it hit? You know the room is a rectangle 49 meters wide and 78 meters long. You could probably find the answer by drawing a scale model of the room and tracing the path of the light, but the sun will be in its place in just minutes, and you’ve got no time to spare. Fortunately, there’s a different way to solve this puzzle that’s both simple and elegant. So in which corner should you place the diffuser to flood the vampire lair with sunlight? Pause the video if you want to figure it out for yourself. Answer in 2 Answer in 1 You could tackle this problem by examining smaller rooms, and you’d find a lot of interesting patterns. But there’s one insight that can unravel this riddle in almost no time at all. Let’s draw the chamber on a coordinate grid, with the Southwest corner at the point (0,0). The light passes through grid points with coordinates that are either both even or both odd. This is true even after it bounces off one or more walls. Another way of thinking about it is this: since the light travels at a 45 degree angle, it always crosses the diagonal of a unit square. Traveling 1 meter horizontally changes the x coordinate from even to odd or vice versa. Traveling 1 meter vertically changes the y coordinate from even to odd or vice versa. Traveling diagonally – as the light does here – does both at once, so the x and y coordinates of any points the light passes through must be both even, or both odd. This observation is more powerful than it seems. In particular, it means that we have a way to identify the kinds of points the light won’t ever go through If one of the coordinates is even and the other is odd, the light will miss them. That means it’ll miss the top two corners of the room, since those points have one even and one odd coordinate. The Southeast corner is the only option for the diffuser. And indeed, when that precious beam of sunlight enters the hall, it bounces between the walls and strikes the Southeast corner, spot on. The vampires, sensing the intrusion, burst from their coffins and turn to dust in the light. It was a “high stakes” test, and you passed with flying colors.

**P674 2019-01-04 The myth of Pandora’s box - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=674)

Curiosity: a blessing, or a curse? The paradoxical nature of this trait was personified for the ancient Greeks in the mythical figure of Pandora. According to legend, she was the first mortal woman, whose blazing curiosity set a chain of earth-shattering events in motion. Pandora was breathed into being by Hephaestus, God of fire, who enlisted the help of his divine companions to make her extraordinary. From Aphrodite she received the capacity for deep emotion; from Hermes she gained mastery over language. Athena gave the gift of fine craftsmanship and attention to detail, and Hermes gave her her name. Finally, Zeus bestowed two gifts on Pandora. The first was the trait of curiosity, which settled in her spirit and sent her eagerly out into the world. The second was a heavy box, ornately curved, heavy to hold – and screwed tightly shut. But the contents, Zeus told her, were not for mortal eyes. She was not to open the box under any circumstance. On earth, Pandora met and fell in love with Epimetheus, a talented titan who had been given the task of designing the natural world by Zeus. He had worked alongside his brother Prometheus, who created the first humans but was eternally punished for giving them fire. Epimetheus missed his brother desperately, but in Pandora he found another fiery-hearted soul for companionship. Pandora brimmed with excitement at life on earth. She was also easily distracted and could be impatient, given her thirst for knowledge and desire to question her surroundings. Often, her mind wandered to the contents of the sealed box. What treasure was so great it could never be seen by human eyes, and why was it in her care? Her fingers itched to pry it open. Sometimes she was convinced she heard voices whispering and the contents rattling around inside, as if straining to be free. Its enigma became maddening. Over time, Pandora became more and more obsessed with the box. It seemed there was a force beyond her control that drew her to the contents, which echoed her name louder and louder. One day she could bear it no longer. Stealing away from Epimetheus, she stared at the mystifying box. She’d take one glance inside, then be able to rid her mind of it forever... But at the first crack of the lid, the box burst open. Monstrous creatures and horrendous sounds rushed out in a cloud of smoke and swirled around her, screeching and cackling. Filled with terror, Pandora clawed desperately at the air to direct them back into their prison. But the creatures surged out in a gruesome cloud. She felt a wave of foreboding as they billowed away. Zeus had used the box as a vessel for all the forces of evil and suffering he’d created – and once released, they were uncontainable. As she wept, Pandora became aware of a sound echoing from within the box. This was not the eerie whispering of demons, but a light tinkling that seemed to ease her anguish. When she once again lifted the lid and peered in, a warm beam of light rose out and fluttered away. As she watched it flickering in the wake of the evil she’d unleashed, Pandora’s pain was eased. She knew that opening the box was irreversible – but alongside the strife, she’d set hope forth to temper its effects. Today, Pandora’s Box suggests the extreme consequences of tampering with the unknown – but Pandora’s burning curiosity also suggests the duality that lies at the heart of human inquiry. Are we bound to investigate everything we don’t know, to mine the earth for more – or are there some mysteries that are better left unsolved?

**P675 2019-01-04 Why should you read Flannery O’Connor - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=675)

A garrulous grandmother and a roaming bandit face off on a dirt road. A Bible salesman lures a one-legged philosopher into a barn. A traveling handyman teaches a deaf woman her first word on an old plantation. From her farm in rural Georgia, surrounded by a flock of pet birds, Flannery O’Connor scribbled tales of outcasts, intruders and misfits staged in the world she knew best: the American South. She published two novels, but is perhaps best known for her short stories, which explored small-town life with stinging language, offbeat humor, and delightfully unsavory scenarios. In her spare time O’Connor drew cartoons, and her writing is also brimming with caricature. In her stories, a mother has a face “as broad and innocent as a cabbage,” a man has as much drive as a “floor mop,” and one woman’s body is shaped like “a funeral urn.” The names of her characters are equally sly. Take the story “The Life You Save May be Your Own,” where the one-handed drifter Tom Shiftlet wanders into the lives of an old woman named Lucynell Crater and her deaf and mute daughter. Though Mrs. Crater is self-assured, her isolated home is falling apart. At first, we may be suspicious of Shiftlet’s motives when he offers to help around the house, but O’Connor soon reveals the old woman to be just as scheming as her unexpected guest– and rattles the reader’s presumptions about who has the upper hand. For O’Connor, no subject was off limits. Though she was a devout Catholic, she wasn’t afraid to explore the possibility of pious thought and unpious behavior co-existing in the same person. In her novel The Violent Bear it Away, the main character grapples with the choice to become a man of God – but also sets fires and commits murder. The book opens with the reluctant prophet in a particularly compromising position: “Francis Marion Tarwater’s uncle had been dead for only half a day when the boy got too drunk to finish digging his grave.” This leaves a passerby to “drag the body from the breakfast table where it was still sitting and bury it […] with enough dirt on top to keep the dogs from digging it up.” Though her own politics are still debated, O’Connor’s fiction could also be attuned to the racism of the South. In “Everything that Rises Must Converge,” she depicts a son raging at his mother’s bigotry. But the story reveals that he has his own blind spots and suggests that simply recognizing evil doesn’t exempt his character from scrutiny. Even as O’Connor probes the most unsavory aspects of humanity, she leaves the door to redemption open a crack. In “A Good Man is Hard to Find,” she redeems an insufferable grandmother for forgiving a hardened criminal, even as he closes in on her family. Though we might balk at the price the woman pays for this redemption, we’re forced to confront the nuance in moments we might otherwise consider purely violent or evil. O’Connor’s mastery of the grotesque and her explorations of the insularity and superstition of the South led her to be classified as a Southern Gothic writer. But her work pushed beyond the purely ridiculous and frightening characteristics associated with the genre to reveal the variety and nuance of human character. She knew some of this variety was uncomfortable, and that her stories could be an acquired taste – but she took pleasure in challenging her readers. O’Connor died of lupus at the age of 39, after the disease had mostly confined her to her farm in Georgia for twelve years. During those years, she penned much of her most imaginative work. Her ability to flit between revulsion and revelation continues to draw readers to her endlessly surprising fictional worlds. As her character Tom Shiftlet notes, the body is “like a house: it don’t go anywhere, but the spirit, lady, is like an automobile: always on the move.”

**P676 2019-01-08 Why should you read Shakespeare’s “The Tempest” - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=676)

Claps of thunder and flashes of lightning illuminate a swelling sea, as a ship buckles beneath the waves. This is no ordinary storm, but a violent and vengeful tempest, and it sets the stage for Shakespeare’s most enigmatic play. As the skies clear, we are invited into a world that seems far removed from our own, but is rife with familiar concerns about freedom, power, and control. The Tempest is set on a desert island, exposed to the elements and ruled with magic and might by Prospero, the exiled Duke of Milan. Betrayed by his brother Antonio, Prospero has been marooned on the island for twelve years with his daughter Miranda and his beloved books. In this time he’s learned the magic of the island and uses it to harness its elementary spirits. He also rules over the island’s only earthly inhabitant, the dejected and demonized Caliban. But after years of plotting revenge, Prospero’s foe is finally in sight. With the help of the fluttering sprite Ariel, the magician destroys his brother’s ship and washes its sailors ashore. Prospero’s plotting even extends to his daughter’s love life, whom he plans to fall for stranded prince Ferdinand. And as Prospero and Ariel close in on Antonio, Caliban joins forces with some drunken sailors, who hatch a comic plot to take the island. The play strips society down to its basest desires, with each faction in hot pursuit of power- be it over the land, other people, or their own destiny. But Shakespeare knows that power is always a moving target; and as he reveals these characters’ dark histories, we begin to wonder if this vicious cycle will ever end. Although Prospero was wronged by Antonio, he has long inflicted his own abuses on the island, hoarding its magical properties and natural re-sources for himself. Caliban especially resents this takeover. The son of Sycorax, a witch who previously ruled the island, he initially helped the exiles find their footing. But he’s since become their slave, and rants with furious regret: “And then I loved thee,/ And showed thee all the qualities o’ th’ isle/ The fresh springs, brine pits, barren place and fertile./ Cursed be I that did so!” With his thunderous language and seething anger, Caliban constantly reminds Prospero of what came before: this island’s mine by Sycorax my mother, Which thou takest from me. Yet Sycorax also abused the island, and imprisoned Ariel until Prospero released him. Now Ariel spends the play hoping to repay his debt and earn his freedom, while Caliban is enslaved indefinitely, or at least as long as Prospero is in charge. For these reasons and many more, The Tempest has often been read as an exploration of colonialism, and the moral dilemmas that come with en-counters of “brave new world(s)." Questions of agency and justice hang over the play: is Caliban the rightful master of the land? Will Ariel flutter free? And is Prospero the mighty overseer- or is there some deeper magic at work, beyond any one character's grasp? Throughout the play, Ariel constantly reminds Prospero of the freedom he is owed. But the question lingers of whether the invader will be able to relinquish his grip. The question of ending one’s reign is particularly potent given that The Tempest is believed to be Shakespeare’s final play. In many ways Prospero’s actions echo that of the great entertainer him-self, who hatched elaborate plots, maneuvered those around him, and cast a spell over characters and audience alike. But by the end of his grand performance of power and control, Prospero’s final lines see him humbled by his audience - and the power that they hold over his creations. "With the help of your good hands./ Gentle breath of yours my sails/ Must fill or else my project fails,/ Which was to please." This evokes Shakespeare’s own role as the great entertainer who surrenders himself, ultimately, to our applause.

**P677 2019-01-09 The wicked wit of Jane Austen - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=677)

Whether she’s describing bickering families, quiet declarations of love, or juicy gossip, Jane Austen’s writing often feels as though it was written just for you. Her dry wit and cheeky playfulness informs her heroines, whose conversational tone welcomes readers with a conspiratorial wink. It’s even been said that some readers feel like the author’s secret confidante, trading letters with their delightfully wicked friend Jane. But this unique brand of tongue-in-cheek humor is just one of the many feats found in her sly satires of society, civility, and sweeping romance. Written in the early nineteenth century, Austen's novels decode the sheltered lives of the upper classes in rural England. From resentment couched in pleasantries to arguing that masks attraction, her work explores the bewildering collision of emotions and etiquette. But while romance is a common thread in her work, Austen dismissed the sentimental style of writing so popular at the time. Instead of lofty love stories, her characters act naturally, and often awkwardly. They trade pragmatic advice, friendly jokes and not-so-friendly barbs about their arrogant peers. As they grapple with the endless rules of their society, Austen’s characters can usually find humor in all the hypocrisy, propriety, and small talk. As Mr. Bennet jokes to his favorite daughter, “For what do we live, but to make sport for our neighbors and laugh at them in our turn?” And though her heroines might ridicule senseless social mores, Austen fully understood the practical importance of maintaining appearances. At the time she was writing, a wealthy marriage was a financial necessity for most young women, and she often explores the tension between the mythical quest for love, and the economic benefits of making a match. The savvy socialite Mary Crawford sums this up in "Mansfield Park;" “I would have everybody marry if they can do it properly: I do not like to have people throw themselves away.” Unsurprisingly, these themes were also present in Austen’s personal life. Born in 1775, she lived in the social circles found in her novels. Jane's parents supported her education, and provided space for her to write and publish her work anonymously. But writing was hardly lucrative work. And although she had sparks of chemistry, she never married. Elements of her circumstances can be found in many of her characters; often intelligent women with witty, pragmatic personalities, and rich inner lives. These headstrong heroines provide an entertaining anchor for their tumultuous romantic narratives. Like the irreverent Elizabeth Bennet of "Pride and Prejudice," whose devotion to her sisters’ love lives blinds her to a clumsy suitor. Or the iron-willed Anne Elliot of "Persuasion," who chooses to remain unmarried after the disappearance of her first love. And Elinor Dashwood, who fiercely protects her family at the cost of her own desires in "Sense and Sensibility." These women all encounter difficult choices about romantic, filial, and financial stability, and they resolve them without sacrificing their values– or their sense of humor. Of course, these characters are far from perfect. They often think they have all the answers. And by telling the story from their perspective, Austen tricks the viewer into believing their heroine knows best– only to pull the rug out from under the protagonist and the reader. In "Emma," the titular character feels surrounded by dull neighbors, and friends who can’t hope to match her wit. As her guests prattle on and on about nothing, the reader begins to agree– Emma is the only exciting character in this quiet neighborhood. Yet despite her swelling ego, Emma may not be as in control as she thinks – in life or love. And Austen’s intimate use of perspective makes these revelations doubly surprising, blindsiding both Emma and her audience. But rather than diminishing her host of heroines, these flaws only confirm “the inconsistency of all human characters.” Their complexity has kept Austen prominent on stage and screen, and made her work easily adaptable for modern sensibilities. So hopefully, new readers will continue to find a friend in Ms. Austen for many years to come.

**P678 2019-01-15 Will there ever be a mile-high skyscraper - Stefan Al**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=678)

In 1956, architect Frank Lloyd Wright proposed a mile-high skyscraper. It was going to be the world’s tallest building, by a lot — five times as high as the Eiffel Tower. But many critics laughed at the architect, arguing that people would have to wait hours for an elevator, or worse, that the tower would collapse under its own weight. Most engineers agreed, and despite the publicity around the proposal, the titanic tower was never built. But today, bigger and bigger buildings are going up around the world. Firms are even planning skyscrapers more than a kilometer tall, like the Jeddah Tower in Saudi Arabia, three times the size of the Eiffel Tower. Very soon, Wright’s mile-high miracle may be a reality. So what exactly was stopping us from building these megastructures 70 years ago, and how do we build something a mile high today? In any construction project, each story of the structure needs to be able to support the stories on top of it. The higher we build, the higher the gravitational pressure from the upper stories on the lower ones. This principle has long dictated the shape of our buildings, leading ancient architects to favor pyramids with wide foundations that support lighter upper levels. But this solution doesn’t quite translate to a city skyline– a pyramid that tall would be roughly one-and-a-half miles wide, tough to squeeze into a city center. Fortunately, strong materials like concrete can avoid this impractical shape. And modern concrete blends are reinforced with steel-fibers for strength and water-reducing polymers to prevent cracking. The concrete in the world’s tallest tower, Dubai’s Burj Khalifa, can withstand about 8,000 tons of pressure per square meter– the weight of over 1,200 African elephants! Of course, even if a building supports itself, it still needs support from the ground. Without a foundation, buildings this heavy would sink, fall, or lean over. To prevent the roughly half a million ton tower from sinking, 192 concrete and steel supports called piles were buried over 50 meters deep. The friction between the piles and the ground keeps this sizable structure standing. Besides defeating gravity, which pushes the building down, a skyscraper also needs to overcome the blowing wind, which pushes from the side. On average days, wind can exert up to 17 pounds of force per square meter on a high-rise building– as heavy as a gust of bowling balls. Designing structures to be aerodynamic, like China’s sleek Shanghai Tower, can reduce that force by up to a quarter. And wind-bearing frames inside or outside the building can absorb the remaining wind force, such as in Seoul’s Lotte Tower. But even after all these measures, you could still find yourself swaying back and forth more than a meter on top floors during a hurricane. To prevent the wind from rocking tower tops, many skyscrapers employ a counterweight weighing hundreds of tons called a “tuned mass damper.” The Taipei 101, for instance, has suspended a giant metal orb above the 87th floor. When wind moves the building, this orb sways into action, absorbing the building’s kinetic energy. As its movements trail the tower’s, hydraulic cylinders between the ball and the building convert that kinetic energy into heat, and stabilize the swaying structure. With all these technologies in place, our mega-structures can stay standing and stable. But quickly traveling through buildings this large is a challenge in itself. In Wright’s age, the fastest elevators moved a mere 22 kilometers per hour. Thankfully, today’s elevators are much faster, traveling over 70 km per hour with future cabins potentially using frictionless magnetic rails for even higher speeds. And traffic management algorithms group riders by destination to get passengers and empty cabins where they need to be. Skyscrapers have come a long way since Wright proposed his mile-high tower. What were once considered impossible ideas have become architectural opportunities. Today it may just be a matter of time until one building goes the extra mile.

**P679 2019-01-23 'All the World's a Stage' by William Shakespeare**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=679)

“All the World’s a Stage” from "As You Like It" by William Shakespeare All the world’s a stage, And all the men and women merely players; They have their exits and their entrances; And one man in his time plays many parts, His acts being seven ages. At first the infant, Mewling and puking in the nurse’s arms; And then the whining school-boy, with his satchel And shining morning face, creeping like snail Unwillingly to school. And then the lover, Sighing like furnace, with a woeful ballad Made to his mistress’ eyebrow. Then a soldier, Full of strange oaths, and bearded like the pard, Jealous in honour, sudden and quick in quarrel, Seeking the bubble reputation Even in the cannon’s mouth. And then the justice, In fair round belly with good capon lin’d, With eyes severe and beard of formal cut, Full of wise saws and modern instances; And so he plays his part. The sixth age shifts Into the lean and slipper’d pantaloon, With spectacles on nose and pouch on side; His youthful hose, well sav’d, a world too wide For his shrunk shank; and his big manly voice, Turning again toward childish treble, pipes And whistles in his sound. Last scene of all, That ends this strange eventful history, Is second childishness and mere oblivion; Sans teeth, sans eyes, sans taste, sans everything.

**P680 2019-01-23 'The Nutritionist' by Andrea Gibson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=680)

Hi I'm Andrea Gibson and this is my poem "The Nutritionist." The nutritionist said I should eat root vegetables Said if I could get down 13 turnips a day I would be grounded, rooted. Said my head would not keep flying away to where the darkness lives. The psychic told me my heart carries too much weight Said for 20 dollars she’d tell me what to do I handed her the twenty, she said “stop worrying darling, you will find a good man soon.” The first psychotherapist said I should spend 3 hours a day sitting in a dark closet with my eyes closed and my ears plugged. I tried it once but couldn’t stop thinking about how gay it was to be sitting in the closet. The yogi told me to stretch everything but truth, said focus on the outbreaths, said everyone finds happiness if they can care more about what they can give than what they get. The pharmacist said klonopin, lamictil, lithium, Xanax. The doctor said an antipsychotic might help me forget what the trauma said The trauma said don’t write this poem. Nobody wants to hear you cry about the grief inside your bones But my bones said “Tyler Clementi dove into the Hudson River convinced he was entirely alone.” My bones said “write the poem.” To the lamplight. Considering the river bed. To the chandelier of your fate hanging by a thread. To everyday you could not get out of bed. To the bulls eye of your wrist To anyone who has ever wanted to die. I have been told, sometimes, the most healing thing we can do- Is remind ourselves over and over and over Other people feel this too The tomorrow that has come and gone And it has not gotten better When you are half finished writing that letter to your mother that says “I swear to God I tried” But when I thought I hit bottom, it started hitting back There is no bruise like the bruise loneliness kicks into your spine So let me tell you I know there are days it looks like the whole world is dancing in the streets when you break down like the doors of their looted buildings You are not alone and wondering who will be convicted of the crime of insisting you keep loading your grief into the chamber of your shame You are not weak just because your heart feels so heavy I have never met a heavy heart that wasn’t a phone booth with a red cape inside Some people will never understand the kind of superpower it takes for some people to just walk outside Some days I know my smile looks like the gutter of a falling house But my hands are always holding tight to the ripchord of believing A life can be rich like the soil Make food of decay Turn wound into highway Pick me up in a truck with that bumper sticker that says “it is no measure of good health to be well adjusted to a sick society” I have never trusted anyone with the pulled back bow of my spine the way I trust the ones who come undone at the throat Screaming for their pulse to find the fight to pound Four nights before Tyler Clementi jumped from the George Washington bridge I was sitting in a hotel room in my own town Calculating exactly what I had to swallow to keep a bottle of sleeping pills down What I know about living is the pain is never just ours Every time I hurt I know the wound is an echo So I keep a listening for the moment when the grief becomes a window When I can see what I couldn’t see before, through the glass of my most battered dream, I watched a dandelion lose its mind in the wind and when it did, it scattered a thousand seeds. So the next time I tell you how easily I come out of my skin, don’t try to put me back in just say here we are together at the window aching for it to all get better but knowing there is a chance our hearts may have only just skinned their knees knowing there is a chance the worst day might still be coming let me say right now for the record, I’m still gonna be here asking this world to dance, even if it keeps stepping on my holy feet you- you stay here with me, okay? You stay here with me. Raising your bite against the bitter dark Your bright longing Your brilliant fists of loss Friend if the only thing we have to gain in staying is each other, my god that’s plenty my god that’s enough my god that is so so much for the light to give each of us at each other’s backs whispering over and over and over “Live” “Live” “Live”

**P681 2019-01-23 'The Road Not Taken' by Robert Frost**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=681)

"The Road Not Taken" By Robert Frost Two roads diverged in a yellow wood, And sorry I could not travel both And be one traveler, long I stood and looked down one as far as I could To where it bent in the undergrowth; Then took the other, as just as fair, And having perhaps the better claim, Because it was grassy and wanted wear; Though as for that the passing there Had worn them really about the same, And both that morning equally lay In leaves no step had trodden black. Oh, I kept the first for another day! Yet knowing how way leads on to way, I doubted if I should ever come back. I shall be telling this with a sigh Somewhere ages and ages hence: Two roads diverged in a wood, and I— I took the one less traveled by, And that has made all the difference.

**P682 2019-01-23 'The Second Coming' by William Butler Yeats**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=682)

"The Second Coming" by William Butler Yeats Turning and turning in the widening gyre The falcon cannot hear the falconer; Things fall apart; the centre cannot hold; Mere anarchy is loosed upon the world, The blood-dimmed tide is loosed, and everywhere The ceremony of innocence is drowned; The best lack all conviction, while the worst Are full of passionate intensity. Surely some revelation is at hand; Surely the Second Coming is at hand. The Second Coming! Hardly are those words out When a vast image out of Spiritus Mundi Troubles my sight: somewhere in sands of the desert A shape with lion body and the head of a man, A gaze blank and pitiless as the sun, Is moving its slow thighs, while all about it Reel shadows of the indignant desert birds. The darkness drops again; but now I know That twenty centuries of stony sleep Were vexed to nightmare by a rocking cradle, And what rough beast, its hour come round at last, Slouches towards Bethlehem to be born?

**P683 2019-01-23 'Three Months After' by Cristin O'Keefe Aptowicz**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=683)

I'm Cristin O'Keefe Aptowicz and this is "Three Months After." To want to disappear is different from wanting to die. To disappear and to not have to explain to anyone, to talk to anyone. To move to somewhere where no one knows you, where you don't have to look at a single laughing face. To elope with this grief who is not your enemy This grief who maybe now is your best friend. This grief who is your husband, the thing you curl into every night, falling asleep in its arms. Who wakes up early to make you your cold thankless breakfast. To go to that place where every surface is a blade. A sharp thing on which to hang your sorry flesh to feel something, anything, other than this.

**P684 2019-01-23 What is consciousness - Michael S. A. Graziano**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=684)

Here are two images of a house. There’s one obvious difference, but to this patient, P.S., they looked completely identical. P.S. had suffered a stroke that damaged the right side of her brain, leaving her unaware of everything on her left side. But though she could discern no difference between the houses, when researchers asked her which she would prefer to live in, she chose the house that wasn’t burning— not once, but again and again. P.S.’s brain was still processing information from her whole field of vision. She could see both images and tell the difference between them, she just didn’t know it. If someone threw a ball at her left side, she might duck. But she wouldn’t have any awareness of the ball, or any idea why she ducked. P.S.’s condition, known as hemispatial neglect, reveals an important distinction between the brain’s processing of information and our experience of that processing. That experience is what we call consciousness. We are conscious of both the external world and our internal selves— we are aware of an image in much the same way we are aware of ourselves looking at an image, or our inner thoughts and emotions. But where does consciousness come from? Scientists, theologians, and philosophers have been trying to get to the bottom of this question for centuries— without reaching any consensus. One recent theory is that consciousness is the brain’s imperfect picture of its own activity. To understand this theory, it helps to have a clear idea of one important way the brain processes information from our senses. Based on sensory input, it builds models, which are continuously updating, simplified descriptions of objects and events in the world. Everything we know is based on these models. They never capture every detail of the things they describe, just enough for the brain to determine appropriate responses. For instance, one model built deep into the visual system codes white light as brightness without color. In reality, white light includes wavelengths that correspond to all the different colors we can see. Our perception of white light is wrong and oversimplified, but good enough for us to function. Likewise, the brain’s model of the physical body keeps track of the configuration of our limbs, but not of individual cells or even muscles, because that level of information isn’t needed to plan movement. If it didn’t have the model keeping track of the body’s size, shape, and how it is moving at any moment, we would quickly injure ourselves. The brain also needs models of itself. For example, the brain has the ability to pay attention to specific objects and events. It also controls that focus, shifting it from one thing to another, internal and external, according to our needs. Without the ability to direct our focus, we wouldn’t be able to assess threats, finish a meal, or function at all. To control focus effectively, the brain has to construct a model of its own attention. With 86 billion neurons constantly interacting with each other, there’s no way the brain’s model of its own information processing can be perfectly self-descriptive. But like the model of the body, or our conception of white light, it doesn’t have to be. Our certainty that we have a metaphysical, subjective experience may come from one of the brain’s models, a cut-corner description of what it means to process information in a focused and deep manner. Scientists have already begun trying to figure out how the brain creates that self model. MRI studies are a promising avenue for pinpointing the networks involved. These studies compare patterns of neural activation when someone is and isn’t conscious of a sensory stimulus, like an image. The results show that the areas needed for visual processing are activated whether or not the participant is aware of the image, but a whole additional network lights up only when they are conscious of seeing the image. Patients with hemispatial neglect, like P.S., typically have damage to one particular part of this network. More extensive damage to the network can sometimes lead to a vegetative state, with no sign of consciousness. Evidence like this brings us closer to understanding how consciousness is built into the brain, but there’s still much more to learn. For instance, the way neurons in the networks related to consciousness compute specific pieces of information is outside the scope of our current technology. As we approach questions of consciousness with science, we’ll open new lines of inquiry into human identity.

**P685 2019-01-24 The sexual deception of orchids - Anne Gaskett**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=685)

The world’s largest orchid grows several meters tall. The tiniest is practically invisible. Some bloom high up in trees, while others live underground. All in, there are around 28,000 species of orchid on earth – about as many as all the bird, mammal and reptile species combined. They grow all over the world, bearing every imaginable colour, shape, and pattern. And there’s a cunning purpose behind these elaborate displays: many orchids trick insects, sometimes even into having sex with them. Like other flowers, most orchids need to attract insects to gather their pollen and carry it between plants. But unlike most flowers, which attract a range of pollinators with sweet nectar, these masters of deception deploy other tactics– like pretending to be an insect’s mate, letting off alluring scents, and mimicking the appearance of other species. One of their most intriguing methods is sexual deception. Through a combination of sexy shapes and pheromones, orchids convince insects to mate with them. Take the bee orchid, whose petals look almost exactly like the velvety body of a bee. This disguise is so convincing that male bees land on the orchid and try to have sex with it, picking up pollen as they go. Other orchids have evolved contrasting colours and ultraviolet spots– invisible to humans but irresistible to insects. Still others have tactile ‘love-handles’ that ensure insects are positioned precisely for pollination. When a male wasp lands on the hammer orchid, for example, his enthusiastic mating motion flips a hinge in the flower, forcing his body into the pollen. At the next flower he visits, that same hinge pushes his pollen-covered body onto the stigma, fertilizing it. Some orchids make such convincing mates that insects even ejaculate on them, wasting valuable sperm. But the most vital component of sexual deception is scent: orchids mimic the precise scent of a single insect species. This is possible because many insects and flowers produce simple organic compounds called hydrocarbons, which form a layer that protects their bodies from drying out. The precise blend of compounds in this layer is species-specific. Its scent can double as a way for insects to attract potential mates, known as a sex pheromone. Over the course of many thousands of years, random compound combinations have given some orchid species precisely the same signature scent as particular insect species. This matching scent allows them to attract male pollinators who fall over and over again for the flowers masquerading as females of their own species. Sexual deception isn’t the only trick orchids have up their sleeves. Their oldest scam is mimicking the shapes and colours of other nectar-producing flowers— but without the sweet nectar. Some orchids also masquerade as places where insects lay their eggs. One species not only has the colour and appearance of rotting meat; it emits a scent of decay as well– drawing in flies who deposit their eggs on the flower and unwittingly pollinate the plant. Other orchids look and smell just like the fungi on which certain insects lay their eggs. Where do all these bizarre adaptations come from? Random genetic mutations in orchids may result in a trait– like a scent or a shape– that, by chance, matches the needs of a single insect species. The huge diversity within the insect world also increases the likelihood that an orchid will find a unique audience. Able to make more seeds and offspring with the help of its dedicated pollinators, the orchid successfully reproduces in isolation, and becomes a new species. But because of their dependence on sometimes just one pollinator species, orchids are also vulnerable, and many quickly go extinct. Over time, though, more orchid species have formed than died out, and orchids are some of the most diverse flowering plants. They have such exuberant and otherworldly shapes that they occasionally deceive human senses, too: In their petals we see what appear to be tiny, dancing people, monkey’s faces, spiders, and even birds in flight.

**P686 2019-01-25 Three ways the universe could end - Venus Keus**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=686)

We know about our universe’s past: the Big Bang theory predicts that all matter, time, and space began in an incredibly tiny, compact state about 14 billion years ago. And we know about the present: scientists’ observations of the movement of galaxies tell us that the universe is expanding at an accelerated rate. But what about the future? Do we know how our universe is going to end? Cosmologists have three possible answers for this question, called the Big Freeze, the Big Rip and the Big Crunch. To understand these three scenarios, imagine two objects representing galaxies. A short, tight rubber band is holding them together— that’s the attractive force of gravity. Meanwhile, two hooks are pulling them apart— that’s the repulsive force expanding the universe. Copy this system over and over again, and you have something approximating the real universe. The outcome of the battle between these two opposing forces determines how the end of the universe will play out. The Big Freeze scenario is what happens if the force pulling the objects apart is just strong enough to stretch the rubber band until it loses its elasticity. The expansion wouldn’t be able to accelerate anymore, but the universe would keep getting bigger. Clusters of galaxies would separate. The objects within the galaxies– suns, planets, and solar systems would move away from each other, until galaxies dissolved into lonely objects floating separately in the vast space. The light they emit would be redshifted to long wavelengths with very low, faint energies, and the gas emanating from them would be too thin to create new stars. The universe would become darker and colder, approaching a frozen state also known as the Big Chill, or the Heat Death of the Universe. But what if the repulsive force is so strong that it stretches the rubber band past its elastic limit, and actually tears it? If the expansion of the universe continues to accelerate, it will eventually overcome not only the gravitational force – tearing apart galaxies and solar systems– but also the electromagnetic, weak, and strong nuclear forces which hold atoms and nuclei together. As a result, the matter that makes up stars breaks into tiny pieces. Even atoms and subatomic particles will be destroyed. That’s the Big Rip. What about the third scenario, where the rubber band wins out? That corresponds to a possible future in which the force of gravity brings the universe’s expansion to a halt— and then reverses it. Galaxies would start rushing towards each other, and as they clumped together their gravitational pull would get even stronger. Stars too would hurtle together and collide. Temperatures would rise as space would get tighter and tighter. The size of the universe would plummet until everything compressed into such a small space that even atoms and subatomic particles would have to crunch together. The result would be an incredibly dense, hot, compact universe — a lot like the state that preceded the Big Bang. This is the Big Crunch. Could this tiny point of matter explode in another Big Bang? Could the universe expand and contract over and over again, repeating its entire history? The theory describing such a universe is known as the Big Bounce. In fact, there’s no way to tell how many bounces could’ve already happened— or how many might happen in the future. Each bounce would wipe away any record of the universe’s previous history. Which one of those scenarios will be the real one? The answer depends on the exact shape of the universe, the amount of dark energy it holds, and changes in its expansion rate. As of now, our observations suggest that we’re heading for a Big Freeze. But the good news is that we’ve probably got about 10 to the 100th power years before the chill sets in — so don’t start stocking up on mittens just yet.

**P687 2019-01-25 'To Make Use of Water' by Safia Elhillo**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=687)

My name is Safia Elhillo, and this poem is called "to make use of water." dilute i forget the arabic word for economy i forget the english word for عسل forget the arabic word for incense & english word for مسكين arabic word for sandwich english for صيدلية & مطعم & وله /stupid girl, atlantic got your tongue/ blur back home we are plagued by a politeness so dense even the doctors cannot call things what they are my grandfather’s left eye swirled thick with smoke what my new mouth can call glaucoma while the arabic still translates to the white water swim i want to go home dissolve i want to go home drown half don’t even make it out or across you get to be ungrateful you get to be homesick from safe inside your blue american passport do you even understand what was lost to bring you here

**P688 2019-01-28 Why should you read Sylvia Plath - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=688)

“From the tip of every branch, like a fat purple fig, a wonderful future beckoned and winked… but choosing one meant losing all the rest, and, as I sat there, unable to decide, the figs began to wrinkle and go black, and, one by one, they plopped to the ground at my feet.” In this passage from Sylvia Plath’s "The Bell Jar," a young woman imagines an uncertain future– and speaks to the universal fear of becoming paralyzed by the prospect of making the wrong choice. Although she considered other careers, Plath chose the artist’s way. Poetry was her calling. Under her shrewd eye and pen, everyday objects became haunting images: a “new statue in a drafty museum,” a shadow in a mirror, a slab of soap. Fiercely intelligent, penetrating and witty, Plath was also diagnosed with clinical depression. She used poetry to explore her own states of mind in the most intimate terms, and her breathtaking perspectives on emotion, nature and art continue to captivate and resonate. In her first collection of poems, "The Colossus," she wrote of a feeling of nothingness: "white: it is a complexion of the mind.” At the same time, she found solace in nature, from “a blue mist” “dragging the lake,” to white flowers that “tower and topple,” to blue mussels “clumped like bulbs.” After "The Colossus" she published "The Bell Jar," her only novel, which fictionalizes the time she spent working for Mademoiselle magazine in New York during college. The novel follows its heroine, Esther, as she slides into a severe depressive episode, but also includes wickedly funny and shrewd depictions of snobby fashion parties and dates with dull men. Shortly after the publication of "The Bell Jar," Plath died by suicide at age 30. Two years later, the collection of poems she wrote in a burst of creative energy during the months before her death was published under the title "Ariel." Widely considered her masterpiece, Ariel exemplifies the honesty and imagination Plath harnessed to capture her pain. In one of "Ariel's" most forceful poems, "Lady Lazarus," she explores her attempts to take her own life through Lazarus, the biblical figure who rose from the dead. She writes, “and I a smiling woman/ I am only thirty/ And like the cat I have nine times to die.” But the poem is also a testament to survival: “I rise with my red hair/ And I eat men like air.” This unflinching language has made Plath an important touchstone for countless other readers and writers who sought to break the silence surrounding issues of trauma, frustration, and sexuality. "Ariel" is also filled with moving meditations on heartbreak and creativity. The title poem begins “Stasis in darkness/ Then the substanceless blue/ Pour of tor and distances.” This sets the scene for a naked ride on horseback in the early morning— one of Plath’s most memorable expressions of the elation of creative freedom. But it is also full of foreboding imagery, such as “a child's cry” that “melts in the wall” and a “red/eye, the cauldron of morning.” This darkness is echoed throughout the collection, which includes controversial references to the holocaust and the Kamikazes. Even the relics of seemingly happier times are described as crucifying the author: “My husband and child smiling out of the family photo; Their smiles catch onto my skin, little smiling hooks.” Her domestic dissatisfaction and her husband’s mistreatment of her are constant themes in her later poetry. After her death, he inherited her estate, and has been accused of excluding some of her work from publication. Despite these possible omissions and her untimely death, what survives is one of the most extraordinary bodies of work by a twentieth century poet. While her work can be shocking in its rage and trauma, Plath casts her readers as witnesses– not only to the truth of her psychological life, but to her astounding ability to express what often remains inexpressible.

**P689 2019-01-30 How does the Rorschach inkblot test work - Damion Searls**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=689)

Take a look at this image. What might this be? A frightening monster? Two friendly bears? Or something else entirely? For nearly a century, ten inkblots like these have been used as what seems like an almost mystical personality test. Long kept confidential for psychologists and their patients, the mysterious images were said to draw out the workings of a person’s mind. But what can inkblots really tell us, and how does this test work? Invented in the early 20th century by Swiss psychiatrist Hermann Rorschach, the Rorschach Test is actually less about the specific things we see, and more about our general approach to perception. As an amateur artist Hermann was fascinated by how visual perception varies from person to person. He carried this interest to medical school, where he learned all our senses are deeply connected. He studied how our process of perception doesn’t just register sensory inputs, but transforms them. And when he started working at a mental hospital in eastern Switzerland, he began designing a series of puzzling images to gain new insight into this enigmatic process. Using his inkblot paintings, Rorschach began quizzing hundreds of healthy subjects and psychiatric patients with the same question: what might this be? However, it wasn’t what the test subjects saw that was most important to Rorschach, but rather, how they approached the task. Which parts of the image did they focus on or ignore? Did they see the image moving? Did the color on some inkblots help them give better answers, or distract and overwhelm them? He developed a system to code people’s responses, reducing the wide range of interpretations to a few manageable numbers. Now he had empirical measures to quantify all kinds of test takers: the creative and imaginative, the detail-oriented, the big-picture perceivers, and flexible participants able to adapt their approach. Some people would get stuck, offering the same answer for multiple blots. Others gave unusual and delightful descriptions. Responses were as varied as the inkblots, which offered different kinds of perceptual problems– some easier to interpret than others. But analyzing the test-taker’s overall approach yielded real insights into their psychology. And as Rorschach tested more and more people, patterns began to pile up. Healthy subjects with the same personalities often took remarkably similar approaches. Patients suffering from the same mental illnesses also performed similarly, making the test a reliable diagnostic tool. It could even diagnose some conditions difficult to pinpoint with other available methods. In 1921, Rorschach published his coding system alongside the ten blots he felt gave the most nuanced picture of people’s perceptual approach. Over the next several decades, the test became wildly popular in countries around the world. By the 1960s, it had been officially administered millions of times in the U.S. alone. Unfortunately, less than a year after publishing the test, Hermann Rorschach had died suddenly. Without its inventor to keep it on track, the test he had methodically gathered so much data to support began to be used in all sorts of speculative ways. Researchers gave the test to Nazi war criminals, hoping to unlock the psychological roots of mass murder. Anthropologists showed the images to remote communities as a sort of universal personality test. Employers made prejudiced hiring decisions based on reductive decoding charts. As the test left clinics and entered popular culture its reputation among medical professionals plummeted, and the blots began to fall out of clinical use. Today, the test is still controversial, and many people assume it has been disproven. But a massive 2013 review of all the existing Rorschach research showed that when administered properly the test yields valid results, which can help diagnose mental illness or round out a patient’s psychological profile. It’s hardly a stand-alone key to the human mind– no test is. But its visual approach and lack of any single right answer continue to help psychologists paint a more nuanced picture of how people see the world. Bringing us one step closer to understanding the patterns behind our perceptions.

**P690 2019-02-08 Notes of a native son - The world according to James Baldwin - Christ**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=690)

Over the course of the 1960s, the FBI amassed almost two thousand documents in an investigation into one of America’s most celebrated minds. The subject of this inquiry was a writer named James Baldwin. At the time, the FBI investigated many artists and thinkers, but most of their files were a fraction the size of Baldwin’s. During the years when the FBI hounded him, he became one of the best-selling black authors in the world. So what made James Baldwin loom so large in the imaginations of both the public and the authorities? Born in Harlem in 1924, he was the oldest of nine children. At age fourteen, he began to work as a preacher. By delivering sermons, he developed his voice as a writer, but also grew conflicted about the Church’s stance on racial inequality and homosexuality. After high school, he began writing novels and essays while taking a series of odd jobs. But the issues that had driven him away from the Church were still inescapable in his daily life. Constantly confronted with racism and homophobia, he was angry and disillusioned, and yearned for a less restricted life. So in 1948, at the age of 24, he moved to Paris on a writing fellowship. From France, he published his first novel, "Go Tell it on the Mountain," in 1953. Set in Harlem, the book explores the Church as a source of both repression and hope. It was popular with both black and white readers. As he earned acclaim for his fiction, Baldwin gathered his thoughts on race, class, culture and exile in his 1955 extended essay, "Notes of a Native Son." Meanwhile, the Civil Rights movement was gaining momentum in America. Black Americans were making incremental gains at registering to vote and voting, but were still denied basic dignities in schools, on buses, in the work force, and in the armed services. Though he lived primarily in France for the rest of his life, Baldwin was deeply invested in the movement, and keenly aware of his country’s unfulfilled promise. He had seen family, friends, and neighbors spiral into addiction, incarceration and suicide. He believed their fates originated from the constraints of a segregated society. In 1963, he published "The Fire Next Time," an arresting portrait of racial strife in which he held white America accountable, but he also went further, arguing that racism hurt white people too. In his view, everyone was inextricably enmeshed in the same social fabric. He had long believed that: “People are trapped in history and history is trapped in them.” Baldwin’s role in the Civil Rights movement went beyond observing and reporting. He also traveled through the American South attending rallies giving lectures of his own. He debated both white politicians and black activists, including Malcolm X, and served as a liaison between black activists and intellectuals and white establishment leaders like Robert Kennedy. Because of Baldwin’s unique ability to articulate the causes of social turbulence in a way that white audiences were willing to hear, Kennedy and others tended to see him as an ambassador for black Americans — a label Baldwin rejected. And at the same time, his faculty with words led the FBI to view him as a threat. Even within the Civil Rights movement, Baldwin could sometimes feel like an outsider for his choice to live abroad, as well as his sexuality, which he explored openly in his writing at a time when homophobia ran rampant. Throughout his life, Baldwin considered it his role to bear witness. Unlike many of his peers, he lived to see some of the victories of the Civil Rights movement, but the continuing racial inequalities in the United States weighed heavily on him. Though he may have felt trapped in his moment in history, his words have made generations of people feel known, while guiding them toward a more nuanced understanding of society’s most complex issues.

**P691 2019-02-13 Harvey Milk's radical vision of equality - Lillian Faderman**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=691)

By 1973, Harvey Milk had already been many things: naval officer, high school teacher, bit-part actor, and wandering hippie. But as he embarked on yet another life running a camera shop in San Francisco, he already found himself distracted. From the Watergate hearings on national news, to the teacher who had to rent a projector when her school couldn’t afford one, Harvey saw a desperate need for political reform. Milk strongly believed that tight knit neighborhoods were essential to the fabric of the city, and that government should solve those community’s most practical problems. From fixing potholes and putting up stop signs, to promoting a friendly culture of cooperation, Milk envisioned a more personal approach to local government. This philosophy led him to run for the city’s Board of Supervisors as the representative for his own district, which included the heart of American gay culture, the Castro. At this time, police brutality, discrimination and media stereotyping plagued the LGBT community, labeling Harvey and his supporters as political outsiders. But Milk refused to downplay his sexuality. He was sure that gay rights could never be won from the closet, and he saw the Castro as one of many minorities without representation in city politics. Milk was determined to bring these basic government services to all of San Francisco’s disenfranchised groups, regardless of race, age, or sexuality. But despite his flair for public speaking and open-hearted approach, voters couldn’t see Milk’s radical vision. In 1973, he lost his first bid for the Board of Supervisors. In 1975, he lost again. A year later, he ran for the California Assembly– and lost. Yet he tirelessly continued to support his district, befriending bartenders, construction unions, and local Chinese grocers. This earned him the affectionate title, the "mayor of Castro Street.” And when he ran his third campaign for the Board of Supervisors in 1977, Harvey finally won the seat– becoming one of the first openly gay public officials in US history. Elated, Milk arrived in office determined to make lasting change. He immediately introduced a bill outlawing discrimination on the grounds of sexuality and launched a major clean-up of the city. But not everyone was happy with this direction. Anti-gay sentiment was gaining national momentum, especially in the form of California’s Proposition 6. The proposition, which sought to make it illegal for homosexuals to work in Californian schools, would prove to be the biggest battle of Milk’s career. Supporters of Prop 6 attacked the LGBT community, calling them unfit to work with students. But Milk urged them not to hide in fear: “Come out to your relatives. Come out to your friends, if indeed they are your friends. Come out to your neighbors, to your fellow workers… break down the myths. Destroy the lies and distortions. For your sake. For their sake.” Alongside other activists, he ran an incandescent campaign against hate. On November 7, 1978, Prop 6 was defeated in a landslide. It was proof that Milk’s message was gaining traction. But just twenty days after this inspiring victory, he was assassinated at City Hall– killed alongside San Francisco Mayor George Moscone. Both men had been murdered by Dan White, a former fellow supervisor, who had positioned himself against those he called "radicals, social deviates and incorrigibles.” He had frequently clashed with Harvey at Board meetings, and resented the spirit of change which Milk personified for many. The night of Milk's murder, thousands marched by candlelight through the city. In the wake of this tragedy, yet another injustice arose. In a highly controversial verdict, White received a sentence of only seven years and eight months– a decision that sparked uproar throughout the city in what became known as the White Night Riots. But even after his death, Milk continued to preach his hopeful cause. He left his friends and followers a total of three different tapes to be played in the event of his assassination. They leave us with a call to action, and a reminder that everyone is welcome in the fight against injustice: "I ask for the movement to continue… and if a bullet should enter my brain, let that bullet destroy every closet door…”

**P693 2019-02-22 Can you solve the jail break riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=693)

Your timing made you and your partner the most infamous bank robbers in the west. Now, you’ll need to use that timing to help you break out of jail. At the appointed time, you’ll be walking in the yard near the electric fence. Your partner will flash you the signal, and exactly 45 seconds later, short out the fence circuit. It’ll automatically restart after a second or two, but as long as you move fast, you’ll be home free. And then you notice, to your horror, that your watch is broken, and there’s no time to fix it. The signal is coming, and if you make even a small mistake in counting off 45 seconds, you’ll get fried. Searching your pockets, you find something that might help: a lighter and two fuses you made earlier in the prison work program. Each fuse is a length of flammable twine, built to be lit on either end and burn for precisely one minute. The problem is that even though the fuses look uniform, they don’t burn evenly, so if you cut one in half, for example, one side might burn longer than the other. Your partner is going to give the signal any minute, and you’ll have to make your move. How can you use the fuses and lighter to time exactly 45 seconds? Pause the video to figure it out yourself. Answer in 3 Answer in 2 Answer in 1 The length of the fuse may not tell you anything, but you do know the fuses take exactly 60 seconds to burn from end to end. Here’s the key insight: If you start a fuse on one side and it burns for 30 seconds, there’ll still be 30 seconds of fuse left. If you had started it from the other end, it would’ve reached the exact same spot in thirty seconds. That means that if you lit it from both ends simultaneously, it would burn out in precisely 30 seconds. But how will you time the last fifteen? That’ll have to come from the second fuse. If it were a 30 second fuse, you’d be able to use that same trick again to double the burning speed and make it last exactly 15 seconds. And, you realize, you can shorten the second fuse by lighting one end of it at the same time as you light the first. At the moment the first burns out, you’ll be left with 30 seconds on the second fuse. Just when you’ve got this all figured out, you see the signal from your partner, and spring into action. You gather the four ends of the two fuses and light three of them. The moment the first burns out, you light the other end of the second fuse. When it flickers and dies, you know that exactly 45 seconds have passed, and the electric fence is dead. By the time it hiccups back to life, you’re over the fence and home free.

**P694 2019-02-22 How to grow a glacier - M Jackson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=694)

In the 13th Century, Genghis Khan embarked on a mission to take over Eurasia, swiftly conquering countries and drawing them into his expanding Mongol Empire. With his vast armies he became almost unstoppable. But, legend has it that there was one obstacle that even the impressive Khan couldn’t overcome: A towering wall of ice, grown by locals across a mountain pass to stop the Khan’s armies from invading their territory. No one knows how historically accurate that particular story is, but remarkably, it draws on fact: For centuries, in the Karakoram and Himalayan mountain ranges, people have been growing glaciers and using these homemade bodies of ice as sources of drinking water and irrigation for their crops. But before we get to that fascinating phenomenon, it’s important to understand the difference between glaciers that grow in the wild, and those that humans create. In the wild, glaciers require three conditions to grow: Snowfall, cold temperatures, and time. First, a great deal of snow falls and accumulates. Cold temperatures then ensure that the stacked up snow persists throughout the winter, spring, summer, and fall. Over the following years, decades, and centuries, the pressure of the accumulated snow transforms layers into highly compacted glacial ice. Artificially growing a glacier, however, is completely different. At the confluence of three great mountain ranges, the Himalayas, Karakoram, and Hindu Kush, some local cultures have believed for centuries that glaciers are alive. And what’s more, that certain glaciers can have different genders including male and female. Local Glacier Growers ‘breed’ new glaciers by grafting together—or marrying— fragments of ice from male and female glaciers, then covering them with charcoal, wheat husks, cloths, or willow branches so they can reproduce. Under their protective coverings, these glacierets transform into fully active glaciers that grow each year with additional snowfall. Those then serve as lasting reserves of water that farmers can use to irrigate their crops. These practices have spread to other cultures, where people are creating their own versions of glaciers and applying them to solve serious modern challenges around water supplies. Take Ladakh, a high-altitude desert region in northern India. It sits in the rain shadow of the Himalayas and receives on average fewer than ten centimeters of rain per year. As local glaciers shrink because of climate change, regional water scarcity is increasing. And so, local people have started growing their own glaciers as insurance against this uncertainty. These glaciers come in two types: horizontal, and vertical. Horizontal glaciers are formed when farmers redirect glacier meltwater into channels and pipes, then carefully siphon it off into a series of basins made from stones and earth. Villagers minutely control the release of water into these reservoirs, waiting for each new layer to freeze before filling the basin with another wave. In early spring, these frozen pools begin to melt, supplying villagers with irrigation for their fields. Local people make vertical glaciers using the meltwater from already-existing glaciers high above their villages. The meltwater enters channels that run downhill, flowing until it reaches a crop site where it bursts forth from a pipe pointing straight into the air. When winter temperatures dip, this water freezes as it arcs out of the pipe, ultimately forming a 50 meter ice sculpture called a stupa, shaped like an upside-down ice cream cone. This inverted form minimizes the amount of surface area it exposes to the sun in the spring and summer. That ensures that the mini-glacier melts slowly and provides a reliable supply of water to feed the farmers’ crops. These methods may be ancient, but they’re becoming more relevant as climate change takes its toll on our planet. In fact, people are now growing their own glaciers in many regions beyond Ladakh. Swiss people, utilizing modern glacier growing technology, created their first stupa in 2016 in the Swiss Alps. There are plans for over 100 more in villages in Pakistan, Kazakhstan, and Kyrgyzstan. Perhaps one day we’ll be able to harness our homegrown glaciers well enough to build whole walls of ice– this time not for keeping people out, but to enable life in some of the planet’s harshest landscapes.

**P695 2019-02-22 Why should you read sci-fi superstar Octavia E. Butler - Ayana Jamies**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=695)

Following a devastating nuclear war, Lilith Iyapo awakens after 250 years of stasis to find herself surrounded by a group of aliens called the Oankali. These highly evolved beings want to trade DNA by breeding with humans so that each species’ genes can diversify and fortify the other. The only alternative they offer is sterilization of the entire human race. Should humanity take the leap into the biological unknown, or hold on to its identity and perish? Questions like this haunt Octavia Butler’s "Dawn," the first in her trilogy "Lilith’s Brood." A visionary storyteller who upended science fiction, Butler built stunning worlds throughout her work– and explored dilemmas that keep us awake at night. Born in 1947, Butler grew up shy and introverted in Pasadena, California. She dreamt up stories from an early age, and was soon scribbling these scenarios on paper. At twelve, she begged her mother for a typewriter after enduring a campy science fiction film called "Devil Girl From Mars." Unimpressed with what she saw, Butler knew she could tell a better story. Much science fiction features white male heroes who blast aliens or become saviors of brown people. Butler wanted to write diverse characters for diverse audiences. She brought nuance and depth to the representation of their experiences. For Butler, imagination was not only for planting the seeds of science fiction– but also a strategy for surviving an unjust world on one’s own terms. Her work often takes troubling features of the world such as discrimination on the basis of race, gender, class, or ability, and invites the reader to contemplate them in new contexts. One of her most beloved novels, the "Parable of the Sower," follows this pattern. It tells the story of Lauren Oya Olamina as she makes her way through a near-future California, ruined by corporate greed, inequality, and environmental destruction. As she struggles with hyperempathy, or a condition in the novel that causes her to feel others’ pain, and less often, their pleasure. Lauren embarks on a quest with a group of refugees to find a place to thrive. There, they seek to live in accordance with Lauren’s found religion, Earthseed, which is based on the principle that humans must adapt to an ever-changing world. Lauren’s quest had roots in a real life event– California Prop 187, which attempted to deny undocumented immigrants fundamental human rights, before it was deemed unconstitutional. Butler frequently incorporated contemporary news into her writing. In her 1998 sequel to "The Parable of the Sower," "Parable of the Talents," she wrote of a presidential candidate who controls Americans with virtual reality and “shock collars.” His slogan? “Make America great again.” While people have noted her prescience, Butler was also interested in re-examining history. For instance, "Kindred" tells the story of a woman who is repeatedly pulled back in time to the Maryland plantation of her ancestors. Early on, she learns that her mission is to save the life of the white man who will rape her great grandmother. If she doesn’t save him, she herself will cease to exist. This grim dilemma forces Dana to confront the ongoing trauma of slavery and sexual violence against Black women. With her stories of women founding new societies, time travelers overcoming historical strife, and interspecies bonding, Butler had a profound influence on the growing popularity of Afrofuturism. That’s a cultural movement where Black writers and artists who are inspired by the past, present and future, produce works that incorporate magic, history, technology and much more. As Lauren comes to learn in "Parable of the Sower," "All that you touch you Change. All that you Change Changes you. The only lasting truth is Change.”

**P696 2019-02-26 The chaotic brilliance of artist Jean-Michel Basquiat - Jordana Moore**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=696)

A sky blue canvas ripped open by an enormous skull. Teeth bared through visceral slashes of oil and spray-paint. In 2017, this untitled artwork was auctioned off for over 110 million dollars. But it’s not the work of some old master. These strokes of genius belong to 21 year old black Brooklynite Jean-Michel Basquiat – one of America’s most charismatic painters, and currently, its highest sold. Born in 1960 to a Haitian father and a Puerto Rican mother, Basquiat spent his childhood making art and mischief in Boerum Hill. While he never attended art school, he learned by wandering through New York galleries, and listening to the music his father played at home. He drew inspiration from unexpected places, scribbling his own versions of cartoons, comic books and biblical scenes on scrap paper from his father’s office. But it was a medical encyclopedia that arguably exerted the most powerful influence on Basquiat. When young Jean-Michael was hit by a car, his mother brought a copy of "Grey’s Anatomy" to his hospital bed. It ignited a lifelong fascination with anatomy that manifested in the skulls, sinew and guts of his later work – which frequently explores both the power and vulnerability of marginalized bodies. By 17, he launched his first foray into the art world with his friend Al Diaz. They spray painted cryptic statements and symbols all over Lower Manhattan, signed with the mysterious moniker SAMO. These humorous, profound, and rebellious declarations were strategically scattered throughout Soho’s art scene. And after revealing himself as the artist, Basquiat leveraged SAMO’s success to enter the scene himself; selling postcards, playing clubs with his avant-garde band, and boldly seeking out his heroes. By 21, he’d turned to painting full time. His process was a sort of calculated improvisation. Like Beat writers who composed their work by shredding and reassembling scraps of writing, Basquiat used similar cut-up techniques to remix his materials. When he couldn't afford canvases, he fashioned them out of discarded wood he found on the street. He used oil stick, crayons, spray paint and pencil and pulled quotes from the menus, comic books and textbooks he kept open on the studio floor. He kept these sources open on his studio floor, often working on multiple projects at once. Pulling in splintered anatomy, reimagined historical scenes, and skulls transplanted from classical still-lives, Basquiat repurposed both present day experiences and art history into an inventive visual language. He worked as if inserting himself into the legacy of artists he borrowed from, producing collages that were just as much in conversation with art history as they were with each other. For instance, "Toussaint L’Overture versus Savonarola" and "Undiscovered Genius of the Mississippi Delta" offer two distinct visions of Basquiat’s historical and contemporary concerns. But they echo each other in the details, such as the reappearing head that also resurfaces in "PPCD." All these pieces form a network that offers physical evidence of Basquiat’s restless and prolific mind. These chaotic canvases won rapid acclaim and attention. But despite his increasingly mainstream audience, Basquiat insisted on depicting challenging themes of identity and oppression. Marginalized figures take center stage, such as prisoners, cooks and janitors. His obsession with bodies, history, and representation can be found in works evoking the Atlantic slave trade and African history, as well as pieces focusing on contemporary race relations. In less than a decade, Basquiat made thousands of paintings and drawings- along with sculpture, fragments of poetry and music. His output accelerated alongside his meteoric rise to fame, but his life and work were cut tragically short when he died from a drug overdose at the age of 27. After his death, Basquiat’s work only increased in value- but the energy and flair of his pieces have impacted much more than their financial worth. Today, his influence swirls around us in music, poetry, fashion and film- and his art retains the power to shock, inspire, and get under our skin.

**P697 2019-02-27 Can you solve the unstoppable blob riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=697)

A shooting star crashes on Earth, and a hideous blob emerges. It creeps and leaps, it glides and slides. It’s also unstoppable: weapons, fire, extreme temperatures… no matter what you throw at it, it just regrows and continues its rampage. Its expansion is breathtaking; it doubles in size every hour. But there’s one opportunity: after each hour, it goes to sleep, forming itself into a flat triangle and resting for a few minutes before it begins eating and growing again. Your only chance to save the planet involves a satellite-mounted nano-fission ray that can cut through the blob. When the blog is active it heals itself within seconds. However, when you break the sleeping blob into two triangles, you make a critical discovery. The acute triangle portion, with all angles less than 90 degrees, is inert. It never “wakes up.” The obtuse triangle, which has an angle greater than 90 degrees, wakes up as usual and keeps growing. Similar experiments show that all shapes other than acute triangles, including right triangles, will also wake up. For the next few minutes, the blob is sleeping in its obtuse triangle form. You can make clean, straight-line cuts between any two points on or inside the triangle. But you’ll only have time to make 7 cuts while the satellite is above you. By the time it completes its orbit and returns, the blob will have consumed the entire world, if even a single portion that will wake up remains. How can you cut the blob entirely into acute triangles and stop it from destroying the planet? Pause the video now to figure out for yourself Answer in 3 Answer in 2 Answer in 1 While this seems doable at first, there’s a hidden difficulty when it comes to avoiding obtuse and right angles. Every time you make a cut that reaches an edge, it either makes an acute and an obtuse angle, or two right angles. That makes it seems like you’re doomed to keep creating obtuse angles. But as with so many of life’s problems, we can look to pizza for inspiration. Imagine squaring off the outside of a pizza, so that instead of a circle, it’s an octagon. When we cut it into slices, each of the eight triangles is acute. This works with larger polygons too. Importantly, it also works for some polygons with fewer sides, including heptagons, hexagons, and pentagons. That’s good news, because if you cut off the sharp corners of the blob triangle, a pentagon is exactly what you’ll be left with. And just like a pizza, you can cut the blob pentagon into five acute triangles. That’s 7 cuts, and it renders the blob completely inert. You’ve saved the day! Now you just need to figure out what to do with all of these giant, practically indestructible triangles.

**P698 2019-02-28 Frida Kahlo - The woman behind the legend - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=698)

In 1925, Frida Kahlo was on her way home from school in Mexico City when the bus she was riding collided with a streetcar. She suffered near-fatal injuries to her spine, pelvis and hips, and was bedridden for months afterward. During her recovery, she had a special easel attached to her bed so she could practice painting techniques. When she set to work, she began to paint the world according to her own singular vision. Over the course of her life, she would establish herself as the creator and muse behind extraordinary art. Though you may have met Kahlo's gaze before, her work provides an opportunity to see the world through her eyes. She painted friends and family, still lives and spiritual scenes; but it was her mesmerizing self-portraits which first caught the world’s attention. In an early work, "Self Portrait with Velvet Dress," the focus is on her strong brows, facial hair, long neck and formidable stare. Such features remained, but Kahlo soon began to present herself in more unusual ways. For example, "The Broken Column" uses symbolism, religious imagery and a ruptured landscape to reveal her physical and mental state. In 1928, Kahlo started dating fellow painter Diego Rivera. They became lifelong partners and cultivated an eccentric celebrity. Together, they traveled the world and dedicated themselves to art, Communist politics and Mexican nationalism. Kahlo and Rivera shared a deep affinity with Mexicanidad, a movement which celebrated indigenous culture after the Revolution. In her daily life, Kahlo wore traditional Tehuana dress and immersed herself in native spirituality. And in her work, she constantly referenced Mexican folk painting, incorporating its bright colors and references to death, religion and nature. With her imagery of giant floating flowers, undulating landscapes, transplanted body parts and billowing clouds of demons, Kahlo has often been associated with Surrealism. But while surrealists used dreamlike images to explore the unconscious mind, Kahlo used them to represent her physical body and life experiences. Two of her most-explored experiences were her physical disabilities and her marriage. As a result of the bus accident, she experienced life-long health complications and endured many hospitalizations. She often contemplated the physical and psychological effects of disability in her work; painting herself in agony, recuperating from operations, or including objects such as her back brace and wheelchair. Meanwhile, her relationship with Rivera was tempestuous, marked by infidelity on both sides. At one point they even divorced, then remarried a year later. During this period, she painted the double self-portrait "The Two Fridas," which speaks to the anguish of loss and a splintered sense of self. The Frida to the left has a broken heart, which drips blood onto her old-fashioned Victorian dress. She symbolizes a version of the artist who is wounded by the past– but is also connected by an artery to a second self. This Frida is dressed in Tehuana attire– and although she remembers Diego with the tiny portrait in her hand, her heart remains intact. Together, the two suggest a position caught between past and present, individuality and dependency. Kahlo died in 1954 at the age of 47. In the years after her death, she experienced a surge in popularity that has lasted to this day. And although her image has proliferated, Kahlo’s body of work reminds us that there are no simple truths about the life, work and legacy of the woman behind the icon. Rather, she put multiple versions of her reality on display– and provided us with a few entry-ways into the contents of her soul.

**P699 2019-02-28 How tall can a tree grow - Valentin Hammoudi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=699)

Reaching heights of over 100 meters, Californian sequoias tower over Earth’s other estimated 60,000 tree species. Growing in the misty Sierra Nevada mountains, their massive trunks support the tallest known trees in the world. But even these behemoths seem to have their limits. No sequoia on record has been able to grow taller than 130 meters – and many researchers say these trees won’t beat that cap even if they live for thousands of years to come. So what exactly is stopping these trees from growing taller, forever? It all comes down to sap. In order for trees to grow, they need to bring sugars obtained from photosynthesis and nutrients brought in through the root system to wherever growth is happening. And just like blood circulates in the human body, trees are designed to circulate two kinds of sap throughout their bodies – carrying all the substances a tree’s cells need to live. The first is phloem sap. Containing the sugars generated in leaves during photosynthesis, phloem sap is thick, like honey, and flows down the plant’s phloem tissue to distribute sugar throughout the tree. By the end of its journey, the phloem sap has thinned into a watery substance, pooling at the base of the tree. Right beside the phloem is the tree’s other tissue type: the xylem. This tissue is packed with nutrients and ions like calcium, potassium, and iron, which the tree has absorbed through its roots. Here at the tree’s base, there are more of these particles in one tissue than the other, so the water from the phloem sap is absorbed into the xylem to correct the balance. This process, called osmotic movement, creates nutrient-rich xylem sap, which will then travel up the trunk to spread those nutrients through the tree. But this journey faces a formidable obstacle: gravity. To accomplish this herculean task, the xylem relies on three forces: transpiration, capillary action, and root pressure. As part of photosynthesis, leaves open and close pores called stomata. These openings allow oxygen and carbon dioxide in and out of the leaf, but they also create an opening through which water evaporates. This evaporation, called transpiration, creates negative pressure in the xylem, pulling watery xylem sap up the tree. This pull is aided by a fundamental property of water called capillary action. In narrow tubes, the attraction between water molecules and the adhesive forces between the water and its environment can beat out gravity. This capillary motion is in full effect in xylem filaments thinner than human hair. And where these two forces pull the sap, the osmotic movement at the tree’s base creates root pressure, pushing fresh xylem sap up the trunk. Together these forces launch sap to dizzying heights, distributing nutrients, and growing new leaves to photosynthesize – far above the tree’s roots. But despite these sophisticated systems, every centimeter is a fight against gravity. As trees grow taller and taller, the supply of these vital fluids begins to dwindle. At a certain height, trees can no longer afford the lost water that evaporates during photosynthesis. And without the photosynthesis needed to support additional growth, the tree instead turns its resources towards existing branches. This model, known as the “hydraulic limitation hypothesis,” is currently our best explanation for why trees have limited heights, even in perfect growing conditions. And using this model alongside growth rates and known needs for nutrients and photosynthesis, researchers have been able to propose height limits for specific species. So far these limits have held up – even the world’s tallest tree still falls about fifteen meters below the cap. Researchers are still investigating the possible explanations for this limit, and there may not be one universal reason why trees stop growing. But until we learn more, the height of trees is yet another way that gravity, literally, shapes life on Earth.

**P700 2019-02-28 The historic women’s suffrage march on Washington - Michelle Mehrtens**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=700)

On March 3, 1913, protesters parted for the woman in white: dressed in a flowing cape and sitting astride a white horse, the activist Inez Milholland was hard to miss. She was riding at the helm of the Women’s Suffrage Parade- the first mass protest for a woman’s right to vote on a national scale. After months of strategic planning and controversy, thousands of women gathered in Washington D.C. Here, they called for a constitutional amendment granting them the right to vote. By 1913, women’s rights activists had been campaigning for decades. As a disenfranchised group, women had no voice in the laws that affected their– or anyone else’s– lives. However, they were struggling to secure broader support for political equality. They’d achieved no major victories since 1896, when Utah and Idaho enfranchised women. That brought the total number of states which recognized a women’s right to vote to four. A new, media-savvy spirit arrived in the form of Alice Paul. She was inspired by the British suffragettes, who went on hunger strikes and endured imprisonment in the early 1900s. Rather than conduct costly campaigns on a state-by-state basis, Paul sought the long-lasting impact of a constitutional amendment, which would protect women’s voting rights nationwide. As a member of the National American Women Suffrage Association, Paul proposed a massive pageant to whip up support and rejuvenate the movement. Washington authorities initially rejected her plan- and then tried to relegate the march to side streets. But Paul got those decisions overturned and confirmed a parade for the day before the presidential inauguration of Woodrow Wilson. This would maximize media coverage and grab the attention of the crowds who would be in town. However, in planning the parade, Paul mainly focused on appealing to white women from all backgrounds, including those who were racist. She actively discouraged African American activists and organizations from participating- and stated that those who did so should march in the back. But black women would not be made invisible in a national movement they helped shape. On the day of the march, Ida B. Wells-Barnett, a ground-breaking investigative journalist and anti-lynching advocate, refused to move to the back and proudly marched under the Illinois banner. The co-founder of the NAACP, Mary Church Terrell, joined the parade with the 22 founders of the Delta Sigma Theta Sorority, an organization created by female students from Howard University. In these ways and more, black women persevered despite deep hostility from white women in the movement, and at great political and physical risk. On the day of the parade, suffragists assembled to create a powerful exhibition. The surging sections of the procession included international suffragists, artists, performers and business-owners. Floats came in the form of golden chariots; an enormous Liberty Bell; and a map of enfranchised countries. On the steps of the Treasury Building, performers acted out the historical achievements of women to a live orchestra. The marchers carried on even as a mob blocked the route, hurling insults and spitting at women, tossing cigars, and physically assaulting participants. The police did not intervene, and in the end, over 100 women were hospitalized. Their mistreatment, widely reported throughout the country, catapulted the parade into the public eye— and garnered suffragists greater sympathy. National newspapers lambasted the police, and Congressional hearings investigated their actions during the parade. After the protest, the "Women’s Journal" declared, “Washington has been disgraced. Equal suffrage has scored a great victory." In this way, the march initiated a surge of support for women’s voting rights that endured in the coming years. Suffragists kept up steady pressure on their representatives, attended rallies, and petitioned the White House. Inez Milholland, the woman on the white horse, campaigned constantly throughout the United States, despite suffering from chronic health problems. She did not live to see her efforts come to fruition. In 1916, she collapsed while giving a suffrage speech and died soon after. According to popular reports, her last words were, “Mr. President, how long must women wait for liberty?” Though full voting inclusion would take decades, in 1920, Congress ratified the 19th amendment, finally granting women the right to vote.

**P701 2019-03-06 A brief history of dogs - David Ian Howe**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=701)

Since their emergence over 200,000 years ago, modern humans have established homes and communities all over the planet. But they didn’t do it alone. Whatever corner of the globe you find homo sapiens in today, you’re likely to find another species nearby: Canis lupus familiaris. Whether they’re herding, hunting, sledding, or slouching the sheer variety of domestic dogs is staggering. But what makes the story of man’s best friend so surprising is that they all evolved from a creature often seen as one of our oldest rivals: Canis lupus, or the gray wolf. When our Paleolithic ancestors first settled Eurasia roughly 100,000 years ago, wolves were one of their main rivals at the top of the food chain. Able to exert over 300 lbs. of pressure in one bone-crushing bite and sniff out prey more than a mile away, these formidable predators didn’t have much competition. Much like human hunter-gatherers, they lived and hunted in complex social groups consisting of a few nuclear families, and used their social skills to cooperatively take down larger creatures. Using these group tactics, they operated as effective persistence hunters, relying not on outrunning their prey, but pursuing it to the point of exhaustion. But when pitted against the similar strengths of their invasive new neighbors, wolves found themselves at a crossroads. For most packs, these bourgeoning bipeds represented a serious threat to their territory. But for some wolves, especially those without a pack, human camps offered new opportunities. Wolves that showed less aggression towards humans could come closer to their encampments, feeding on leftovers. And as these more docile scavengers outlasted their aggressive brethren, their genetic traits were passed on, gradually breeding tamer wolves in areas near human populations. Over time humans found a multitude of uses for these docile wolves. They helped to track and hunt prey, and might have served as sentinels to guard camps and warn of approaching enemies. Their similar social structure made it easy to integrate with human families and learn to understand their commands. Eventually they moved from the fringes of our communities into our homes, becoming humanity’s first domesticated animal. The earliest of these Proto-Dogs or Wolf-Dogs, seem to have appeared around 33,000 years ago, and would not have looked all that different from their wild cousins. They were primarily distinguished by their smaller size and a shorter snout full of comparatively smaller teeth. But as human cultures and occupations became more diverse and specialized, so did our friends. Short stocky dogs to herd livestock by nipping their heels; elongated dogs to flush badgers and foxes out of burrows; thin and sleek dogs for racing; and large, muscular dogs for guard duty. With the emergence of kennel clubs and dog shows during England’s Victorian era, these dog types were standardized into breeds, with many new ones bred purely for appearance. Sadly, while all dog breeds are the product of artificial selection, some are healthier than others. Many of these aesthetic characteristics come with congenital health problems, such as difficulty breathing or being prone to spinal injuries. Humanity’s longest experiment in controlled evolution has had other side effects as well. Generations of selection for tameness have favored more juvenile and submissive traits that were pleasing to humans. This phenomenon of selecting traits associated with youth is known as neoteny, and can be seen in many domestic animals. Thousands of years of co-evolution may even have bonded us chemically. Not only can canines understand our emotions and body language, but when dogs and humans interact, both our bodies release oxytocin; a hormone commonly associated with feelings of love and protectiveness. It might be difficult to fathom how every Pomeranian, Chihuahua, and Poodle are descended from fierce wolves. But the diversity of breeds today is the result of a relationship that precedes cities, agriculture, and even the disappearance of our Neanderthal cousins. And it’s heartening to know that given enough time, even our most dangerous rivals can become our fiercest friends.

**P702 2019-03-07 Why are earthquakes so hard to predict - Jean-Baptiste P. Koehl**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=702)

In 132 CE, Chinese polymath Zhang Heng presented the Han court with his latest invention. This large vase, he claimed, could tell them whenever an earthquake occurred in their kingdom– including the direction they should send aid. The court was somewhat skeptical, especially when the device triggered on a seemingly quiet afternoon. But when messengers came for help days later, their doubts turned to gratitude. Today, we no longer rely on pots to identify seismic events, but earthquakes still offer a unique challenge to those trying to track them. So why are earthquakes so hard to anticipate, and how could we get better at predicting them? To answer that, we need to understand some theories behind how earthquakes occur. Earth’s crust is made from several vast, jagged slabs of rock called tectonic plates, each riding on a hot, partially molten layer of Earth’s mantle. This causes the plates to spread very slowly, at anywhere from 1 to 20 centimeters per year. But these tiny movements are powerful enough to cause deep cracks in the interacting plates. And in unstable zones, the intensifying pressure may ultimately trigger an earthquake. It’s hard enough to monitor these miniscule movements, but the factors that turn shifts into seismic events are far more varied. Different fault lines juxtapose different rocks– some of which are stronger–or weaker– under pressure. Diverse rocks also react differently to friction and high temperatures. Some partially melt, and can release lubricating fluids made of superheated minerals that reduce fault line friction. But some are left dry, prone to dangerous build-ups of pressure. And all these faults are subject to varying gravitational forces, as well as the currents of hot rocks moving throughout Earth’s mantle. So which of these hidden variables should we be analyzing, and how do they fit into our growing prediction toolkit? Because some of these forces occur at largely constant rates, the behavior of the plates is somewhat cyclical. Today, many of our most reliable clues come from long-term forecasting, related to when and where earthquakes have previously occurred. At the scale of millennia, this allows us to make predictions about when highly active faults, like the San Andreas, are overdue for a massive earthquake. But due to the many variables involved, this method can only predict very loose timeframes. To predict more imminent events, researchers have investigated the vibrations Earth elicits before a quake. Geologists have long used seismometers to track and map these tiny shifts in the earth’s crust. And today, most smartphones are also capable of recording primary seismic waves. With a network of phones around the globe, scientists could potentially crowdsource a rich, detailed warning system that alerts people to incoming quakes. Unfortunately, phones might not be able to provide the advance notice needed to enact safety protocols. But such detailed readings would still be useful for prediction tools like NASA’s Quakesim software, which can use a rigorous blend of geological data to identify regions at risk. However, recent studies indicate the most telling signs of a quake might be invisible to all these sensors. In 2011, just before an earthquake struck the east coast of Japan, nearby researchers recorded surprisingly high concentrations of the radioactive isotope pair: radon and thoron. As stress builds up in the crust right before an earthquake, microfractures allow these gases to escape to the surface. These scientists think that if we built a vast network of radon-thoron detectors in earthquake-prone areas, it could become a promising warning system– potentially predicting quakes a week in advance. Of course, none of these technologies would be as helpful as simply looking deep inside the earth itself. With a deeper view we might be able to track and predict large-scale geological changes in real time, possibly saving tens of thousands of lives a year. But for now, these technologies can help us prepare and respond quickly to areas in need– without waiting for directions from a vase.

**P703 2019-03-08 The physics of surfing - Nick Pizzo**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=703)

Whether or not you realize it, as a surfer you’re a master of complicated physics. The science of surfing begins as soon as you and your board first hit the water. The board’s size and light construction help it displace a lot of water. In turn, a buoyant force equal to the weight of the displaced water pushes up, counteracting you and your board’s weight. This lets you stay afloat while you wait to paddle for a wave. And what exactly are you waiting for? The perfect wave, of course. Like other waves in physics, ocean waves represent a transfer of energy. Wind blowing across the ocean accelerates water particles near the surface, leading to the growth of ripples that become waves. These deviations from the flat surface are acted upon by gravity, which tries to restore the surface to its original flat state. As the waves then move through the water, particles push and pull on their neighbors through the wave induced pressure, and this motion propagates energy through the water in unison with the wave motion. The motion of these particles is much more limited than the overall motion of the waves. Near the shore, the shallower seafloor constrains the motion of the waves to occur in a more limited region than out at sea, concentrating the wave energy near the surface. If the topography of the shoreline is even and smooth, this will refract the waves to become more parallel to the shore as they approach. This is the crucial moment. As the wave gets near, you quickly pivot your board in the same direction as the wave and paddle to match its speed. Your board forms an angle with the water, and this creates a dynamic pressure on the bottom of it, forcing you and your board out of the water, to skim along the surface. At the same time, your increased forward momentum makes you more stable, allowing you to stand up and surf along the wave. Now you’ve caught the wave, and are riding along its front face parallel to the shoreline. Fins on the surfboard allow you to alter your speed and direction by repositioning your weight. Above you is the wave’s crest, where the water particles are undergoing their greatest acceleration. That forces them to move faster than the underlying wave, so they shoot ahead before falling under gravity’s influence. This forms the waves’ characteristic curls, or jets, as they break along the shore. Sometimes, the curl might completely enclose part of the wave, forming a moving tube of water known as the barrel. Because of irregularities in the seafloor and the swell itself, few barrels last as long as the legendary 27-second ride off the coast of Namibia. But many who manage to get barreled have said they feel time passing differently inside, making it one of the most magical experiences a surfer can have. Of course, not all beaches are created equal. Offshore underwater canyons or rock formations in certain locations like Nazare, Portugal or Mavericks, California refract the incoming wave energy into a single spot, creating massive waves sought by surfers worldwide. And some of these waves travel for more than a week, with swells originating more than 10,000 kilometers away from shore. Waves surfed in sunny California may have originated in the stormy seas near New Zealand. So while you may not be thinking about weather patterns in the South Pacific, tectonic geology, or fluid mechanics, the art of catching the perfect wave relies on all these things and more. And the waves we surf, created by wind, are just one visible part of the continuous oscillation of energy that has shaped our universe since its very beginning.

**P704 2019-03-15 The wild world of carnivorous plants - Kenny Coogan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=704)

Little do they know it, but these six creatures are each about to experience a very unusual death. One-by-one, they will fall prey to the remarkable, predatory antics of... a carnivorous plant. Around the world there are more than 600 plant species that supplement a regular diet of sunlight, water, and soil with insects, microbes, or even frogs and rats. Scientists believe that carnivory in plants evolved separately at least six times on our planet, suggesting that this flesh-munching adaptation holds a major benefit for plants. Carnivorous plants tend to grow in places with highly acidic soil, which is poor in crucial nutrients like nitrogen, phosphorus, and potassium. In these hostile conditions, plants that are able to lure, trap, and digest prey have an advantage over those that rely on soil for their nutrients. Take this inhospitable bog, where pitcher plants reign supreme. Drawn to the pitcher’s vivid colors and alluring scent, the fly closes in and slurps its nectar. But this pitcher species has an ingredient called coniine in its nectar, a powerful narcotic to insects. As the coniine takes effect, the fly grows sluggish, stumbles, and falls down the funnel into a pool of liquid at the base, where he drowns. Enzymes and bacteria in the liquid slowly break his body down into microscopic particles the pitcher plant can consume through its leaves. Occasionally, larger prey also tumbles into the fatal funnel of the pitcher plant. The second victim faces off with the sticky sundew plant. The sundew’s tiny leaves are equipped with a viscous secretion called mucilage. The ant is swiftly trapped in this goo. As she struggles, enzymes begin to digest her body. Special tentacles sense her movement and curl around her, clenching her in their suffocating grip. Once she asphyxiates, which can happen in under an hour, the tentacles unfurl again to snare their next victim. Two down, four to go. The next target meets his end underground, in the coils of the corkscrew plant. He enters the roots through a tiny slit in search of food. But inside, he quickly loses his way through the tangled labyrinth. A forest of curved hairs prevents his escape, guiding him into a central chamber with flesh-digesting enzymes and deadly low levels of oxygen. In the murky depths of a nearby pond, a tadpole unwittingly swims into the path of the bladderwort, the speediest of all carnivorous plants. She treads on the bladderwort’s trigger, and in milliseconds, a trapdoor swings open and sucks her in. Trapped half in and half out, she struggles to free herself while the part of her body inside the plant gets digested. Over the next few hours, her writhing sets the trap off repeatedly, each time bringing her deeper into the plant to be digested alive bit by bit. Meanwhile, this beetle is bewitched by sweet-smelling nectar. The scent draws him closer and closer until he lands on the leaves of the world’s most infamous carnivorous plant. His landing triggers tiny hairs on the surface of the leaves, and the jaws of the venus fly trap snap shut around him. The spikes interlock to seal his fate. Once closed, the leaves act like an external stomach that digests the beetle’s soft tissues. When they open again a few days later, only the dry husk of his exoskeleton remains. The mayfly is the last creature standing. As she approaches the butterwort plant, she heads for the flowers that wave high above the plant’s globs of adhesive goo. She alights on the petals, drinks the nectar, and takes off unscathed. These long flower stalks keep certain insects away from the carnivore’s traps— a way of separating pollinators from food. Off the mayfly buzzes to live a long and fruitful life– oh.

**P705 2019-03-18 The Chinese myth of the immortal white snake - Shunan Teng**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=705)

The talented young herbalist named Xu Xian was in trouble. It should have been a victorious moment– he had just opened his very own medicine shop. But he bought his supplies from his former employer, and the resentful man sold him rotten herbs. As Xu Xian wondered what to do with this useless inventory, patients flooded into his shop. A plague had stricken the city, and he had nothing to treat them. Just as he was starting to panic, his wife, Bai Su Zhen, produced a recipe to use the rotten herbs as medicine. Her remedy cured all the plague-afflicted citizens immediately. Xu Xian’s former boss even had to buy back some of the rotten herbs to treat his own family. Shortly after, a monk named Fa Hai approached Xu Xian, warning him that there was a demon in his house. The demon, he said, was Bai Su Zhen. Xu Xian laughed. His kindhearted, resourceful wife was not a demon. Fa Hai insisted. He told Xu Xian to serve his wife realgar wine on the 5th day of the 5th month, when demons’ powers are weakest. If she wasn’t a demon, he explained, it wouldn’t hurt her. Xu Xian dismissed the monk politely, with no intention of serving Bai Su Zhen the wine. But as the day approached, he decided to try it. As soon as the wine touched Bai Su Zhen’s lips, she ran to the bedroom, claiming she wasn’t feeling well. Xu Xian prepared some medicine and went to check on her. But instead of his wife, he found a giant white serpent with a bloody forked tongue in the bed. He collapsed, killed by the shock. When Bai Su Zhen opened her eyes, she realized immediately what must have happened. The truth was that Bai Su Zhen was an immortal snake with formidable magical powers. She had used her powers to take a human form and improve her and her husband’s fortunes. Her magic couldn’t revive Xu Xian, but she had one more idea to save him: an herb that could grant longevity and even bring the dead back to life, guarded by the Old Man of the South Pole in the forbidden peaks of the Kun Lun Mountains. She rode to the mountains on a cloud, then continued on foot passed gateways and arches until she reached one marked “beyond mortals” hanging over a silver bridge. On the other side, two of the Old Man’s disciples guarded the herb. Bai Su Zhen disguised herself as a monk and told them she’d come to invite the Old Man to a gathering of the gods. While they relayed her message, she plucked some leaves from the herb and ran. The servants realized they had been tricked and chased her. Bai Su Zhen coughed up a magic ball and threw it at one. As the other closed in on her, she put the herb under her tongue for safekeeping, but its magic forced both of them into their true forms. As the crane’s long beak clamped around her, the Old Man appeared. Why, he asked, would she risk her life to steal his herb when she was already immortal? Bai Su Zhen explained her love for Xu Xian. Even if he didn’t want to be with her now that he knew she was a demon, she was determined to bring him back to life. The two had a karmic connection dating back more than a thousand years. When Bai Su Zhen was a small snake, a beggar was about to kill her, but a kind passerby rescued her. Her rescuer was Xu Xian in a past life. Touched by her willingness to risk her life for him, the Old Man permitted her to leave the mountain with the immortal herb. Bai Su Zhen returned home to revive Xu Xian. When he opened his eyes, the terrified look frozen on his face became a smile. Demon or not, he was still happy to see his wife.

**P706 2019-03-21 The surprising reason our muscles get tired - Christian Moro**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=706)

You're lifting weights. The first time feels easy, but each lift takes more and more effort until you can’t continue. Inside your arms, the muscles responsible for the lifting have become unable to contract. Why do our muscles get fatigued? We often blame lactic acid or running out of energy, but these factors alone don’t account for muscle fatigue. There’s another major contributor: the muscle’s ability to respond to signals from the brain. To understand the roots of muscle fatigue, it helps to know how a muscle contracts in response to a signal from a nerve. These signals travel from the brain to the muscles in a fraction of a second via long, thin cells called motor neurons. The motor neuron and the muscle cell are separated by a tiny gap, and the exchange of particles across this gap enables the contraction. On one side of the gap, the motor neuron contains a neurotransmitter called acetylcholine. On the other side, charged particles, or ions, line the muscle cell’s membrane: potassium on the inside, and sodium on the outside. In response to a signal from the brain, the motor neuron releases acetylcholine, which triggers pores on the muscle cell membrane to open. Sodium flows in, and potassium flows out. The flux of these charged particles is a crucial step for muscle contraction: the change in charge creates an electrical signal called an action potential that spreads through the muscle cell, stimulating the release of calcium that’s stored inside it. This flood of calcium causes the muscle to contract by enabling proteins buried in the muscle fibers to lock together and ratchet towards each other, pulling the muscle tight. The energy used to power the contraction comes from a molecule called ATP. ATP also helps pump the ions back across the membrane afterward, resetting the balance of sodium and potassium on either side. This whole process repeats every time a muscle contracts. With each contraction, energy in the form of ATP gets used up, waste products like lactic acid are generated, and some ions drift away from the muscle’s cell membrane, leaving a smaller and smaller group behind. Though muscle cells use up ATP as they contract repeatedly, they are always making more, so most of the time even heavily fatigued muscles still have not depleted this energy source. And though many waste products are acidic, fatigued muscles still maintain pH within normal limits, indicating that the tissue is effectively clearing these wastes. But eventually, over the course of repeated contractions there may not be sufficient concentrations of potassium, sodium or calcium ions immediately available near the muscle cell membrane to reset the system properly. So even if the brain sends a signal, the muscle cell can’t generate the action potential necessary to contract. Even when ions like sodium, potassium or calcium are depleted in or around the muscle cell, these ions are plentiful elsewhere in the body. With a little time, they will flow back to the areas where they’re needed, sometimes with the help of active sodium and potassium pumps. So if you pause and rest, muscle fatigue will subside as these ions replenish throughout the muscle. The more regularly you exercise, the longer it takes for muscle fatigue to set in each time. That’s because the stronger you are, the fewer times this cycle of nerve signal from the brain to contraction in the muscle has to be repeated to lift a certain amount of weight. Fewer cycles means slower ion depletion, so as your physical fitness improves, you can exercise for longer at the same intensity. Many muscles grow with exercise, and larger muscles also have bigger stores of ATP and a higher capacity to clear waste, pushing fatigue even farther into the future.

**P707 2019-03-21 What “Machiavellian” really means - Pazit Cahlon and Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=707)

From Shakespeare’s plays to modern TV dramas, the unscrupulous schemer for whom the ends always justify the means has become a familiar character type we love to hate. So familiar, in fact, that for centuries we’ve had a single word to describe such characters: Machiavellian. But is it possible that we’ve been using that word wrong this whole time? The early 16th century statesman Niccoló Machiavelli wrote many works of history, philosophy, and drama. But his lasting notoriety comes from a brief political essay known as The Prince, framed as advice to current and future monarchs. Machiavelli wasn’t the first to do this– in fact there was an entire tradition of works known as “mirrors for princes” going back to antiquity. But unlike his predecessors, Machiavelli didn’t try to describe an ideal government or exhort his audience to rule justly and virtuously. Instead, he focused on the question of power– how to acquire it, and how to keep it. And in the decades after it was published, The Prince gained a diabolical reputation. During the European Wars of Religion, both Catholics and Protestants blamed Machiavelli for inspiring acts of violence and tyranny committed by their opponents. By the end of the century, Shakespeare was using “Machiavel” to denote an amoral opportunist, leading directly to our popular use of “Machiavellian” as a synonym for manipulative villainy. At first glance, The Prince’s reputation as a manual for tyranny seems well-deserved. Throughout, Machiavelli appears entirely unconcerned with morality, except insofar as it’s helpful or harmful to maintaining power. For instance, princes are told to consider all the atrocities necessary to seize power, and to commit them in a single stroke to ensure future stability. Attacking neighboring territories and oppressing religious minorities are mentioned as effective ways of occupying the public. Regarding a prince’s personal behavior, Machiavelli advises keeping up the appearance of virtues such as honesty or generosity, but being ready to abandon them as soon as one’s interests are threatened. Most famously, he notes that for a ruler, “it is much safer to be feared than loved.” The tract even ends with an appeal to Lorenzo de’ Medici, the recently installed ruler of Florence, urging him to unite the fragmented city-states of Italy under his rule. Many have justified Machiavelli as motivated by unsentimental realism and a desire for peace in an Italy torn by internal and external conflict. According to this view, Machiavelli was the first to understand a difficult truth: the greater good of political stability is worth whatever unsavory tactics are needed to attain it. The philosopher Isaiah Berlin suggested that rather than being amoral, The Prince hearkens back to ancient Greek morality, placing the glory of the state above the Christian ideal of individual salvation. But what we know about Machiavelli might not fit this picture. The author had served in his native Florence for 14 years as a diplomat, staunchly defending its elected republican government against would-be monarchs. When the Medici family seized power, he not only lost his position, but was even tortured and banished. With this in mind, it’s possible to read the pamphlet he wrote from exile not as a defense of princely rule, but a scathing description of how it operates. Indeed, Enlightenment figures like Spinoza saw it as warning free citizens of the various ways in which they can be subjugated by aspiring rulers. In fact, both readings might be true. Machiavelli may have written a manual for tyrannical rulers, but by sharing it, he also revealed the cards to those who would be ruled. In doing so, he revolutionized political philosophy, laying the foundations for Hobbes and future thinkers to study human affairs based on their concrete realities rather than preconceived ideals. Through his brutal and shocking honesty, Machiavelli sought to shatter popular delusions about what power really entails. And as he wrote to a friend shortly before his death, he hoped that people would “learn the way to Hell in order to flee from it."

**P708 2019-03-22 How to spot a pyramid scheme - Stacie Bosley**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=708)

In 2004, a new company called Vemma Nutrition started offering a life-changing opportunity to earn full time income for part time work. Vemma’s offer was open to everybody, regardless of prior experience or education. There were only two steps to start get started earning: purchase a $500-600 kit of their liquid nutrition products, and recruit two more members to do the same. Vemma Nutrition Company grew quickly, becoming a global operation that brought in 30,000 new members per month at its peak. There was just one problem— while the company generated $200 million of annual revenue by 2013, the vast majority of participants earned less than they paid in. Vemma was eventually charged with operating a pyramid scheme: a common type of fraud where members make money by recruiting more people to buy in. Typically, the founder solicits an initial group of people to buy in and promote the scheme. They are then encouraged to recruit others and promised part of the money those people invest, while the founder also takes a share. The pattern repeats for each group of new participants, with money from recent arrivals funneled to those who recruited them. This differs from a Ponzi scheme, where the founders recruit new members and secretly use their fees to pay existing members, who think the payments come from a legitimate investment. As a pyramid scheme grows, it becomes increasingly difficult for new recruits to make money. That’s because the number of participants expands exponentially. Take a structure where each person has to recruit six more to earn a profit. The founder recruits six people to start, and each of them recruits six more. There are 36 people in that second round of recruits, who then each recruit 6 people— a total of 216 new recruits. By the twelfth round of recruiting, the 2.1 billion newest members would have to recruit over 13 billion more people total to make money– more than the entire world population. In this scenario, the most recent recruits, over 80% of the scheme’s participants, lose all the money they paid in. And in real life, many earlier joiners lose out too. Pyramid schemes are illegal in most countries, but they can be difficult to detect. They are presented as many different things, including gifting groups, investment clubs, and multi-level marketing businesses. The distinction between pyramid schemes and legitimate multi-level marketing can be particularly hazy. In theory, the difference is that the members of the multi-level marketing companies primarily earn compensation from selling a particular product or a service to retail customers, while pyramid schemes primarily compensate members for recruitment of new sellers. In practice, though, many multi-level marketing companies make it all but impossible for members to profit purely through sales. And many pyramid schemes, like Vemma Nutrition, disguise themselves as legal multi-level marketing businesses, using a product or service to hide the pay-and-recruit structure. Many pyramid schemes also capitalize on already existing trust within churches, immigrant communities, or other tightly knit groups. The first few members are encouraged to report a good experience before they actually start making a profit. Others in their network follow their example, and the schemes balloon in size before it comes clear that most members aren’t actually profiting. Often, the victims are embarrassed into silence. Pyramid schemes entice people with the promise of opportunity and empowerment. So when members don’t end up making money, they can blame themselves rather than the scheme, thinking they weren’t tenacious enough to earn the returns promised. Some victims keep trying, investing in multiple schemes, and losing money each time. In spite of all these factors, there are ways to spot a pyramid scheme. Time pressure is one red flag— be wary of directives to “act now or miss a once-in-a-lifetime opportunity.” Promises of large, life-altering amounts of income are also suspect. And finally, a legitimate multi-level marketing business shouldn’t require members to pay for the opportunity to sell a product or service. Pyramid schemes can be incredibly destructive to individuals, communities, and even entire countries. But you can fight fire with fire by sending this video to three people you know, and encouraging them to do the same.

**P709 2019-03-25 What is a butt tuba and why is it in medieval art - Michelle Brown**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=709)

A rabbit attempts to play a church organ, while a knight fights a giant snail and a naked man blows a trumpet with his rear end. Painted with squirrel-hair brushes on vellum or parchment by monks, nuns, and urban craftspeople, these bizarre images populate the margins of the most prized books from the Middle Ages. Their illustrations often tell a second story as rich as the text itself. Some images appear in many different illuminated manuscripts, and often reinforce the religious content of the books they decorated. For example, a porcupine picking up fruit on its spines could represent the devil stealing the fruits of faith-- or Christ taking up the sins of mankind. Medieval lore stated that a hunter could only capture a unicorn when it lay its horn in the lap of a virgin, so a unicorn could symbolize either sexual temptation or Christ being captured by his enemies. Rabbits, meanwhile, could represent human’s lustful natures— and could redeem themselves through attempts to make sacred music despite their failings. All of these references would have been familiar to medieval Europeans from other art forms and oral tradition, though some have grown more mysterious over the centuries. Today, no one can say for sure what the common motif of a knight fighting a snail means— or why the knight so often appears to be losing. The snail might be a symbol of the inevitability of death, which defeats even the strongest knights. Or it could represent humility, and a knight’s need to vanquish his own pride. Many illuminated manuscripts were copies of religious or classical texts, and the bookmakers incorporated their own ideas and opinions in illustrations. The butt tuba, for example, was likely shorthand to express disapproval with-- or add an ironic spin to-- the action in the text. Illuminations could also be used to make subversive political commentary. The text of the "Smithfield Decretals" details the Church’s laws and punishments for lawbreakers. But the margins show a fox being hanged by geese, a possible allusion to the common people turning on their powerful oppressors. In the "Chronica Majora," Matthew Paris summarized a scandal of his day, in which the Welsh prince Griffin plummeted to his death from the tower of London. Some believed the prince fell, Paris wrote, while others thought he was pushed. He added his own take in the margins, which show the prince falling to his death while trying to escape on a rope made of bed-sheets. Some margins told stories of a more personal nature. "The Luttrell Psalter," a book of psalms and prayers commissioned by Sir Geoffrey Luttrell, shows a young woman having her hair done, while a young man catches a bird in a net. The shaved patch on his head is growing out, indicating that he is a clergyman neglecting his duties. This alludes to a family scandal where a young cleric ran away with Sir Geoffrey’s daughter Elizabeth. The family’s personal spiritual advisor likely painted it into the book to remind his clients of their failings and encourage their spiritual development. Some artists even painted themselves into the manuscripts. The opening image of Christine de Pisan’s collected works shows de Pisan presenting the book to the Queen of France. The queen was so impressed by de Pisan's previous work that she commissioned her own copy. Such royal patronage enabled her to establish her own publishing house in Paris. The tradition of illuminated manuscripts lasted for over a thousand years. The books were created by individuals or teams for uses as wide-ranging as private prayer aids, service books in churches, textbooks, and protective talismans to take into battle. Across all this variation, those tricky little drawings in the margins are a unique window into the minds of medieval artists.

**P710 2019-03-27 'First Kiss' by Tim Seibles**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=710)

First Kiss Her mouth fell into my mouth like a summer snow, like a 5th season, like a fresh Eden, like Eden when Eve made God whimper with the liquid tilt of her hips— her kiss hurt like that— I mean, it was as if she’d mixed the sweat of an angel with the taste of a tangerine, I swear. My mouth had been a helmet forever greased with secrets, my mouth a dead-end street a little bit lit by teeth—my heart, a clam slammed shut at the bottom of a dark, but her mouth pulled up like a baby-blue Cadillac packed with canaries driven by a toucan—I swear those lips said bright wings when we kissed, wild and precise—as if she were teaching a seahorse to speak— her mouth so careful, chumming the first vowel from my throat until my brain was a piano banged loud, hammered like that— it was like, I swear her tongue was Saturn’s 7th moon— hot like that, hot and cold and circling, circling, turning me into a glad planet— sun on one side, night pouring her slow hand over the other: one fire flying the kite of another. Her kiss, I swear—if the Great Mother rushed open the moon like a gift and you were there to feel your shadow finally unhooked from your wrist. That’d be it, but even sweeter— like a riot of peg-legged priests on pogo-sticks, up and up, this way and this, not falling but on and on like that, badly behaved but holy—I swear! That kiss: both lips utterly committed to the world like a Peace Corps, like a free store, forever and always a new city—no locks, no walls, just doors—like that, I swear, like that.

**P711 2019-04-01 How to biohack your cells to fight cancer - Greg Foot**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=711)

Ok, so you, are a 4 billion year old meat robot. Yeah, you heard me right. In fact, as you're made of 30-ish trillion cells, and each of those have their own task, you're a robot made of trillions of mini robots- you are a mega-meat-bot! And your mission, for the past 4 billion years or so- and for as long as you keep playing this game of life- is to safeguard the code. To duplicate it. To pass it on. The thing is, you're rubbish at copying your own code. Every time it's copied, errors crop up. Not good when an error makes a robot worse at surviving, but sometimes a mistake helps them survive... and they pass that glitch in the code on- that's evolution in a nutshell, right? Which means you're not the result of some fancy design, I'm afraid. You're a result of billions of years of bad copies. Go you. Another reason you're not totally awesome is because that megabot of yours often breaks down. Fortunately, cardiologists, immunologists, microbiologists- all the "ists"- have spent centuries figuring out our sensors and wiring so if something does go wrong, they can usually fix it. Where they struggle, though, is when the machinery turns on itself- when a copying error leads a cell to start dividing uncontrollably, to grow and multiply into a tumor. That's cancer. And sadly, even with the might of our modern medicine, some cancers evade treatment. But this is where a new band of biologists step into the story: The "Synthetic Biologists." These biohackers are mashing up science, medicine and engineering to rewrite the code and fix the un-fixable. Biohackers are going into a patient's genetic code and reprogramming their own immune system to recognize cancer cells and destroy them. It's called CAR T-cell therapy, and it's awesome. See, you're constantly under attack by pathogens- single-celled bacteria, viruses and fungi. Despite deciding, back in the day, to stay solo and not 'avengers assemble' like you did, those pathogens see you, in all your mega-meat-bot glory, as a fortress ripe for the plundering. Thankfully, you've got a security team in place to battle these invaders- your immune system- and some of it's top guards are your white blood cells. They trawl the darkness that is your inner space, checking the IDs of any cells they pass... although they're not name badges, but rather protein fragments on the cell's surface called antigens. There are two types of these guards: T-cells and B-cells. T-cells check those antigen IDs using special claws- receptors that lock with a particular antigen. If they find a match, they attach and they release toxic chemicals that burst open the invading cell's membrane. Their B-cell workmates create antibodies- loads of small proteins, little claws that latch perfectly onto a particular antigen, marking them for destruction. These two comrades have got your back and your immune system is brilliant at spotting and fighting pathogens that invade from outside. However, they're not so good at spotting your own cells that have gone rogue. The antigens on cancerous cells don't look weird, they look a lot like your own cells, and the T's and B's aren't programmed to attack them. The usual way to deal with cancer is to try to cut the tumor out, or turn to radiotherapy and then chemotherapy to destroy or block the growth of cancer cells, but if it's a blood cancer, if it's floating around your whole body, you can't do that. And if the blood cancer actually starts in your white blood cells- those key guards in your immune system- you'll really struggle to spot it. That's the case with acute lymphoblastic leukemia, and that's where CAR T-cell therapy is kicking butt. The biohackers are reprogramming a patient's own immune system to recognize particular antigens- those particular protein fragments- on the cancer cells. To do it, you first need millions of a patient's T-cells Then, to get a T-cell to do something different, you need to replace its normal code with something new, something you've designed. What synthetic biologists can now do with DNA is super cool- they use a computer to put together their own sequences of bases- the chemical letters that spell out the DNA- then they model what that new genetic code will do on a computer and then make those sequences on a DNA printer- yeah, that's a thing!- printing not with ink, or with a plastic polymer like in a 3D printer, but with those fundamental building blocks of life, with those A's and C's and T's and G's. The new code they designed for a T-cell has 3 key instructions: 1. It tells it how to recognize and kill a cancer cell. More specifically, how to modify an antibody- what the B-cells make to latch onto a target antigen. The antibody is modified to make a new receptor that can detect the particular antigens on the specific cancer. 2. It tells it to make copies of itself when it finds that cancer cell and 3. It tells it to survive in the patient's body. To get this new code into the patient's T-cells, you use a vector- it's something that will easily infect the T-cell and carry that bespoke DNA in with it. And voila! One CAR T-cell. The name comes from a fire-breathing monster from Ancient Greece, that had a lion's head, a goat's body and a serpent's tail. It was called "Chimera"- a name that has now come to be used for something that contains two or more different types of tissues or cells. As this newly engineered cell's genetic code is part T-cell, part antibody, it's a "C"himera and it goes in search of the cancer's "A"ntigen using its new "R"eceptor. Before you put the multiplied up T-cells back into the patient, you give them a mild dose of chemotherapy to wipe their existing T-cells. Then you simply reinsert the now modified T-cells- the CAR T-cells- and they follow their normal DNA programming to move and search. However, thanks to their new butt-kicking code, they've changed what they're looking for: they're now on a mission to find the cancerous cells and destroy them. Unlike conventional chemical-based drugs that get used up or excreted from the body pretty quickly, CAR T-cells are living drugs that stay in the patient's bloodstream for years. That's a huge pro. The flip side is that they're expensive- each CAR T-cell treatment is bespoke to the patient- and it's more difficult to get them to work with common cancers like breast or lung, because you need a specific antigen on the cancer cells for the CAR T-cell to target- and it's much easier to find that in blood cancers. It's still early days, though, and there's an exciting future for CAR T-cell therapy. Researchers like Dr. Martin Pule and his team at UCL, are working on improving the leukemia and lymphoma treatments even further, and there's recently been some promising work on solid cancers. Thanks to CAR T-cell therapy, the survival rate for B acute lymphoblastic leukemia has improved hugely -nearly all patients go into remission- which means that leukemia cannot be detected anymore- and most patients stay in remission. Biohacking is here, and it can reprogram your own genetic code to enable your mega-meat-bot to do things it's never been able to do before!

**P713 2019-04-09 'Accents' by Denice Frohman**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=713)

I'm Denice Frohman, and this is "Accents." my mom holds her accent like a shotgun, with two good hands. her tongue, all brass knuckle slipping in between her lips her hips, are all laughter and wind clap. she speaks a sanchocho of spanish and english, pushing up and against one another, in rapid fire there is no telling my mama to be "quiet," my mama don't know "quiet." her voice is one size better fit all and you best not tell her to hush, she waited too many years for her voice to arrive to be told it needed house keeping. English sits in her mouth remixed so "strawberry" becomes "eh-strawbeddy" and "cookie" becomes "eh-cookie" and kitchen, key chain, and chicken all sound the same. my mama doesn't say "yes" she says, "ah ha" and suddenly the sky in her mouth becomes a Hector Lavoe song. her tongue can't lay itself down flat enough for the English language, it got too much hip too much bone too much conga too much cuatro to two step got too many piano keys in between her teeth, it got too much clave too much hand clap got too much salsa to sit still it be an anxious child wanting to make Play-Doh out of concrete English be too neat for her kind of wonderful. her words spill in conversation between women whose hands are all they got sometimes our hands are all we got and accents that remind us that we are still bomba, still plena you say "wepa" and a stranger becomes your hermano, you say "dale" and a crowd becomes a family reunion. my mother's tongue is a telegram from her mother decorated with the coqui's of el campo so even when her lips can barely stretch themselves around english, her accent is a stubborn compass always pointing her towards home.

**P714 2019-04-10 Can you solve the cuddly duddly fuddly wuddly riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=714)

For your son’s sixth birthday, you’ve promised to get him the cutest creature in creation: the cuddly. It’s hard to believe that it’s a cousin of the terrifying duddly or the hideous fuddly. They’re all members of the Wuddly species, and the process of adopting them is deeply peculiar. It takes 100 eggs to make a single animal in genus Wuddly. When 100 eggs are placed together in an incubator, they undergo egg fusion, and combine in the following way. Blue and purple combine to make red eggs. Red and blue combine to make purple eggs, and red and purple combine to make blue eggs. The most plentiful eggs pair up first, and if two piles are even, an egg comes from one of them at random. They keep combining until there’s just one left. If the final egg is blue, a Cuddly hatches out of it. Purple eggs give you Duddlies, and Red eggs give you Fuddlies. The incubator currently has 99 eggs in it. 23 are blue, 33 are purple, and 43 are red. You can begin the process of egg fusion by adding an egg of any color to the room. When all the eggs have combined into a single egg, the creature that hatches will bond with you on sight, which is why getting a Cuddly is so important. After all, you made a promise to your son. Which color egg should you add to the incubator to get a cuddly? Pause the video to figure it out for yourself. Answer in 3 Answer in 2 Answer in 1 It’s easy to get mixed up with all the cuddlies, duddlies, and fuddlies coming from different colored eggs. If we ignore how many total eggs of each color there are, and just look at the process of egg fusion, we might notice something that will make this problem simpler. When two eggs fuse, the number of eggs of each of those colors decreases by one, and the number of the third color increases by one. That means they all change parity, or evenness and oddness, at the same time. Right now all three piles are odd, but you get to add an egg to one color, which means that it’ll be even and the other two will be odd. Whichever color you choose will always be the opposite parity of the other two piles: odd when they’re even and even when they’re odd, since every egg fusion flips each pile’s parity simultaneously. We want to end with 1 blue, 0 purple, and 0 red eggs, or odd, even, even. That means we want the blue egg pile to be the opposite parity of the other two piles at the start as well. So you add a blue egg into the room, and 99 egg fusions later, only a single blue egg remains. The Cuddly that hatches is sure to make your 6-year-old as happy as can be. Just be sure to follow the shopkeeper’s warning, and never feed it after midnight.

**P715 2019-04-11 Can you spot the problem with these headlines (Level 1) - Jeff Leek &**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=715)

"New drug may cure cancer." "Aspirin may reduce risk of heart attacks." "Eating breakfast can help you lose weight." Health headlines like these flood the news, often contradicting each other. So how can you figure out what’s a genuine health concern or a truly promising remedy, and what’s less conclusive? In medicine, there’s often a disconnect between news headlines and the scientific research they cover. That’s because a headline is designed to catch attention— it’s most effective when it makes a big claim. By contrast, many scientific studies produce meaningful results when they focus on a narrow, specific question. The best way to bridge this gap is to look at the original research behind a headline. We’ve come up with a simplified research scenario for each of these three headlines to test your skills. Keep watching for the explanation of the first study; then pause at the headline to figure out the flaw. Assume all the information you need to spot the flaw is included. Let’s start with this hypothetical scenario: a study using mice to test a new cancer drug. The study includes two groups of mice, one treated with the drug, the other with a placebo. At the end of the trial, the mice that receive the drug are cured, while those that received the placebo are not. Can you spot the problem with this headline: "Study shows new drug could cure cancer" Since the subjects of the study were mice, we can’t draw conclusions about human disease based on this research. In real life, early research on new drugs and therapies is not conducted on humans. If the early results are promising, clinical trials follow to determine if they hold up in humans. Now that you’ve warmed up, let’s try a trickier example: a study about the impact of aspirin on heart attack risk. The study randomly divides a pool of men into two groups. The members of one group take aspirin daily, while the others take a daily placebo. By the end of the trial, the control group suffered significantly more heart attacks than the group that took aspirin. Based on this situation, what’s wrong with the headline: "Aspirin may reduce risk of heart attacks" In this case, the study shows evidence that aspirin reduces heart attacks in men, because all the participants were men. But the conclusion “aspirin reduces risk of heart attacks” is too broad; we can’t assume that results found in men would also apply to women. Studies often limit participants based on geographic location, age, gender, or many other factors. Before these findings can be generalized, similar studies need to be run on other groups. If a headline makes a general claim, it should draw its evidence from a diverse body of research, not one study. Can you take your skills from the first two questions to the next level? Try this example about the impact of eating breakfast on weight loss. Researchers recruit a group of people who had always skipped breakfast and ask them to start eating breakfast everyday. The participants include men and women of a range of ages and backgrounds. Over a year-long period, participants lose an average of five pounds. So what’s wrong with the headline: "Eating breakfast can help you lose weight" The people in the study started eating breakfast and lost weight— but we don’t know that they lost weight because they started eating breakfast; perhaps having their weight tracked inspired them to change their eating habits in other ways. To rule out the possibility that some other factor caused weight loss, we would need to compare these participants to a group who didn’t eat breakfast before the study and continued to skip it during the study. A headline certainly shouldn’t claim the results of this research are generally applicable. And if the study itself made such a claim without a comparison group, then you should question its credibility. Now that you’ve battle-tested your skills on these hypothetical studies and headlines, you can test them on real-world news. Even when full papers aren’t available without a fee, you can often find summaries of experimental design and results in freely available abstracts, or even within the text of a news article. Individual studies have results that don’t necessarily correspond to a grabby headline. Big conclusions for human health issues require lots of evidence accumulated over time. But in the meantime, we can keep on top of the science, by reading past the headlines.

**P716 2019-04-12 How do self-driving cars “see” - Sajan Saini**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=716)

It’s late, pitch dark, and a self-driving car winds down a narrow country road. Suddenly, three hazards appear at the same time. What happens next? Before it can navigate this onslaught of obstacles, the car has to detect them— gleaning enough information about their size, shape, and position, so that its control algorithms can plot the safest course. With no human at the wheel, the car needs smart eyes, sensors that’ll resolve these details— no matter the environment, weather, or how dark it is— all in a split-second. That’s a tall order, but there’s a solution that partners two things: a special kind of laser-based probe called LIDAR, and a miniature version of the communications technology that keeps the internet humming, called integrated photonics. To understand LIDAR, it helps to start with a related technology— radar. In aviation, radar antennas launch pulses of radio or microwaves at planes to learn their locations by timing how long the beams take to bounce back. That’s a limited way of seeing, though, because the large beam-size can’t visualize fine details. In contrast, a self-driving car’s LIDAR system, which stands for Light Detection and Ranging, uses a narrow invisible infrared laser. It can image features as small as the button on a pedestrian’s shirt across the street. But how do we determine the shape, or depth, of these features? LIDAR fires a train of super-short laser pulses to give depth resolution. Take the moose on the country road. As the car drives by, one LIDAR pulse scatters off the base of its antlers, while the next may travel to the tip of one antler before bouncing back. Measuring how much longer the second pulse takes to return provides data about the antler’s shape. With a lot of short pulses, a LIDAR system quickly renders a detailed profile. The most obvious way to create a pulse of light is to switch a laser on and off. But this makes a laser unstable and affects the precise timing of its pulses, which limits depth resolution. Better to leave it on, and use something else to periodically block the light reliably and rapidly. That’s where integrated photonics come in. The digital data of the internet is carried by precision-timed pulses of light, some as short as a hundred picoseconds. One way to create these pulses is with a Mach-Zehnder modulator. This device takes advantage of a particular wave property, called interference. Imagine dropping pebbles into a pond: as the ripples spread and overlap, a pattern forms. In some places, wave peaks add up to become very large; in other places, they completely cancel out. The Mach-Zehnder modulator does something similar. It splits waves of light along two parallel arms and eventually rejoins them. If the light is slowed down and delayed in one arm, the waves recombine out of sync and cancel, blocking the light. By toggling this delay in one arm, the modulator acts like an on/off switch, emitting pulses of light. A light pulse lasting a hundred picoseconds leads to a depth resolution of a few centimeters, but tomorrow’s cars will need to see better than that. By pairing the modulator with a super- sensitive, fast-acting light detector, the resolution can be refined to a millimeter. That’s more than a hundred times better than what we can make out with 20/20 vision, from across a street. The first generation of automobile LIDAR has relied on complex spinning assemblies that scan from rooftops or hoods. With integrated photonics, modulators and detectors are being shrunk to less than a tenth of a millimeter, and packed into tiny chips that’ll one day fit inside a car’s lights. These chips will also include a clever variation on the modulator to help do away with moving parts and scan at rapid speeds. By slowing the light in a modulator arm only a tiny bit, this additional device will act more like a dimmer than an on/off switch. If an array of many such arms, each with a tiny controlled delay, is stacked in parallel, something novel can be designed: a steerable laser beam. From their new vantage, these smart eyes will probe and see more thoroughly than anything nature could’ve imagined— and help navigate any number of obstacles. All without anyone breaking a sweat— except for maybe one disoriented moose.

**P717 2019-04-15 The Chinese myth of the meddling monk - Shunan Teng**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=717)

Xu Xian had just received yet another invitation to the opening ceremony of the new Jin Shan Temple. His wife, Bai Su Zhen, had warned him not to attend. Since she was in fact a benevolent white snake spirit in human form, their marriage had already weathered attacks by meddling monks. But devout Buddhist that he was, Xu Xian felt obligated to make an appearance. What they didn’t know was that these invitations had come from none other than Fa Hai– the misguided monk who had tried to separate the young lovers, almost killing Xu Xian in the process. The monk confronted Xu Xian, telling him that because he consorted with a demon, he must remain at the monastery and cleanse his soul. Xu Xian protested, but Fa Hai would not let him escape. At home, Bai Su Zhen was uneasy. Her husband had departed so quickly that she hadn’t been able to tell him she was pregnant with his child. And now he had been gone so long she sensed something must be wrong. She made her way to the temple, and upon encountering Fa Hai the monk threw his prayer mat, which erupted into fire and smoke. Weakened from her pregnancy, Bai Su Zhen desperately summoned a fleet of shrimp soldiers and crab generals to subdue the monk, and waves to put out the blaze. But the water also flooded the surrounding area, drowning many innocent villagers. For the first time, Bai Su Zhen had harmed humans, and she fell out of the gods’ favor. With their blessing retracted, Fa Hai attempted to trap her in his magical alms bowl. But just when all hope seemed lost, a bright glow came from within her belly, saving her from the mad monk’s magic. The couple fled home, grateful to the mysterious power that had saved them, and soon after, Bai Su Zhen gave birth to their son, Xu Shi Lin. Yet despite this joyous occasion, Xu Xian was uneasy. He was shaken by his wife’s accidental act of destruction, and he feared the misfortune it might bring upon their home. Not a month later, Fa Hai appeared at their doorstep. He offered Xu Xian an alms bowl to ensure good fortune for his newborn son. Still wary of the monk, but also remembering Bai Su Zhen’s destructive act, Xu Xian accepted the gift. But as soon as the bowl entered their home, it flew to Bai Su Zhen’s head and trapped her inside. Against the family’s wishes, Fa Hai buried the bowl beneath the Lei Feng Pagoda. And when Xu Xian begged him to release his wife, the monk sternly replied: “She will be free when the iron tree blooms.” Overcome with guilt, Xu Xian ran away to a monastery, leaving Shi Lin in the care of his aunt. But there was something neither of them knew. The boy was the reincarnation of Wen Qu Xing, the wisdom god, sent to the family to reward Xu Xian’s devotion. It was this power that had protected Bai Su Zhen at the temple, and as he grew, so did his wisdom. At age 19, Shi Lin went to the capital city to take the nation-wide imperial exam and obtained the highest score in all the empire. The Emperor himself bestowed Shi Lin’s prize: an ornate hat decorated with jewel-encrusted flowers. But though he returned home in glory, the fate of his parents still weighed heavy on his mind. Coaxing his father from exile, Shi Lin took him to visit the Lei Feng Pagoda to pay respects to his mother. Kneeling before it, he placed his jeweled prize on the iron tree as an offering. Suddenly, the ground opened and Bai Su Zhen stepped out. With her sins absolved by the tribute of a god, and a blossom on the iron tree, Shi Lin had freed his mother, and reunited his family– both mortal and divine.

**P718 2019-04-16 The Opposites Game**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=718)

"The Opposites Game" For Patricia Maisch This day my students and I play the Opposites Game with a line from Emily Dickinson. My life had stood a loaded gun, it goes and I write it on the board, pausing so they can call out the antonyms – My Your Life Death Had stood ? Will sit A Many Loaded Empty Gun ? Gun. For a moment, very much like the one between lightning and its sound, the children just stare at me, and then it comes, a flurry, a hail storm of answers – Flower, says one. No, Book, says another. That's stupid, cries a third, the opposite of a gun is a pillow. Or maybe a hug, but not a book, no way is it a book. With this, the others gather their thoughts and suddenly it’s a shouting match. No one can agree, for every student there’s a final answer. It's a song, a prayer, I mean a promise, like a wedding ring, and later a baby. Or what’s that person who delivers babies? A midwife? Yes, a midwife. No, that’s wrong. You're so wrong you’ll never be right again. It's a whisper, a star, it's saying I love you into your hand and then touching someone's ear. Are you crazy? Are you the president of Stupid-land? You should be, When's the election? It’s a teddy bear, a sword, a perfect, perfect peach. Go back to the first one, it's a flower, a white rose. When the bell rings, I reach for an eraser but a girl snatches it from my hand. Nothing's decided, she says, We’re not done here. I leave all the answers on the board. The next day some of them have stopped talking to each other, they’ve taken sides. There's a Flower club. And a Kitten club. And two boys calling themselves The Snowballs. The rest have stuck with the original game, which was to try to write something like poetry. It's a diamond, it's a dance, the opposite of a gun is a museum in France. It's the moon, it's a mirror, it's the sound of a bell and the hearer. The arguing starts again, more shouting, and finally a new club. For the first time I dare to push them. Maybe all of you are right, I say. Well, maybe. Maybe it's everything we said. Maybe it’s everything we didn't say. It's words and the spaces for words. They're looking at each other now. It's everything in this room and outside this room and down the street and in the sky. It's everyone on campus and at the mall, and all the people waiting at the hospital. And at the post office. And, yeah, it's a flower, too. All the flowers. The whole garden. The opposite of a gun is wherever you point it. Don’t write that on the board, they say. Just say poem. Your death will sit through many empty poems.

**P719 2019-04-17 How does the stock market work - Oliver Elfenbaum**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=719)

In the 1600s the Dutch East India Company employed hundreds of ships to trade gold, porcelain, spices, and silks around the globe. But running this massive operation wasn’t cheap. In order to fund their expensive voyages, the company turned to private citizens– individuals who could invest money to support the trip in exchange for a share of the ship’s profits. This practice allowed the company to afford even grander voyages, increasing profits for both themselves and their savvy investors. Selling these shares in coffee houses and shipping ports across the continent, the Dutch East India Company unknowingly invented the world’s first stock market. Since then, companies have been collecting funds from willing investors to support all kinds of businesses. And today, the stock market has schools, careers, and even whole television channels dedicated to understanding it. But the modern stock market is significantly more complicated than its original incarnation. So how do companies and investors use the market today? Let’s imagine a new coffee company that decides to launch on the market. First, the company will advertise itself to big investors. If they think the company is a good idea, they get the first crack at investing, and then sponsor the company’s initial public offering, or IPO. This launches the company onto the official public market, where any company or individual who believes the business could be profitable might buy a stock. Buying stocks makes those investors partial owners in the business. Their investment helps the company to grow, and as it becomes more successful, more buyers may see potential and start buying stocks. As demand for those stocks increases, so does their price, increasing the cost for prospective buyers, and raising the value of the company's stocks people already own. For the company, this increased interest helps fund new initiatives, and also boosts its overall market value by showing how many people are willing to invest in their idea. However, if for some reason a company starts to seem less profitable the reverse can also happen. If investors think their stock value is going to decline, they’ll sell their stocks with the hopes of making a profit before the company loses more value. As stocks are sold and demand for the stock goes down, the stock price falls, and with it, the company’s market value. This can leave investors with big losses– unless the company starts to look profitable again. This see-saw of supply and demand is influenced by many factors. Companies are under the unavoidable influence of market forces– such as the fluctuating price of materials, changes in production technology, and the shifting costs of labor. Investors may be worried about changes in leadership, bad publicity, or larger factors like new laws and trade policies. And of course, plenty of investors are simply ready to sell valuable stocks and pursue personal interests. All these variables cause day-to-day noise in the market, which can make companies appear more or less successful. And in the stock market, appearing to lose value often leads to losing investors, and in turn, losing actual value. Human confidence in the market has the power to trigger everything from economic booms to financial crises. And this difficult-to-track variable is why most professionals promote reliable long term investing over trying to make quick cash. However, experts are constantly building tools in efforts to increase their chances of success in this highly unpredictable system. But the stock market is not just for the rich and powerful. With the dawn of the Internet, everyday investors can buy stocks in many of the exact same ways a large investor would. And as more people educate themselves about this complex system they too can trade stocks, support the businesses they believe in, and pursue their financial goals. The first step is getting invested.

**P720 2019-04-17 Titan of terror - the dark imagination of H.P. Lovecraft - Silvia Mor**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=720)

Arcane books of forbidden lore, disturbing secrets in the family bloodline, and terrors so unspeakable the very thought of them might drive you mad. By now, these have become standard elements in many modern horror stories. But they were largely popularized by a single author– one whose name has become an adjective for the particular type of terror he inspired. Born in Providence, Rhode Island in 1890, Howard Phillips Lovecraft grew up admiring the Gothic horror stories written by Edgar Allan Poe and Robert Chambers. But by the time he began writing in 1917, World War I had cast a long shadow over the arts. People had seen real horrors, and were no longer frightened of fantastical folklore. Lovecraft sought to invent a new kind of terror, one that responded to the rapid scientific progress of his era. His stories often used scientific elements to lend eerie plausibility. In "The Colour out of Space," a strange meteorite falls near a farmhouse, mutating the farm into a nightmarish hellscape. Others incorporated scientific methodology into their form. "At the Mountains of Madness" is written as a report of an Antarctic expedition that unearths things better left undiscovered. In others, mathematics themselves become a source of horror, as impossible geometric configurations wreak havoc on the minds of any who behold them. Like then-recent discoveries of subatomic particles or X-rays, the forces in Lovecraft’s fiction were powerful, yet often invisible and indescribable. Rather than recognizable monsters, graphic violence, or startling shocks, the terror of “Lovecraftian” horror lies in what’s not directly portrayed– but left instead to the dark depths of our imagination. Lovecraft’s dozens of short stories, novellas, and poems often take place in the same fictional continuity, with recurring characters, locations, and mythologies. At first glance, they appear to be set within Lovecraft’s contemporary New England. But beneath the surface of this seemingly similar reality lie dark masters, for whom Earth’s inhabitants are mere playthings. More like primordial forces than mere deities, Lovecraft’s Great Old Ones lurk at the corners of our reality. Beings such as Yog-Sothoth, “who froths as primal slime in nuclear chaos beyond the nethermost outposts of space and time.” Or the blind, idiot god Azathoth, whose destructive impulses are stalled only by the “maddening beating of vile drums and the thin monotonous whine of accursed flutes.” These beings exist beyond our conceptions of reality, their true forms as inscrutable as their motives. Lovecraft’s protagonists– often researchers, anthropologists, or antiquarians– stumble onto hints of their existence. But even these indirect glimpses are enough to drive them insane. And if they survive, the reader is left with no feeling of triumph, only cosmic indifference– the terrible sense that we are but insignificant specks at the mercy of unfathomable forces. But perhaps the greatest power these creatures had was their appeal to Lovecraft’s contemporaries. During his lifetime, Lovecraft corresponded with other writers, encouraging them to employ elements and characters from his stories in their own. References to Lovecraftian gods or arcane tomes can be found in many stories by his pen pals, such as Robert E. Howard and Robert Bloch. Today, this shared universe is called the Cthulhu Mythos, named after Lovecraft’s infamous blend of dragon and octopus. Unfortunately, Lovecraft’s fear of the unknown found a less savory expression in his personal views. The author held strong racist views, and some of his works include crude stereotypes and slurs. But the rich world he created would outlive his personal prejudices. And after Lovecraft’s death, the Cthulhu Mythos was adopted by a wide variety of authors, often reimagining them from diverse perspectives that transcend the author’s prejudices. Despite his literary legacy, Lovecraft was never able to find financial success. He died unknown and penniless at the age of 46– a victim of the universe’s cosmic indifference. But his work has inspired numerous short stories, novels, tabletop games, and cultural icons. And as long as humans feel a sense of dread about our unknown future, Lovecraftian horror will have a place in the darkest corners of our imagination.

**P721 2019-04-18 The hidden network that makes the internet possible - Sajan Saini**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=721)

In 2012, a team of Japanese and Danish researchers set a world record, transmitting 1 petabit of data— that’s 10,000 hours of high-def video— over a fifty-kilometer cable, in a second. This wasn’t just any cable. It was a souped-up version of fiber optics— the hidden network that links our planet and makes the internet possible. For decades, long-distance communications between cities and countries were carried by electrical signals, in wires made of copper. This was slow and inefficient, with metal wires limiting data rates and power lost as wasted heat. But in the late 20th century, engineers mastered a far superior method of transmission. Instead of metal, glass can be carefully melted and drawn into flexible fiber strands, hundreds of kilometers long and no thicker than human hair. And instead of electricity, these strands carry pulses of light, representing digital data. But how does light travel within glass, rather than just pass through it? The trick lies in a phenomenon known as total internal reflection. Since Isaac Newton’s time, lensmakers and scientists have known that light bends when it passes between air and materials like water or glass. When a ray of light inside glass hits its surface at a steep angle, it refracts, or bends as it exits into air. But if the ray travels at a shallow angle, it’ll bend so far that it stays trapped, bouncing along inside the glass. Under the right condition, something normally transparent to light can instead hide it from the world. Compared to electricity or radio, fiber optic signals barely degrade over great distances— a little power does scatter away, and fibers can’t bend too sharply, otherwise the light leaks out. Today, a single optical fiber carries many wavelengths of light, each a different channel of data. And a fiber optic cable contains hundreds of these fiber strands. Over a million kilometers of cable crisscross our ocean floors to link the continents— that’s enough to wind around the Equator nearly thirty times. With fiber optics, distance hardly limits data, which has allowed the internet to evolve into a planetary computer. Increasingly, our mobile work and play rely on legions of overworked computer servers, warehoused in gigantic data centers flung across the world. This is called cloud computing, and it leads to two big problems: heat waste and bandwidth demand. The vast majority of internet traffic shuttles around inside data centers, where thousands of servers are connected by traditional electrical cables. Half of their running power is wasted as heat. Meanwhile, wireless bandwidth demand steadily marches on, and the gigahertz signals used in our mobile devices are reaching their data delivery limits. It seems fiber optics has been too good for its own good, fueling overly-ambitious cloud and mobile computing expectations. But a related technology, integrated photonics, has come to the rescue. Light can be guided not only in optical fibers, but also in ultrathin silicon wires. Silicon wires don’t guide light as well as fiber. But they do enable engineers to shrink all the devices in a hundred kilometer fiber optic network down to tiny photonic chips that plug into servers and convert their electrical signals to optical and back. These electricity-to-light chips allow for wasteful electrical cables in data centers to be swapped out for power-efficient fiber. Photonic chips can help break open wireless bandwidth limitations, too. Researchers are working to replace mobile gigahertz signals with terahertz frequencies, to carry data thousands of times faster. But these are short-range signals: they get absorbed by moisture in the air, or blocked by tall buildings. With tiny wireless-to-fiber photonic transmitter chips distributed throughout cities, terahertz signals can be relayed over long-range distances. They can do so via a stable middleman, optical fiber, and make hyperfast wireless connectivity a reality. For all of human history, light has gifted us with sight and heat, serving as a steady companion while we explored and settled the physical world. Now, we’ve saddled light with information and redirected it to run along a fiber optic superhighway— with many different integrated photonic exits— to build an even more expansive, virtual world.

**P722 2019-04-19 Why is this painting so shocking - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=722)

On April 26th, 1937, Fascist forces bombed the Basque village of Guernica in Northern Spain. It was one of the worst civilian casualties of the Spanish Civil War, waged between the democratic republic and General Franco’s fascist contingent. For Pablo Picasso, the tragedy sparked a frenzied period of work in which he produced a massive anti-war mural, aptly titled "Guernica." The painting is a powerful work of historical documentation and political protest. But while Picasso’s artistic motivations are clear, the symbolism of the painting can be as confusing and chaotic as war itself. How can we make sense of this overwhelming image, and what exactly makes it a masterpiece of anti-war art? The painting’s monumental canvas is disorienting from the start, rendered in the abstracted Cubist style Picasso pioneered. Cubism deliberately emphasized the two-dimensionality of the canvas by flattening the objects being painted. This afforded viewers multiple and often impossible perspectives on the same object; a technique considered shocking even in Picasso’s domestic scenes. But in this context, the style offers a profoundly overwhelming view of violence, destruction, and casualties. Multiple perspectives only compound the horror on display– sending the eyes hurtling around the frame in a futile hunt for peace. On the far left, a woman holding her dead child releases a scream; her eyes sliding down her face in the shape of tears and her head bending back unnaturally to echo her baby’s. There is the statue of a soldier present below, but he is unable to defend the woman and child. Instead his broken body lies in pieces, his arm clutching a splintered sword in a signal of utmost defeat. The tip of his sword meets a woman’s foot as she attempts to flee the devastation. But her other leg appears rooted to the spot, locked in the corner of the canvas even as she stretches to move it. Another victim appears behind this slouching figure. Falling helplessly as flames lick around her, she too is caught in her own hopeless scene. Each of these figures bordering the painting are horribly trapped, giving the work an acute sense of claustrophobia. And where you might expect the canvas’ massive size to counteract this feeling, its scale only highlights the nearly life-sized atrocities on display. Some possible relief comes from a lamp held tightly by a ghostly woman reaching out her window. But is her lantern’s hopeful glow truly lighting the scene? Or is it the jagged lightbulb– thought to represent the technologies of modern warfare– which illuminates her view of the chaos below? From the coffin-like confines of her window, her arm guides the viewer back into the fray, to perhaps the most controversial symbols of all– two ghostly animals caught in the destruction. Does the screaming horse embody the threat of Franco’s military nationalism; or does the spike running through its body convey its victimhood? Does the white bull represent Spain, the country of matadors and a common theme in Picasso’s work– or does it stand for the brutality of war? In this scene of strife, these animals raise more questions than answers. And additional elements hidden throughout the frame offer even more secrets for close observers. At the top of the canvas flashes a bird desperate to escape the carnage. And the abundance of animals on display may hint at the bombing’s date– a market day which flooded the streets with villagers, animals, and other potential causalities. Like the bombing of Guernica itself, Picasso’s painting is dense with destruction. But hidden beneath this supposed chaos, are carefully crafted scenes and symbols, carrying out the painting’s multifaceted attack on fascism. Decades after its creation, "Guernica" retains its power to shock viewers and ignite debate, and is often referenced at anti-war gatherings around the world. Hundreds of viewers have grappled with its harsh imagery, shattering symbolism and complex political messaging. But even without a close understanding of it’s complicated subtext, Picasso’s work remains a searing reminder of the true casualties of violence.

**P723 2019-04-25 How this disease changes the shape of your cells - Amber M. Yates**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=723)

What shape are your cells? Squishy cylinders? Jagged zig-zags? You probably don’t think much about the bodies of these building blocks, but at the microscopic level, small changes can have huge consequences. And while some adaptations change these shapes for the better, others can spark a cascade of debilitating complications. This is the story of sickle-cell disease. Sickle-cell disease affects the red blood cells, which transport oxygen from the lungs to all the tissues in the body. To perform this vital task, red blood cells are filled with hemoglobin proteins to carry oxygen molecules. These proteins float independently inside the red blood cell’s pliable, doughnut-like shape, keeping the cells flexible enough to accommodate even the tiniest of blood vessels. But in sickle cell disease, a single genetic mutation alters the structure of hemoglobin. After releasing oxygen to tissues, these mutated proteins lock together into rigid rows. Rods of hemoglobin cause the cell to deform into a long, pointed sickle. These red blood cells are harder and stickier, and no longer flow smoothly through blood vessels. Sickled cells snag and pile up– sometimes blocking the vessel completely. This keeps oxygen from reaching a variety of cells, causing the wide range of symptoms experienced by people with sickle-cell disease. Starting when they’re less than a year old, patients suffer from repeated episodes of stabbing pain in oxygen-starved tissues. The location of the clogged vessel determines the specific symptoms experienced. A blockage in the spleen, part of the immune system, puts patients at risk for dangerous infections. A pileup in the lungs can produce fevers and difficulty breathing. A clog near the eye can cause vision problems and retinal detachment. And if the obstructed vessels supply the brain the patient could even suffer a stroke. Worse still, sickled red blood cells also don’t survive very long— just 10 or 20 days, versus a healthy cell’s 4 months. This short lifespan means that patients live with a constantly depleted supply of red blood cells; a condition called sickle-cell anemia. Perhaps what’s most surprising about this malignant mutation is that it originally evolved as a beneficial adaptation. Researchers have been able to trace the origins of the sickle cell mutation to regions historically ravaged by a tropical disease called malaria. Spread by a parasite found in local mosquitoes, malaria uses red blood cells as incubators to spread quickly and lethally through the bloodstream. However, the same structural changes that turn red blood cells into roadblocks also make them more resistant to malaria. And if a child inherits a copy of the mutation from only one parent, there will be just enough abnormal hemoglobin to make life difficult for the malaria parasite, while most of their red blood cells retain their normal shape and function. In regions rife with this parasite, sickle cell mutation offered a serious evolutionary advantage. But as the adaptation flourished, it became clear that inheriting the mutation from both parents resulted in sickle-cell anemia. Today, most people with sickle-cell disease can trace their ancestry to a country where malaria is endemic. And this mutation still plays a key role in Africa, where more than 90% of malaria infections occur worldwide. Fortunately, as this “adaptation” thrives, our treatment for sickle cell continues to improve. For years, hydroxyurea was the only medication available to reduce the amount of sickling, blunting symptoms and increasing life expectancy. Bone marrow transplantations offer a curative measure, but these procedures are complicated and often inaccessible. But promising new medications are intervening in novel ways, like keeping oxygen bonded to hemoglobin to prevent sickling, or reducing the stickiness of sickled cells. And the ability to edit DNA has raised the possibility of enabling stem cells to produce normal hemoglobin. As these tools become available in the areas most affected by malaria and sickle cell disease, we can improve the quality of life for more patients with this adverse adaptation.

**P724 2019-04-29 Why should you read “Crime and Punishment” - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=724)

What drives someone to kill in cold blood? What goes through the murderer’s mind? And what kind of a society breeds such people? Over 150 years ago Fyodor Mikhailovich Dostoyevsky took these questions up in what would become one of the best-known works of Russian literature: "Crime and Punishment." First serialized in a literary magazine in 1866, the novel tells the story of Rodion Romanovich Raskolnikov, a young law student in Saint Petersburg. Raskolnikov lives in abject poverty, and at the start of the story has run out of funds to continue his studies. Letters from his rural home only add to his distress when he realizes how much his mother and sister have sacrificed for his success. Increasingly desperate after selling the last of his valuables to an elderly pawnbroker, he resolves on a plan to murder and rob her. But the impact of carrying out this unthinkable act proves to be more than he was prepared for. Though the novel is sometimes cited as one of the first psychological thrillers, its scope reaches far beyond Raskolnikov’s inner turmoil. From dank taverns to dilapidated apartments and claustrophobic police stations, the underbelly of 19th century Saint Petersburg is brought to life by Dostoyevsky’s searing prose. We’re introduced to characters such as Marmeladov, a miserable former official who has drank his family into ruin, and Svidrigailov, an unhinged and lecherous nobleman. As Raskolnikov’s own family arrives in town, their moral innocence stands in stark contrast to the depravity of those around them, even as their fates grow increasingly intertwined. This bleak portrait of Russian society reflects the author’s own complex life experiences and evolving ideas. As a young writer who left behind a promising military career, Fyodor had been attracted to ideas of socialism and reform, and joined a circle of intellectuals to discuss radical texts banned by the Imperial government. Upon exposure, members of this group, including Dostoyevsky, were arrested. Many were sentenced to death, only to be subjected to a mock execution and last-minute pardon from the Tsar. Dostoyevsky spent the next four years in a Siberian labor camp before being released in 1854. The experience left him with a far more pessimistic view of social reform, and his focus shifted toward spiritual concerns. In the 1864 novella "Notes from Underground," he expounded on his belief that utopian Western philosophies could never satisfy the contradictory yearnings of the human soul. "Crime and Punishment" was conceived and completed the following year, picking up on many of the same themes. In many ways, the novel follows a common narrative thread where a promising youth is seduced and corrupted by the dangers of urban life. But its social critique cuts far deeper. Raskolnikov rationalizes that his own advancement at the cost of the exploitative pawnbroker’s death would be a net benefit to society. In doing so, he echoes the doctrines of egoism and utilitarianism embraced by many of Dostoyevsky’s contemporary intellectuals. And in believing that his intelligence allows him to transcend moral taboos, Raskolnikov cuts himself off from his own humanity. Yet although the book is deeply concerned with morality, "Crime and Punishment" never comes across as merely moralizing, with each character given their own distinctive and convincing voice. One of the most remarkable things about "Crime and Punishment" is its ability to thrill despite the details of the central murder being revealed in the first act. Raskolnikov’s crime is clear. But it’s only through Dostoyevsky’s gripping account of the ensuing social and psychological turmoil that we learn the true nature of his punishment– and the possibility of redemption.

**P725 2019-05-02 Can a black hole be destroyed - Fabio Pacucci**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=725)

Black holes are among the most destructive objects in the universe. Anything that gets too close to the central singularity of a black hole, be it an asteroid, planet, or star, risks being torn apart by its extreme gravitational field. And if the approaching object happens to cross the black hole’s event horizon, it’ll disappear and never re-emerge, adding to the black hole’s mass and expanding its radius in the process. There is nothing we could throw at a black hole that would do the least bit of damage to it. Even another black hole won’t destroy it– the two will simply merge into a larger black hole, releasing a bit of energy as gravitational waves in the process. By some accounts, it’s possible that the universe may eventually consist entirely of black holes in a very distant future. And yet, there may be a way to destroy, or “evaporate,” these objects after all. If the theory is true, all we need to do is to wait. In 1974, Stephen Hawking theorized a process that could lead a black hole to gradually lose mass. Hawking radiation, as it came to be known, is based on a well-established phenomenon called quantum fluctuations of the vacuum. According to quantum mechanics, a given point in spacetime fluctuates between multiple possible energy states. These fluctuations are driven by the continuous creation and destruction of virtual particle pairs, which consist of a particle and its oppositely charged antiparticle. Normally, the two collide and annihilate each other shortly after appearing, preserving the total energy. But what happens when they appear just at the edge of a black hole’s event horizon? If they’re positioned just right, one of the particles could escape the black hole’s pull while its counterpart falls in. It would then annihilate another oppositely charged particle within the event horizon of the black hole, reducing the black hole’s mass. Meanwhile, to an outside observer, it would look like the black hole had emitted the escaped particle. Thus, unless a black hole continues to absorb additional matter and energy, it’ll evaporate particle by particle, at an excruciatingly slow rate. How slow? A branch of physics, called black hole thermodynamics, gives us an answer. When everyday objects or celestial bodies release energy to their environment, we perceive that as heat, and can use their energy emission to measure their temperature. Black hole thermodynamics suggests that we can similarly define the “temperature” of a black hole. It theorizes that the more massive the black hole, the lower its temperature. The universe’s largest black holes would give off temperatures of the order of 10 to the -17th power Kelvin, very close to absolute zero. Meanwhile, one with the mass of the asteroid Vesta would have a temperature close to 200 degrees Celsius, thus releasing a lot of energy in the form of Hawking Radiation to the cold outside environment. The smaller the black hole, the hotter it seems to be burning– and the sooner it’ll burn out completely. Just how soon? Well, don’t hold your breath. First of all, most black holes accrete, or absorb matter and energy, more quickly than they emit Hawking radiation. But even if a black hole with the mass of our Sun stopped accreting, it would take 10 to the 67th power years– many many magnitudes longer than the current age of the Universe— to fully evaporate. When a black hole reaches about 230 metric tons, it’ll have only one more second to live. In that final second, its event horizon becomes increasingly tiny, until finally releasing all of its energy back into the universe. And while Hawking radiation has never been directly observed, some scientists believe that certain gamma ray flashes detected in the sky are actually traces of the last moments of small, primordial black holes formed at the dawn of time. Eventually, in an almost inconceivably distant future, the universe may be left as a cold and dark place. But if Stephen Hawking was right, before that happens, the normally terrifying and otherwise impervious black holes will end their existence in a final blaze of glory.

**P726 2019-05-02 The Aztec myth of the unlikeliest sun god - Kay Almere Read**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=726)

Nanahuatl, weakest of the Aztec gods, sickly and covered in pimples, had been chosen to form a new world. There had already been four worlds, each set in motion by its own “Lord Sun," and each, in turn, destroyed: the first by jaguars, the next by winds, the next by rains of fire, and the fourth by floods. To establish the Fifth Sun, Lord Quetzalcoatl, the “Feathered Serpent,” had gone to the underworld and returned with the bones of earlier people, nourishing them with his own blood to create new life. But for them to have a world to live in, another god had to leap into the great bonfire and become the fifth sun. The Lord of Sustenance and the Lord of Fire had chosen Nanahuatl for this task, while the Lord of Rain and the Lord of the Four Quarters had picked their own offering: the proud, rich Tecciztecatl. First, the chosen ones had to complete a four-day fasting and bloodletting ritual. Nanahuatl had nothing but cactus thorns with which to bleed himself, and fir branches to paint with his red offering, but he resolved to try his best. Meanwhile, Tecciztecatl flaunted his riches, using magnificent jade spines and branches adorned with iridescent quetzal feathers for his own blood offering. When four days had passed, the fire was roaring high. Four times proud Tecciztecatl approached the flames, and four times he pulled back in fear. Humble Nanahuatl stepped forward. The other gods painted him chalky white and glued feathers to him. Without hesitation, he threw himself into the flames. A fire-blackened eagle swooped over the fire, grabbed Nanahuatl and carried him into the sky. There, Lord and Lady Sustenance bathed him, sat him on a feathered throne, and wrapped a red band around his head. Inspired by Nanahuatl, Tecciztecatl threw himself into what was left of the fire: cooled ashes. A jaguar jumped over the fire pit, but couldn’t carry Tecciztecatl into the sky. When Tecciztecatl reached the horizon, a band of goddesses dressed him in rags. Still, he shined just as brightly as Nanahuatl. But since he had shown far less bravery and much more pride, one of the gods picked up a rabbit and tossed it in his face, dimming his light. But the fifth world still wasn’t truly established. Nanahuatl, Lord Sun, shined for four days straight without moving through the sky like all the previous suns had moved. Back in their home, Teotihuacan, the gods began to worry. They sent Obsidian Hawk up to ask what was wrong. Nanahuatl replied that just as he had sacrificed himself to become Lord Sun, he now needed the nourishing blood of the other gods in order to move through the sky. Enraged at this suggestion, Lord Dawn stepped up and shot an arrow at Lord Sun. Lord Sun shot back, and his quetzal-feathered arrows struck Lord Dawn in the face, turning him to frost. Before anyone else could act rashly, the other gods turned to each other to discuss what to do. Of course, no one wanted to sacrifice themselves, but nor did anyone want to act like Lord Dawn. Besides, Nanahuatl had held up his end of the bargain to nourish the earth— how could they refuse to nourish him in return? They remembered how even the wimpy Tecciztecatl had eventually managed to emulate Nanahuatl's bravery. At long last, five other gods agreed to sacrifice themselves. One by one, Lord Death stabbed them in the heart with an obsidian knife, offering their bodies to their new Lord Sun. As the last god made the sacrifice, Lord Quetzalcoatl blew the embers of the great fire back to life, and the sun began to move through the sky at last, ushering in the fifth age. Thanks to a pimply weakling whose fortitude inspired all the other gods, the sun moves along its daily path, the rabbit-faced moon following in its wake.

**P727 2019-05-02 You are more transparent than you think - Sajan Saini**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=727)

It’s an increasingly common sight in hospitals around the world: a nurse measures our height, weight, blood pressure, and attaches a glowing plastic clip to our finger. Suddenly, a digital screen reads out the oxygen level in our bloodstream. How did that happen? How can a plastic clip learn something about our blood… without a blood sample? Here’s the trick: our bodies are translucent, meaning they don’t completely block and reflect light. Rather, they allow some light to actually pass through our skin, muscles, and blood vessels. Don’t believe it? Hold a flashlight to your thumb. Light, it turns out, can help probe the insides of our bodies. Consider that medical fingerclip— it’s called a pulse oximeter. When you inhale, your lungs transfer oxygen into hemoglobin molecules, and the pulse oximeter measures the ratio of oxygenated to oxygen-free hemoglobin. It does this by using a tiny red LED light on one side of the fingerclip, and a small light detector on the other. When the LED shines into your finger, oxygen-free hemoglobin in your blood vessels absorbs the red light more strongly than its oxygenated counterpart. So the amount of light that makes it out the other side depends on the concentration ratio of the two types of hemoglobin. But any two patients will have different-sized blood vessels in their fingers. For one patient, a saturation reading of ninety-five percent corresponds to a healthy oxygen level, but for another with smaller arteries, the same reading could dangerously misrepresent the actual oxygen level. This can be accounted for with a second infrared wavelength LED. Light comes in a vast spectrum of wavelengths, and infrared light lies just beyond the visible colors. All molecules, including hemoglobin, absorb light at different efficiencies across this spectrum. So contrasting the absorbance of red to infrared light provides a chemical fingerprint to eliminate the blood vessel size effect. Today, an emerging medical sensor industry is exploring all-new degrees of precision chemical fingerprinting, using tiny light-manipulating devices no larger than a tenth of a millimeter. This microscopic technology, called integrated photonics, is made from wires of silicon that guide light— like water in a pipe— to redirect, reshape, even temporarily trap it. A ring resonator device, which is a circular wire of silicon, is a light trapper that enhances chemical fingerprinting. When placed close to a silicon wire, a ring siphons off and temporarily stores only certain waves of light— those whose periodic wavelength fits a whole number of times along the ring’s circumference. It’s the same effect at work when we pluck guitar strings. Only certain vibrating patterns dominate a string of a particular length, to give a fundamental note and its overtones. Ring resonators were originally designed to efficiently route different wavelengths of light— each a channel of digital data— in fiber optics communication networks. But some day this kind of data traffic routing may be adapted for miniature chemical fingerprinting labs, on chips the size of a penny. These future labs-on-a-chip may easily, rapidly, and non-invasively detect a host of illnesses, by analyzing human saliva or sweat in a doctor’s office or the convenience of our homes. Human saliva in particular mirrors the composition of our bodies’ proteins and hormones, and can give early-warning signals for certain cancers and infectious and autoimmune diseases. To accurately identify an illness, labs-on-a-chip may rely on several methods, including chemical fingerprinting, to sift through the large mix of trace substances in a sample of spit. Various biomolecules in saliva absorb light at the same wavelength— but each has a distinct chemical fingerprint. In a lab-on-a-chip, after the light passes through a saliva sample, a host of fine-tuned rings may each siphon off a slightly different wavelength of light and send it to a partner light detector. Together, this bank of detectors will resolve the cumulative chemical fingerprint of the sample. From this information, a tiny on-chip computer, containing a library of chemical fingerprints for different molecules, may figure out their relative concentrations, and help diagnose a specific illness. From globe-trotting communications to labs-on-a-chip, humankind has repurposed light to both carry and extract information. Its ability to illuminate continues to astonish us with new discoveries.

**P728 2019-05-06 The lovable (and lethal) sea lion - Claire Simeone**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=728)

Sunning themselves on rocks or waddling awkwardly across the beach, it’s easy to think of these immobile mammals less as sea lions, and more as sea house cats. But don’t be fooled by their beachside behavior. Under the waves, sea lions are incredible endurance hunters. Hurtling around at speeds from 4 to 18 miles an hour and hunting for up to 30 hours at a time, these majestic mammals live up to their name. And thanks to a suite of physical adaptations, finely tuned over millions of years, they make for resourceful foragers. To find their favorite food, sea lions hunt much deeper than many of their semi-aquatic peers. With some species diving to depths of nearly 400 meters, they’re able to cope with the mounting pressure by collapsing their pliable rib cage, and compressing a pair of springy lungs. This pushes air up through the smaller airways, collapsing rings of cartilage as oxygen travels out from the lungs, to be held in the larger, upper airways. Upon surfacing, this air will be used to re-inflate the lungs, but for now their heart slows down to preserve oxygen. Blood flow is redirected towards only the most essential organs like the heart, lungs, and brain, which rely on reserve oxygen stored in blood and muscle. Once they arrive at their hunting ground, sea lions depend on their superior vision to find their prey. Most mammal eyes have a structure called a lens– a transparent, convex structure whose shape refracts light to enable sight. In humans, this lens is curved to process light waves traveling through air. But sea lions need to see their best at hundreds of meters deep. To accommodate, their eyes have a much rounder lens to refract light underwater, as well as teardrop-shaped pupils which can expand to 25 times their original size. This lets in as much light as possible, helping them pinpoint their prey in even the dimmest conditions. But once they’ve closed in, they rely on something akin to a sixth sense to actually catch their meal. Their whiskers, or vibrissae, are composed of keratin and full of nerve fibers that run deep into the connective tissue of their face. Sea lions have full directional control over these whiskers, which can lie flat against their face, or stick out at a 90-degree angle. When properly tuned, these whiskers can sense the slim trails of moving water fish leave in their wake. And they’re precise enough to let blindfolded sea lions tell the difference between objects less than two centimeters different in size. With these tools a healthy sea lion can catch generous helpings of fish such as anchovy, mackerel, and squid on every outing. And with their exceptional memories, they can remember multiple hunting grounds, including those they haven’t visited in decades. This memory also extends to breeding territories and birthing areas, as well as which neighbors are friend and foe. There’s even evidence that sea lions can remember how to perform tasks after 10 years with no practice in between, letting them navigate old stomping grounds with ease. Yet despite these incredible adaptations, there are changes unfolding in their habitats too rapidly for sea lions to handle. As climate change warms the oceans, certain toxic algae species thrive. This algae is harmless to the fish who eat it, but for the sea lions which ingest those fish, the algae’s domoic acid can trigger seizures and brain damage. Changing ocean conditions keep this algae blooming year round, causing more and more sea lions to wash up on beaches. This tragic discovery is just one of the many ways the health of aquatic animal communities can help us better understand Earth’s oceans. These red flags help us take action to protect ourselves and other maritime mammals. And the more we can learn about the changing ocean that sea lions inhabit, the better equipped we’ll be to help these clever creatures thrive.

**P729 2019-05-07 Why should you read “The Master and Margarita” - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=729)

The Devil has come to town. But don’t worry – all he wants to do is stage a magic show. This absurd premise forms the central plot of Mikhail Bulgakov’s masterpiece, "The Master and Margarita." Written in Moscow during the 1930s, this surreal blend of political satire, historical fiction, and occult mysticism has earned a legacy as one of the 20th century’s greatest novels– and one of its strangest. The story begins when a meeting between two members of Moscow’s literary elite is interrupted by a strange gentleman named Woland, who presents himself as a foreign scholar invited to give a presentation on black magic. As the stranger engages the two companions in a philosophical debate and makes ominous predictions about their fates, the reader is suddenly transported to 1st century Jerusalem. There a tormented Pontius Pilate reluctantly sentences Jesus of Nazareth to death. With the narrative shifting between the two settings, Woland and his entourage– Azazello, Koroviev, Hella, and a giant cat named Behemoth– are seen to have uncanny magical powers, which they use to stage their performance while leaving a trail of havoc and confusion in their wake. Much of the novel’s dark humor comes not only from this demonic mischief, but also the backdrop against which it occurs. Bulgakov’s story takes place in the same setting where it was written– the USSR at the height of the Stalinist period. There, artists and authors worked under strict censorship, subject to imprisonment, exile, or execution if they were seen as undermining state ideology. Even when approved, their work– along with housing, travel, and everything else– was governed by a convoluted bureaucracy. In the novel, Woland manipulates this system along with the fabric of reality, to hilarious results. As heads are separated from bodies and money rains from the sky, the citizens of Moscow react with petty-self interest, illustrating how Soviet society bred greed and cynicism despite its ideals. And the matter-of-fact narration deliberately blends the strangeness of the supernatural events with the everyday absurdity of Soviet life. So how did Bulgakov manage to publish such a subversive novel under an oppressive regime? Well… he didn’t. He worked on "The Master and Margarita" for over ten years. But while Stalin’s personal favor may have kept Bulgakov safe from severe persecution, many of his plays and writings were kept from production, leaving him safe but effectively silenced. Upon the author’s death in 1940, the manuscript remained unpublished. A censored version was eventually printed in the 1960s, while copies of the unabridged manuscript continued to circulate among underground literary circles. The full text was only published in 1973, over 30 years after its completion. Bulgakov’s experiences with censorship and artistic frustration lend an autobiographical air to the second part of the novel, when we are finally introduced to its namesake. "The Master" is a nameless author who’s worked for years on a novel but burned the manuscript after it was rejected by publishers– just as Bulgakov had done with his own work. Yet the true protagonist is the Master’s mistress Margarita. Her devotion to her lover’s abandoned dream bears a strange connection to the diabolical company’s escapades– and carries the story to its surreal climax. Despite its dark humor and complex structure, "The Master and Margarita" is, at its heart, a meditation on art, love, and redemption, that never loses itself in cynicism. And the book’s long overdue publication and survival against the odds is a testament to what Woland tells the Master: “Manuscripts don’t burn.”

**P730 2019-05-08 The mysterious science of pain - Joshua W. Pate**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=730)

In 1995, the British Medical Journal published an astonishing report about a 29-year-old builder. He accidentally jumped onto a 15-centimeter nail, which pierced straight through his steel-toed boot. He was in such agonizing pain that even the smallest movement was unbearable. But when the doctors took off his boot, they faced a surprising sight: the nail had never touched his foot at all. For hundreds of years, scientists thought that pain was a direct response to damage. By that logic, the more severe an injury is, the more pain it should cause. But as we’ve learned more about the science of pain, we’ve discovered that pain and tissue damage don’t always go hand in hand, even when the body’s threat signaling mechanisms are fully functioning. We’re capable of experiencing severe pain out of proportion to an actual injury, and even pain without any injury, like the builder, or the well-documented cases of male partners of pregnant women experiencing pain during the pregnancy or labor. What’s going on here? There are actually two phenomena at play: the experience of pain, and a biological process called nociception. Nociception is part of the nervous system’s protective response to harmful or potentially harmful stimuli. Sensors in specialized nerve endings detect mechanical, thermal, and chemical threats. If enough sensors are activated, electrical signals shoot up the nerve to the spine and on to the brain. The brain weighs the importance of these signals and produces pain if it decides the body needs protection. Typically, pain helps the body avoid further injury or damage. But there are a whole set of factors besides nociception that can influence the experience of pain— and make pain less useful. First, there are biological factors that amplify nociceptive signals to the brain. If nerve fibers are activated repeatedly, the brain may decide they need to be more sensitive to adequately protect the body from threats. More stress sensors can be added to nerve fibers until they become so sensitive that even light touches to the skin spark intense electrical signals. In other cases, nerves adapt to send signals more efficiently, amplifying the message. These forms of amplification are most common in people experiencing chronic pain, which is defined as pain lasting more than 3 months. When the nervous system is nudged into an ongoing state of high alert, pain can outlast physical injury. This creates a vicious cycle in which the longer pain persists, the more difficult it becomes to reverse. Psychological factors clearly play a role in pain too, potentially by influencing nociception and by influencing the brain directly. A person’s emotional state, memories, beliefs about pain and expectations about treatment can all influence how much pain they experience. In one study, children who reported believing they had no control over pain actually experienced more intense pain than those who believed they had some control. Features of the environment matter too: In one experiment, volunteers with a cold rod placed on the back of their hand reported feeling more pain when they were shown a red light than a blue one, even though the rod was the same temperature each time. Finally, social factors like the availability of family support can affect perception of pain. All of this means that a multi-pronged approach to pain treatment that includes pain specialists, physical therapists, clinical psychologists, nurses and other healthcare professionals is often most effective. We’re only beginning to uncover the mechanisms behind the experience of pain, but there are some promising areas of research. Until recently, we thought the glial cells surrounding neurons were just support structures, but now we know they have a huge role in influencing nociception. Studies have shown that disabling certain brain circuits in the amygdala can eliminate pain in rats. And genetic testing in people with rare disorders that prevent them from feeling pain have pinpointed several other possible targets for drugs and perhaps eventually gene therapy.

**P731 2019-05-08 This one weird trick will help you spot clickbait - Jeff Leek & Lucy**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=731)

One simple vitamin can reduce your risk of heart disease. Eating chocolate reduces stress in students. New drug prolongs lives of patients with rare disease. Health headlines like these are published every day, sometimes making opposite claims from each other. There can be a disconnect between broad, attention-grabbing headlines and the often specific, incremental results of the medical research they cover. So how can you avoid being misled by grabby headlines? The best way to assess a headline’s credibility is to look at the original research it reports on. We’ve come up with a hypothetical research scenario for each of these three headlines. Keep watching for the explanation of the first example; then pause at the headline to answer the question. These are simplified scenarios. A real study would detail many more factors and how it accounted for them, but for the purposes of this exercise, assume all the information you need is included. Let’s start by considering the cardiovascular effects of a certain vitamin, Healthium. The study finds that participants taking Healthium had a higher level of healthy cholesterol than those taking a placebo. Their levels became similar to those of people with naturally high levels of this kind of cholesterol. Previous research has shown that people with naturally high levels of healthy cholesterol have lower rates of heart disease. So what makes this headline misleading: "Healthium reduces risk of heart disease." The problem with this headline is that the research didn’t actually investigate whether Healthium reduces heart disease. It only measured Healthium’s impact on levels of a particular kind of cholesterol. The fact that people with naturally high levels of that cholesterol have lower risk of heart attacks doesn’t mean that the same will be true of people who elevate their cholesterol levels using Healthium. Now that you’ve cracked the case of Healthium, try your hand at a particularly alluring mystery: the relationship between eating chocolate and stress. This hypothetical study recruits ten students. Half begin consuming a daily dose of chocolate, while half abstain. As classmates, they all follow the same schedule. By the end of the study, the chocolate eaters are less stressed than their chocolate-free counterparts. What’s wrong with this headline: "Eating chocolate reduces stress in students" It’s a stretch to draw a conclusion about students in general from a sample of ten. That’s because the fewer participants are in a random sample, the less likely it is that the sample will closely represent the target population as a whole. For example, if the broader population of students is half male and half female, the chance of drawing a sample of 10 that’s skewed 70% male and 30% is about 12%. In a sample of 100 that would be less than a .0025% chance, and for a sample of 1000, the odds are less than 6 x 10^-36. Similarly, with fewer participants, each individual’s outcome has a larger impact on the overall results— and can therefore skew big-picture trends. Still, there are a lot of good reasons for scientists to run small studies. By starting with a small sample, they can evaluate whether the results are promising enough to run a more comprehensive, expensive study. And some research requires very specific participants that may be impossible to recruit in large numbers. The key is reproducibility— if an article draws a conclusion from one small study, that conclusion may be suspect— but if it’s based on many studies that have found similar results, it’s more credible. We’ve still got one more puzzle. In this scenario, a study tests a new drug for a rare, fatal disease. In a sample of 2,000 patients, the ones who start taking the drug upon diagnosis live longer than those who take the placebo. This time, the question is slightly different. What’s one more thing you’d like to know before deciding if the headline, "New drug prolongs lives of patients with rare disease", is justified? Before making this call, you’d want to know how much the drug prolonged the patients’ lives. Sometimes, a study can have results that, while scientifically valid, don’t have much bearing on real world outcomes. For example, one real-life clinical trial of a pancreatic cancer drug found an increase in life expectancy— of ten days. The next time you see a surprising medical headline, take a look at the science it’s reporting on. Even when full papers aren’t available without a fee, you can often find summaries of experimental design and results in freely available abstracts, or even within the text of a news article. It’s exciting to see scientific research covered in the news, and important to understand the studies’ findings.

**P732 2019-05-13 How close are we to eradicating HIV - Philip A. Chan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=732)

The world is getting closer to achieving one of the most important public health goals of our time: eradicating HIV. And to do this, we won’t even have to cure the disease. We simply have to stop HIV from being transmitted until eventually it fizzles out. Once, this goal would have seemed impossible. HIV has caused millions of deaths and is one of the most devastating diseases that humanity has ever known. But we’re now at a point where new advances such as one-pill, once-a-day medications are helping us tackle HIV in effective ways. HIV is a retrovirus– meaning it integrates copies of itself into an infected cell’s DNA, allowing it to replicate and infect other cells. HIV has evolved numerous ways to evade the human immune system, which makes it difficult to cure. But by developing ways to block HIV replication, we can stop the spread of HIV itself. That’s where antiretrovirals– a.k.a. ARVs– come in. ARVs are a group of drugs which work in different ways to combat HIV. Some block HIV’s access into immune cells, and others work by stopping the virus itself from replicating. ARVs also work preventatively in people who don’t have HIV. This type of approach is called pre-exposure prophylaxis, or PrEP. PrEP works by accumulating in a person’s body and preventing HIV from establishing itself. That means an HIV-negative person who may be at risk of contracting the disease can take certain ARVs to protect themselves, before they become exposed. Here’s where it gets especially interesting: In people with HIV, ARVs can also dramatically reduce HIV transmission. This is called “Treatment as Prevention.” On a global scale, this has the potential to end the HIV epidemic. It’s based on the idea that someone with HIV who takes ARV’s can lower the virus level in their bodies until it becomes undetectable. That doesn’t mean the virus is gone; it could still be lurking within cells, ready to reactivate if treatment stops. But so long as it’s kept dormant with drugs, HIV remains undetectable. And when HIV is undetectable, it’s untransmittable, too. In theory this means that by testing everyone who’s at risk of HIV and treating those who test positive, we could stop transmission and eventually eradicate HIV. In the real world, however, things are more complex. Many at-risk HIV negative people across the world do not have access to PrEP or ARVs, and those who are HIV positive may experience challenges to taking ARVs. These problems are often greatest in countries where the burden of HIV is highest. Getting these medications depends on access to a functioning healthcare system– and this isn’t something everyone has. That’s part of the reason why stopping the spread of HIV for good will require a significant investment of resources to improve those systems. One study carried out by the UNAIDS estimated that between 20-30 billion dollars per year would be needed to achieve a nearly 90% reduction in new HIV infections by 2030. This investment would ensure more people would get tested in the first place, and more would be able to access and maintain treatment. Achieving this goal and improving healthcare in general is in everyone’s best interest, from individual people to society as a whole. We have roadmaps that could allow us to bring the HIV epidemic to an end in the near future, with the possibility of eradicating the disease altogether several generations in the future. In the period from 1996 to 2017 we almost halved the number of new HIV infections, and for the millions of people who still live with the virus, ARV treatments enable most to lead long and healthy lives. With continued and increased investments, we can get transmission rates low enough to end HIV once and for all. A world without HIV is no longer inconceivable: it’s closer than ever.

**P733 2019-05-14 'For Estefani' poem by Aracelis Girmay**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=733)

I'm Aracelis Girmay, and this is, "For Estefani, Third Grade, Who Made Me a Card." Elephant on an orange line, underneath a yellow circle, meaning sun. Six green, vertical lines, with color all from the top, meaning flowers. The first time I peel back the five squares of Scotch tape, unfold the crooked-crease fold of art class paper. I am in my living room. It is June. Inside of the card, there is one long word, and then Estefani’s name: Loisfoeribari Estefani Loisfoeribari? Loisfoeribari: The scientific, Latinate way of saying hibiscus. Loisforeribari: A direction, as in: are you going North? South? East? West? Loisfoeribari? I try, over and over, to read the word out loud. Loisfoeribari. LoISFOeribari. LoiSFOEribari. LoisFOERibARI. What is this word? I imagine using it in sentences like, “Man, I have to go back to the house, I forgot my Loisfoeribari.” or “There’s nothing better than rain, hot rain, open windows with music, and a tall glass of Loisfoeribari.” or “How are we getting to Pittsburgh? Should we drive or take the Loisfoeribari?” I have lived four minutes with this word not knowing what it means. It is the end of the year. I consider writing my student, Estefani, a letter that goes: To The BRILLIANT Estefani! Hola, querida, I hope that you are well. I’ve just opened the card that you made me, and it is beautiful. I really love the way you filled the sky with birds. I believe that you are chula, chulita, and super fly! Yes, the card is beautiful. I only have one question for you. What does the word ‘Loisfoeribari’ mean? I try the word again. Loisfoeribari. Loisfoeribari. Loisfoeribari. I try the word in Spanish. Loisfoeribari Lo-ees-fo-eh-dee-bah-dee Lo-ees-fo-eh-dee-bah-dee and then, slowly, Lo is fo e ri bari Lo is fo eribari love is for everybody love is for every every body love love love everybody love everybody love love is love everybody everybody is love love love for love for everybody for love is everybody love is for every love is for every body love love love for body love body body is love love is body every body is love is every love for every love is love for love everybody love love love love for everybody Love is for everybody.

**P734 2019-05-14 'New Colossus' by Emma Lazarus**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=734)

"The New Colossus" by Emma Lazarus Not like the brazen giant of Greek fame, With conquering limbs astride from land to land; Here at our sea-washed, sunset gates shall stand A mighty woman with a torch, whose flame Is the imprisoned lightning, and her name Mother of Exiles. From her beacon-hand Glows world-wide welcome; her mild eyes command The air-bridged harbor that twin cities frame. “Keep, ancient lands, your storied pomp!” cries she With silent lips. “Give me your tired, your poor, Your huddled masses yearning to breathe free, The wretched refuse of your teeming shore. Send these, the homeless, tempest-tost to me, I lift my lamp beside the golden door!”

**P735 2019-05-14 'Ode to the Only Black Kid in the Class' poem by Clint Smith**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=735)

I'm Clint Smith and this is "Ode to the Only Black Kid in the Class." You, it seems, are the manifestation of several lifetimes of toil. Brown v. Board in flesh. Most days the classroom feels like an antechamber. You are deemed expert on all things Morrison, King, Malcolm, Rosa. Hell, weren’t you sitting on that bus, too? You are every- body’s best friend until you are not. Hip-hop lyricologist. Presumed athlete. Free & Reduced sideshow. Exception and caricature. Too black and too white all at once. If you are successful it is because of affirmative action. If you fail it is because you were destined to. You are invisible until they turn on the Friday night lights. Here you are star before they render you asteroid. Before they watch you turn to dust.

**P736 2019-05-14 There may be extraterrestrial life in our solar system - Augusto Carb**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=736)

Deep in our solar system, a new era of space exploration is unfolding. Beneath the thick ice of Europa, in the vapor plumes on Enceladus, and within the methane lakes of Titan, astrobiologists are on the hunt for extraterrestrial life. We’ve honed in on these three moons because each is an ‘ocean world,’ an environment that contains a liquid ocean– and liquid can support the formation of life. Living organisms have to be able to grow, reproduce, and feed themselves, among other things. All of those functions require the formation of complex molecules from more basic components. Liquids such as water allow chemical compounds to remain in suspension instead of sinking under the force of gravity. This enables them to interact frequently in a 3-dimensional space and, in the right conditions, go through chemical reactions that lead to the formation of living matter. That alone isn’t enough; the small but complex biomolecules that we’re familiar with are sensitive to temperature— too hot or cold, and they won’t mix. Liquid water has an additional advantage in that it’s relatively temperature-stable, meaning it can insulate molecules against large shifts in heat. On Earth, these and other conditions in aquatic environments may have supported the emergence of life billions of years ago. Tantalizingly, the same could be true in other parts of our solar system, like these three icy moons. Europa, which is a moon of Jupiter, is probably the most intriguing ocean world. Beneath a surface layer of ice thicker than Mount Everest, there exists a liquid ocean as much as 100 kilometers deep. Astrobiologists think this hidden ocean could harbor life. Thanks to the Galileo probe, we can deduce that its potential salt content is similar to that of some lakes on Earth. But most of its characteristics will be a mystery until we can explore it further. Like Jupiter, Saturn also has moons that might have the right conditions for life. For instance– Enceladus is a tiny ball of ice that’s small enough to nestle within the surface area of the Gulf of Mexico. Similarly to Europa, it likely contains an ocean deep under the ice. But Enceladus also has geysers that frequently vent water vapor and tiny ice grains into space. Astrobiologists are curious about whether these geysers are connected to the ocean below. They hope to send a probe to test whether the geysers’ plumes of vapor contain life-enabling material from that hidden sea. Although it’s the best known substance for nurturing life, water isn’t necessarily the only medium that can support living things. Take Titan, Saturn’s largest moon, which has a thick nitrogen atmosphere containing methane and many other organic molecules. Its clouds condense and rain onto Titan’s surface, sustaining lakes and seas full of liquid methane. This compound’s particular chemistry means it’s not as supportive a medium as water. But, paired with the high quantities of organic material that also rain down from the sky, these bodies of liquid methane could possibly support unfamiliar life forms. So what might indicate that life exists on these or other worlds? If it is out there, astrobiologists speculate that it would be microscopic, comparable to the bacteria we have on earth. This would make it difficult to directly observe from a great distance, so astrobiologists seek clues called biosignatures. Those may be cells, fossils, or mineral traces left behind by living things. And finding any biosignatures will be challenging for many reasons. One of the biggest concerns is to make sure we sterilize our probes extremely thoroughly. Otherwise we could accidentally contaminate ocean worlds with Earth’s own bacteria, which could destroy alien life. Titan, Enceladus, and Europa are just three of possibly many ocean worlds that we could explore. We already know of several other candidates in our solar system, including Jupiter’s moons Callisto and Ganymede, Neptune’s Triton, and even Pluto. If there’s this much potential for life to exist in our own tiny solar system, what unimagined secrets might the rest of the universe contain?

**P737 2019-05-14 Ugly History - Witch Hunts - Brian A. Pavlac**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=737)

In the German town of Nördlingen in 1593, an innkeeper named Maria Höll found herself accused of witchcraft. She was arrested for questioning, and denied the charges. She continued to insist she wasn’t a witch through 62 rounds of torture before her accusers finally released her. Rebekka Lemp, accused a few years earlier in the same town, faced a worse fate. She wrote to her husband from jail worrying that she would confess under torture, even though she was innocent. After giving a false confession, she was burned at the stake in front of her family. Höll and Lemp were both victims of the witch hunts that occurred in Europe and the American colonies from the late 15th century until the early 18th century. These witch hunts were not a unified initiative by a single authority, but rather a phenomenon that occurred sporadically and followed a similar pattern each time. The term “witch” has taken on many meanings, but in these hunts, a witch was someone who allegedly gained magical powers by obeying Satan rather than God. This definition of witchcraft spread through churches in Western Europe starting at the end of the 15th century. It really gained traction after the pope gave a friar and professor of theology named Heinrich Kraemer permission to conduct inquisitions in search of witches in 1485. His first, in the town of Innsbruck, didn’t gain much traction with the local authorities, who disapproved of his harsh questioning of respectable citizens and shut down his trials. Undeterred, he wrote a book called the "Malleus Maleficarum," or "Hammer of Witches." The text argued for the existence of witches and suggested ruthless tactics for hunting and prosecuting them. He singled out women as easier targets for the devil’s influence, though men could also be witches. Kraemer’s book spurred others to write their own books and give sermons on the dangers of witchcraft. According to these texts, witches practiced rituals including kissing the Devil’s anus and poisoning or bewitching targets the devil singled out for harm. Though there was no evidence to support any of these claims, belief in witches became widespread. A witch hunt often began with a misfortune: a failed harvest, a sick cow, or a stillborn child. Community members blamed witchcraft, and accused each other of being witches. Many of the accused were people on the fringes of society: the elderly, the poor, or social outcasts, but any member of the community could be targeted, even occasionally children. While religious authorities encouraged witch hunts, local secular governments usually carried out the detainment and punishment of accused witches. Those suspected of witchcraft were questioned and often tortured— and under torture, thousands of innocent people confessed to witchcraft and implicated others in turn. Because these witch hunts occurred sporadically over centuries and continents the specifics varied considerably. Punishments for convicted witches ranged from small fines to burning at the stake. The hunt in which Höll and Lemp were accused dragged on for nine years, while others lasted just months. They could have anywhere from a few to a few hundred victims. The motivations of the witch hunters probably varied as well, but it seems likely that many weren’t consciously looking for scapegoats— instead, they sincerely believed in witchcraft, and thought they were doing good by rooting it out in their communities. Institutions of power enabled real harm to be done on the basis of these beliefs. But there were dissenters all along– jurists, scholars, and physicians countered books like Kraemer’s "Hammer of Witches" with texts objecting to the cruelty of the hunts, the use of forced confessions, and the lack of evidence of witchcraft. From the late 17th through the mid-18th century, their arguments gained force with the rise of stronger central governments and legal norms like due process. Witch hunting slowly declined until it disappeared altogether. Both the onset and demise of these atrocities came gradually, out of seemingly ordinary circumstances. The potential for similar situations, in which authorities use their powers to mobilize society against a false threat, still exists today— but so does the capacity of reasoned dissent to combat those false beliefs.

**P738 2019-05-14 Your body vs. implants - Kaitlyn Sadtler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=738)

Insulin pumps improve the lives of many of the 415 million people with diabetes around the world by monitoring blood sugar, delivering insulin, and preventing the need for constant finger-pricking and blood testing. These small machines include a pump and a needle, which can sense glucose levels, feed back to the pump, and then calculate how much insulin to deliver through the needle. But they have a catch: they’re temporary. Within a few days, glucose sensors have to be moved and replaced. And it’s not just glucose monitors and insulin pumps that have this problem, but all bodily implants, at different time scales. Plastic prosthetic knees have to be replaced after about 20 years. Other implants, such as those used for cosmetic reasons, can meet the same fate in about 10. That isn’t just a nuisance: it can be expensive and risky. This inconvenience happens because of our bodies’ immune systems. Honed by several hundred million years of evolution, these defensive fronts have become exceptionally good at identifying foreign objects. Our immune systems boast an impressive arsenal of tools to tackle, intercept, and destroy anything they believe shouldn’t be there. But the consequence of this constant surveillance is that our bodies treat helpful implants, like insulin pumps, with the same suspicion as they would a harmful virus or bacteria. As soon as the insulin pump has been implanted in the skin, its presence triggers what’s known as a “foreign body response.” This starts with free-floating proteins that stick themselves to the surface of the implant. Those proteins include antibodies, which attempt to neutralize the new object and send out a signal that calls other immune cells to the site to strengthen the attack. Early-responding inflammatory cells, like neutrophils and macrophages, respond to the emergency call. Neutrophils release little granules filled with enzymes that try to break down the surface of the insulin pump’s needle. Macrophages secrete enzymes too, together with nitric oxide radicals, which create a chemical reaction that degrades the object over time. If the macrophages are unable to dispatch the foreign body rapidly, they fuse together, forming a mass of cells called a “giant cell.” At the same time, cells called fibroblasts travel to the site and begin to deposit layers of dense connective tissue. Those enclose the needle that the pump uses to deliver insulin and test for glucose levels. Over time this scaffolding builds up, forming a scar around the implant. The scar functions as an almost impenetrable wall that might start to block vital interactions between the body and the implant. For example, scarring around pacemakers can interrupt the electrical transmission that’s crucial for their functioning. Synthetic knee joints may give off particles as they’re worn down, causing immune cells to inflame around these fragments. Tragically, the immune system’s attack can even be life-threatening. However, researchers are finding ways to trick the immune system into accepting the new devices we introduce into our bodily tissues. We’ve discovered that coating implants with certain chemicals and drugs can dampen the immune response. Those basically make the implants invisible to the immune system. We’re also making more implants out of natural materials and in forms that directly mimic tissues, so that the body launches a weaker attack than it would if it came across a completely artificial implant. Some medical treatments involve implants designed to regenerate lost or damaged tissues. In those cases, we can design the implants to contain ingredients that will release specific signals, and carefully tailor our bodies’ immune reactions. In the future, this way of working alongside the immune system could help us develop completely artificial organs, totally integrative prostheses, and self-healing wound therapies. These treatments might one day revolutionize medicine– and transform, forever, the bodies we live in.

**P739 2019-05-22 How do crystals work - Graham Baird**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=739)

Deep beneath the geysers and hot springs of Yellowstone Caldera lies a magma chamber produced by a hot spot in the earth’s mantle. As the magma moves towards the Earth’s surface, it crystallizes to form young, hot igneous rocks. The heat from these rocks drives groundwater towards the surface. As the water cools, ions precipitate out as mineral crystals, including quartz crystals from silicon and oxygen, feldspar from potassium, aluminum, silicon, and oxygen, galena from lead and sulfur. Many of these crystals have signature shapes— take this cascade of pointed quartz, or this pile of galena cubes. But what causes them to grow into these shapes again and again? Part of the answer lies in their atoms. Every crystal’s atoms are arranged in a highly organized, repeating pattern. This pattern is the defining feature of a crystal, and isn’t restricted to minerals— sand, ice, sugar, chocolate, ceramics, metals, DNA, and even some liquids have crystalline structures. Each crystalline material’s atomic arrangement falls into one of six different families: cubic, tetragonal, orthorhombic, monoclinic, triclinic, and hexagonal. Given the appropriate conditions, crystals will grow into geometric shapes that reflect the arrangement of their atoms. Take galena, which has a cubic structure composed of lead and sulfur atoms. The relatively large lead atoms are arranged in a three-dimensional grid 90 degrees from one another, while the relatively small sulfur atoms fit neatly between them. As the crystal grows, locations like these attract sulfur atoms, while lead will tend to bond to these places. Eventually, they will complete the grid of bonded atoms. This means the 90 degree grid pattern of galena’s crystalline structure is reflected in the visible shape of the crystal. Quartz, meanwhile, has a hexagonal crystalline structure. This means that on one plane its atoms are arranged in hexagons. In three dimensions, these hexagons are composed of many interlocking pyramids made up of one silicon atom and four oxygen atoms. So the signature shape of a quartz crystal is a six-sided column with pointed tips. Depending on environmental conditions, most crystals have the potential to form multiple geometric shapes. For example, diamonds, which form deep in the Earth’s mantle, have a cubic crystalline structure and can grow into either cubes or octahedrons. Which shape a particular diamond grows into depends on the conditions where it grows, including pressure, temperature, and chemical environment. While we can’t directly observe growth conditions in the mantle, laboratory experiments have shown some evidence that diamonds tend to grow into cubes at lower temperatures and octahedrons at higher temperatures. Trace amounts of water, silicon, germanium, or magnesium might also influence a diamond’s shape. And diamonds never naturally grow into the shapes found in jewelry— those diamonds have been cut to showcase sparkle and clarity. Environmental conditions can also influence whether crystals form at all. Glass is made of melted quartz sand, but it isn’t crystalline. That’s because glass cools relatively quickly, and the atoms do not have time to arrange themselves into the ordered structure of a quartz crystal. Instead, the random arrangement of the atoms in the melted glass is locked in upon cooling. Many crystals don’t form geometric shapes because they grow in extremely close quarters with other crystals. Rocks like granite are full of crystals, but none have recognizable shapes. As magma cools and solidifies, many minerals within it crystallize at the same time and quickly run out of space. And certain crystals, like turquoise, don’t grow into any discernible geometric shape in most environmental conditions, even given adequate space. Every crystal’s atomic structure has unique properties, and while these properties may not have any bearing on human emotional needs, they do have powerful applications in materials science and medicine.

**P740 2019-06-03 Underwater farms vs. climate change - Ayana Elizabeth Johnson and Meg**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=740)

For 3 billion people around the world, seafood provides a significant source of protein and nutrition. But recent studies show that 33% of wild fisheries are overfished, while another 60% are fished at their maximum capacity. In fact, over half the seafood we eat– from finfish and shellfish to seaweed and algae– isn’t caught in the wild. It’s grown through aquaculture, or aquatic farming. Farmed seafood is one of the fastest-growing food industries, expanding in volume by 5.8% each year. But different methods of aquaculture come with different advantages and issues– some of which echo the serious problems we’ve seen in industrial agriculture. So how can we avoid repeating the mistakes we’ve made on land, at sea? What aquaculture approaches are we currently using, and what does a sustainable way to farm the ocean really look like? One of the most common aquaculture methods involves large pens made of nets, where fish are farmed offshore in floating cages roughly 1000 square meters in size. Commonly employed off the coast of Chile and in the fjords of Norway, these fish, like many industrially farmed animals, occupy stressful, overcrowded pens. They produce massive amounts of waste, polluting the surrounding areas and potentially spreading diseases to wild species. Worse still, since the antibiotics employed to fight disease aren’t fully absorbed by the fish, they get excreted back into the environment. Net pens are also susceptible to escapes, unleashing huge numbers of fish which compete for resources and weaken the local gene pool with genes adapted for captivity. Escaped fish can even disrupt local ecosystems as invasive species. Other techniques, such as man-made coastal ponds commonly used for shrimp farming in Southeast Asia, create additional environmental problems. Just like net pens, these ponds are prone to spreading pollution and disease. Their construction also frequently destroys important ecosystems like mangroves and marshes, which protect coastal areas from storms, provide habitats, and absorb tons of greenhouse gases. One way to solve these problems is to farm fish on land in completely contained systems. Tanks and raceways can recirculate and filter water to prevent pollution. But even fully contained facilities still contend with another major hurdle: fishmeal. About 10% of the seafood caught globally is used to feed animals, including carnivorous farmed fish. Researchers are working on fish feed made of insects and plant-based proteins, but for now many inland fish farms are connected to overfishing. All these obstacles can make sustainable aquaculture feel a long way off, but innovative farmers are finding new ways to responsibly farm the seas. The most promising solution of all may be to look lower on the food chain. Instead of cramming large, carnivorous fish into pens, we can work with natural ocean systems to produce huge amounts of shellfish and seaweeds. These low-maintenance flora and fauna don’t need to be fed at all. In fact, they naturally improve water quality, filtering it as they feed off of sunlight and nutrients in the seawater. By absorbing carbon through photosynthesis, these farms help battle climate change, and reduce local ocean acidification while creating habitats for other species to thrive. Shifting to restorative ocean farming could provide good jobs for coastal communities, and support healthy plant and shellfish-based diets that have an incredibly low carbon footprint. In just 5 months, 4,000 square meters of ocean can produce 25 tons of seaweed and 250,000 of shellfish. With the right distribution network, a series of small farms, collectively the size of Washington State could feed the planet. Farms like these are already popping up around the globe, and a new generation of farmers is stepping up to pursue a more sustainable future. Done properly, regenerative ocean farming could play a vital role in helping our oceans, our climate, and ourselves.

**P741 2019-06-04 The Romans flooded the Colosseum for sea battles - Janelle Peters**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=741)

The cry of the crowd. The roar of a lion. The clash of metal. Starting in 80 CE these sounds rang through the stands of the Colosseum. On hundreds of days a year, over 50,000 residents of Rome and visitors from across the Roman Empire would fill the stadiums’ four stories to see gladiators duel, animals fight, and chariots race around the arena. And for the grand finale, water poured into the arena basin, submerging the stage for the greatest spectacle of all: staged naval battles. The Romans’ epic, mock maritime encounters, called naumachiae, started during Julius Caesar’s reign in the first century BC, over a hundred years before the Colosseum was built. They were held alongside other aquatic spectacles on natural and artificial bodies of water around Rome up through Emperor Flavius Vespasian, who began building the Colosseum in 70 CE on the site of a former lake. The Colosseum was intended to be a symbol of Rome’s power in the ancient world, and what better way to display that power than a body of water that could drain and refill at the Emperor’s command? Vespasian’s son Flavius Titus fulfilled his father’s dream in 80 CE when he used war spoils to finish the Colosseum– or as it was known at the time, the Flavian Amphitheater. The grand opening was celebrated with 100 days of pageantry and gladiatorial games, setting the precedent for programming that included parades, musical performances, public executions, and of course, gladiatorial combat. Unlike the games in smaller amphitheaters funded by wealthy Romans, these lavish displays of Imperial power were financed by the Emperor. Parades of exotic animals, theatrical performances, and the awe-inspiring naumachiae were all designed to bolster faith in the god-like Emperor, who would be declared a god after his own death. It’s still a mystery how engineers flooded the arena to create this aquatic effect. Some historians believe a giant aqueduct was diverted into the arena. Others think the system of chambers and sluice gates used to drain the arena, were also used to fill it. These chambers could’ve been filled with water prior to the event and then opened to submerge the stage under more than a million gallons of water, to create a depth of five feet. But even with all that water, the Romans had to construct miniature boats with special flat bottoms that wouldn’t scrape the Colosseum floor. These boats ranged from 7 to 15 meters long, and were built to look like vessels from famous encounters. During a battle, dozens of these ships would float around the arena, crewed by gladiators dressed as the opposing sides of the recreated battle. These warriors would duel across ships; boarding them, fighting, drowning, and incapacitating their foes until only one faction was left standing. Fortunately, not every watery display told such a gruesome story. In some of these floodings, a submerged stage allowed chariot drivers to glide across the water as though they were Triton, making waves as he piloted his chariot on the sea. Animals walked on water, myths were re-enacted by condemned prisoners, and at night, nude synchronized swimmers would perform by torchlight. But the Colosseum’s aquatic age didn’t last forever. The naval battles proved so popular they were given their own nearby lake by Emperor Domitian in the early 90s CE. The larger lake proved even better for naumachiae, and the Colosseum soon gained a series of underground animal cages and trap doors that didn’t allow for further flooding. But for a brief time, the Flavian Emperors controlled the tides of war and water in a spectacular show of power.

**P742 2019-06-13 Why should you read 'Hamlet' - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=742)

"Who’s there?" Whispered in the dark, this question begins a tale of conspiracy, deception and moral ambiguity. And in a play where everyone has something to hide, its answer is far from simple. Written by William Shakespeare between 1599 and 1601, "Hamlet" depicts its titular character haunted by the past, but immobilized by the future. Mere months after the sudden death of his father, Hamlet returns from school a stranger to his own home, and deeply unsure of what might be lurking in the shadows. But his brooding takes a turn when he’s visited by a ghost that bears his father’s face. The phantom claims to be the victim of a “murder most foul,” and convinces Hamlet that his uncle Claudius usurped the throne and stole queen Gertrude’s heart. The prince’s mourning turns to rage, and he begins to plots his revenge on the new king and his court of conspirators. The play is an odd sort of tragedy, lacking either the abrupt brutality or all-consuming romance that characterize Shakespeare’s other work in the genre. Instead it plumbs the depths of its protagonist’s indecisiveness, and the tragic consequences thereof. The ghost’s revelation draws Hamlet into multiple dilemmas– what should he do, who can he trust, and what role might he play in the course of justice? These questions are complicated by a tangled web of characters, forcing Hamlet to negotiate friends, family, court counselors, and love interests– many of whom possess ulterior motives. The prince constantly delays and dithers over how to relate to others, and how he should carry out revenge. This can make Hamlet more than a little exasperating, but it also makes him one of the most human characters Shakespeare ever created. Rather than rushing into things, Hamlet becomes consumed with the awful machinations of thinking itself. And over the course of the play, his endless questions come to echo throughout our own racing minds. To accomplish this, Shakespeare employs his most introspective language. From the usurping king’s blazing contemplation of heaven and hell, to the prince’s own cackling meditation on mortality, Shakespeare uses melancholic monologues to breathtaking effect. This is perhaps best exemplified in Hamlet’s most famous declaration of angst: "To be or not to be—that is the question: Whether ’tis nobler in the mind to suffer The slings and arrows of outrageous fortune, Or to take arms against a sea of troubles And, by opposing, end them." This monologue personifies Hamlet’s existential dilemma: being torn between thought and action, unable to choose between life and death. But his endless questioning raises yet another anxiety: is Hamlet’s madness part of a performance to confuse his enemies, or are we watching a character on the brink of insanity? These questions weigh heavily on Hamlet’s interactions with every character. And since he spends much of the play facing inward, he often fails to see the destruction left in his wake. He’s particularly cruel to Ophelia, his doomed love interest who is brought to madness by the prince’s erratic behavior. Her fate is one example of how tragedy could have been easily avoided, and shows the ripple effect of Hamlet’s toxic mind games. Similar warning signs of tragedy are constantly overlooked throughout the play. Sometimes, these oversights occur because of willful blindness– such as when Ophelia’s father dismisses Hamlet’s alarming actions as mere lovesickness. At other points, tragedy stems from deliberate duplicity– as when a case of mistaken identity leads to yet more bloodshed. These moments leave us with the uncomfortable knowledge that tragedy evolves from human error– even if our mistake is to leave things undecided. For all these reasons, perhaps the one thing we never doubt is Hamlet’s humanity. But we must constantly grapple with who the “real” Hamlet might be. Is he a noble son avenging his father? Or a mad prince creating courtly chaos? Should he act or observe, doubt or trust? Who is he? Why is he here? And who’s out there– waiting in the dark?

**P743 2019-06-14 The secret language of trees - Camille Defrenne and Suzanne Simard**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=743)

Most of the forest lives in the shadow of the giants that make up the highest canopy. These are the oldest trees, with hundreds of children and thousands of grandchildren. They check in with their neighbors, sharing food, supplies, and wisdom gained over their long lives. They do all this rooted in place, unable to speak, reach out, or move around. The secret to their success lies under the forest floor, where vast root systems support the towering trunks above. Partnering with these roots are symbiotic fungi called mycorrhizae. These fungi have countless branching, thread-like hyphae that together make up the mycelium. The mycelium spreads across a much larger area than the tree root system and connect the roots of different trees together. These connections form mycorrhizal networks. Through mycorrhizal networks, fungi can pass resources and signaling molecules between trees. We know the oldest trees have the largest mycorrhizal networks with the most connections to other trees, but these connections are incredibly complicated to trace. That’s because there are about a hundred species of mycorrhizal fungi– and an individual tree might be colonized by dozens of different fungal organisms, each of which connects to a unique set of other trees, which in turn each have their own unique set of fungal associations. To get a sense of how substances flow through this network, let’s zoom in on sugars, as they travel from a mature tree to a neighboring seedling. Sugar’s journey starts high above the ground, in the leaves of the tallest trees above the canopy. The leaves use the ample sunlight up there to create sugars through photosynthesis. This essential fuel then travels through the tree to the base of the trunk in the thick sap. From there, sugar flows down to the roots. Mycorrhizal fungi encounter the tips of the roots and either surround or penetrate the outer root cells, depending on the type of fungi. Fungi cannot produce sugars, though they need them for fuel just like trees do. They can, however, collect nutrients from the soil much more efficiently than tree roots— and pass these nutrients into the tree roots. In general, substances flow from where they are more abundant to where they are less abundant, or from source to sink. That means that the sugars flow from the tree roots into the fungal hyphae. Once the sugars enter the fungus, they travel along the hyphae through pores between cells or through special hollow transporter hyphae. The fungus absorbs some of the sugars, but some travels on and enters the roots of a neighboring tree, a seedling that grows in the shade and has less opportunity to photosynthesize sugars. But why does fungus transport resources from tree to tree? This is one of the mysteries of the mycorrhizal networks. It makes sense for fungus to exchange soil nutrients and sugar with a tree— both parties benefit. The fungus likely benefits in less obvious ways from being part of a network between trees, but the exact ways aren’t totally clear. Maybe the fungus benefits from having connections with as many different trees as possible, and maximizes its connections by shuttling molecules between trees. Or maybe plants reduce their contributions to fungi if the fungi don’t facilitate exchanges between trees. Whatever the reasons, these fungi pass an incredible amount of information between trees. Through the mycorrhizae, trees can tell when nutrients or signaling molecules are coming from a member of their own species or not. They can even tell when information is coming from a close relative like a sibling or parent. Trees can also share information about events like drought or insect attacks through their fungal networks, causing their neighbors to increase production of protective enzymes in anticipation of threats. The forest’s health relies on these intricate communications and exchanges. With everything so deeply interconnected, what impacts one species is bound to impact others.

**P744 2019-06-24 Can you solve the dark matter fuel riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=744)

It’s an incredible discovery: an ancient, abandoned alien space station filled with precursor technology. But now, every species in the galaxy is in a mad dash to get there first and claim it for themselves. And right away, you’ve got a problem. Your ship’s faster-than-light jump drive consumes 1 unit of fuel for every parsec of distance it takes you, and your ship holds only 15 units of fuel. But the space station is 23 parsecs away, and there’s only empty space between there and here. There’s one thing that can help you, though: dark matter fuel is stable in deep space. That means you can vent a cache of it from your fuel chamber, and then come back to pick it up again later. Even though your ship holds only 15 units of fuel, you’ve been granted use of all 45 units in your current location. With some strategic fuel caching along the way, you might be able to make it all 23 parsecs. So how can you reach the alien space station? Answer in 3, 2, 1. It’s possible to solve this riddle using as few as two cache points, and there are also valid solutions that use more. No matter how you go about it though, the key is determining exactly where to cache fuel along your route. Let’s work backwards from the alien space station. To reach 23 parsecs, you’ll have to leave the 8-parsec mark with a full tank of fuel. The 8-parsec point is too far from the start to use as a cache right away; you could jump there, but wouldn’t have enough fuel to return to the start, let alone store any for later. So that means you’ll need to find a cache somewhere between the start and 8. But where? There’s an interesting pattern that can help. At the start you have exactly 3 tanks’ worth of fuel. At 8 parsecs you need exactly 1. Is there a point, which we can call point X, where you could have exactly 2? That would be useful, because then you could refuel there exactly twice, making full use of your storage capacity without any waste. Wherever point X is, you’ll jump forward from it twice: once to deposit some fuel at the 8-parsec cache point, and a second time for good. So you’ll jump the distance between X and 8-parsecs 3 times in all. You’d have 2 tanks of fuel at point X, and need 1 left at the 8 parsec cache point, so you can spend one tank-- or 15 units-- going back and forth. Since 15 units divided by 3 trips is 5, we can place these two cache points 5 parsecs apart. Any farther, and you wouldn’t have enough fuel to reach the alien space station. So it looks like the earliest we can place point X is at the 3-parsec mark. Is it possible to transport 30 units of fuel there? Let’s try. You set out with a full tank of 15 units. You jump 3 parsecs, drop 9 units off at the cache point, and then jump the 3 units home, arriving with an empty tank. Repeating this process gets you 18 units of fuel at the cache point, and one more jump puts you at the 3-parsec cache with 30 total units of fuel. So far so good! Next, you jump to the 8-parsec mark, drop off 5 units of fuel, and jump back to the 3-parsec mark. You fill up your tank and jump forward again, arriving with 10 units of fuel in your tank. And now the end is in sight. You beam the 5 units of fuel in from deep space to fill your tank to capacity, and type in the coordinates of your final destination. A 15-parsec jump leaves you running on fumes, but ready to dock with the precursor space station. Time to put this alien tech to work and make life better for everyone in the galaxy.

**P745 2019-06-26 Ancient Rome’s most notorious doctor - Ramon Glazov**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=745)

In the middle of the 16th century, a talented young anatomist named Andreas Vesalius made a shocking discovery: the most famous human anatomy texts in the world were wrong. They not only failed to account for many details of the human body, they also described the organs of apes and other mammals. While Vesalius knew he was right, announcing these errors would mean challenging Galen of Pergamon– the most renowned physician in medical history. But who was this towering figure? And why did doctors working more than 1,300 years later so revere and fear him? Born in 129 CE, Galen left home as a teen to scour the Mediterranean for medical wisdom. He returned home a gifted surgeon with a passion for anatomy and a penchant for showmanship. He gleefully entered public anatomy contests, eager to show up his fellow physicians. In one demonstration, he caused a pig to lose its voice by tying off one of its nerves. In another, he disemboweled a monkey and challenged his colleagues to repair it. When they couldn’t, he did. These grizzly feats won him a position as surgeon to the city’s gladiators. Eventually, he would leave the arena to become the personal physician to four Roman Emperors. While his peers debated symptoms and their origins, Galen obsessively studied anatomy. He was convinced that each organ had a specific function. Since the Roman government largely prohibited working with human cadavers, Galen conducted countless dissections of animals instead. Even with this constraint, his exhaustive investigations yielded some remarkably accurate conclusions. One of Galen’s most important contributions was the insight that the brain, not the heart, controlled the body. He confirmed this theory by opening the cranium of a living cow. By applying pressure to different parts of the brain, he could link various regions to specific functions. Other experiments allowed him to distinguish sensory from motor nerves, establish that urine was made in the kidneys, and deduce that respiration was controlled by muscles and nerves. But these wild experiments also produced extraordinary misconceptions. Galen never realized that blood cycles continuously throughout the body. Instead, he believed the liver constantly produces an endless supply of blood, which gets entirely depleted on its one-way trip to the organs. Galen is also credited with solidifying the popular theory of the Four Humours. Introduced by Hippocrates centuries earlier, this misguided hypothesis attributed most medical problems to an imbalance in four bodily fluids called humours. To correct the balance of these fluids, doctors employed dangerous treatments like bloodletting and purging. Informed by his poor understanding of the circulatory system, Galen was a strong proponent of these treatments, despite their sometimes lethal consequences. Unfortunately, Galen’s ego drove him to believe that all his discoveries were of the utmost importance. He penned treatises on everything from anatomy to nutrition to bedside manner, meticulously cataloguing his writings to ensure their preservation. Over the next 13 centuries, Galen’s prolific collection dominated all other schools of medical thought. His texts became the standard works taught to new generations of doctors, who in turn, wrote new essays extolling Galen’s ideas. Even doctors who actually dissected human cadavers would bafflingly repeat Galen’s mistakes, despite seeing clear evidence to the contrary. Meanwhile, the few practitioners bold enough to offer conflicting opinions were either ignored or ridiculed. For 1,300 years, Galen’s legacy remained untouchable– until renaissance anatomist Vesalius spoke out against him. As a prominent scientist and lecturer, his authority influenced many young doctors of his time. But even then, it took another hundred years for an accurate description of blood flow to emerge, and two hundred more for the theory of the Four Humours to fade. Hopefully, today we can reap the benefits of Galen’s experiments without attributing equal credence to his less accurate ideas. But perhaps just as valuable is the reminder that science is an ever-evolving process, which should always place evidence above ego.

**P746 2019-06-26 Infinity according to Jorge Luis Borges - Ilan Stavans**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=746)

When Ireneo Funes looked at a glass of wine on a table, he saw “all the shoots, clusters, and grapes of the vine. He remembered the shapes of the clouds in the south at the dawn of the 30th of April of 1882, and he could compare them in his recollection with the marbled grain in the design of a leather-bound book which he had seen only once, and with the lines in the spray which an oar raised in the Rio Negro on the eve of the battle of the Quebrancho.” In the short story “Funes, the Memorious,” Jorge Luis Borges explores what it would be like to have a perfect memory. His character not only remembers everything he has ever seen, but every time he has seen it in perfect detail. These details are so overwhelming Funes has to spend his days in a dark room, and can only sleep by imagining a part of town he has never visited. According to Borges, Funes’s memories even rendered him incapable of real thought, because “To think is to forget a difference, to generalize, to abstract. In the overly replete world of Funes there were nothing but details.” Funes’ limitless memory was just one of Borges’s many explorations of infinity. Born in Argentina in 1899, he admired the revolutionaries of his mother’s family but took after his father’s bookish clan. His body of essays, poems, and stories, or, as he called them, ficciones pioneered the literary style of “lo real maravilloso,” known in English as Magical Realism— and each was just a few pages long. Though Borges was not interested in writing long books, he was an avid reader, recruiting friends to read to him after he went blind in middle age. He said his image of paradise was an infinite library, an idea he brought to life in “The library of Babel.” Built out of countless identical rooms, each containing the same number of books of the same length, the library of babel is its own universe. It contains every possible variation of text, so there are some profound books, but also countless tomes of complete gibberish. The narrator has spent his entire life wandering this vast labyrinth of information in a possibly futile search for meaning. Labyrinths appeared over and over in Borges’ work. In “The Garden of Forking Paths,” as Yu Tsun winds his way through country roads, he remembers a lost labyrinth built by one of his ancestors. Over the course of the story, he finds out the labyrinth is not a physical maze but a novel. And this novel reveals that the real Garden of Forking Paths is time: in every instant, there are infinite possible courses of action. And as one moment follows another, each possibility begets another set of divergent futures. Borges laid out infinite expanses of time in his labyrinths, but he also explored the idea of condensing all of time into a single moment. In “The God’s Script,” at the very beginning of the world the god writes exactly one message into the spots of the jaguars, who then “love and reproduce without end, in caverns, in cane fields, on islands, in order that the last men might receive it.” The last man turns out to be a tenacious old priest who spends years memorizing and deciphering the jaguar’s spots, culminating in an epiphany where he finally understands the god’s message. Imprisoned deep underground, he has no one to share this meaning with, and it changes nothing about his circumstances, but he doesn’t mind: in that one moment, he has experienced all the experience of everyone who has ever existed. Reading Borges, you might catch a glimpse of infinity too.

**P747 2019-06-26 Romance and revolution - The poetry of Pablo Neruda - Ilan Stavans**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=747)

Pablo Neruda published his first collection of poems at age 19. He went on to win the Nobel Prize in Literature— and also rescue 2,000 refugees, spend three years in political exile, and run for president of Chile. A romantic and a revolutionary, Neruda was one of the most celebrated poets of the 20th century, but also one of the most accessible and controversial. Originally written in Spanish, his poems often use straightforward language and everyday experience to create lasting impact. Neruda was born Ricardo Eliezer Neftalí Reyes Basoalto in a small Chilean town in 1904. His father didn’t want him to be a poet, so at sixteen he began to write under the pen name “Pablo Neruda.” The poems in his early collection "Twenty Love Poems and a Song of Despair" were tender and perceptive, illuminating the subtleties of love and enchantment. In "Poem VI," for example, he writes: “Tu recuerdo es de luz, de humo, de estanque en calma!/ Más allá de tus ojos ardían los crepúsculos.” Later, he poured this attention to detail into poems of appreciation for everyday objects. Many of the 225 short poems in his collection "All the Odes" are dedicated to the assortment of small, apparently insignificant items that surround us, from a pair of shoelaces to a watermelon. An onion is más hermosa que un ave/ de plumas cegadoras, while a tuna in the market is a bala del profundo/ océano, proyectil natatorio, te vi, muerto. Despite this early literary success, Neruda struggled financially, and took a series of diplomatic jobs in places such as Burma, Indonesia, Singapore and Spain. In 1936, while Neruda was working at the consulate in Madrid, civil war broke out and the government was overthrown by a fascist military dictatorship. Neruda organized an evacuation of refugees from Spain to Chile, saving 2,000 lives. Over a period of twenty years, Neruda captured his experiences abroad in a three volume poetry collection titled "Residence on Earth." Many of these poems were experimental and surreal, merging epic landscapes, supernatural themes, and feelings of longing with discussion of political strife and a poet’s responsibility to speak out against injustice. In “I Explain a Few Things” he lingers on haunting details of the destruction of the Spanish Civil War. For the rest of his life, Neruda remained committed to revolutionary ideals. His politics led to several years of exile before he was able to return to Chile in 1952. While in exile, he published his influential "Canto General." The book attempts to retell the entire history of Latin America through poetry, touching on everything from its flora and fauna to its politics and wars, but above all paying homage to the common people behind its civilizations’ achievements. Although he continued to travel, after returning from exile Neruda lived in Chile for the rest of his life. In 1970, at age 66, Neruda ran for president of Chile before yielding to Salvador Allende and becoming his close advisor. But in 1973, Allende was overthrown in a military coup by General Augusto Pinochet. Neruda died in the hospital a couple of weeks later. Because of the timing of his death so soon after the coup, rumors swirled that he had died of sadness or even been assassinated, but the hospital recorded his cause of death as cancer. Today, Neruda’s lines are recited at protests and marches worldwide. Much like his life, Neruda’s poems bridged romance and revolution by emphasizing the everyday moments worth fighting for.

**P748 2019-06-28 Why should you read “Kafka on the Shore” - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=748)

“Sometimes fate is like a small sandstorm that keeps changing directions. You change direction but the sandstorm chases you. You turn again, but the storm adjusts. Over and over you play this out, like some ominous dance with death just before dawn. Why? Because this storm isn't something that blew in from far away… This storm is you. Something inside of you.” This quote, from the first chapter of Haruki Murakami’s "Kafka on the Shore," captures the teenage protagonist's turmoil. Desperate to escape his tyrannical father and the family curse he feels doomed to repeat, he renames himself Kafka after his favorite author and runs away from home. But memories of a missing mother, along with dreams that haunt his waking life, prove more difficult to outrun. Published in Japanese in 2002 and translated into English three years later, "Kafka on the Shore" is an epic literary puzzle filled with time travel, hidden histories, and magical underworlds. Readers delight in discovering how the mind-bending imagery, whimsical characters and eerie coincidences fit together. Kafka narrates every second chapter, with the rest centering on an old man named Satoru Nakata. After awakening from a coma he went into during the Second World War, Nakata loses the ability to read and write– but gains a mysterious knack for talking to cats. When he’s asked to tail a missing pet, he’s thrown onto a dangerous path that runs parallel to Kafka’s. Soon prophecies come true, portals to different dimensions open up– and fish and leeches begin raining from the sky. But what ties these two characters together– and is it a force either one of them can control? The collision of different worlds is a common thread in Haruki Murakami’s work. His novels and short stories often forge fantastic connections between personal experience, supernatural possibilities, and Japanese history. Born in Kyoto in 1949, Murakami grew up during the post-World War II American occupation of Japan. The shadow of war hung over his life as it does his fiction; "Kafka on the Shore" features biological attacks, military ghosts and shady conspiracies. Murakami’s work blurs historical periods and draws from multiple cultural traditions. References to Western society and Japanese customs tumble over each other, from literature and fashion to food and ghost stories. He has a penchant for musical references, too, especially in "Kafka on the Shore." As the runaway Kafka wanders the streets of a strange city, Led Zeppelin and Prince keep him company. Soon, he takes refuge in an exquisite private library. While he spends his days poring over old books and contemplating a strange painting and the library’s mysterious owner, he also befriends the librarian– who introduces him to classical music like Schubert. This musical sensibility makes Murakami’s work all the more hypnotic. He frequently bends the line between reality and a world of dreams, and is considered a master of magic lurking in the mundane. This is a key feature of magical realism. In contrast to fantasy, magic in this sort of writing rarely offers a way out of a problem. Instead, it becomes just one more thing that complicates life. In "Kafka on the Shore," characters are faced with endless otherworldly distractions, from a love sick ghost to a flute made from cat souls. These challenges offer no easy answers. Instead, they leave us marveling at the resourcefulness of the human spirit to deal with the unexpected. While Kafka often seems suspended in strangeness, there’s a tenderness and integrity at the heart of his mission that keeps him moving forward. Gradually he comes to accept his inner confusion. In the end, his experience echoes the reader’s: the deeper you go, the more you find.

**P749 2019-07-05 A brief history of cannibalism - Bill Schutt**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=749)

15th century Europeans believed they had hit upon a miracle cure: a remedy for epilepsy, hemorrhage, bruising, nausea, and virtually any other medical ailment. This brown powder could be mixed into drinks, made into salves or eaten straight up. It was known as mumia and made by grinding up mummified human flesh. The word "cannibal" dates from the time of Christopher Columbus; in fact, Columbus may even have coined it himself. After coming ashore on the island of Guadaloupe, Columbus' initial reports back to the Queen of Spain described the indigenous people as friendly and peaceful— though he did mention rumors of a group called the Caribs, who made violent raids and then cooked and ate their prisoners. In response, Queen Isabella granted permission to capture and enslave anyone who ate human flesh. When the island failed to produce the gold Columbus was looking for, he began to label anyone who resisted his plundering and kidnapping as a Caribe. Somewhere along the way, the word "Carib" became "Canibe" and then "Cannibal." First used by colonizers to dehumanize indigenous people, it has since been applied to anyone who eats human flesh. So the term comes from an account that wasn't based on hard evidence, but cannibalism does have a real and much more complex history. It has taken diverse forms— sometimes, as with mumia, it doesn't involved recognizable parts of the human body. The reasons for cannibalistic practices have varied, too. Across cultures and time periods, there's evidence of survival cannibalism, when people living through a famine, siege or ill-fated expedition had to either eat the bodies of the dead or starve to death themselves. But it's also been quite common for cultures to normalize some form of eating human flesh under ordinary circumstances. Because of false accounts like Columbus's, it's difficult to say exactly how common cultural cannibalism has been— but there are still some examples of accepted cannibalistic practices from within the cultures practicing them. Take the medicinal cannibalism in Europe during Columbus's time. Starting in the 15th century, the demand for mumia increased. At first, stolen mummies from Egypt supplied the mumia craze, but soon the demand was too great to be sustained on Egyptian mummies alone, and opportunists stole bodies from European cemeteries to turn into mumia. Use of mumia continued for hundreds of years. It was listed in the Merck index, a popular medical encyclopedia, into the 20th century. And ground up mummies were far from the only remedy made from human flesh that was common throughout Europe. Blood, in either liquid or powdered form, was used to treat epilepsy, while human liver, gall stones, oil distilled from human brains, and pulverized hearts were popular medical concoctions. In China, the written record of socially accepted cannibalism goes back almost 2,000 years. One particularly common form of cannibalism appears to have been filial cannibalism, where adult sons and daughters would offer a piece of their own flesh to their parents. This was typically offered as a last-ditch attempt to cure a sick parent, and wasn't fatal to their offspring— it usually involved flesh from the thigh or, less often, a finger. Cannibalistic funerary rites are another form of culturally sanctioned cannibalism. Perhaps the best-known example came from the Fore people of New Guinea. Through the mid-20th century, members of the community would, if possible, make their funerary preferences known in advance, sometimes requesting that family members gather to consume the body after death. Tragically, though these rituals honored the deceased, they also spread a deadly disease known as kuru through the community. Between the fictionalized stories, verifiable practices, and big gaps that still exist in our knowledge, there's no one history of cannibalism. But we do know that people have been eating each other, volunteering themselves to be eaten, and accusing others of eating people for millennia.

**P750 2019-07-05 The rise and fall of the Mongol Empire - Anne F. Broadbridge**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=750)

It was the largest contiguous land empire in history— stretching from Korea to Ukraine and from Siberia to southern China, and was forged on the open plains. In the 12th century CE, before the Mongol Empire formed, the East Asian steppe was home to scattered groups of Mongol and Turkic pastoral nomads led by Khans. The people herded sheep, cattle, yaks and camels. They lived in felt tents and moved between summer and winter campsites. Nomadic women held significant authority, managing these migrations, many of the flocks and trade. Meanwhile, men specialized in mounted warfare. These nomadic groups often fought each other. That was to change under Temujin, who was born into an aristocratic Mongol family. Despite losing his father at an early age and growing up in poverty, he quickly rose to power by forging strategic alliances with other leaders. Unlike those khans, Temujin promoted soldiers based on merit and distributed spoils evenly among them. His most brilliant move was to scatter the nomads he conquered among his own soldiers so they couldn't join together against him. These innovations made him unstoppable, and by 1206, he had united the people of the felt-walled tents and become Chinggis Khan. The Mongols were shamanists, believing that the spirits of nature and their ancestors inhabited the world around them. Over all arched the Sky god Tenggeri. Chinggis Khan believed that Tenggeri wanted him to conquer the entire world in his name. With the nomads of the Mongolian plain united, this seemed within reach. Anyone who resisted the Mongols was resisting Tenggeri's will, and for this insubordination, had to die. Under Chinggis Khan, the Mongols first subdued northern China and the eastern Islamic lands. After his death in 1227, the Divine Mandate passed to his family, or the Golden Lineage. In the 1230s, Chinggis Khan's sons and daughters conquered the Turks of Central Asia and the Russian princes, then destroyed two European armies in 1241. In the 1250s, the Mongols seized Islamic territory as far as Baghdad, while in the East their grasp reached southern China by 1279. Life within the Mongol Empire wasn't just war, pillage and destruction. Once the Mongols conquered a territory, they left its internal politics alone and used local administrators to govern for them. The Mongols let all religions flourish, as long as the leaders prayed for them. Although they routinely captured artisans, scholars and engineers, they appreciated what those specialists could do and forcibly settled them across Asia to continue their work. The most valuable produce in the Empire was gold brocade, which took silk from China, gold from Tibet and weavers from Baghdad. Gold brocade clothed the Mongol rulers, covered their horses and lined their tents. The Mongols particularly prized gunpowder technicians from China. With much of Eurasia politically unified, trade flourished along the Silk Road, helped by an extensive system of horse messengers and relay posts. Robust trade continued at sea, especially in blue-and-white porcelain, which combined white pottery from Mongol China with blue dye from Mongol Iran. But this was not to last. Succession to the Great Khan didn't automatically go to the eldest son, but rather allowed brothers, uncles and cousins to vie for leadership with senior widows acting as regents for their sons. By the 1260s, Chinggis Khan's grandsons were in a full- blown civil war over inheritance and fragmented the realm into four separate empires. In China, Kublai Khan's Yuan Dynasty is remembered as a golden age of science and culture. In Iran, the Ilkhanate inaugurated the development of new monumental architecture and Persian miniature painting. In Central Asia, the Chagatai Khanate brought forth leaders like Timur and his descendant Babur, who founded the Mughal Empire in India. And in Eastern Europe, the Golden Horde ruled for years until a trading post named Muscovy grew into a major world power. Even though the Empire lasted only a short while, the Mongols left a legacy of world- domination that remains unmatched today.

**P751 2019-07-12 Can you solve the multiverse rescue mission riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=751)

It was a normal Tuesday at the superconductor, until a bug in the system created a small situation. Now your team is trapped in eleven separate pocket dimensions. Luckily for you, there’s a half-finished experimental teleportation robot that may be able to get you all home, if you can figure out how to work through the quirks of its design. Over interdimensional radio, your engineers explain that the robot can teleport into the alternate universes you’re trapped in, but it’ll do so completely at random. The robot has two levers and one big button. When it appears, you just switch the position of one of the levers from A to B or vice versa, and then the robot will note your dimensional position and teleport to another of the eleven dimensions at random. If it shows up again, you’ll have to pull a lever before it’ll teleport away. When anyone presses the button, the robot will bring everyone who pulled a lever back home. Anyone who didn’t will be lost in the multi-verse forever. The challenge is to make sure everyone has pulled a lever before anyone hits the button. While you can talk to each other now over the interdimensional radio and agree on a plan, the robot’s teleportation technology will interfere with all attempts at communication once it arrives. You won’t be able to attach messages to the robot or scratch notes into its superstrong alloy body. Your only way to communicate information is to change the position of exactly one lever or hit the button. What plan will make sure everyone gets home? Pause the video now if you want to figure it out for yourself. Answer in 3 Answer in 2 Answer in 1 It would be nice if you could set different combinations of the levers to indicate who’s already been visited by the robot. But it has only two levers. That gives four combinations— far too few to communicate about 11 people, especially when you’re forced to flip one to send the robot onward. There must be another way. The critical insight is that not everyone has to know when every pocket dimension has been visited. If one person accepts responsibility ahead of time for hitting the button, then only they need to know who the robot has visited. In fact, they don’t even need to know exactly who’s been visited… just how many people have been. You volunteer to be the person in charge of pressing the button when the moment is right, and give the following directions to everyone else. Your plan is simple: you’ll use the left lever to count visits, and the right lever will have no meaning, so there’s no harm in moving it up or down. Each of the others will pull the left lever from position A to position B exactly once. If the robot appears with the left lever already pulled down, or if an individual has previously pulled the left lever down at any point in the past, then they should move the right lever. You, meanwhile, will be the only one who ever resets the left lever from position B to position A. This gives you a way to count how many people have been visited by the robot. Everyone needs to pull the left lever down exactly once, and you’re the only one to pull it back up. So you know that the tenth time the robot visits you with its left lever in the down position, it must have visited all ten of the others. And that means you’re safe to press the button and teleport everyone home. It may take a while– most likely the robot will need to teleport around 355 times; but better that than leave anyone behind. Your teammates phase back into your home dimension one at a time. The mission proves a great success. Well...mostly.

**P752 2019-07-17 From pacifist to spy - WWII’s surprising secret agent - Shrabani Basu**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=752)

Noor Inayat Khan was in the midst of a desperate escape. She had been imprisoned for her activities as an Allied spy, but with the help of a screwdriver and two other prisoners, she was back under the Parisian stars. As she began to run, her thoughts leapt to the whirlwind of events that had brought her here… Born in Moscow in 1914 to an Indian Muslim father and an American mother, Noor was raised in a profoundly peaceful home. Her parents were Sufi pacifists, who put their faith in the power of music and compassion. They moved to Paris, where Noor studied child psychology and published children’s books. But all this changed with the advent of the Second World War. In May 1940, with the German army ready to occupy Paris, Noor and her brother were faced with a difficult choice. As pacifists, they believed that all disputes should be settled non-violently. But witnessing the devastation across Europe, they decided that standing on the sidelines was not an option. Traveling to England, Noor volunteered for the Women’s Auxiliary Air Force and trained as a radio operator. She immersed herself in wireless operations and Morse code– unaware that she was being monitored by a secret organization. The British Special Operations Executive was established to sabotage the Germans in Nazi-occupied countries. As a trained radio operator who knew Paris well and spoke fluent French, Noor was an attractive recruit. In her interview, she was warned that wireless operation was some of the most dangerous work in the intelligence field. Operators had to lug a conspicuous transmitter through enemy territory, and the clandestine agency couldn’t protect her if she was caught. Noor accepted her assignment immediately. While she was determined to take her pacifist principles as far as possible, Noor had to learn the art of espionage. She learned how to contact intelligence networks, pick a lock, resist interrogation and fire a gun. In June 1943 she landed in Angers, south of Paris, and made her way to the city armed with a false passport, a pistol and a few French francs. But her network was compromised. Within a week of her deployment, all her fellow agents were arrested, and Noor was called home. She convinced her supervisors to let her stay– which meant doing the work of six radio operators singlehandedly. Over the following months, she tracked and transported supplies to the French resistance, sent reports of Nazi activity back to London and arranged safe passage for allied soldiers. This work was essential to building the French resistance and Allied intelligence networks– and, ultimately, ending the war. Protected only by her quick thinking and charisma, she frequently talked her way out of questioning. When the Gestapo searched her on the train, she gave them a casual tour of her “film projector.” When an officer spotted her hanging her aerial, she chatted about her passion for listening to music on the radio– and charmed him into helping her set up the cable. In her entire four month tenure, her sharp wits and stealth never failed her. But her charm had inspired lethal jealousy. In October 1943, the sister of a colleague, in love with an agent that loved Noor, sold her address to the Gestapo. Noor refused to give away any information, focusing instead on her escape. Secreting a screwdriver away from the guards, they were able to loosen a skylight and slip out into the night. But just as the prisoners began to run for their lives, an air raid siren alerted her captors. Noor was caught once again and sent to a German prison. Then, on to Dachau concentration camp. Despite being tortured, deprived and isolated, Noor gave nothing away. In the moments before her execution she is thought to have shouted “Liberté!” Since her heroic sacrifice, Noor has been honoured as a hero who waged secret battles behind enemy lines– paving the way for freedom without ever taking a life.

**P753 2019-07-17 How turtle shells evolved... twice - Judy Cebra Thomas**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=753)

Meet Odontochelys semitestacea. This little creature spends its days splashing in Late Triassic swamps with a host of other reptiles. Under the surface lies its best defense against attack: a hard shell on its belly. Odontochelys is an early ancestor of the turtle. Its half-shelled body illustrates an important point about the modern turtle: it actually has two shells that develop totally separately while the turtle is still an embryo. Both are extensions of the animal’s skeleton, and together they are made of almost 60 bones. Like other embryos, turtle embryos are made of undifferentiated cells that become specific cell types, and then organs and tissues, through gene activity and communication between cells. At first, turtle embryos look very similar to those of other reptiles, birds, and mammals, except for a bulge of cells called the carapacial ridge. The ridge expands around the body between the neck and lower back, creating a disc shape. It guides the formation of the upper part of the turtle’s shell, called the carapace, likely by attracting the cells that will become ribs. Instead of curving downwards to make a regular rib cage, the ribs move outwards towards the carapacial ridge. They then secrete a signaling protein that converts surrounding cells into bone-forming cells. These fifty bones grow until they meet and connect with sutures. A ring of bone solidifies the carapace’s edges. The outer layer of skin cells produces the scales, known as scutes, that cover the carapace. The development of the bottom half of the shell, the plastron, is driven by neural crest cells, which can produce a variety of different cell types including neurons, cartilage and bone. A thick shield of these cells spreads across the belly, coming together in regions that produce nine plate-like bones. Eventually, these connect to the carapace by sutures. A turtle’s shell has obvious advantages for guarding against predators, but the rigid casing also presents some challenges. As the turtle grows, the sutures between the bones of the carapace and plastron spread. Most mammals and reptiles rely on a flexible rib cage that expands to allow them to breathe, but turtles use abdominal muscles attached to the shell instead: one to breathe in, and one to breathe out. So how did the shell evolve? Though there are still gaps in the fossil record, the first step seems to have been a thickening of the ribs. The oldest known turtle ancestor, a creature called Eunotosaurus africanus, lived 260 million years ago and looked almost nothing like a modern turtle, but it had a set of broad, flat ribs that anchored the muscles of its powerful forearms. Eunotosaurus was likely a burrowing creature, digging homes for itself in what’s now southern Africa. Odontochelys semitestacea illustrates another, later step in turtle evolution, with thick ribs like Eunotosaurus plus a belly plate for protection. Our first fossil evidence of the full shell characteristic of modern turtles is about 210 million years old, and belongs to a species called Proganochelys quenstedti, whose ribs had fused. Proganochelys could move between water and land. Unlike modern turtles, it couldn’t retract its head into its shell, but had defensive spines on its neck. Modern turtle shells are almost as diverse as the turtles themselves. Sea turtles have flatter, lighter shells for streamlined gliding through the water. Land-dwelling tortoises, meanwhile, have domed shells that can slip free of predators’ jaws and help them turn right-side up if they fall on their backs. Leatherback and softshell turtles have shells without the ring of bone around the edge of the carapace or the tough scutes covering it, making it easier for them to squeeze into tight spaces.

**P754 2019-07-19 The high-stakes race to make quantum computers work - Chiara Decaroli**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=754)

The contents of this metal cylinder could either revolutionize technology or be completely useless— it all depends on whether we can harness the strange physics of matter at very, very small scales. To have even a chance of doing so, we have to control the environment precisely: the thick tabletop and legs guard against vibrations from footsteps, nearby elevators, and opening or closing doors. The cylinder is a vacuum chamber, devoid of all the gases in air. Inside the vacuum chamber is a smaller, extremely cold compartment, reachable by tiny laser beams. Inside are ultra-sensitive particles that make up a quantum computer. So what makes these particles worth the effort? In theory, quantum computers could outstrip the computational limits of classical computers. Classical computers process data in the form of bits. Each bit can switch between two states labeled zero and one. A quantum computer uses something called a qubit, which can switch between zero, one, and what’s called a superposition. While the qubit is in its superposition, it has a lot more information than one or zero. You can think of these positions as points on a sphere: the north and south poles of the sphere represent one and zero. A bit can only switch between these two poles, but when a qubit is in its superposition, it can be at any point on the sphere. We can’t locate it exactly— the moment we read it, the qubit resolves into a zero or a one. But even though we can’t observe the qubit in its superposition, we can manipulate it to perform particular operations while in this state. So as a problem grows more complicated, a classical computer needs correspondingly more bits to solve it, while a quantum computer will theoretically be able to handle more and more complicated problems without requiring as many more qubits as a classical computer would need bits. The unique properties of quantum computers result from the behavior of atomic and subatomic particles. These particles have quantum states, which correspond to the state of the qubit. Quantum states are incredibly fragile, easily destroyed by temperature and pressure fluctuations, stray electromagnetic fields, and collisions with nearby particles. That’s why quantum computers need such an elaborate set up. It’s also why, for now, the power of quantum computers remains largely theoretical. So far, we can only control a few qubits in the same place at the same time. There are two key components involved in managing these fickle quantum states effectively: the types of particles a quantum computer uses, and how it manipulates those particles. For now, there are two leading approaches: trapped ions and superconducting qubits. A trapped ion quantum computer uses ions as its particles and manipulates them with lasers. The ions are housed in a trap made of electrical fields. Inputs from the lasers tell the ions what operation to make by causing the qubit state to rotate on the sphere. To use a simplified example, the lasers could input the question: what are the prime factors of 15? In response, the ions may release photons— the state of the qubit determines whether the ion emits photons and how many photons it emits. An imaging system collects these photons and processes them to reveal the answer: 3 and 5. Superconducting qubit quantum computers do the same thing in a different way: using a chip with electrical circuits instead of an ion trap. The states of each electrical circuit translate to the state of the qubit. They can be manipulated with electrical inputs in the form of microwaves. So: the qubits come from either ions or electrical circuits, acted on by either lasers or microwaves. Each approach has advantages and disadvantages. Ions can be manipulated very precisely, and they last a long time, but as more ions are added to a trap, it becomes increasingly difficult to control each with precision. We can’t currently contain enough ions in a trap to make advanced computations, but one possible solution might be to connect many smaller traps that communicate with each other via photons rather than trying to create one big trap. Superconducting circuits, meanwhile, make operations much faster than trapped ions, and it’s easier to scale up the number of circuits in a computer than the number of ions. But the circuits are also more fragile, and have a shorter overall lifespan. And as quantum computers advance, they will still be subject to the environmental constraints needed to preserve quantum states. But in spite of all these obstacles, we’ve already succeeded at making computations in a realm we can’t enter or even observe.

**P755 2019-07-22 The dust bunnies that built our planet - Lorin Swint Matthews**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=755)

Consider the spot where you’re sitting. Travel backwards in time and it might’ve been submerged at the bottom of a shallow sea, buried under miles of rock, or floating through a molten, infernal landscape. But go back far enough— about 4.6 billion years, and you’d be in the middle of an enormous cloud of dust and gas orbiting a newborn star. This is the setting for some of the biggest, smallest mysteries of physics: the mysteries of cosmic dust bunnies. Seemingly empty regions of space between stars actually contain clouds of gas and dust, usually blown there by supernovas. When a dense cloud reaches a certain threshold called the Jeans mass, it collapses in on itself. The shrinking cloud rotates faster and faster, and heats up, eventually becoming hot enough to burn hydrogen in its core. At this point a star is born. As fusion begins in the new star, it sends out jets of gas that blow off the top and bottom of the cloud, leaving behind an orbiting ring of gas and dust called a protoplanetary disk. This is a surprisingly windy place; eddies of gas carry particles apart, and send them smashing into each other. The dust consists of tiny metal fragments, bits of rock, and, further out, ices. We’ve observed thousands of these disks in the sky, at various stages of development as dust clumps together into larger and larger masses. Dust grains 100 times smaller than the width of a human hair stick to each other through what’s called the van der Waals force. That’s where a cloud of electrons shifts to one side of a molecule, creating a negative charge on one end, and a positive charge on the other. Opposites attract, but van der Waals can only hold tiny things together. And there’s a problem: once dust clusters grow to a certain size, the windy atmosphere of a disk should constantly break them up as they crash into each other. The question of how they continue to grow is the first mystery of dust bunnies. One theory looks to electrostatic charge to answer this. Energetic gamma rays, x-rays, and UV photons knock electrons off of gas atoms within the disk, creating positive ions and negative electrons. Electrons run into and stick to dust, making it negatively charged. Now, when the wind pushes clusters together, like repels like and slows them down as they collide. With gentle collisions they won’t fragment, but if the repulsion is too strong, they’ll never grow. One theory suggests that high energy particles can knock more electrons off of some dust clumps, leaving them positively charged. Opposites again attract, and clusters grow rapidly. But before long we reach another set of mysteries. We know from evidence found in meteorites that these fluffy dust bunnies eventually get heated, melted and then cooled into solid pellets called chondrules. And we have no idea how or why that happens. Furthermore, once those pellets do form, how do they stick together? The electrostatic forces from before are too weak, and small rocks can’t be held together by gravity either. Gravity increases proportionally to the mass of the objects involved. That’s why you could effortlessly escape an asteroid the size of a small mountain using just the force generated by your legs. So if not gravity, then what? Perhaps it’s dust. A fluffy dust rim collected around the outside of the pellets could act like Velcro. There’s evidence for this in meteors, where we find many chondrules surrounded by a thin rim of very fine material– possibly condensed dust. Eventually the chondrule pellets get cemented together inside larger rocks, which at about 1 kilometer across are finally large enough to hold themselves together through gravity. They continue to collide and grow into larger and larger bodies, including the planets we know today. Ultimately, the seeds of everything familiar– the size of our planet, its position within the solar system, and its elemental composition– were determined by an uncountably large series of random collisions. Change the dust cloud just a bit, and perhaps the conditions wouldn’t have been right for the formation of life on our planet.

**P756 2019-07-23 How do viruses jump from animals to humans - Ben Longdon**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=756)

At a Maryland country fair in 2017, the prize pigs were not looking their best. Farmers reported feverish hogs with inflamed eyes and running snouts. But while fair officials worried about the pigs, the Maryland department of health was concerned about a group of sick fairgoers. Some had pet the pigs, while others had merely been near their barns; but soon, 40 of these attendees would be diagnosed with swine flu. More often than not, sick animals don’t infect humans. But when they do, these cross-species infections, or viral host jumps, have the potential to produce deadly epidemics. So how can pathogens from one species infect another, and what makes host jumps so dangerous? Viruses are a type of organic parasite infecting nearly all forms of life. To survive and reproduce, they must move through three stages: contact with a susceptible host, infection and replication, and transmission to other individuals. As an example, let’s look at human influenza. First, the flu virus encounters a new host and makes its way into their respiratory tract. This isn’t so difficult, but to survive in this new body, the virus must mount a successful infection before it’s caught and broken down by an immune response. To accomplish this task, viruses have evolved specific interactions with their host species. Human flu viruses are covered in proteins adapted to bind with matching receptors on human respiratory cells. Once inside a cell, the virus employs additional adaptations to hijack the host cell’s reproductive machinery and replicate its own genetic material. Now the virus only needs to suppress or evade the host’s immune system long enough to replicate to sufficient levels and infect more cells. At this point, the flu can be passed on to its next victim via any transmission of infected bodily fluid. However, this simple sneeze also brings the virus in contact with pets, plants, or even your lunch. Viruses are constantly encountering new species and attempting to infect them. More often than not, this ends in failure. In most cases, the genetic dissimilarity between the two hosts is too great. For a virus adapted to infect humans, a lettuce cell would be a foreign and inhospitable landscape. But there are a staggering number of viruses circulating in the environment, all with the potential to encounter new hosts. And because viruses rapidly reproduce by the millions, they can quickly develop random mutations. Most mutations will have no effect, or even prove detrimental; but a small proportion may enable the pathogen to better infect a new species. The odds of winning this destructive genetic lottery increase over time, or if the new species is closely related to the virus’ usual host. For a virus adapted to another mammal, infecting a human might just take a few lucky mutations. And a virus adapted to chimpanzees, one of our closest genetic relatives, might barely require any changes at all. It takes more than time and genetic similarity for a host jump to be successful. Some viruses come equipped to easily infect a new host’s cells, but are then unable to evade an immune response. Others might have a difficult time transmitting to new hosts. For example, they might make the host’s blood contagious, but not their saliva. However, once a host jump reaches the transmission stage, the virus becomes much more dangerous. Now gestating within two hosts, the pathogen has twice the odds of mutating into a more successful virus. And each new host increases the potential for a full-blown epidemic. Virologists are constantly looking for mutations that might make viruses such as influenza more likely to jump. However, predicting the next potential epidemic is a major challenge. There’s a huge diversity of viruses that we’re only just beginning to uncover. Researchers are tirelessly studying the biology of these pathogens. And by monitoring populations to quickly identify new outbreaks, they can develop vaccines and containment protocols to stop these deadly diseases.

**P757 2019-07-25 The mysterious origins of life on Earth - Luka Seamus Wright**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=757)

Billions of years ago on the young planet Earth simple organic compounds assembled into more complex coalitions that could grow and reproduce. They were the very first life on Earth, and they gave rise to every one of the billions of species that have inhabited our planet since. At the time, Earth was almost completely devoid of what we’d recognize as a suitable environment for living things. The young planet had widespread volcanic activity and an atmosphere that created hostile conditions. So where on Earth could life begin? To begin the search for the cradle of life, it’s important to first understand the basic necessities for any life form. Elements and compounds essential to life include hydrogen, methane, nitrogen, carbon dioxide, phosphates, and ammonia. In order for these ingredients to comingle and react with each other, they need a liquid solvent: water. And in order to grow and reproduce, all life needs a source of energy. Life forms are divided into two camps: autotrophs, like plants, that generate their own energy, and heterotrophs, like animals, that consume other organisms for energy. The first life form wouldn’t have had other organisms to consume, of course, so it must have been an autotroph, generating energy either from the sun or from chemical gradients. So what locations meet these criteria? Places on land or close to the surface of the ocean have the advantage of access to sunlight. But at the time when life began, the UV radiation on Earth’s surface was likely too harsh for life to survive there. One setting offers protection from this radiation and an alternative energy source: the hydrothermal vents that wind across the ocean floor, covered by kilometers of seawater and bathed in complete darkness. A hydrothermal vent is a fissure in the Earth’s crust where seawater seeps into magma chambers and is ejected back out at high temperatures, along with a rich slurry of minerals and simple chemical compounds. Energy is particularly concentrated at the steep chemical gradients of hydrothermal vents. There’s another line of evidence that points to hydrothermal vents: the Last Universal Common Ancestor of life, or LUCA for short. LUCA wasn’t the first life form, but it’s as far back as we can trace. Even so, we don’t actually know what LUCA looked like— there’s no LUCA fossil, no modern-day LUCA still around— instead, scientists identified genes that are commonly found in species across all three domains of life that exist today. Since these genes are shared across species and domains, they must have been inherited from a common ancestor. These shared genes tell us that LUCA lived in a hot, oxygen-free place and harvested energy from a chemical gradient— like the ones at hydrothermal vents. There are two kinds of hydrothermal vent: black smokers and white smokers. Black smokers release acidic, carbon-dioxide-rich water, heated to hundreds of degrees Celsius and packed with sulphur, iron, copper, and other metals essential to life. But scientists now believe that black smokers were too hot for LUCA— so now the top candidates for the cradle of life are white smokers. Among the white smokers, a field of hydrothermal vents on the Mid-Atlantic Ridge called Lost City has become the most favored candidate for the cradle of life. The seawater expelled here is highly alkaline and lacks carbon dioxide, but is rich in methane and offers more hospitable temperatures. Adjacent black smokers may have contributed the carbon dioxide necessary for life to evolve at Lost City, giving it all the components to support the first organisms that radiated into the incredible diversity of life on Earth today.

**P758 2019-07-27 The murder of ancient Alexandria's greatest scholar - Soraya Field Fi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=758)

In the city of Alexandria in 415 CE, the bishop and the governor were in a fight. It started with a disagreement over the behavior of a militia of monks, and ended with an accusation of witchcraft leveled against one of the most powerful figures in the city. Hypatia of Alexandria was a prominent mathematician, philosopher, and advisor to the city’s leaders. In the centuries since she lived, the details of her life have been the subject of much dispute and have taken on an almost mythical status. But while none of Hypatia’s own writings survive, her contemporaries’ and students’ accounts of her work and life paint a picture of the qualities that made her renowned as a scholar, beloved as a teacher, and ultimately led to her downfall. Hypatia was born around 355 in Alexandria, then part of the Egyptian province of the Eastern Roman Empire, and an intellectual center. Her father Theon was an accomplished Greek mathematician and astronomer; her mother is unknown. Hypatia was likely an only child, and Theon educated her himself. By adulthood, she had surpassed her father in both mathematics and philosophy, becoming the city’s foremost scholar and taking over his position at the head of the Platonic school, similar to a modern university. She refined scientific instruments, wrote math textbooks, and developed a more efficient method of long division. But perhaps her most significant contributions to intellectual life in Alexandria came through her teaching. The philosophy Hypatia taught drew from the legacy of Plato and Aristotle, as well as the mystical philosopher Plotinus and the mathematician Pythagoras. The convergence of these influences merged to form a school called Neoplatonism. For the Neoplatonists, mathematics had a spiritual aspect, divided among the four branches of arithmetic, geometry, astronomy and music. These subjects were not studied merely for the sake of curiosity or practical utility, but because they authenticated the belief that numbers were the sacred language of the universe. In the repeated patterns of algebraic formulas and geometric shapes, the orbits of the planets, and the harmonious intervals of musical tones, the Neoplatonists saw a rational cosmic force at work. Students delved into this ordered mathematical world to achieve higher unity with this force, known as “the One.” While Hypatia was considered pagan— a term for traditional Roman belief before Christianity— she worshipped no particular deity or deities, and her ideas could be applied alongside multiple religious viewpoints. Jewish and Christian as well as pagan students travelled from the farthest reaches of the empire to study with her. The nonpartisan environment Hypatia fostered, where all students could feel comfortable, was especially remarkable given the religious and political turmoil that was fracturing the city of Alexandria at the time. Christianity had recently become the Empire’s state religion. The local archbishop Cyril had steadily gained political power, commanding zealous militias of Christian monks to destroy pagan temples and harass the Jewish population. In doing so, he encroached on the secular authority of the Roman governor Orestes, himself a moderate Christian, leading to a bitter public feud between the two men. Because she was seen as a wise and impartial figure, governor Orestes consulted Hypatia, who advised him to act with fairness and restraint. But when a group of Cyril’s monks incited a riot, badly injuring Orestes in the process, he had their leader tortured to death. Cyril and his followers blamed Hypatia, accusing her of witchcraft to turn Orestes against Christianity. In March 415, as Hypatia was traveling through the city, the bishop’s militia of monks dragged her from her carriage and brutally murdered and dismembered her. Hypatia’s death was a turning point in the politics of Alexandria. In the wake of her murder, other philosophers in the Greek and Roman tradition fled, and the city’s role as a center of learning declined. In a very real way, the spirit of inquisition, openness, and fairness she fostered died with her.

**P759 2019-07-29 Can you solve the secret sauce riddle - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=759)

One of the top chefs from Pasta Palace has been kidnapped by operatives from Burger Bazaar hoping to learn the location of their secret sauce recipe. Little do they know that a third party— Sausage Saloon— has sent you to take advantage of the situation. As their top spy, your skills range from infiltration and subterfuge, to safecracking and reading faces for signs of deception. You’ve tracked the captors to where they’re holding the chef prisoner. From your hiding spot, you can see him on the other side of the glass, while in front of you an interrogator wearing headphones speaks into a microphone. “We already know the recipe is on the 13th floor of the bank vault, in a safe deposit box numbered between 13 and 1300. Now tell us… Is the number less than 500?” You can’t hear the chef’s answer, but you can see that he’s lying. The interrogator, however, falls for it. He follows up by asking, “Is it a perfect square?” Again you can’t hear the answer but can tell the chef is lying, while the interrogator takes him at his word. He then asks, “Is it a perfect cube?” This time the chef answers truthfully. The interrogator thinks for a minute and says, “Good. Now if you just tell me whether or not the number’s second digit is a one, we’ll be done here.” But as the chef starts to answer, the interrogator stands up, blocking your view. Within moments he rushes out of the room, announcing that he’s got the answer and is sending agents to retrieve the recipe. You know that the Burger Bazaar people have the wrong box number. But can you figure out the right one and retrieve the recipe yourself? Pause the video to figure it out for yourself. Answer in 3 Answer in 2 Answer in 1 The key here is to work backwards. We don’t know what the chef answers to the final question or whether he answers truthfully. But we do know that by the time the interrogator asks it, he’s narrowed the options down to two numbers– one where the second digit is 1, and one where it isn’t. Our goal, then, is to find answers to the previous questions that lead to just two possibilities. Of the three constraints offered, the one that narrows our options the most is if the number is a perfect cube. That leaves us with only eight answers between 13 and 1300. So let’s assume the answer to the third question was a truthful YES. Now, let’s look at the second question. If the chef answered YES to the number being a perfect square, it would narrow the interrogator’s options to just 64 and 729– the only numbers in our range that are both a square and a cube. But neither of these has a 1 as the second digit. So the given answer to the second question must’ve been NO. And that also means we can eliminate these two squares from the interrogator's list, leaving only six numbers. Now for the first question, which allows us to divide this list. If the chef answered YES to the number being less than 500, we’d have four options, which is too many. But a NO leaves us with two numbers greater than 500, one of which does have a 1 as its second digit. We don’t know which of these numbers the interrogator thinks is correct. But that doesn’t matter– remember, his conclusion was based on lies. You, on the other hand, are now in a position to reconstruct the truth. First, the chef said the number was greater than 500 but lied, meaning it’s actually less than 500. Second, the chef said it wasn’t a perfect square but lied again, meaning the number is indeed a square. And finally, he truthfully confirmed that it was also a cube. And as we’ve already seen, the only number under 500 that’s both a square and a cube is 64. You find the secret recipe and are gone before anyone’s the wiser. Corporate espionage is not an easy game— but sometimes, that’s just how the sausage is made.

**P760 2019-07-31 The myth of Jason and the Argonauts - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=760)

Hercules, the strongest man alive with a mighty heart to match. Orpheus, charmer of nature and master of music. Castor and Pollux, the twin tricksters hatched from an egg. The Boreads, sons of the North Wind who could hurtle through the air. For untold times these heroes had roamed ancient Greece, creating new legends wherever they went. But none of their adventures was so great as when they joined forces for the sake of a young man named Jason. Years before, Jason’s uncle Pelias had ruthlessly usurped the throne of Thessaly from Jason’s grandfather. When Jason returned to his father’s stolen court, the cowardly king set him a seemingly impossible task: cross the teeming seas to Colchis, and steal the golden fleece of a flying ram under King Aeetes’ nose. If Jason retrieved the Fleece, Pelias promised to relinquish the throne. Touched by his heroic mission, the Gods spread Jason’s call for help, and soon he had assembled a not-so-motley crew. These heroes, alongside countless sailors, soothsayers, and rebel demigods, named themselves the Argonauts after their sturdy ship. But the path ahead was marked with untold terrors– enough to test even the fiercest heroes. Their first stop was Lemnos, an isle of women who had killed all the island’s men. As punishment, Aphrodite had cursed them with a sickening stench– but that didn’t stop Jason fathering twins with the queen. The rest of the crew also found themselves embroiled in new romances; until Hercules chastised them for not behaving like heroes. Eventually, they sailed on to the Mount of Bears, an island where a group of ancient, six-armed monsters lived alongside the peaceful Doliones. While the clan welcomed the Argonauts with open arms, the monsters surged down from the mountains and hurled rocks at the docked ship. Hercules held them off single-handedly, before his comrades joined the fray. Bolstered by their victory, the triumphant heroes sailed onward– only to be blown back to the island several stormy nights later. In the tempest, the Doliones thought these new arrivals invaders. The Argonauts were similarly unaware of their surroundings, and fought blunderingly in the dark, slaying wave after wave of foe. But the morning light revealed a horrible truth: their victims were none other than their previous hosts. Yet again, Jason had allowed the crew to be distracted, this time at a terrible cost. Ashamed at his conduct, he resolved to focus only on the Fleece, but even this haste proved ruinous. When Hercules’ squire was abducted by a water nymph, Jason sailed on– oblivious to the absence of his most powerful crewmate. The remaining Argonauts continued their quest, until stopping at the sight of an old man surrounded by a swirl of harpies. This was Phineas, a seer cursed by Zeus to endure old age, blindness, and endless torture for giving away his prophecies. Moved by his plight, the wind brothers set upon the flock, providing Phineas with a brief respite from his punishment. In return, the seer told them how to overcome the terrifying trial that lay ahead: the Symplegades, a pair clashing rocks that reduced ships to splinters. But first, the Argonauts would have to maneuver past the mouth of hell, around the island of the bloodthirsty Amazons, and under psychedelic skies. These adventures cost the crew both in men and morale– and some feared they might be losing their minds. Upon reaching the clashing rocks, the exhausted crew quaked with fear. But Phineas’ advice rang in their heads. The Argonauts released a single dove and sped through in its wake to emerge unscathed. With this narrow escape, the Argonauts finally had Colchis in their sights. Yet while Jason rested and celebrated with his crew, he could feel his time among them was drawing to a close. As the fleece gleamed in his mind, he knew he would have to retrieve it alone. But he could not guess that this final task would have the most horrible price of all.

**P761 2019-08-01 A brief history of chess - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=761)

The attacking infantry advances steadily, their elephants already having broken the defensive line. The king tries to retreat, but enemy cavalry flanks him from the rear. Escape is impossible. But this isn’t a real war– nor is it just a game. Over the roughly one-and-a-half millennia of its existence, chess has been known as a tool of military strategy, a metaphor for human affairs, and a benchmark of genius. While our earliest records of chess are in the 7th century, legend tells that the game’s origins lie a century earlier. Supposedly, when the youngest prince of the Gupta Empire was killed in battle, his brother devised a way of representing the scene to their grieving mother. Set on the 8x8 ashtapada board used for other popular pastimes, a new game emerged with two key features: different rules for moving different types of pieces, and a single king piece whose fate determined the outcome. The game was originally known as chaturanga– a Sanskrit word for "four divisions." But with its spread to Sassanid Persia, it acquired its current name and terminology– "chess," derived from "shah," meaning king, and “checkmate” from "shah mat," or “the king is helpless.” After the 7th century Islamic conquest of Persia, chess was introduced to the Arab world. Transcending its role as a tactical simulation, it eventually became a rich source of poetic imagery. Diplomats and courtiers used chess terms to describe political power. Ruling caliphs became avid players themselves. And historian al-Mas’udi considered the game a testament to human free will compared to games of chance. Medieval trade along the Silk Road carried the game to East and Southeast Asia, where many local variants developed. In China, chess pieces were placed at intersections of board squares rather than inside them, as in the native strategy game Go. The reign of Mongol leader Tamerlane saw an 11x10 board with safe squares called citadels. And in Japanese shogi, captured pieces could be used by the opposing player. But it was in Europe that chess began to take on its modern form. By 1000 AD, the game had become part of courtly education. Chess was used as an allegory for different social classes performing their proper roles, and the pieces were re-interpreted in their new context. At the same time, the Church remained suspicious of games. Moralists cautioned against devoting too much time to them, with chess even being briefly banned in France. Yet the game proliferated, and the 15th century saw it cohering into the form we know today. The relatively weak piece of advisor was recast as the more powerful queen– perhaps inspired by the recent surge of strong female leaders. This change accelerated the game’s pace, and as other rules were popularized, treatises analyzing common openings and endgames appeared. Chess theory was born. With the Enlightenment era, the game moved from royal courts to coffeehouses. Chess was now seen as an expression of creativity, encouraging bold moves and dramatic plays. This "Romantic" style reached its peak in the Immortal Game of 1851, where Adolf Anderssen managed a checkmate after sacrificing his queen and both rooks. But the emergence of formal competitive play in the late 19th century meant that strategic calculation would eventually trump dramatic flair. And with the rise of international competition, chess took on a new geopolitical importance. During the Cold War, the Soviet Union devoted great resources to cultivating chess talent, dominating the championships for the rest of the century. But the player who would truly upset Russian dominance was not a citizen of another country but an IBM computer called Deep Blue. Chess-playing computers had been developed for decades, but Deep Blue’s triumph over Garry Kasparov in 1997 was the first time a machine had defeated a sitting champion. Today, chess software is capable of consistently defeating the best human players. But just like the game they’ve mastered, these machines are products of human ingenuity. And perhaps that same ingenuity will guide us out of this apparent checkmate.

**P762 2019-08-01 Why should you read “Midnight’s Children” - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=762)

It begins with a countdown. On August 14th, 1947, a woman in Bombay goes into labor as the clock ticks towards midnight. Across India, people hold their breath for the declaration of independence after nearly two centuries of British occupation and rule. And at the stroke of midnight, a squirming infant and two new nations are born in perfect synchronicity. These events form the foundation of "Midnight’s Children," a dazzling novel by the British-Indian author Salman Rushdie. The baby who is the exact same age as the nation is Saleem Sinai, the novel’s protagonist. His narrative stretches over 30 years of his life, jumping backwards and forwards in time to speculate on family secrets and deep-seated mysteries. These include the greatest enigma of all: Saleem has magic powers, and they’re somehow related to the time of his birth. And he’s not the only one. All children born in and around the stroke of midnight are imbued with extraordinary powers; like Parvati the Witch, a spectacular conjurer; and Saleem’s nemesis Shiva, a gifted warrior. With his powers of telepathy, Saleem forges connections with a vast network of the children of midnight— including a figure who can step through time and mirrors, a child who changes their gender when immersed in water, and multilingual conjoined twins. Saleem acts as a delightful guide to magical happenings and historical context alike. Although his birthday is a day of celebration, it also marks a turbulent period in Indian history. In 1948, the leader of the Indian independence movement, Mahatma Gandhi, was assassinated. Independence also coincided with Partition, which divided British-controlled India into the two nations of India and Pakistan. This contributed to the outbreak of the Indo-Pakistani Wars in 1965 and 1971. Saleem touches on all this and more, tracing the establishment of Bangladesh in 1971 and the emergency rule of Indira Gandhi. This vast historical frame is one reason why "Midnight’s Children" is considered one of the most illuminating works of postcolonial literature ever written. This genre typically addresses the experience of people living in colonized and formerly colonized countries, and explores the fallout through themes like revolution, migration, and identity. Rushdie, who like Saleem was born in 1947, was educated in India and Britain, and is renowned for his cross-continental histories, political commentary, and magical realism. He enriches "Midnight’s Children" with a plethora of Indian and Pakistani cultural references, from family traditions to food, religion and folktales. Scribbling by night under the watchful eyes of his lover Padma, Saleem’s frame narrative echoes that of "1001 Nights," where a woman named Scheherazade tells her king a series of stories to keep herself alive. And as Saleem sees it, 1001 is “the number of night, of magic, of alternative realities.” Over the course of the novel, Rushdie dazzles us with multiple versions of reality. Sometimes, this is like reading a rollercoaster. Saleem narrates: “Who what am I? My answer: I am everyone everything whose being-in- the-world affected was affected by mine. I am anything that happens after I’ve gone which would not have happened if I had not come. Nor am I particularly exceptional in this matter; each 'I,' every one of the now-six- hundred-million-plus of us, contains a similar multitude. I repeat for the last time: to understand me, you’ll have to swallow a world.” Saleem’s narrative often has a breathless quality— and even as Rushdie depicts the cosmological consequences of a life, he questions the idea that we can ever condense history into a single narrative. His mind-bending plot and shapeshifting characters have garnered continuing fascination and praise. Not only did "Midnight’s Children" win the prestigious Man Booker Prize in its year of publication, but in a 2008 competition that pitted all 39 winners against each other, it was named the best of all the winners. In a masterpiece of epic proportions, Rushdie reveals that there are no singular truths— rather, it’s wiser to believe in several versions of reality at once, hold many lives in the palms of our hands, and experience multiple moments in a single stroke of the clock.

**P763 2019-08-09 The secret student resistance to Hitler - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=763)

In 1943 Allied aircraft swooped over Nazi Germany, raining tens of thousands of leaflets on people below. Written by anonymous Germans, the leaflets urged readers to renounce Hitler, to fight furiously for the future— and to never give up hope. Their call to action rippled through homes and businesses— and news of their message even reached concentration camps and prisons. It was only after the war had ended that the authors’ identities, stories, and tragic fate would come to light. When Hitler seized power 10 years earlier, Hans and Sophie Scholl were teenagers in the town of Forchtenberg. At that time, fear, propaganda, and surveillance kept all aspects of life for the Scholl family and millions of other Germans under Nazi control. The government specifically targeted young people, setting up institutions to regulate their behavior and police their thoughts. As teenagers, Hans was a member of the Hitler Youth and Sophie joined The League of German Girls. Hans rose through the ranks and oversaw the training and indoctrination of other young people. In 1936, he was chosen to carry the flag at a national rally. But when he witnessed the zeal of Nazi rhetoric, he began to question it for the first time. Meanwhile, Sophie was also starting to doubt the information she was being fed. Their parents Robert and Magdalena, who had feared they were losing their children to Nazi ideology, encouraged these misgivings. At home, Robert and Magdalena listened to foreign radio stations that the government first discouraged and later banned. While the government churned out national broadcasts which denied Nazi atrocities, the Scholls learned shocking truths. And yet, they were still subject to the rules of life in Hitler’s Germany. After the outbreak of war, Sophie reluctantly worked for the national effort, and Hans had to take on army duties while attending medical school in Munich. That was where Hans met Christoph Probst, Willi Graf and Alexander Schmorell. Day by day, each grew more sickened by Nazi ideology. They longed to share their views. But how could they spread them, when it was impossible to know who to trust? And so, the friends decided to rebel anonymously. They pooled their money and bought printing materials. An acquaintance let them use a cellar under his studio. In secret, they began drafting their message. In June 1942, mysterious anti-Nazi leaflets began appearing all over Munich. They were signed: the White Rose. The first leaflet denounced Hitler and called for Germans to sabotage the war effort: “Adopt passive resistance… block the functioning of this atheistic war machine before it is too late, before the last city is a heap of rubble… before the last youth of our nation bleeds to death... Don’t forget that each people gets the government it deserves!” At a time when a sarcastic remark could constitute treason, this language was unprecedented. It was written mostly by Hans Scholl. In 1942, Sophie came to Munich knowing nothing of her brother’s activities. She soon encountered the leaflets at school. But it was not until she discovered evidence in Han’s room that she realized who’d written them. Her shock soon gave way to resolve: she wanted in. For both siblings, it was time to escalate the fury that had been brewing for years. From June 1942 to February 1943, the group worked feverishly. While the Gestapo searched for leads, the White Rose were constantly on guard. The war raged on. Regulations tightened, and Munich suffered air raids. But the White Rose ventured deeper into conspiracy. They graffitied buildings and braved trains swarming with Gestapo. In the winter of 1942, Hans made a treacherous journey to the Czechoslovakian border to meet anti-Nazi rebels. On February 18, 1943, Sophie and Hans brought a suitcase of leaflets to their university. A custodian noticed what they were doing and reported them to the Gestapo. Both calmly denied any involvement— until the police gathered all the leaflets and placed them back in the empty case, where they fit perfectly. When Hans and Sophie confessed, they were immediately led to court and sentenced to death by guillotine. Despite a grueling interrogation, the two refused to betray their co-conspirators. Before her execution, Sophie declared her fury at the state of her country. But she also spoke to a more hopeful future: “How can we expect righteousness to prevail when there is hardly anyone willing to give himself up individually to a righteous cause? Such a fine, sunny day, and I have to go, but what does my death matter, if through us, thousands of people are awakened and stirred to action?”

**P764 2019-08-12 What makes neon signs glow A 360° animation - Michael Lipman**

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When the Hoover Dam was completed in 1936, it created a huge source of hydroelectric power and zapped a sleepy desert town to life: Las Vegas, Nevada. With the power supply from the dam, Las Vegas soon exploded with vibrant displays. The source of these dazzling lights was electrified neon gas. There are two tricky obstacles to making lighted signs out of this naturally clear, odorless gas: capturing it and making it glow. French inventor Georges Claude came up with techniques to do both. In 1902, he developed a way of liquefying and separating specific gases from the air, producing neon on an industrial scale for the first time. By 1910, he had come up with a way to trap the gas in a glass tube with a special electrode at either end, and neon lighting was born. In workshops like Claude's, artisans known as tube-benders made neon signs by hand. The tube-benders heated small sections of a long, hollow glass tube and quickly bent them into shape. After the glass cooled, they attached electrodes to each end and removed the air with a vacuum pump. Then, they passed a high voltage current through the tube to remove any impurities on the inside of the glass. Finally, they pumped the neon gas in and sealed off the electrodes. When a neon sign is turned on, the electric current causes some of the neon atoms' electrons to accelerate and break free of their orbits, leaving behind positively charged ions. As these free electrons rush from one electrode to the other, they collide with more neon atoms, causing them to ionize as well. When these excited electrons fall back to their normal energy levels, their excess energy is carried away by photons, or particles of light. All this happens in an instant, and the glow from the photons is what we see when we switch on a neon sign. Though it's common to call any gas-filled sign a "neon" sign, there are actually 5 different gases used in production. Each gas emits photons of a different wavelength when electrified, which correspond to different colors of light. Neon gives off an orange-red glow, argon glows a pale lavender, helium a dusty pink, krypton a silver- white, and xenon a light purple. These 5 gases can be combined with color-coated tubing to create an electrified rainbow of text and images. Business owners soon realized how effective these colorful beacons were for attracting customers. And unlike a light bulb, a neon sign has no incandescent filaments to burn out, and can shine continuously for 40 years before the gas depletes. By the 1930s, neon signs were lighting up storefronts all over the world. Because of the glass tubes' fragile nature, it usually wasn't feasible to ship them over long distances. Instead, most neon signs were created by local neon shops and then installed nearby. Signs with humor, personality, and intricate designs proliferated, no two exactly alike. But by the end of World War II, plastics had become widely available and inexpensive, and plastic signs supplanted neon as messengers of modernity. Many towns removed neon signs they viewed as old-fashioned. Today, neon sign production is only a fraction of what it was at its peak, but the craft of tube bending lives on relatively unchanged. New creations hand-crafted by local artisans join survivors from the heyday of neon, hiding in plain sight in city streets around the world.

**P765 2019-08-13 A day in the life of a Celtic Druid - Philip Freeman**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=765)

As the sun rises on a fall morning in 55 BCE, Camma lays two pigeons on the altar at the center of her village. She offers a prayer to Matrona mother goddess of the Earth, and Lugus chief of the gods. Then, she wrings the birds’ necks and cuts them open to examine their entrails for divine messages. Camma is a druid. This means she conducts religious rites, but she also serves as a judge, healer, and scholar, teaching children and mediating conflict between Celtic tribes. She began her studies as a child, memorizing the countless details necessary to perform her many roles, since the druids’ knowledge is considered too sacred to record in writing. Like many druids, she spent years studying in Britain. Now, she is a resident Druid of the Veneti tribe in a small farming village near the western coast of Gaul, in what is now France. Since returning to Gaul, she has received many offers of marriage– but she has decided to devote herself to her work, at least for now. This morning, the omens are troubling. They tell of war and strife, as they often have in recent months. A neighboring tribe, the Redones, have raided their village and stolen cattle in broad daylight twice this fall. The children have gathered around to watch her work. Camma plays her lyre and sings to them. She weaves stories of the powerful kings who once ruled their land – brave warriors who were slain naked in combat but who will be reborn, as will all the Celts. When the children go off to help in the fields, Camma heads across the village to visit an old woman with an eye infection. On the way to the old woman’s hut, she passes men salting pigs for the winter food supply and women weaving clothing from dyed wool. She delivers a remedy for the injured eye– it’s made from mistletoe, a sacred healing plant, but deadly if used incorrectly. From there, Camma visits the chieftain to discuss the omens. She convinces him to go and talk through their problems with their neighbors. Accompanied by several warriors, they head through the forest and demand a meeting outside the Redones’ village walls. The Redones’ representatives bring their own druid, who Camma recognizes from the annual gathering in central Gaul where head druids are elected. The chieftains immediately begin to argue and threaten each other. Camma steps between the opposing sides to stop them from fighting— they must honor her authority. Finally, the Redones agree to pay Camma’s tribe several cattle. In spite of this resolution, Camma still feels uneasy on the long walk home. As they approach the village walls, a bright streak shoots across the sky— another omen, but of what? Back home, Camma sits among the elders for her evening meal of porridge, a bit of meat, and a cup of wine. While they were out during the day, an intercepted parchment arrived. Camma recognizes the writing immediately. Although the druids are forbidden from recording their knowledge, she and many other young druids can read Latin. From the message, she learns that the Romans are drawing closer to their lands. Some of the elders say that the tribe should flee to the nearby hills and hide, but Camma counsels them to trust in the gods and remain in their home. Privately, she has her doubts. Should the Romans reach them, her power to help might be limited. Unlike the other Celtic tribes, Roman legions have no regard for the druids’ sacred role as peacemakers. Before going to bed, she observes the course of the planets and consults her charts, trying to make sense of the meteor she saw earlier. The signs are converging on a larger threat than their neighbors.

**P766 2019-08-13 A day in the life of a Cossack warrior - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=766)

Despite a serene sunset on the Dnipro river, the mood is tense for the Zaporozhian Cossacks. The year is 1676, and the Treaty of Żurawno has officially ended hostilities between the Polish-Lithuanian Commonwealth and the Ottoman Empire. But as Stepan and his men ride towards their stronghold, peace is far from their minds. Having made their home in the Wild Fields north of the Black Sea, these cossacks— derived from a Turkic word for "free man"— are renowned as one of Europe’s most formidable military forces. Composed of hunters, fishermen, nomads and outlaws, the Cossacks found freedom in these fertile unclaimed lands. Yet this freedom has proven increasingly difficult to maintain. Their decades-long strategy of shifting alliances between Poland and Moscow has led to the partitioning of their lands. In a desperate bid to reclaim independence and reunite the fractured Cossack state, their most recent leader, hetman Petro Doroshenko allied with the Ottoman Empire. This alliance successfully freed the Zaporozhian Cossacks in the west from Polish dominion, but their victory was a bitter one. Doroshenko’s Ottoman allies ravaged the countryside, carrying off peasants into slavery. And outrage at allying with Muslims against fellow Christians cost him any remaining local support. Now, with Doroshenko deposed and exiled, the Cossacks are at odds, disagreeing on what their next move should be. Until then, Stepan must keep order. With his musket and curved saber, he cuts an imposing figure. He surveys his battalion of 180 men. Most are Orthodox Christians and speak a Slavic language that will become modern Ukrainian. But there are also Greeks, Tatars, and even some Mongolian Kalmyks, many with different opinions on recent events. Officially, all of Stepan’s men have sworn to uphold the Cossack code by undergoing seven years of military training and remaining unmarried. In practice, some are part-timers, holding more closely to their own traditions, and maintaining families in nearby villages, outside Cossack lands. Thankfully, the tenuous peace is not broken before they reach the Sich— the center of Cossack military life. Currently located at Chortomlyk, the Sich’s location shifts with the tide of military action. The settlement is remarkably well- organized, with administrative buildings, officers’ quarters, and even schools, as Cossacks prize literacy. Stepan and his men make their way to the barracks where they live and train alongside several other battalions or kurins, all of which make up a several hundred man regiment. Inside, the men dine on dried fish, sheep’s cheese, and salted pork fat— along with plenty of wine. Stepan instructs his friend Yuri to lighten the mood with his bandura. But before long, an argument has broken out. One of his men has raised a toast to Doroshenko. Stepan cuts him off. The room is silent until he raises his own toast to Ivan Sirko, the new hetman who favors an alliance with Moscow against the Turks. Stepan plans to support him, and he expects his men to do the same. Suddenly, one of Sirko’s men rushes in, calling an emergency Rada, or general council meeting. Stepan and the others make their way towards the church square— the center of Sich life. Ivan Sirko welcomes the confused crowd with exciting news— scouts have located a large Ottoman camp completely vulnerable on one side. Sirko vows that tomorrow, they will ride against their common enemy, defend the Cossacks’ autonomy, and bring unity to the Wild Fields. As the men cheer in unison, Stepan is relieved at their renewed sense of brotherhood. Over the next 200 years, these freedom fighters would take on many foes. And tragically, they would eventually become the oppressive hand of the Russian government they once opposed. But today, these 17th century Cossacks are remembered for their spirit of independence and defiance. As the Russian painter Ilya Repin once said: “No people in the world held freedom, equality, and fraternity so deeply.”

**P767 2019-08-28 Why should you read “The God of Small Things” by Arundhati Roy - Laur**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=767)

“A few dozen hours can affect the outcome of whole lifetimes/ And that when they do, those few dozen hours, like the salvaged remains of a burned clock… must be resurrected from the ruins and examined.” This is the premise of Arundhati Roy’s 1997 novel "The God of Small Things." Set in a town in Kerala, India called Ayemenem, the story revolves around fraternal twins Rahel and Estha, who are separated for 23 years after the fateful few dozen hours in which their cousin drowns, their mother’s illicit affair is revealed, and her lover is murdered. While the book is set at the point of Rahel and Estha’s reunion, the narrative takes place mostly in the past, reconstructing the details around the tragic events that led to their separation. Roy’s rich language and masterful storytelling earned her the prestigious Booker prize for "The God of Small Things." In the novel, she interrogates the culture of her native India, including its social mores and colonial history. One of her focuses is the caste system, a way of classifying people by hereditary social class that is thousands of years old. By the mid-20th century, the original four castes associated with specific occupations had been divided into some 3000 sub-castes. Though the caste system was Constitutionally abolished in 1950, it continued to shape social life in India, routinely marginalizing people of lower castes. In the novel, Rahel and Estha have a close relationship with Velutha, a worker in their family’s pickle factory and member of the so-called “untouchable” caste. When Velutha and the twins’ mother, Ammu, embark on an affair, they violate what Roy describes as the “love laws” forbidding intimacy between different castes. Roy warns that the tragic consequences of their relationship “would lurk forever in ordinary things,” like “coat hangers,” “the tar on roads,” and “the absence of words.” Roy’s writing makes constant use of these ordinary things, bringing lush detail to even the most tragic moments. The book opens at the funeral of the twins’ half-British cousin Sophie after her drowning. As the family mourns, lilies curl and crisp in the hot church. A baby bat crawls up a funeral sari. Tears drip from a chin like raindrops from a roof. The novel forays into the past to explore the characters’ struggles to operate in a world where they don’t quite fit, alongside their nation’s political turmoil. Ammu struggles not to lash out at her beloved children when she feels particularly trapped in her parents’ small-town home, where neighbors judge and shun her for being divorced. Velutha, meanwhile, balances his affair with Ammu and friendship with the twins not only with his employment to their family, but also with his membership to a budding communist countermovement to Indira Ghandi’s “Green Revolution.” In the 1960s, the misleadingly named “Green Revolution” introduced chemical fertilizers and pesticides and the damming of rivers to India. While these policies produced high-yield crops that staved off famine, they also forced people from lower castes off their land and caused widespread environmental damage. When the twins return to Ayemenem as adults, the consequences of the Green Revolution are all around them. The river that was bursting with life in their childhood greets them “with a ghastly skull’s smile, with holes where teeth had been, and a limp hand raised from a hospital bed.” As Roy probes the depths of human experience, she never loses sight of the way her characters are shaped by the time and the place where they live. In the world of "The God of Small Things," “Various kinds of despair competed for primacy… personal despair could never be desperate enough... personal turmoil dropped by at the wayside shrine of the vast, violent, circling, driving, ridiculous, insane, unfeasible public turmoil of a nation.”

**P769 2019-09-06 Are we living in a simulation - Zohreh Davoudi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=769)

We live in a vast universe, on a small wet planet, where billions of years ago single-celled life forms evolved from the same elements as all non-living material around them, proliferating and radiating into an incredible ray of complex life forms. All of this— living and inanimate, microscopic and cosmic— is governed by mathematical laws with apparently arbitrary constants. And this opens up a question: If the universe is completely governed by these laws, couldn’t a powerful enough computer simulate it exactly? Could our reality actually be an incredibly detailed simulation set in place by a much more advanced civilization? This idea may sound like science fiction, but it has been the subject of serious inquiry. Philosopher Nick Bostrom advanced a compelling argument that we’re likely living in a simulation, and some scientists also think it’s a possibility. These scientists have started thinking about experimental tests to find out whether our universe is a simulation. They are hypothesizing about what the constraints of the simulation might be, and how those constraints could lead to detectable signs in the world. So where might we look for those glitches? One idea is that as a simulation runs, it might accumulate errors over time. To correct for these errors the simulators could adjust the constants in the laws of nature. These shifts could be tiny— for instance, certain constants we’ve measured with accuracies of parts per million have stayed steady for decades, so any drift would have to be on an even smaller scale. But as we gain more precision in our measurements of these constants, we might detect slight changes over time. Another possible place to look comes from the concept that finite computing power, no matter how huge, can’t simulate infinities. If space and time are continuous, then even a tiny piece of the universe has infinite points and becomes impossible to simulate with finite computing power. So a simulation would have to represent space and time in very small pieces. These would be almost incomprehensibly tiny. But we might be able to search for them by using certain subatomic particles as probes. The basic principle is this: the smaller something is, the more sensitive it will be to disruption— think of hitting a pothole on a skateboard versus in a truck. Any unit in space-time would be so small that most things would travel through it without disruption— not just objects large enough to be visible to the naked eye, but also molecules, atoms, and even electrons and most of the other subatomic particles we’ve discovered. If we do discover a tiny unit in space-time or a shifting constant in a natural law, would that prove the universe is a simulation? No— it would only be the first of many steps. There could be other explanations for each of those findings. And a lot more evidence would be needed to establish the simulation hypothesis as a working theory of nature. However many tests we design, we’re limited by some assumptions they all share. Our current understanding of the natural world on the quantum level breaks down at what’s known as the planck scale. If the unit of space-time is on this scale, we wouldn’t be able to look for it with our current scientific understanding. There’s still a wide range of things that are smaller than what’s currently observable but larger than the planck scale to investigate. Similarly, shifts in the constants of natural laws could occur so slowly that they would only be observable over the lifetime of the universe. So they could exist even if we don’t detect them over centuries or millennia of measurements. We're also biased towards thinking that our universe’s simulator, if it exists, makes calculations the same way we do, with similar computational limitations. Really, we have no way of knowing what an alien civilization’s constraints and methods would be— but we have to start somewhere. It may never be possible to prove conclusively that the universe either is, or isn’t, a simulation, but we’ll always be pushing science and technology forward in pursuit of the question: what is the nature of reality?

**P770 2019-09-06 Einstein's twin paradox explained - Amber Stuver**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=770)

On their 20th birthday, identical twin astronauts volunteer for an experiment. Terra will remain on Earth, while Stella will board a spaceship. Stella’s ship will travel at 86.6% the speed of light to visit a star that is 10 light-years away, then return to Earth at the same speed. As they prepare to part ways, the twins wonder what will happen when they’re reunited. Since a light year is exactly the distance light can travel in a year, Stella’s journey should take 23 years. But from having studied special relativity, the twins know it’s not that simple. First of all, the faster an object moves through space, the slower it moves through time compared to an unmoving observer. This relationship can be quantified with something called the Lorentz factor, which is defined by this equation. And secondly, the length of a moving object as measured by an observer at rest will contract by the same factor. At 86.6% of the speed of light the Lorentz factor is 2, meaning time will pass twice as slowly aboard the spaceship. Of course, Stella won’t notice time slowing down. That’s because all time-based processes in the ship will slow down as well– clocks and electrical devices; Stella’s biological activities including her rate of aging and her perception of time itself. The only people who could notice time on the moving spaceship passing slower for Stella would be observers in an inertial, or non-accelerating, reference frame– like Terra back on Earth. Thus, Terra concludes that when they meet back on Earth, she’ll be older than Stella. But that’s just one way of looking at things. Because all movement is relative, Stella argues it would be just as valid to say her spaceship will stand still while the rest of the universe, including Terra, moves around her. And in that case, time will pass twice as slowly for Terra, making Stella the older twin in the end. They can’t each be older than the other, so which one of them is right? This apparent contradiction is known as the “Twin Paradox.” But it’s not really a paradox– just an example of how special relativity can be easily misunderstood. To test their theories in real-time, each of the twins agrees to send a burst of light to the other every time a year has passed for them. Unlike other objects, the speed of light is always constant regardless of an observer’s reference frame. A light burst sent from Earth will be measured at the same speed as a light burst sent from the spaceship, regardless of whether it’s on its outbound or return trip. So when one twin observes a burst of light, they’re measuring how long it took the other twin to experience a year passing, plus how long it took for light to travel between them. We can track what’s happening on a graph. The X axis marks distance from Earth, and the Y axis tracks the passage of time. From Terra’s perspective, her path will simply be a vertical line, with distance equal to zero and each tick on the line equivalent to a year as she perceives it. Stella’s path will stretch from the same origin to a point 11.5 years in time and 10 light-years in distance from Terra… before converging again at zero distance and 23 years’ time. At her first one-year mark, Terra will send a pulse of light from Earth towards Stella’s spaceship. Since light takes a year to travel one light-year, its path will be a 45-degree diagonal line. And because Stella is traveling away from it, by the time the light catches up to her, over 7 total years will have passed for Terra, and over 4 for Stella. By the time Stella observes Terra’s second burst, she will already be on her return journey. But now, since she’s moving towards the source of the light, it will take less time to reach her, and she’ll observe the bursts more frequently. This means that Stella observes Terra aging slowly for the first half of her journey, but aging rapidly during the return half. Meanwhile for Stella, it seems as though Terra, the destination star, and the whole universe are moving around her. And because of length contraction, Stella observes the distance between them shrinking by a factor of 2. This means each leg of the trip will only take about six years from Stella’s perspective. When she sends the first signal to Earth, two years will have passed for Terra. Stella will send four more light bursts during her outbound journey, each one from farther away. By the time Terra observes the first pulse from Stella's inbound journey, over 21 years will have passed for her. For the rest of Stella's return home, Terra receives multiple light bursts each year. Thus, Terra observes Stella aging slowly for about 90% of their 23 years apart, and aging rapidly during the last 10%. This asymmetry accounts for why the paradox isn’t really a paradox. Although each twin witnesses time both speeding up and slowing down for the other, Stella sees an even split, while Terra sees Stella aging slowly for most of the time they’re apart. This is consistent with each twin’s measurement of the space voyage, which takes 23 Earth years, but only 11.5 as experienced aboard the ship. When the twins are reunited, Terra will be 43 years old, while Stella will be 31. Where Stella went wrong was her assumption that she and Terra had equal claim to being inertial observers. To be an inertial observer, one has to maintain a constant speed and direction relative to the rest of the universe. Terra was at rest the entire time, so her velocity was a constant zero. But when Stella changed her direction for the return journey, she entered a different reference frame from the one she’d started in. Terra and Stella now both have a better understanding of how spacetime works. And as twins who are eleven years apart in age, they’re a perfect example of special relativity.

**P771 2019-09-12 What causes an economic recession - Richard Coffin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=771)

For millennia, the people of Britain had been using bronze to make tools and jewelry, and as a currency for trade. But around 800 BCE, that began to change: the value of bronze declined, causing social upheaval and an economic crisis— what we would call a recession today. What causes recessions? This question has long been the subject of heated debate among economists, and for good reason. A recession can be a mild decline in economic activity in a single country that lasts months, a long-lasting downturn with global ramifications that last years, or anything in between. Complicating matters further, there are countless variables that contribute to an economy’s health, making it difficult to pinpoint specific causes. So it helps to start with the big picture: recessions occur when there is a negative disruption to the balance between supply and demand. There’s a mismatch between how many goods people want to buy, how many products and services producers can offer, and the price of the goods and services sold, which prompts an economic decline. An economy’s relationship between supply and demand is reflected in its inflation rates and interest rates. Inflation happens when goods and services get more expensive. Put another way, the value of money decreases. Still, inflation isn’t necessarily a bad thing. In fact, a low inflation rate is thought to encourage economic activity. But high inflation that isn’t accompanied with high demand can both cause problems for an economy and eventually lead to a recession. Interest rates, meanwhile, reflect the cost of taking on debt for individuals and companies. The rate is typically an annual percentage of a loan that borrowers pay to their creditors until the loan is repaid. Low interest rates mean that companies can afford to borrow more money, which they can use to invest in more projects. High interest rates, meanwhile, increase costs for producers and consumers, slowing economic activity. Fluctuations in inflation and interest rates can give us insight into the health of the economy, but what causes these fluctuations in the first place? The most obvious causes are shocks like natural disaster, war, and geopolitical factors. An earthquake, for example, can destroy the infrastructure needed to produce important commodities such as oil. That forces the supply side of the economy to charge more for products that use oil, discouraging demand and potentially prompting a recession. But some recessions occur in times of economic prosperity— possibly even because of economic prosperity. Some economists believe that business activity from a market’s expansion can occasionally reach an unsustainable level. For example, corporations and consumers may borrow more money with the assumption that economic growth will help them handle the added burden. But if the economy doesn’t grow as quickly as expected, they may end up with more debt than they can manage. To pay it off, they’ll have to redirect funds from other activities, reducing business activity. Psychology can also contribute to a recession. Fear of a recession can become a self-fulfilling prophecy if it causes people to pull back investing and spending. In response, producers might cut operating costs to help weather the expected decline in demand. That can lead to a vicious cycle as cost cuts eventually lower wages, leading to even lower demand. Even policy designed to help prevent recessions can contribute. When times are tough, governments and central banks may print money, increase spending, and lower central bank interest rates. Smaller lenders can in turn lower their interest rates, effectively making debt “cheaper” to boost spending. But these policies are not sustainable and eventually need to be reversed to prevent excessive inflation. That can cause a recession if people have become too reliant on cheap debt and government stimulus. The Bronze recession in Britain eventually ended when the adoption of iron helped revolutionize farming and food production. Modern markets are more complex, making today’s recessions far more difficult to navigate. But each recession provides new data to help anticipate and respond to future recessions more effectively.

**P772 2019-09-16 The ballet that incited a riot - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=772)

We typically think of ballet as harmonious, graceful and polished– hardly features that would trigger a riot. But at the first performance of Igor Stravinsky’s "The Rite of Spring," audience members were so outraged that they drowned out the orchestra. Accounts of the event include people hurling objects at the stage, challenging each other to fights, and getting arrested– all on what started as a sophisticated night at the ballet. First performed in May 1913 at the Théâtre des Champs-Elysées in Paris, "The Rite of Spring" is set in prehistoric times. The narrative follows an ancient Pagan community worshipping the Earth and preparing for the sacrifice of a woman intended to bring about the change of seasons. But the ballet is much more concerned with the violent relationship between humans, nature, and culture than with character or plot. These themes manifest in a truly upsetting production which combines harsh music, jerky dancing, and uncanny staging. It opens with dancers awakening to a solo bassoon, playing in an eerily high register. This gives way to discordant strings, punctured by unexpected pauses while the dancers twitch to the music. These frightening figures enact the ballet’s brutal premise, which set audiences on edge and shattered the conventions of classical music. In these ways and many more, "The Rite of Spring" challenged the orchestral traditions of the 19th century. Composed on the cusp of both the first World War and the Russian revolution, "The Rite of Spring" seethes with urgency. This tension is reflected in various formal experiments, including innovative uses of syncopation, or irregular rhythm; atonality or the lack of a single key, and the presence of multiple time signatures. Alongside these strikingly modern features, Stravinsky spliced in aspects of Russian folk music– a combination that deliberately disrupted the expectations of his sophisticated, urban audience. This wasn’t Stravinsky’s first use of folk music. Born in a small town outside of St. Petersburg in 1882, Stravinsky’s reputation was cemented with the lush ballet "The Firebird." Based on a Russian fairytale, this production was steeped in Stravinsky’s fascination with folk culture. But he plotted a wilder project in "The Rite of Spring," pushing folk and musical boundaries to draw out the rawness of pagan ritual. Stravinsky brought this reverie to life in collaboration with artist Nicholas Roerich. Roerich was obsessed with prehistoric times. He had published essays about human sacrifice and worked on excavations of Slavic tombs in addition to set and costume design. For "The Rite of Spring," he drew from Russian medieval art and peasant garments to create costumes that hung awkwardly on the dancers’ bodies. Roerich set them against vivid backdrops of primeval nature; full of jagged rocks, looming trees and nightmarish colors. Along with its dazzling sets and searing score, the original choreography for "The Rite of Spring" was highly provocative. This was the doing of legendary dancer Vaslav Nijinsky, who developed dances to rethink “the roots of movement itself.” Although Stravinsky later expressed frustration with Nijinsky’s demanding rehearsals and single-minded interpretations of the music, his choreography proved as pioneering as Stravinsky’s composition. He contorted traditional ballet– to both the awe and horror of his audience, many of whom expected the refinement and romance of the genre. The dancing in "The Rite of Spring" is agitated and uneven, with performers cowering, writhing and leaping about as if possessed. Often, the dancers are not one with the music but rather seem to struggle against it. Nijinsky instructed them to turn their toes inwards and land heavily after jumps, often off the beat. For the final, frenzied scene, a woman dances herself to death to loud bangs and jarring strings. The ballet ends abruptly on a harsh, haunting chord. Today, "The Rite of Spring" remains as chilling as its controversial debut, but the shockwaves of the original work continue to resound and inspire. You can hear Stravinsky’s influence in modern jazz’s dueling rhythms, folky classical music, and even film scores for horror movies, which still illicit a riotous audience response.

**P773 2019-09-16 The myth of the Sampo— an infinite source of fortune and greed - Hann**

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After a savage seafaring skirmish and eight long days of being battered by waves, Väinämöinen— a powerful bard and sage as old as the world itself— washed up on the shores of distant Pohjola. Unlike his home Kalevala, Pohjola was a dark and frozen land, ruled by Louhi, “the gap-tooth hag of the North." The cunning witch nursed Väinämöinen back to health but demanded a reward for returning him home. Not content with mere gold or silver, Louhi wanted what did not yet exist— the Sampo. To be forged from “the tips of white-swan feathers," “the milk of greatest virtue," “a single grain of barley," and “the finest wool of lambskins," this artifact was said to be an endless font of wealth. But Väinämöinen knew that only Seppo Ilmarinen, the Eternal Hammerer who forged the sky-dome itself, could craft such an object. So he convinced Louhi to send him home and fetch the smith. Though the journey was far from easy, the bard finally made it back to Kalevala. But Ilmarinen refused to go to the gloomy North— a land of witches and man-eaters. But keeping true to his word, Väinämöinen tricked Ilmarinen into climbing a giant tree, before summoning a mighty storm to carry the smith all the way to Pohjola. Ilmarinen was well received in the North. Louhi lavished her guest with extravagant hospitality and promised him the hand of her beautiful daughter— if he could craft what she wished. When she finally asked if Ilmarinen was capable of forging the Sampo, the powerful smith declared he could indeed accomplish the task. But try as he might to bend the forge to his will, its fires only produced other artifacts— beautiful in appearance but ill-mannered in nature. An elegant crossbow that thirsted for blood and a gleaming plow that ruined cultivated fields among others. Finally, Ilmarinen summoned the winds themselves to work the bellows, and in three days time he pulled the Sampo, with its lid of many colors from the forge’s flames. On its sides the smith carefully crafted a grain mill, a salt mill, and a money mill. Louhi was so delighted with the object’s limitless productive power that she ran off to lock her treasure inside a mountain. But when Ilmarinen tried to claim his prize, the promised maiden refused to marry him, and the smith had to return home alone. Years passed, and while Pohjola prospered, Ilmarinen and Väinämöinen were without wives or great wealth. Bitter about this injustice, the bard proposed a quest to retrieve the Sampo, and the two sailed north with the help of Lemminkäinen— a beautiful young man with a history of starting trouble. Upon arrival, Väinämöinen requested half the Sampo’s profits as compensation— or they’d take the artifact by force. Outraged at this request, Louhi summoned her forces to fight the heroes. But as her army readied for war, the bard played his magic harp, Kantele, entrancing all who heard it and sending Pohjola into a deep slumber. Unimpeded, the three men took the Sampo and quietly made their escape. Lemminkäinen was ecstatic at their success, and demanded that Väinämöinen sing of their triumph. The bard refused, knowing the dangers of celebrating too early. But after three days of traveling, Lemminkäinen’s excitement overwhelmed him, and he recklessly broke out in song. His awful singing voice woke a nearby crane, whose screeching cries roused the Pohjolan horde. The army made chase. As their warship closed in, Väinämöinen raised a rock to breach their hull. Undeterred, Louhi transformed into a giant eagle, carrying her army on her back as they attacked the heroes’ vessel. She managed to grab the Sampo in her claw, but just as quickly, it dropped into the sea, shattering into pieces and sinking deep beyond her talon’s reach. Buried on the ocean floor, the remnants of this powerful device remain in the realm of Ahti, god of water— where they grind salt for the seas to this very day.

**P774 2019-09-20 The Prison Break \_ Think Like A Coder, Ep 1**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=774)

Upon emerging from stasis, Ethic is the unfortunate recipient of three surprises. The first: a prison cell. The second: complete amnesia. And the third: a mysterious stranger has gotten stuck squeezing through the bars on her window. His name is Hedge, and he has come to help Ethic save the world. But first they have to break out of jail. Hedge turns his hand into a lockpick and outlines the challenge ahead. Each lock in the prison works in the same unusual way. Inside the keyhole is a red dial that can be rotated to one of 100 positions numbered 1 through 100. The key for a given cell spins the dial to the right position, which, when stopped there, makes it turn green and unlocks the door. It would be out of the question to steal keys from a guard, but Hedge has a better idea. Hedge can carry out Ethic‘s commands. If Ethic tells him to walk 5 steps forward, turn right, then walk another 5 steps, that’s exactly what he’ll do. Hedge needs specific instructions though. If Ethic says “pick the lock” or “try every combination” that would be too vague, but “spin the dial 5 positions forward” would work. Once out of the cell, they will only have a few moments to crack the lock for the outer prison door too before the guards catch them. So what instructions will allow Hedge to efficiently open any door? Pause now to figure it out for yourself. Before we explain the solution, here’s a hint. A key programming concept that can help unlock the door is called a loop. This can be one or more instructions that Hedge will iterate— or repeat— a specified number of times, like “jump up and down 100 times.” Or an instruction that Hedge will repeat until a condition is met, such as “keep jumping up and down until it’s 7 o’clock.” Pause now to figure it out for yourself. The first thing that’s clear is that you need to find a way for Hedge to try every combination until one works. What takes a little more effort is how exactly you do so. One solution would be to instruct Hedge to try every combination in succession. Try 1 and check the light. If it turns green, open the door, and if not, try 2. If that doesn’t work try 3. All the way up to 100. But it would be tedious to lay that out in its entirety. Why write more than 100 lines of code, when you can do the same thing with just 3? This is where a loop comes in. There are a few ways to go about this. The lock has 100 positions, so Ethic could say “Check the dial’s color, then spin the dial forward once, for 100 repetitions. Remember where the dial turns green, then have Hedge set it back to that number.” A loop like this, where you specify the number of times it repeats, is called a “for" loop. But an even more efficient loop would have Hedge spin the dial one position at a time until it turns green and as soon as that happens, have him stop and open the door. That way if the door unlocks on 1, he doesn’t need to cycle through all the rest of the numbers. This is an “until” loop, because it involves doing an action until a condition is met. A similar, alternate approach would be to turn the dial while it’s still red, then stop. That’s called a “while” loop. Back to the adventure. Hedge loops through the combinations, and the cell opens at 41. Ethic and Hedge wait until the perfect moment in the guards’ rotation and make a break for it. Soon, Ethic faces a choice: hide inside a mysterious crystal, or try to crack the outer door and make a run for it. Ethic chooses to run. The second door takes Hedge longer, requiring him to spin all the way to 93. But he gets it open and takes the opportunity to explain why he’s rescued Ethic. The world is in turmoil: robots have taken over, and only Ethic can set things right. In order to do so, they’ll need to collect three powerful artifacts that are being used for nefarious purposes across the land. Only then can Ethic return to the world machine— that giant crystal— to set things right. Ethic may have escaped the prison… but what has she gotten herself into?

**P775 2019-09-23 Why should you read Dante’s “Divine Comedy” - Sheila Marie Orfano**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=775)

“Abandon all hope, ye who enter here… ” Inscribed above the Gate of Hell, these ominous words warn dark tidings for Dante as he begins his descent into inferno. Yet despite the grim tone, this prophecy sets into motion what is perhaps the greatest love story ever told; an epic journey that encompasses both the human and the divine. But for Dante to reach benevolent salvation, he must first find his way through Hell. This landscape of torture is the setting for "Inferno," the first in a three-part narrative poem written by Dante Alighieri in the 14th century. Casting himself as the protagonist, Dante travels deeper and deeper into Hell’s abyss, witnessing obscene punishments distinct to each of its nine realms. Beginning in Limbo, he travels through the circles of Lust, Gluttony, Greed, Wrath, Heresy, Violence, and Fraud, to the horrific ninth circle of Treachery, where sinners are trapped under the watchful eyes of Satan himself. The following two parts, "Purgatorio" and "Paradiso," continue Dante’s journey, as he scales the Mount of Purgatory and ascends the nine celestial spheres of Heaven. Written together over 10 years, these 3 sections comprise the "Divine Comedy"– an allegorical imagining of the soul’s journey towards God. But Dante’s "Divine Comedy" is more than just religious allegory. It’s also a witty, scathing commentary on Italian politics. A soldier and statesman from Florence, Dante was staunchly faithful to God, but often critical of the Roman Catholic Church. He particularly disliked its rampant nepotism and practice of simony, the buying and selling of religious favours such as pardons from sin. Many groups took advantage of these corrupt customs, but few supported them as much as the Guelfi Neri, or Black Guelphs. This was a political and religious faction which sought to expand the pope’s political influence. Dante was a member of the Guelfi Bianchi, or White Guelphs– who believed Florence needed more freedom from Roman influence. As a public representative for the White Guelphs, Dante frequently spoke out against the pope’s power, until the Black Guelphs leveraged their position to exile him from Florence in 1302. But rather than silencing him, this lifelong exile led to Dante’s greatest critique of all. Dishonored and with little hope of return, the author freely aired his grievances with the Church and Italian society. Writing the "Divine Comedy" in Italian, rather than the traditional Latin of the educated elite, Dante ensured the widest possible audience for his biting political commentary. In the "Inferno’s" circle of the Wrathful, Dante eagerly witnesses sinners tear Black Guelph Filippo Argenti limb from limb. In the circle of Fraud, Dante converses with a mysterious sinner burning in the circle’s hottest flames. He learns that this is Pope Nicholas III, who tells Dante that his two successors will take his place when they die— all three guilty of simony and corruption. Despite the bleak and sometimes violent imagery in "Inferno," the "Divine Comedy" is also a love story. Though Dante had an arranged marriage with the daughter of a powerful Florentine family, he had also been unrequitedly in love with another woman since he was nine years old: Beatrice Portinari. Despite allegedly meeting just twice, she became Dante’s lifelong muse, serving as the inspiration and subject for many of his works. In fact, it’s Beatrice who launches his intrepid journey into the pits of Hell and up the terraces of Mount Purgatory. Portrayed as a powerful, heavenly figure, she leads Dante through "Paradiso’s" concentric spheres of Heaven until he is finally face-to-face with God. In the centuries since its publication, the "Divine Comedy’s" themes of love, sin, and redemption have been embraced by numerous artists– from Auguste Rodin and Salvador Dali, to Ezra Pound and Neil Gaiman. And the poet himself received his own belated, earthly redemption in 2008, when the city of Florence finally revoked Dante’s antiquated exile.

**P776 2019-09-25 How to 3D print human tissue - Taneka Jones**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=776)

There are currently hundreds of thousands of people on transplant lists, waiting for critical organs like kidneys, hearts, and livers that could save their lives. Unfortunately, there aren’t nearly enough donor organs available to fill that demand. What if instead of waiting, we could create brand-new, customized organs from scratch? That’s the idea behind bioprinting, a branch of regenerative medicine currently under development. We’re not able to print complex organs just yet, but simpler tissues including blood vessels and tubes responsible for nutrient and waste exchange are already in our grasp. Bioprinting is a biological cousin of 3-D printing, a technique that deposits layers of material on top of each other to construct a three-dimensional object one slice at a time. Instead of starting with metal, plastic, or ceramic, a 3-D printer for organs and tissues uses bioink: a printable material that contains living cells. The bulk of many bioinks are water-rich molecules called hydrogels. Mixed into those are millions of living cells as well as various chemicals that encourage cells to communicate and grow. Some bioinks include a single type of cell, while others combine several different kinds to produce more complex structures. Let’s say you want to print a meniscus, which is a piece of cartilage in the knee that keeps the shinbone and thighbone from grinding against each other. It’s made up of cells called chondrocytes, and you’ll need a healthy supply of them for your bioink. These cells can come from donors whose cell lines are replicated in a lab. Or they might originate from a patient’s own tissue to create a personalized meniscus less likely to be rejected by their body. There are several printing techniques, and the most popular is extrusion-based bioprinting. In this, bioink gets loaded into a printing chamber and pushed through a round nozzle attached to a printhead. It emerges from a nozzle that’s rarely wider than 400 microns in diameter, and can produce a continuous filament roughly the thickness of a human fingernail. A computerized image or file guides the placement of the strands, either onto a flat surface or into a liquid bath that’ll help hold the structure in place until it stabilizes. These printers are fast, producing the meniscus in about half an hour, one thin strand at a time. After printing, some bioinks will stiffen immediately; others need UV light or an additional chemical or physical process to stabilize the structure. If the printing process is successful, the cells in the synthetic tissue will begin to behave the same way cells do in real tissue: signaling to each other, exchanging nutrients, and multiplying. We can already print relatively simple structures like this meniscus. Bioprinted bladders have also been successfully implanted, and printed tissue has promoted facial nerve regeneration in rats. Researchers have created lung tissue, skin, and cartilage, as well as miniature, semi-functional versions of kidneys, livers, and hearts. However, replicating the complex biochemical environment of a major organ is a steep challenge. Extrusion-based bioprinting may destroy a significant percentage of cells in the ink if the nozzle is too small, or if the printing pressure is too high. One of the most formidable challenges is how to supply oxygen and nutrients to all the cells in a full-size organ. That’s why the greatest successes so far have been with structures that are flat or hollow— and why researchers are busy developing ways to incorporate blood vessels into bioprinted tissue. There’s tremendous potential to use bioprinting to save lives and advance our understanding of how our organs function in the first place. And the technology opens up a dizzying array of possibilities, such as printing tissues with embedded electronics. Could we one day engineer organs that exceed current human capability, or give ourselves features like unburnable skin? How long might we extend human life by printing and replacing our organs? And exactly who—and what— will have access to this technology and its incredible output?

**P777 2019-09-26 Hawking's black hole paradox explained - Fabio Pacucci**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=777)

Scientists work on the boundaries of the unknown, where every new piece of knowledge forms a path into a void of uncertainty. And nothing is more uncertain– or potentially enlightening– than a paradox. Throughout history, paradoxes have threatened to undermine everything we know, and just as often, they’ve reshaped our understanding of the world. Today, one of the biggest paradoxes in the universe threatens to unravel the fields of general relativity and quantum mechanics: the black hole information paradox. To understand this paradox, we first need to define what we mean by "information." Typically, the information we talk about is visible to the naked eye. For example, this kind of information tells us that an apple is red, round, and shiny. But physicists are more concerned with quantum information. This refers to the quantum properties of all the particles that make up that apple, such as their position, velocity and spin. Every object in the universe is composed of particles with unique quantum properties. This idea is evoked most significantly in a vital law of physics: the total amount of quantum information in the Universe must be conserved. Even if you destroy an object beyond recognition, its quantum information is never permanently deleted. And theoretically, knowledge of that information would allow us to recreate the object from its particle components. Conservation of information isn’t just an arbitrary rule, but a mathematical necessity, upon which much of modern science is built. But around black holes, those foundations get shaken. When an apple enters a black hole, it seems as though it leaves the universe, and all its quantum information becomes irretrievably lost. However, this doesn’t immediately break the laws of physics. The information is out of sight, but it might still exist within the black hole’s mysterious void. Alternatively, some theories suggest that information doesn’t even make it inside the black hole at all. Seen from outside, it’s as if the apple’s quantum information is encoded on the surface layer of the black hole, called the event horizon. As the black hole’s mass increases, the surface of the event horizon increases as well. So it’s possible that as a black hole swallows an object, it also grows large enough to conserve the object’s quantum information. But whether information is conserved inside the black hole or on its surface, the laws of physics remain intact– until you account for Hawking Radiation. Discovered by Stephen Hawking in 1974, this phenomenon shows that black holes are gradually evaporating. Over incredibly long periods of time black holes lose mass as they shed particles away from their event horizons. Critically, it seems as though the evaporating particles are unrelated to the information the black hole encodes– suggesting that a black hole and all the quantum information it contains could be completely erased. Does that quantum information truly disappear? If not, where does it go? While the evaporation process would take an incredibly long time, the questions it raises for physics are far more urgent. The destruction of information would force us to rewrite some of our most fundamental scientific paradigms. But fortunately, in science, every paradox is an opportunity for new discoveries. Researchers are investigating a broad range of possible solutions to the Information Paradox. Some have theorized that information actually is encoded in the escaping radiation, in some way we can’t yet understand. Others have suggested the paradox is just a misunderstanding of how general relativity and quantum field theory interact. Respectively, these two theories describe the largest and smallest physical phenomena, and they’re notoriously difficult to combine. Some researchers argue that a solution to this and many other paradoxes will come naturally with a “unified theory of everything.” But perhaps the most mind-bending theory to come from exploring this paradox is the holographic principle. Expanding on the idea that the 2D surface of an event horizon can store quantum information, this principle suggests that the very boundary of the observable universe is also a 2D surface encoded with information about real, 3D objects. If this is true, it’s possible that reality as we know it is just a holographic projection of that information. If proven, any of these theories would open up new questions to explore, while still preserving our current models of the universe. But it’s also possible that those models are wrong! Either way, this paradox has already helped us take another step into the unknown.

**P778 2019-09-30 The first and last king of Haiti - Marlene Daut**

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The royal couple of Haiti rode into their coronation to thunderous applause. After receiving his ornate crown and scepter, Henry Christophe ascended his throne, towering 20 meters in the air. But little did the cheering onlookers know that the first king of Haiti would also be its last. Enslaved at birth on the island of Grenada, Christophe spent his childhood being moved between multiple Caribbean islands. Just 12 years old in 1779, he accompanied his master to aid the American revolutionaries in the Battle of Savannah. This prolonged siege would be Christophe’s first encounter with violent revolution. There are few surviving written records about Christophe’s life immediately after the war. Over the next decade, we know he worked as a mason and a waiter at a hotel in the French colony of Saint-Domingue, as Haiti was then known. In 1791, when the colony’s slaves rose up in rebellion, Christophe got another opportunity to fight for freedom. Led by Toussaint Louverture, the rebels fought against plantation owners, as well as British and Spanish forces seeking control of the island. Christophe quickly rose through the ranks, proving himself the equal of more experienced generals. By 1793, Louverture had successfully liberated all of Saint-Domingue’s enslaved people, and by 1801 he’d established the island as a semi-autonomous colony. But during this time, Napoleon Bonaparte had assumed power in France, and made it his mission to restore slavery and French authority throughout the empire. French attempts to reinstate slavery met fierce resistance, with General Christophe even burning the capital city to prevent military occupation. Finally, the rebellion and an outbreak of yellow fever forced French soldiers to withdraw— but the fight was not without casualties. Louverture was captured, and left to die in a French prison; a fate that Christophe’s nine-year-old son would share only a few years later. Following the revolution, Christophe and generals Jean-Jacques Dessalines and Alexandre Pétion rose to prominent positions in the new government. In 1804, Dessalines was proclaimed the emperor of independent Haiti. But his desire to hold exclusive power alienated his supporters. Eventually, Dessalines’ rule incited a political conspiracy that ended in his assassination in 1806. The subsequent power struggle led to a Civil War, which split the country in two. By 1807, Christophe was governing as president of the north in Cap-Haïtien, and Pétion was ruling the south from Port-au-Prince. Pétion tried to stay true to the revolution’s democratic roots by modeling his republic after the United States. He even supported anti-colonial revolutionaries in other nations. These policies endeared him to his people, but they slowed trade and economic growth. Christophe, conversely, had more aggressive plans for an independent Haiti. He redistributed land to the people, while retaining state control of agriculture. He also established trade with many foreign nations, including Great Britain and the United States, and pledged non-interference with their foreign policies. He even built a massive Citadel in case the French tried to invade again. To accomplish all of this, Christophe instituted mandatory labor, and to strengthen his authority, he crowned himself king in 1811. During his reign, he lived in an elegant palace called Sans Souci along with his wife and their three remaining children. Christophe’s kingdom oversaw rapid development of trade, industry, culture, and education. He imported renowned European artists to Haiti’s cultural scene, as well as European teachers, in order to establish public education. But while the king was initially popular among his subjects, his labor mandates were an uncomfortable reminder of the slavery Haitians fought to destroy. Over time, his increasingly authoritarian policies lost support, and his opponents to the south gained strength. In October 1820, his reign finally reached its tragic conclusion. Months after a debilitating stroke left him unable to govern, key members of his military defected to southern forces. Betrayed and despondent, the king committed suicide. Today, the traces of Christophe’s complicated history can still be found in the crumbling remains of his palaces, and in Haiti’s legacy as the first nation to permanently abolish slavery.

**P779 2019-10-04 The Greek myth of Talos, the first robot - Adrienne Mayor**

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Hephaestus, god of technology, was hard at work on his most ingenious invention yet. He was creating a new defense system for King Minos, who wanted fewer intruders on his island kingdom of Crete. But mortal guards and ordinary weapons wouldn’t suffice, so the visionary god devised an indomitable new defender. In the fires of his forge, Hephaestus cast his invention in the shape of a giant man. Made of gleaming bronze; endowed with superhuman strength, and powered by ichor, the life fluid of the gods, this automaton was unlike anything Hephaestus had forged before. The god named his creation Talos: the first robot. Three times a day, the bronze guardian marched around the island's perimeter searching for interlopers. When he identified ships approaching the coast, he hurled massive boulders into their path. If any survivors made it ashore, he would heat his metal body red-hot and crush victims to his chest. Talos was intended to fulfill his duties day after day, with no variation. But despite his robotic behavior, he possessed an internal life his victims could scarcely imagine. And soon, the behemoth would encounter a ship of invaders that would test his mettle. The bedraggled crew of Jason, Medea, and the Argonauts were returning from their hard-won quest to retrieve the Golden Fleece. Their adventure had taken many dark turns, and the weary sailors were desperate to rest in a safe harbor. They’d heard tales of Crete’s invulnerable bronze colossus, and made for a sheltered cove. But before they could even drop anchor, Talos spotted them. While the Argonauts cowered at the approach of the awesome automaton, the sorceress Medea spotted a glinting bolt on the robot’s ankle— and devised a clever gambit. Medea offered Talos a bargain: she claimed that she could make Talos immortal in exchange for removing the bolt. Medea's promise resonated deep within his core. Unaware of his own mechanical nature, and human enough to long for eternal life, Talos agreed. While Medea muttered incantations, Jason removed the bolt. As Medea suspected, the bolt was a weak point in Hephaestus’ design. The ichor flowed out like molten lead, draining Talos of his power source. The robot collapsed with a thunderous crash, and the Argonauts were free to travel home. This story, first recorded in roughly 700 BCE, raises some familiar anxieties about artificial intelligence— and even provides an ancient blueprint for science fiction. But according to historians, ancient robots were more than just myths. By the 4th century BCE, Greek engineers began making actual automatons including robotic servants and flying models of birds. None of these creations were as famous as Talos, who appeared on Greek coins, vase paintings, public frescoes, and in theatrical performances. Even 2,500 years ago, Greeks had already begun to investigate the uncertain line between human and machine. And like many modern myths about artificial intelligence, Talos’ tale is as much about his robotic heart as it is about his robotic brain. Illustrating the demise of Talos on a vase of the fifth century BCE, one painter captured the dying automaton’s despair with a tear rolling down his bronze cheek.

**P780 2019-10-07 Claws vs. nails - Matthew Borths**

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Consider the claw. Frequently found on four-limbed animals around the world, it’s one of nature’s most versatile tools. Bears use claws for digging as well as defense. An eagle’s needle-like talons can pierce the skulls of their prey. And lions can retract their massive claws for easy movement, before flicking them out to hunt. Even the ancestors of primates used to wield these impressive appendages, until their claws evolved into nails. So what in our evolutionary past led to this manicured adaptation, and what can nails do that their sharper cousins can’t? When nails first appeared in the fossil record around 55.8 million years ago, claws had already been present for over 260 million years in the ancestors of mammals and reptiles. But despite the gulf of time between their emergence, these adaptations are both part of the same evolutionary story. Both nails and claws are made of keratin— a tough, fibrous protein also found in horns, scales, hooves and hair. This protein is produced by a wedge of tissue called the keratin matrix. Rich in blood vessels and nutrients, this protein factory produces an endless stream of keratin, which is tightly packed into cells called keratinocytes. These high-density cells give nails and claws their trademark toughness. Since nails evolved from claws, both adaptations produce keratinocytes in the same way. The cells grow out from the matrix, emerging from the skin where they die and harden into a water-resistant sheath. The primary difference between the two keratin coverings is really just their shape, which depends on the shape of the bone at the end of the animal’s digits. In claws, the bed of keratinocytes conforms to a narrow finger bone, wrapping around the end of the digit and radiating outwards to form a cone-shaped structure. Animals with nails, on the other hand, have much broader digits, and keratinocytes only cover the top surface of their wide bones. It’s possible that nails have simply persisted as a side effect of primates evolving wider, more dexterous fingers. But given what we know about the habitats of our primate ancestors, it’s more likely that nails came with their own powerful advantages. High in the forest canopy where these primates lived, wide finger bones and expansive finger pads were ideal for gripping narrow branches. And nails improved that grip even further. By providing a rigid surface to press against, primates could splay out their pads to create even more contact with the trees. Additionally, nails improved the sensitivity of their digits by providing an extra surface to detect changes in pressure while climbing. This combination of sensitivity and dexterity gave our ancestors the precise motor control needed to snatch up insects, pinch berries and seeds, and keep a firm grip on slim branches. The evolution of nails and the evolution of opposable thumbs and toes are closely linked. And when our ancestors moved down from the trees, this flexible grasp enabled them to create and wield complex tools. Even if it was possible for wide fingers to sport claws, their sharp points would’ve likely interfered with these primates’ regular tasks. Claws are ideal for piercing, puncturing, and hooking, but their points make grabbing difficult, and potentially dangerous. However, both claws and nails are used in some unexpected ways. Manatees use nails to grasp their food, and researchers think elephant toenails may sense vibrations in the ground to help them hear. Meanwhile, some primates, like the aye-ayes of Madagascar, have re-acquired claws. They use these extra-long appendages to tap branches and trunks, while listening for hollow sections with their bat-like ears. When they hear an opening, they burrow into the tree and skewer grubs with their needle-like middle finger. We’ve only scratched the surface of all the incredible ways nails and claws are used throughout the animal kingdom. But as for which of these adaptations is better? That’s an answer we may never nail down.

**P781 2019-10-08 The Resistance \_ Think Like A Coder, Ep 2**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=781)

After breaking Ethic out of prison, Hedge flies them both towards a frontier settlement in the shadow of the Bradbarrier, the great wall that encircles the nation. All the settlers there will soon gather for the monthly feeding. The people of the wall spend their days gathering up works of art and literature, from all across the land. On feeding day, the furnace-bots arrive, ravenous. If they eat, the lights stay on, and the food gets delivered. If they starve, the people do too. Hedge’s fuel supply runs out just as he and Ethic reach the outskirts of town, and they come in for a crash landing. Luckily, everyone is too busy preparing for the feeding to notice. Today’s feeding is where Ethic can find the leader of an underground resistance movement. This person knows the location of the first of three powerful artifacts. The problem is, Hedge and Ethic don’t know the resistance leader’s name or appearance. But Hedge has gathered the following information: The leader has green eyes. If the leader has red hair, their name has at least one consecutive double letter. If the leader wear glasses, their name has exactly 2 vowels. Otherwise, their name has exactly 3 vowels. There is exactly one person for whom these are all true. As a fugitive, Ethic can’t sneak into the crowd without drawing attention to herself. But she can give instructions to Hedge. And one tool she has is what programmers call a conditional. That’s a statement of the form “If A, then B.” Flowcharts are great illustrations of how those work. This conditional translates to: if A is true, carry out instruction B. There are also conditionals that account for different possibilities. This says, “If A is true, perform instruction B. Otherwise, carry out instruction C.” So what instructions does she give Hedge so he can find the resistance leader? Pause now to figure it out for yourself. With a problem like this, it can help to simplify first. What if Hedge just has to examine this one person? What information does he need to collect about her? He might ask, “Does she have green eyes?” What other questions should Hedge ask to find the resistance leader, and how can he track those answers? Pause now to figure it out for yourself. It may seem intuitive how you’d approach this problem as a human. But Hedge isn’t a human, and so the challenge comes from needing to give him systematic instructions that will work in any scenario. Hedge needs to examine the settlers, one at a time, until he discovers the right person. In other words, like with the lock on the prison cell, this is a loop that repeats the same instructions. Only this time the loop will involve a series of questions in the form of conditionals, and will end as soon as Hedge finds his target. But first, you’ll want to organize your information. Each person has a set of characteristics: Eye color, hair color, glasses, and name. Does this person have green eyes? If so, mark a check next to “eye color." If not, mark an X there. If they have red hair, does their name contain a double letter? If so, mark a check next to “hair color.” If they don’t have a double letter, mark an X next to “hair color.” Anyone with red hair and no double letter can’t be the resistance leader. But notice that if they have blue hair, Hedge will skip this question and go on to the next one. For the last question, we can say, “If they wear glasses, does their name have exactly 2 vowels? If they don’t have glasses, does their name have exactly 3 vowels?” There will be people in the crowd with glasses and 1 vowel, or no glasses and 2 vowels. But they’re not who we’re looking for, so they’ll get X’s. The resistance leader must be someone with either check marks or blanks next to every question. Blanks are ok, because if someone has blue hair, the rule about red hair doesn’t apply to them. You could have Hedge ask every question about every person, and then choose the person with only checks and blanks. But there’s a way to save yourself lots of time: as soon as Hedge marks an X, have him move on to the next person. You don’t need to know the answer to every question; just one X means they’re not the target of your search. Hedge buzzes through the crowd, and within minutes finds Adila, the resistance leader, and brings her back to Ethic. Adila agrees to help them steal the first artifact— the node of power— but under one condition: that Ethic and Hedge jump-start the revolution by reprogramming the furnace-bots that terrorize the town. And right on cue, the robots descend.

**P782 2019-10-14 Are the illuminati real - Chip Berlet**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=782)

The year was 1776. In Bavaria, new ideals of rationalism, religious freedom, and universal human rights competed with the Catholic church’s heavy influence over public affairs. Across the Atlantic, a new nation staked its claim for independence on the basis of these ideas. But back in Bavaria, law professor Adam Weishaupt’s attempts to teach secular philosophy continued to be frustrated. Weishaupt decided to spread his ideas through a secret society that would shine a light on the shortcomings of the Church’s ideology. He called his secret society the Illuminati. Weishaupt modelled aspects of his secret society off a group called the Freemasons. Originally an elite stoneworkers’ guild in the late Middle Ages, the Freemasons had gone from passing down the craft of masonry to more generally promoting ideals of knowledge and reason. Over time, they had grown into a semi-secret, exclusive order that included many wealthy and influential individuals, with elaborate, secret initiation rituals. Weishaupt created his parallel society while also joining the Freemasons and recruiting from their ranks. He adopted the code name Spartacus for himself, after the famed leader of the Roman slave revolt. Early members became the Illuminati’s ruling council, or Areopagus. One of these members, Baron Adolph Knigge, was also a freemason, and became an influential recruiter. With Knigge’s help, the Illuminati expanded their numbers, gained influence within several Masonic chapters, and incorporated Masonic rituals. By 1784, there were over 600 members, including influential scholars and politicians. As the Illuminati gained members, the American Revolution also gained momentum. Thomas Jefferson would later cite Weishaupt as an inspiration. European monarchs and clergy were fearful of similar revolts on their home soil. Meanwhile, the existence of the Illuminati had become an open secret. Both the Illuminati and the Freemasons drew exclusively from society’s wealthy elite, which meant they were constantly rubbing shoulders with members of the religious and political establishment. Many in the government and church believed that both groups were determined to undermine the people’s religious faith. But these groups didn’t necessarily oppose religion— they just believed it should be kept separate from governance. Still, the suspicious Bavarian government started keeping records of alleged members of the Illuminati. Just as Illuminati members begun to secure important positions in local governments and universities, a 1784 decree by Duke Karl Theodor of Bavaria banned all secret societies. While a public ban on something ostensibly secret might seem difficult to enforce, in this case it worked. Only nine years after its founding, the group dissolved, their records were seized, and Weishaupt forced into exile. The Illuminati would become more notorious in their afterlife than they had ever been in their brief existence. A decade later, in the aftermath of the French Revolution, conservative authors claimed the Illuminati had survived their banishment and orchestrated the overthrow of the monarchy. In the United States, preacher Jedidiah Morse promoted similar ideas of an Illuminati conspiracy against the government. But though the idea of a secret group orchestrating political upheaval is still alive and well today, there is no evidence that the Illuminati survived, reformed, or went underground. Their brief tenure is well-documented in Bavarian government records, the still-active Freemasons’s records, and particularly the overlap between these two sources, without a whisper since. In the spirit of rationalism the Illuminati embraced, one must conclude they no longer exist. But the ideas that spurred Weishaupt to found the illuminati still spread, becoming the basis for many Western governments today. These ideas didn’t start or end with the Illuminati— instead, it was one community that represented a wave of change that was already underway when it was founded and continued long after it ended.

**P783 2019-10-14 How close are we to uploading our minds - Michael S.A. Graziano**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=783)

Imagine a future where nobody dies— instead, our minds are uploaded to a digital world. They might live on in a realistic, simulated environment with avatar bodies, and could still call in and contribute to the biological world. Mind uploading has powerful appeal— but what would it actually take to scan a person’s brain and upload their mind? The main challenges are scanning a brain in enough detail to capture the mind and perfectly recreating that detail artificially. But first, we have to know what to scan. The human brain contains about 86 billion neurons, connected by at least a hundred trillion synapses. The pattern of connectivity among the brain’s neurons, that is, all of the neurons and all their connections to each other, is called the connectome. We haven’t yet mapped the connectome, and there’s also a lot more to neural signaling. There are hundreds, possibly thousands of different kinds of connections, or synapses. Each functions in a slightly different way. Some work faster, some slower. Some grow or shrink rapidly in the process of learning; some are more stable over time. And beyond the trillions of precise, 1-to-1 connections between neurons, some neurons also spray out neurotransmitters that affect many other neurons at once. All of these different kinds of interactions would need to be mapped in order to copy a person’s mind. There are also a lot of influences on neural signaling that are poorly understood or undiscovered. To name just one example, patterns of activity between neurons are likely influenced by a type of cell called glia. Glia surround neurons and, according to some scientists, may even outnumber them by as many as ten to one. Glia were once thought to be purely for structural support, and their functions are still poorly understood, but at least some of them can generate their own signals that influence information processing. Our understanding of the brain isn’t good enough to determine what we’d need to scan in order to replicate the mind, but assuming our knowledge does advance to that point, how would we scan it? Currently, we can accurately scan a living human brain with resolutions of about half a millimeter using our best non-invasive scanning method, MRI. To detect a synapse, we’ll need to scan at a resolution of about a micron— a thousandth of a millimeter. To distinguish the kind of synapse and precisely how strong each synapse is, we’ll need even better resolution. MRI depends on powerful magnetic fields. Scanning at the resolution required to determine the details of individual synapses would requires a field strength high enough to cook a person’s tissues. So this kind of leap in resolution would require fundamentally new scanning technology. It would be more feasible to scan a dead brain using an electron microscope, but even that technology is nowhere near good enough– and requires killing the subject first. Assuming we eventually understand the brain well enough to know what to scan and develop the technology to safely scan at that resolution, the next challenge would be to recreate that information digitally. The main obstacles to doing so are computing power and storage space, both of which are improving every year. We’re actually much closer to attaining this technological capacity than we are to understanding or scanning our own minds. Artificial neural networks already run our internet search engines, digital assistants, self-driving cars, Wall Street trading algorithms, and smart phones. Nobody has yet built an artificial network with 86 billion neurons, but as computing technology improves, it may be possible to keep track of such massive data sets. At every step in the scanning and uploading process, we’d have to be certain we were capturing all the necessary information accurately— or there’s no telling what ruined version of a mind might emerge. While mind uploading is theoretically possible, we’re likely hundreds of years away from the technology and scientific understanding that would make it a reality. And that reality would come with ethical and philosophical considerations: who would have access to mind uploading? What rights would be accorded to uploaded minds? How could this technology be abused? Even if we can eventually upload our minds, whether we should remains an open question.

**P784 2019-10-14 The Maya myth of the morning star**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=784)

Chak Ek’ rose from the underworld to the surface of the eastern sea and on into the heavens. His brother K’in Ahaw followed. Though Chak Ek’ had risen first, K’in Ahaw outshone him, and the resentful Chak Ek’ descended back to the underworld to plot against his brother. In Mayan mythology, Chak Ek’ represents Venus and K’in Ahaw represents the sun. Known as both the morning and the evening star, Venus moves through the sky, sometimes visible before sunrise, sometimes after sunset, and occasionally not at all. The ancient Maya identified this roughly 584 day cycle more than a thousand years ago and it still accurately predicts when and where Venus will appear in the sky around the world. Five of these cycles make up almost exactly eight years, and the Maya also recognized this larger cycle. They assigned Chak Ek’ five different forms, one for each cycle of Venus, that were repeated every eight years. Within the 584 day cycle, Venus is visible in the evening sky for 250 days, then disappears for 8 days before reappearing as the Morning Star. The ancient Maya ascribed particular significance to this point in this cycle: the first time Venus appears before sunrise after being invisible. On this day, Chak Ek’ rose again from the underworld, wielding a spearthrower and darts. To bring discord to the world, he decided to attack his brother and his brother’s allies. His first target was K’awiil, god of sustenance and lightning. Rising in the late rainy season, Chak Ek’ aimed his spear and struck K’awiil, causing damage to the food and a period of chaos in the social order until K’awiil was reborn. 584 days after attacking K’awiil, Chak Ek’ turned his attention back to his brother, the Sun. Each night, the Sun took the form of jaguar and journeyed through the underworld. Chak Ek’ speared the jaguar sun as it rose at dawn towards the end of the dry season. The Sun was wounded, plunging the world into a period of chaos and warfare. Chak Ek’s third victim was the god of maize, who provided sustenance for all humankind. Chak Ek’ speared him at the time of the harvest. He was buried in the underworld, and maize—the staple of life— was no longer available to Earth’s inhabitants. But the maize god emerged after three months in the place of new beginnings– the eastern cave known as Seven Water Place– bringing food once again to earth. When the turtle Ak Na'ak rose in the sky to mark the summer solstice, Chak Ek’ claimed his fourth victim. With the death of this good omen, the Sun, the food supply, and the people were buried within the earth, and the forces of chaos reigned. But out of the chaos rose a new order established by Hun Ajaw, one of the hero twins known to all for having vanquished the lords of the underworld. A new race of humans was created, made from maize. This state of balance was not to last, however. Chak Ek’s fifth and final victim was a mysterious stranger from the west, and his death in the heart of the dry season shook the order established by Hun Ajaw. The gods, the lords, and the maize were buried in the underworld. But this victory for Chak Ek’ would also prove temporary. The two brothers, Venus and the Sun, were caught in an endless cycle as they battled for supremacy, re-enacting the same five struggles, while the world alternated between order and chaos with the rising of the Morning Star.

**P785 2019-10-23 The Taino myth of the cursed creator - Bill Keegan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=785)

Before the world of humans began, there was the world of the gods, made of fields, plains and gardens. Four brothers wandered this celestial realm. They had no family other than each other— they didn’t even know who their parents were. One of the brothers, Deminan, looked different from the others. His skin was covered in painful scabs, and he wondered why he alone had been marked with this affliction. One day, while the supreme spirit Yaya was out in his gardens, Deminan and his brothers snuck into Yaya’s house. After feasting and exploring, they spotted a giant gourd hanging in the corner. But as they tried to look inside the gourd, they dropped it. The gourd broke apart, releasing a deluge that swept the brothers away, separating them from the celestial lands forever. The waters from the gourd formed a new world. This realm was covered in seas, which didn’t exist in the gods’ world. The waters were full of fish and other creatures, and dotted with islands and caves. This world of seas was also cut off completely from the celestial realm, and the brothers wandered aimlessly, even more lost than they had been before. One day, three of the brothers stumbled upon a house. In the house lived an elder named Bayamanacao, and he invited them in. When Deminan caught up slightly later, he followed them into the house. Bayamanacao told the brothers he was their grandfather and gave them a gift of special cassava bread. He revealed their family lineage to them: their mother had been the Earth Mother Goddess Itibi Cahubaba and had died when they were born. The brothers were grateful for his hospitality and insight into their past. But then Bayamanacao turned on Deminan, blowing tobacco spittle from his nose onto Deminan’s back. The spot where the spittle landed immediately began to swell and sting. Soon Deminan was delirious and his back was so swollen his brothers feared he would die. Not knowing what else to do, they cut open the welt. A turtle emerged from the wound and swam away, alternating easily between sea and land as she went. When Deminan recovered from his delirium, he finally understood what the curse of his disease meant: he was a caracaracol, able to communicate with the gods. He was the link between the celestial realm and the earthly realm. Deminan was the first in a long lineage of caracaracols. The world of seas he and his brothers had created when they dropped the gourd became the world of humans, where the caracaracols who followed Deminan maintained the delicate balance between people and gods. But their unique power came at a price: Deminan and all the caracaracols who followed him continued to suffer from the illness that had first marked Deminan as special. Represented in Taino carvings and figurines with a swollen back and emaciated arms, the caracaracol is both cursed and blessed to be a conduit between worlds.

**P786 2019-10-28 Why haven’t we cured arthritis - Kaitlyn Sadtler and Heather J. Faust**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=786)

While regaling you with daring stories from her youth, it might be hard to believe your grandmother used to be a trapeze artist. However, the bad backs, elbow pain, and creaky knees so common in older people is more than just “old age." In fact, the source of this stiffness plagues many young people as well. The culprit is arthritis: a condition that causes inflammation and pain in the joints of over 90 million people in the U.S. alone. But are stiff, creaky joints really inevitable? What makes arthritis so pervasive, and why haven’t we found a cure for this widespread condition? The first hurdle is that arthritis is actually a spectrum of over 100 different arthritic conditions. All these conditions share symptoms of joint pain and inflammation, but the origin and severity of those symptoms vary widely. Even the most common type, osteoarthritis, is trickier to prevent than one might think. It’s a general misconception that arthritis is confined to old age. The origins of osteoarthritis can often be traced to a patient’s early life, from any seemingly ordinary joint injury. Following impact, immune cells rush in to help clean and repair the damaged site and begin pumping out enzymes, including matrix metalloproteinases and aggrecanases. These enzymes clear out the damaged tissue and contribute to inflammation. But while this rapid swelling helps protect the joint during recovery, inadequately healed tissue can cause these immune cells to overstay their welcome. The continuing flood of enzymes starts to degrade the cartilage, weakening the joint and leading to arthritis later on. Not all forms of arthritis can simply be traced to an old sports injury. Take rheumatoid arthritis, which affects 1.3 million U.S. adults. This condition is actually an autoimmune disease in which autoantibodies target natively produced proteins, some of which are secreted by cartilage cells. We still don’t know what causes this behavior, but the result is that the body treats joint tissue like a foreign invader. Immune cells infiltrate the joint despite there being no tissue damage to repair. This response leads to chronic inflammation, which destroys bone and cartilage. Yet another condition, spondyloarthritis, has similarities to both of the conditions we’ve covered. Patients experience continuous inflammation in the joints and at the sites where ligaments and tendons attach to bones, even without any initial injury. This leads to the flood of enzymes and degradation seen in osteoarthritis, but is driven by different inflammatory proteins called cytokines. As the enzymes eat away at cartilage, the body attempts to stabilize smaller joints by fusing them together. This process sometimes leads to outgrowths called bone spurs, which also cause intense stiffness and joint pain. With so many factors causing arthritis, our current treatments are tailored to tackle specific symptoms rather than underlying causes. These range from promising MACI techniques, which harvest cells from small pieces of cartilage to grow replacement tissue. To a technique called microfracture, where surgeons create small holes in the bone, allowing bone marrow stem cells to leak out and form new cartilage. As a last resort, people with withered cartilage can even undergo full joint replacements. But outside these drastic measures, the underlying drivers of autoimmune arthritis still present a unique treatment challenge. Scientists are making progress with therapies that block TNF-alpha, one of the primary proteins causing inflammation in rheumatoid arthritis. But even this approach only treats the symptoms of the condition, not the cause. In the meantime, some of our best defenses against arthritis are lifestyle choices: maintaining a healthy weight to take pressure off joints, low-impact exercises like yoga or cycling, and avoiding smoking. These arthritis-fighting behaviors can help us lead longer lives as we continue to research cures and treatments for the huge diversity of arthritic conditions.

**P787 2019-10-29 Game theory challenge - Can you predict human behavior - Lucas Husted**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=787)

A few months ago we posed a challenge to our community. We asked everyone: given a range of integers from 0 to 100, guess the whole number closest to 2/3 of the average of all numbers guessed. So if the average of all guesses is 60, the correct guess will be 40. What number do you think was the correct guess at 2/3 of the average? Let’s see if we can try and reason our way to the answer. This game is played under conditions known to game theorists as common knowledge. Not only does every player have the same information — they also know that everyone else does, and that everyone else knows that everyone else does, and so on, infinitely. Now, the highest possible average would occur if every person guessed 100. In that case, 2/3 of the average would be 66.66. Since everyone can figure this out, it wouldn’t make sense to guess anything higher than 67. If everyone playing comes to this same conclusion, no one will guess higher than 67. Now 67 is the new highest possible average, so no reasonable guess should be higher than ⅔ of that, which is 44. This logic can be extended further and further. With each step, the highest possible logical answer keeps getting smaller. So it would seem sensible to guess the lowest number possible. And indeed, if everyone chose zero, the game would reach what’s known as a Nash Equilibrium. This is a state where every player has chosen the best possible strategy for themselves given everyone else playing, and no individual player can benefit by choosing differently. But, that’s not what happens in the real world. People, as it turns out, either aren’t perfectly rational, or don’t expect each other to be perfectly rational. Or, perhaps, it’s some combination of the two. When this game is played in real-world settings, the average tends to be somewhere between 20 and 35. Danish newspaper Politiken ran the game with over 19,000 readers participating, resulting in an average of roughly 22, making the correct answer 14. For our audience, the average was 31.3. So if you guessed 21 as 2/3 of the average, well done. Economic game theorists have a way of modeling this interplay between rationality and practicality called k-level reasoning. K stands for the number of times a cycle of reasoning is repeated. A person playing at k-level 0 would approach our game naively, guessing a number at random without thinking about the other players. At k-level 1, a player would assume everyone else was playing at level 0, resulting in an average of 50, and thus guess 33. At k-level 2, they’d assume that everyone else was playing at level 1, leading them to guess 22. It would take 12 k-levels to reach 0. The evidence suggests that most people stop at 1 or 2 k-levels. And that’s useful to know, because k-level thinking comes into play in high-stakes situations. For example, stock traders evaluate stocks not only based on earnings reports, but also on the value that others place on those numbers. And during penalty kicks in soccer, both the shooter and the goalie decide whether to go right or left based on what they think the other person is thinking. Goalies often memorize the patterns of their opponents ahead of time, but penalty shooters know that and can plan accordingly. In each case, participants must weigh their own understanding of the best course of action against how well they think other participants understand the situation. But 1 or 2 k-levels is by no means a hard and fast rule— simply being conscious of this tendency can make people adjust their expectations. For instance, what would happen if people played the 2/3 game after understanding the difference between the most logical approach and the most common? Submit your own guess at what 2/3 of the new average will be by using the form below, and we’ll find out.

**P788 2019-10-29 Why do humans have a third eyelid - Dorsa Amir**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=788)

You know that little pink thing nestled in the corner of your eye? It’s actually the remnant of a third eyelid. Known as the “plica semilunaris,” it’s much more prominent in birds and a few mammals, and functions like a windshield wiper to keep dust and debris out of their eyes. But in humans, it doesn’t work. It’s vestigial, meaning it no longer serves its original purpose. There are several other vestigial structures like the plica semilunaris in the human body. Most of these became vestigial long before homo sapiens existed, quietly riding along from one of our ancestor species to the next. But why have they stuck around for so long? To answer this question, it helps to understand natural selection. Natural selection simply means that traits which help an organism survive and reproduce in a given environment are more likely to make it to the next generation. As the environment changes, traits that were once useful can become harmful. Those traits are often selected against, meaning they gradually disappear from the population. But if a trait isn’t actively harmful, it might not get selected against, and stick around even though it isn’t useful. Take the tailbone. Evolutionary biologists think that as the climate got drier and grasslands popped up, our tail-bearing ancestors left the trees and started walking on land. The tails that had helped them in the trees began to disrupt their ability to walk on land. So individuals with mutations that reduced the length of their tails became more successful at life on land, surviving long enough to pass their short tails on to the next generation. The change was likely gradual over millions of years until, about 20 million years ago, our ancestors’ external tails disappeared altogether. Today, we know human embryos have tails that dissolve as the embryo develops. But the stubby tailbone sticks around, probably because it doesn’t cause any harm— in fact, it serves a more minor function as the anchor point for certain other muscles. Up to 85% of people have a vestigial muscle called the “palmaris longus.” To see if you do, put your hand down on a flat surface and touch your pinkie to your thumb. If you see a little band pop up in the middle of your wrist, that’s the tendon that attaches to this now-defunct muscle. In this case, the fact that not everyone has it has helped us trace its function. Vestigial traits can persist when there’s no incentive to lose them— but since there’s also no incentive to keep them, random mutations will sometimes still eliminate them from part of the population. Looking at our primate relatives, we can see that the palmaris longus is sometimes absent in those that spend more time on the land, but always present in those that spend more time in trees. So we think it used to help us swing from branch to branch, and became unnecessary when we moved down to land. The appendix, meanwhile, may once have been part of the intestinal system our ancestors used for digesting plant materials. As their diets changed, those parts of the intestinal system began to shrink. Unlike other vestigial structures, though, the appendix isn’t always harmless— it can become dangerously inflamed. For most of human history, a burst appendix could be a death sentence. So why did it stick around? It’s possible that it was very slowly on its way out, or that mutations simply hadn’t arisen to make it smaller. Or maybe it has other benefits— for example, it might still be a reservoir of bacteria that helps us break down food. But the fact is, we’re not really sure why the appendix persists. Evolution is an imperfect process. Human beings are the result of millions of years of trial, error, and random chance— and we’re full of evolutionary relics to remind us of that.

**P789 2019-11-04 The dangers of mixing drugs - Céline Valéry**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=789)

Which of these three people is doing something risky? Is it the one who takes their cholesterol medication with grapefruit juice? The one who takes Acetaminophen pain relievers for a sore ankle before going out for drinks? Or the one who’s on a blood-thinning medication and takes an aspirin for a headache? Actually, all of them are. Each has inadvertently created a drug interaction that could, in extreme cases, lead to kidney failure; liver damage; or internal bleeding. Drug interactions happen when the combination of a drug with another substance causes different effects than either would individually. Foods, herbal supplements, legal drugs, and illicit substances can all cause drug interactions. Most drug interactions fall into two categories. Some take place when two substances’ effects influence each other directly. In other cases, one substance effects how the body processes another, like how it is absorbed, metabolized, or transported around the body. Blood thinners and aspirin, for example, have similar effects that become dangerous when combined. Both prevent blood clots from forming— blood thinners by preventing the formation of the clotting factors that hold clots together, and aspirin by preventing blood cells from clumping into groups that become clots. Individually, these effects are usually safe, but taken together, they can prevent blood clotting to a dangerous extent, possibly causing internal bleeding. While blood thinners and aspirin are generally harmless when taken individually, interactions where one substance exacerbates the effects of another can also take place between drugs that are independently harmful. Cocaine and heroin are each dangerous, and those dangers compound when the two drugs are combined— even though their behavioral effects may feel like they cancel each other out. Cocaine is a stimulant, and many of its effects, like increased heart rate, cause the body to need more oxygen. But heroin, a depressant, slows breathing— reducing the body’s oxygen supply just when it needs more. This combination strains the organs and can cause respiratory failure and death. The interaction between grapefruit juice and certain medications in class of cholesterol-lowering drugs called statins, has to do with drug metabolism. The liver produces enzymes, molecules that facilitate the breakdown of substances that enter the body. Enzymes can both activate drugs, by breaking them down into their therapeutic ingredients from more complex molecules, and deactivate them, by breaking harmful compounds down into harmless metabolites. There are many, many different enzymes, each of which has a binding site that fits a specific molecule. Grapefruit binds to the same enzyme as statins, making less of that enzyme available to break down statins. So combining the two means that a greater concentration of the drug stays in the bloodstream for a longer period of time, potentially causing kidney failure. Alcohol can also alter the function of the enzyme that breaks down Acetaminophen, the active ingredient in pain relievers like Tylenol and paracetamol. When someone takes Acetaminophen, some of it is converted into a toxic substance. At the recommended dose, there isn’t usually enough of this toxic byproduct to cause harm. But heavy drinking can alter enzyme activity so more of that byproduct is produced, potentially causing liver damage even with what’s usually a safe dose of acetominophen. Meanwhile, the herbal remedy Saint John’s Wort increases the liver’s production of a particular enzyme. That means the drugs this enzyme is responsible for breaking down get metabolized faster— sometimes too fast, before they can have their therapeutic effects. In spite of the dizzying number of possible interactions, most of the dangerous interactions with commonly used drugs are well known. And new developments in science are helping us keep better track of drug interactions than ever. Some researchers are developing AI programs that can predict the side effects of drug interactions before they occur, using information about the landscape of protein interactions within your body. For the new drugs that are being developed all the time, supercomputers are being used to find potential interactions while those drugs are still in development.

**P790 2019-11-12 The myth of Loki and the master builder - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=790)

Asgard, a realm of wonders, was where the Norse Gods made their home. There Odin’s great hall of Valhalla towered above the mountains and Bifrost, the rainbow bridge, anchored itself. But though their domain was magnificent, it stood undefended from the giants and trolls of Jotunheim, who despised the gods and sought to destroy them. One day when Thor, strongest of the gods, was off fighting these foes, a stranger appeared, riding a powerful gray horse. The visitor made the gods an astonishing offer. He would build them the greatest wall they’d ever seen, higher than any giant could climb and stronger than any troll could break. All he asked in return was the beautiful goddess Freya’s hand in marriage— along with the sun and moon from the sky. The gods balked at this request and were ready to send him away. But the trickster Loki concocted a devious plan. He told the gods they should accept the stranger’s offer, but set such strict conditions that he would fail to complete the wall in time. That way, they would lose nothing, while getting most of the wall built for free. Freya didn’t like this idea at all, but Odin and the other gods were convinced and came to an agreement with the builder. He would only have one winter to complete the wall. If any part was unfinished by the first day of summer, he would receive no payment. And he could have no help from any other people. The gods sealed the deal with solemn oaths and swore the mason would come to no harm in Asgard. In the morning, the stranger began to dig the foundations at an astonishing speed, and at nightfall he set off towards the mountains to obtain the building stones. But it was only the next morning, when they saw him returning, that the gods began to worry. As agreed, no other people were helping the mason. But his horse Svadilfari was hauling a load of stones so massive it left trenches in the ground behind them. Winter came and went. The stranger kept building, Svadilfari kept hauling, and neither snow nor rain could slow their progress. With only three days left until summer, the wall stood high and impenetrable, with only the gate left to be built. Horrified, the gods realized that not only would they lose their fertility goddess forever, but without the sun and moon the world would be plunged into eternal darkness. They wondered why they’d made such a foolish wager— and then remembered Loki and his terrible advice. Suddenly, Loki didn’t feel so clever. All of his fellow gods threatened him with an unimaginably painful death if he didn’t find some way to prevent the builder from getting his payment. So Loki promised to take care of the situation, and dashed away. Outside, night had fallen, and the builder prepared to set off to retrieve the final load of stones. But just as he called Svadilfari to him, a mare appeared in the field. She was so beautiful that Svadilfari ignored his master and broke free of his reins. The mason tried to catch him, but the mare ran deep into the woods and Svadilfari followed. The stranger was furious. He knew that the gods were behind this and confronted them: no longer as a mild-mannered mason, but in his true form as a terrifying mountain giant. This was a big mistake. Thor had just returned to Asgard, and now that the gods knew a giant was in their midst, they disregarded their oaths. The only payment the builder would receive— and the last thing he would ever see— was the swing of Thor’s mighty hammer Mjolnir. As they set the final stones into the wall, the gods celebrated their victory. Loki was not among them, however. Several months would pass before he finally returned, followed by a beautiful gray foal with eight legs. The foal would grow into a magnificent steed named Sleipnir and become Odin’s mount, a horse that could outrun the wind itself. But exactly where he had come from was something Loki preferred not to discuss.

**P791 2019-11-13 The history of the world according to corn - Chris A. Kniesly**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=791)

Corn currently accounts for more than one tenth of our global crop production. The United States alone has enough cornfields to cover Germany. But while other crops we grow come in a range of varieties, over 99% of cultivated corn is the exact same type: Yellow Dent #2. This means that humans grow more Yellow Dent #2 than any other plant on the planet. So how did this single variety of this single plant become the biggest success story in agricultural history? Nearly 9,000 years ago, corn, also called maize, was first domesticated from teosinte, a grass native to Mesoamerica. Teosinte’s rock-hard seeds were barely edible, but its fibrous husk could be turned into a versatile material. Over the next 4,700 years, farmers bred the plant into a staple crop, with larger cobs and edible kernels. As maize spread throughout the Americas, it took on an important role, with multiple indigenous societies revering a “Corn Mother” as the goddess who created agriculture. When Europeans first arrived in America, they shunned the strange plant. Many even believed it was the source of physical and cultural differences between them and the Mesoamericans. However, their attempts to cultivate European crops in American soil quickly failed, and the settlers were forced to expand their diet. Finding the crop to their taste, maize soon crossed the Atlantic, where its ability to grow in diverse climates made it a popular grain in many European countries. But the newly established United States was still the corn capital of the world. In the early 1800’s, different regions across the country produced strains of varying size and taste. In the 1850’s, however, these unique varieties proved difficult for train operators to package, and for traders to sell. Trade boards in rail hubs like Chicago encouraged corn farmers to breed one standardized crop. This dream would finally be realized at 1893’s World’s Fair, where James Reid’s yellow dent corn won the Blue Ribbon. Over the next 50 years, yellow dent corn swept the nation. Following the technological developments of World War II, mechanized harvesters became widely available. This meant a batch of corn that previously took a full day to harvest by hand could now be collected in just 5 minutes. Another wartime technology, the chemical explosive ammonium nitrate, also found new life on the farm. With this new synthetic fertilizer, farmers could plant dense fields of corn year after year, without the need to rotate their crops and restore nitrogen to the soil. While these advances made corn an attractive crop to American farmers, US agricultural policy limited the amount farmers could grow to ensure high sale prices. But in 1972, President Richard Nixon removed these limitations while negotiating massive grain sales to the Soviet Union. With this new trade deal and WWII technology, corn production exploded into a global phenomenon. These mountains of maize inspired numerous corn concoctions. Cornstarch could be used as a thickening agent for everything from gasoline to glue or processed into a low-cost sweetener known as High-Fructose Corn Syrup. Maize quickly became one of the cheapest animal feeds worldwide. This allowed for inexpensive meat production, which in turn increased the demand for meat and corn feed. Today, humans eat only 40% of all cultivated corn, while the remaining 60% supports consumer good industries worldwide. Yet the spread of this wonder-crop has come at a price. Global water sources are polluted by excess ammonium nitrate from cornfields. Corn accounts for a large portion of agriculture-related carbon emissions, partly due to the increased meat production it enables. The use of high fructose corn syrup may be a contributor to diabetes and obesity. And the rise of monoculture farming has left our food supply dangerously vulnerable to pests and pathogens— a single virus could infect the world’s supply of this ubiquitous crop. Corn has gone from a bushy grass to an essential element of the world’s industries. But only time will tell if it has led us into a maze of unsustainability.

**P792 2019-11-15 The Furnace Bots \_ Think Like A Coder, Ep 3**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=792)

Ethic and her robot Hedge agree to help the resistance leader, Adila, sabotage the art-incinerating furnace-bots. In exchange, Adila promises to lead them to the first object of Ethic’s quest, an artifact called the Node of Power. Years ago, there was just one furnace-bot. It had a 0 inside its furnace and an unknown, randomly generated serial number. Over time, the original self-replicated to produce more identical furnace-bots. Each child inherited the original’s unknown serial number within its furnace, and had a random, unique serial number of its own inscribed on its shell. The second generation of furnace- bots also self-replicated in the same way, always passing their own serial numbers to their offspring’s furnaces. This continued on for many generations. Today, each furnace-bot receives its orders from its parent. So if Ethic can find the original 0 bot and somehow change its instructions, she could take over the entire army, all at once. Adila has the perfect solution: a data crystal that she’s been carrying for years, waiting for the right moment to activate it. It contains a program designed to gain control of a bot and give it new instructions. But if it’s uploaded to any furnace- bot other than the original, the 0 bot will override the instructions and destroy the data crystal in the process. The feeding is just a few minutes away, and there’s only one chance to get this right. Fortunately, Hedge’s ability to store data can help. In programming, a piece of information gets stored in something called a variable. Variables are basically containers that hold onto numbers, words, or other values. How does Ethic program Hedge to find the original 0 bot as quickly as possible? Pause now to figure it out for yourself. Here’s a hint. Programs can be written to have as many variables as you need, but you can solve this problem with just one. Hedge can use it to store a serial number and replace it with a new one as often as he needs. Pause now to figure it out for yourself. A key insight here is that Hedge doesn’t need to map out the entire set of relationships to find the original furnace-bot. If, for example, he gets lucky and picks the original one right away, he’ll be done. But if he starts with any other bot, he can still find a path that leads straight back to the 0-bot by following a simple set of instructions. To help craft them, let’s first simplify the problem. Let’s say there were only three furnace-bots; a parent and two children, but you don’t know which is which. You could have Hedge pick one at random and look inside its furnace. Now, you know the family tree looks like this. If the number inside the furnace is a 0, you’ve found the parent. If not, then no matter which child you chose, it must have the parent’s serial number in its furnace. So in this scenario, you’re guaranteed to find the parent in one or two moves. In actuality, there are many furnace-bots, and you don’t know how many generations there are nor what the family tree looks like. But you don’t need to, because Hedge can just keep repeating the same sequence of actions until he gets to the original. How? With a loop. Hedge can pick any bot at random, look inside its furnace, and store that serial number as a variable. Then he’ll begin the following loop that will repeat until the stored variable equals 0, the furnace number of the original bot: 1. Find the bot whose shell serial number matches the stored number. 2. Look inside its furnace. 3. Store that new number, overwriting the old one. Once the loop ends, we’ll know that Hedge has found the 0 bot, so he should upload the control program. So here’s what happens: Hedge only takes 5 repetitions to find the original: robot 733 has the 0 in its furnace. In a blink of a mechanical eye, the program spreads through the entire army, and Adila takes control. She has the furnace-bots give off theatrical bouts of flame to hide the fact that they’re now secretly safe-guarding all of that artistic output. Now that Ethic’s delivered the furnace-bots, Adila honors her end of the deal. She leads Ethic and Hedge to the location of the first artifact, the Node of Power. There, one thing is immediately clear: they’ll have to steal it.

**P793 2019-11-18 Can you outsmart this logical fallacy - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=793)

Meet Lucy. She was a math major in college, and aced all her courses in probability and statistics. Which do you think is more likely: that Lucy is a portrait artist, or that Lucy is a portrait artist who also plays poker? In studies of similar questions, up to 80 percent of participants chose the equivalent of the second statement: that Lucy is a portrait artist who also plays poker. After all, nothing we know about Lucy suggests an affinity for art, but statistics and probability are useful in poker. And yet, this is the wrong answer. Look at the options again. How do we know the first statement is more likely to be true? Because it’s a less specific version of the second statement. Saying that Lucy is a portrait artist doesn’t make any claims about what else she might or might not do. But even though it’s far easier to imagine her playing poker than making art based on the background information, the second statement is only true if she does both of these things. However counterintuitive it seems to imagine Lucy as an artist, the second scenario adds another condition on top of that, making it less likely. For any possible set of events, the likelihood of A occurring will always be greater than the likelihood of A and B both occurring. If we took a random sample of a million people who majored in math, the subset who are portrait artists might be relatively small. But it will necessarily be bigger than the subset who are portrait artists and play poker. Anyone who belongs to the second group will also belong to the first– but not vice versa. The more conditions there are, the less likely an event becomes. So why do statements with more conditions sometimes seem more believable? This is a phenomenon known as the conjunction fallacy. When we’re asked to make quick decisions, we tend to look for shortcuts. In this case, we look for what seems plausible rather than what is statistically most probable. On its own, Lucy being an artist doesn’t match the expectations formed by the preceding information. The additional detail about her playing poker gives us a narrative that resonates with our intuitions— it makes it seem more plausible. And we choose the option that seems more representative of the overall picture, regardless of its actual probability. This effect has been observed across multiple studies, including ones with participants who understood statistics well– from students betting on sequences of dice rolls, to foreign policy experts predicting the likelihood of a diplomatic crisis. The conjunction fallacy isn’t just a problem in hypothetical situations. Conspiracy theories and false news stories often rely on a version of the conjunction fallacy to seem credible– the more resonant details are added to an outlandish story, the more plausible it begins to seem. But ultimately, the likelihood a story is true can never be greater than the probability that its least likely component is true.

**P794 2019-11-18 History's 'worst' nun - Theresa A. Yugar**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=794)

Juana Ramírez de Asbaje sat before a panel of prestigious theologians, jurists, and mathematicians. The viceroy of New Spain had invited them to test the young woman’s knowledge by posing the most difficult questions they could muster. But Juana successfully answered every challenge, from complicated equations to philosophical queries. Observers would later liken the scene to “a royal galleon fending off a few canoes.” The woman who faced this interrogation was born in the mid-17th century. At that time, Mexico had been a Spanish colony for over a century, leading to a complex and stratified class system. Juana’s maternal grandparents were born in Spain, making them members of Mexico’s most esteemed class. But Juana was born out of wedlock, and her father – a Spanish military captain – left her mother, Doña Isabel, to raise Juana and her sisters alone. Fortunately, her grandfather’s moderate means ensured the family a comfortable existence. And Doña Isabel set a strong example for her daughters, successfully managing one of her father’s two estates, despite her illiteracy and the misogyny of the time. It was perhaps this precedent that inspired Juana’s lifelong confidence. At age three, she secretly followed her older sister to school. When she later learned that higher education was open only to men, she begged her mother to let her attend in disguise. Her request denied, Juana found solace in her grandfather’s private library. By early adolescence, she’d mastered philosophical debate, Latin, and the Aztec language Nahuatl. Juana’s precocious intellect attracted attention from the royal court in Mexico City, and when she was sixteen, the viceroy and his wife took her in as their lady-in-waiting. Here, her plays and poems alternately dazzled and outraged the court. Her provocative poem Foolish Men infamously criticized sexist double standards, decrying how men corrupt women while blaming them for immorality. Despite its controversy, her work still inspired adoration, and numerous proposals. But Juana was more interested in knowledge than marriage. And in the patriarchal society of the time, there was only one place she could find it. The Church, while still under the zealous influence of the Spanish Inquisition, would allow Juana to retain her independence and respectability while remaining unmarried. At age 20, she entered the Hieronymite Convent of Santa Paula and took on her new name: Sor Juana Inés de la Cruz. For years, Sor Juana was considered a prized treasure of the church. She wrote dramas, comedies, and treatises on philosophy and mathematics, in addition to religious music and poetry. She accrued a massive library, and was visited by many prominent scholars. While serving as the convent’s treasurer and archivist, she also protected the livelihoods of her niece and sisters from men who tried to exploit them. But her outspokenness ultimately brought her into conflict with her benefactors. In 1690, a bishop published Sor Juana’s private critique of a respected sermon. In the publication, he admonished Sor Juana to devote herself to prayer rather than debate. She replied that God would not have given women intellect if he did not want them to use it. The exchange caught the attention of the conservative Archbishop of Mexico. Slowly, Sor Juana was stripped of her prestige, forced to sell her books and give up writing. Furious at this censorship, but unwilling to leave the church, she bitterly renewed her vows. In her last act of defiance, she signed them “I, the worst of all,” in her own blood. Deprived of scholarship, Sor Juana threw herself into charity work, and in 1695, she died of an illness she contracted while nursing her sisters. Today, Sor Juana has been recognized as the first feminist in the Americas. She’s the subject of countless documentaries, novels, and operas, and appears on Mexico’s 200-peso banknote. In the words of Nobel laureate Octavio Paz: “It is not enough to say that Sor Juana’s work is a product of history; we must add that history is also a product of her work.”

**P795 2019-11-18 How does laser eye surgery work - Dan Reinstein**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=795)

In 1948, Spanish ophthalmologist Jose Ignacio Barraquer Moner was fed up with glasses. He wanted a solution for blurry vision that fixed the eye itself, without relying on external aids. But the surgery he eventually devised was not for the faint of heart. Barraquer began by slicing off the front of a patient’s cornea and dunking it in liquid nitrogen. Using a miniature lathe, he ground the frozen cornea into the precise shape necessary to focus the patient’s vision. Then he thawed the disc, and sewed it back on. Barraquer called this procedure keratomileusis, from the Greek words for “carving” and “cornea.” And though it might sound grisly, his technique produced reliable results. So how did Barraquer’s surgery work? Keratomileusis corrects what are called refractive errors: imperfections in the way the eye focuses incoming light. Ideally, the cornea and lens work together to focus light on the surface of the retina, but several kinds of refractive errors can impair this delicate system. In people with myopia, or short-sightedness, a steep cornea focuses light just short of the retina. Those with hyperopia, or far-sightedness, have the opposite problem: light is focused too far beyond the retina. And in people with astigmatism, the cornea has two different curvatures which focus light at two distances and produce blurry vision. Even those with perfect vision will eventually suffer from presbyopia, or “aging eyes.” As the proteins in the lens age, they slowly increase its size. By an adult’s mid-40’s, the lens is too large to easily change shape and shift focus. Glasses and contact lenses bend light to compensate for these refractive errors. But, as Barraquer’s procedure shows, we can also alter the shape of the cornea itself; moving the focal point backwards, forwards, or pulling a divided image together. And thankfully, modern eye surgeons can sculpt the cornea with far less invasive tools. In corrective laser eye surgery, surgeons rely on excimer lasers. These tools are accurate enough to etch words into a human hair. To safely accomplish these ultra-fine incisions, they use a technique called photoablation. This allows the laser to essentially evaporate organic tissue without overheating surrounding eye tissue. So how does laser eye surgery actually work? The first step is to separate a thin layer from the front of the cornea. This can be done with either a flat, wide blade, or a femto-second laser that produces millions of tiny plasma bubbles to create a plane beneath the corneal surface. Surgeons then lift the flap to expose the inside of the cornea. Guided by the refractive error and the shape of the cornea, the excimer laser robotically sculpts the exposed corneal bed into the correct shape. This process usually takes less than 30 seconds for each eye. Finally, the flap is closed, and its edges reseal themselves in just a few hours. Because the lasering is done on the eyeball itself, it’s described as “in situ,” or “on site.” Its complete name is “laser in-situ keratomileusis” – but you probably know it as LASIK. Essentially, this technique carves a patient’s contact lens prescription onto their cornea. Like any surgical procedure, LASIK comes with certain risks. Some patients experience slightly blurred vision that can’t be corrected by glasses. But the technique is currently about as likely to damage your eyes as wearing daily disposable contact lenses for one year. Today, a technique called SMILE enables surgeons to sculpt the cornea through even smaller incisions – further reducing recovery time. And lasers aren’t just correcting the three types of refractive errors – this technology can also restore aging eyes. In a technique called Laser Blended Vision, surgeons adjust one eye to be slightly better at distance vision and the other to be better at close range vision. The difference between the two eyes is small enough that most patients can merge their vision, allowing both eyes to work together at all distances. Advances in laser technology continue to make vision correction surgery more effective and accessible. One day soon, Barraquer’s vision of a world without glasses may finally come true.

**P796 2019-11-21 Is marijuana bad for your brain - Anees Bahji**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=796)

In 1970, marijuana was classified as a schedule 1 drug in the United States: the strictest designation possible, meaning it was completely illegal and had no recognized medical uses. For decades, this view persisted and set back research on the drug's mechanisms and effects. Today, marijuana’s therapeutic benefits are widely acknowledged, and some nations have legalized medical use or are moving in that direction. But a growing recognition for marijuana’s medical value doesn’t answer the question: is recreational marijuana use bad for your brain? Marijuana acts on the body’s cannabinoid system, which has receptors all over the brain and body. Molecules native to the body, called endocannabinoids, also act on these receptors. We don’t totally understand the cannabinoid system, but it has one feature that provides a big clue to its function. Most neurotransmitters travel from one neuron to the next through a synapse to propagate a message. But endocannabinoids travel in the opposite direction. When a message passes from the one neuron to the next, the receiving neuron releases endocannabinoids. Those endocannabinoids travel backward to influence the sending neuron— essentially giving it feedback from the receiving neuron. This leads scientists to believe that the endocannabinoid system serves primarily to modulate other kinds of signals— amplifying some and diminishing others. Feedback from endocannabinoids slows down rates of neural signaling. That doesn’t necessarily mean it slows down behavior or perception, though. For example, slowing down a signal that inhibits smell could actually make smells more intense. Marijuana contains two main active compounds, tetrahydrocannabinol or THC, and cannabidiol, or CBD. THC is thought to be primarily responsible for marijuana’s psychoactive effects on behavior, cognition, and perception, while CBD is responsible for the non-psychoactive effects. Like endocannabinoids, THC slows down signaling by binding to cannabinoid receptors. But it binds to receptors all over this sprawling, diffuse system at once, whereas endocannabinoids are released in a specific place in response to a specific stimulus. This widespread activity coupled with the fact that the cannabinoid system indirectly affects many other systems, means that each person’s particular brain chemistry, genetics, and previous life experience largely determine how they experience the drug. That’s true much more so with marijuana than with other drugs that produce their effects through one or a few specific pathways. So the harmful effects, if any, vary considerably from person to person. And while we don’t know how exactly how marijuana produces specific harmful effects, there are clear risk factors that can increase peoples’ likelihood of experiencing them. The clearest risk factor is age. In people younger than 25, cannabinoid receptors are more concentrated in the white matter than in people over 25. The white matter is involved in communication, learning, memory, and emotions. Frequent marijuana use can disrupt the development of white matter tracts, and also affect the brain’s ability to grow new connections. This may damage long-term learning ability and problem solving. For now, it’s unclear how severe this damage can be or whether it’s reversible. And even among young people, the risk is higher the younger someone is— much higher for a 15 year old than a 22 year old, for instance. Marijuana can also cause hallucinations or paranoid delusions. Known as marijuana-induced psychosis, these symptoms usually subside when a person stops using marijuana. But in rare cases, psychosis doesn’t subside, instead unmasking a persistent psychotic disorder. A family history of psychotic disorders, like schizophrenia, is the clearest, though not the only, risk factor for this effect. Marijuana-induced psychosis is also more common among young adults, though it’s worth noting that psychotic disorders usually surface in this age range anyway. What’s unclear in these cases is whether the psychotic disorder would have appeared without marijuana use— whether marijuana use triggers it early, is a catalyst for a tipping point that wouldn’t have been crossed otherwise, or whether the reaction to marijuana is merely an indication of an underlying disorder. In all likelihood, marijuana’s role varies from person to person. At any age, as with many other drugs, the brain and body become less sensitive to marijuana after repeated uses, meaning it takes more to achieve the same effects. Fortunately, unlike many other drugs, there’s no risk of fatal overdose from marijuana, and even heavy use doesn’t lead to debilitating or life-threatening withdrawal symptoms if use stops. There are more subtle forms of marijuana withdrawal, though, including sleep disturbances, irritability, and depressed mood, which pass within a few weeks of stopping use. So is marijuana bad for your brain? It depends who you are. But while some risk factors are easy to identify, others aren’t well understood— which means there’s still some possibility of experiencing negative effects, even if you don’t have any of the known risk factors.

**P797 2019-11-22 Why doesn’t the Leaning Tower of Pisa fall over - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=797)

In 1990, the Italian government enlisted top engineers to stabilize Pisa’s famous Leaning Tower. There’d been many attempts to right the tower during its 800 year history, but this team’s computer models revealed the urgency of their situation. They projected the tower would topple if it reached an angle of 5.44 degrees— and it was currently leaning at 5.5. No one knew how the tower was still standing, but the crisis was clear: they had to solve a problem that stumped centuries of engineers, and they needed to do it fast. To understand their situation, it’s helpful to understand why the tower tilted in the first place. In the 12th century, the wealthy maritime republic of Pisa set about turning its cathedral square into a magnificent landmark. Workers embellished and enlarged the existing church, and added a massive domed baptistry to the plaza. In 1173, construction began on a free-standing campanile, or bell tower. The engineers and architects of the time were masters of their craft. But for all their engineering knowledge, they knew far less about the ground they stood on. Pisa’s name comes from a Greek word for “marshy land," which perfectly describes the clay, mud, and wet sand below the city’s surface. Ancient Romans counteracted similar conditions with massive stone pillars called piles which rest on Earth’s stable bedrock. However, the tower’s architects believed a three-meter foundation would suffice for their relatively short structure. Unfortunately for them, less than five years later, the tower’s southern side was already underground. Such a shifting foundation would normally have been a fatal flaw. If workers added more weight, the pressure from upper stories would sink the structure and fatally increase the lean. But construction halted at the fourth story for nearly a century as Pisa descended into prolonged warfare. This long pause allowed the soil to settle, and when construction began again in 1272, the foundation was on slightly more stable footing. Under the direction of architect Giovanni di Simone, workers compensated for the tower’s minor tilt by making the next few floors taller on the southern side. But the weight of the extra masonry made that side sink even deeper. By the time they completed the seventh floor and bell chamber, the angle of the tilt was 1.6 degrees. For centuries, engineers tried numerous strategies to address the lean. In 1838, they dug a walkway around the base to examine the sunken foundation. But removing the supporting sand only worsened the tilt. In 1935, the Italian Corps of Engineers injected mortar to strengthen the base. However, the mortar wasn’t evenly distributed throughout the foundation, resulting in another sudden drop. All these failed attempts, along with the ever-sinking foundation, moved the tower closer to its tipping point. And without definitive knowledge of the soil composition, engineers couldn’t pinpoint the tower’s fatal angle or devise a way to stop its fall. In the years following WWII, researchers developed tests to identify those missing variables. And in the 1970’s, engineers calculated the curved tower’s center of gravity. With this data and new computing technology, engineers could model how stiff the soil was, the tower’s trajectory, and the exact amount of excavation needed for the tower to remain standing. In 1992, the team drilled diagonal tunnels to remove 38 cubic meters of soil from under the tower’s north end. Then, they temporarily counterbalanced the structure with 600 tons of lead ingots before anchoring the base with steel cables. More than six centuries after its construction, the tower was finally straightened… to a tilt of about four degrees. No one wanted the tower to fall, but they also didn’t want to lose the landmark’s most famous feature. Today the tower stands at 55– or 56– meters tall, and it should remain stable for at least 300 years as a monument to the beauty of imperfection.

**P798 2019-11-25 How does chemotherapy work - Hyunsoo Joshua No**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=798)

During World War I, one of the horrors of trench warfare was a poisonous yellow cloud called mustard gas. For those unlucky enough to be exposed, it made the air impossible to breathe, burned their eyes, and caused huge blisters on exposed skin. Scientists tried desperately to develop an antidote to this vicious weapon of war. In the process they discovered the gas was irrevocably damaging the bone marrow of affected soldiers— halting its ability to make blood cells. Despite these awful effects, it gave scientists an idea. Cancer cells share a characteristic with bone marrow: both replicate rapidly. So could one of the atrocities of war become a champion in the fight against cancer? Researchers in the 1930s investigated this idea by injecting compounds derived from mustard gas into the veins of cancer patients. It took time and trial and error to find treatments that did more good than harm, but by the end of World War II, they discovered what became known as the first chemotherapy drugs. Today, there are more than 100. Chemotherapy drugs are delivered through pills and injections and use "cytotoxic agents," which means compounds that are toxic to living cells. Essentially, these medicines cause some level of harm to all cells in the body— even healthy ones. But they reserve their most powerful effects for rapidly-dividing cells, which is precisely the hallmark of cancer. Take, for example, those first chemotherapy drugs, which are still used today and are called alkylating agents. They’re injected into the bloodstream, which delivers them to cells all over the body. Once inside, when the cell exposes its DNA in order to copy it, they damage the building blocks of DNA’s double helix structure, which can lead to cell death unless the damage is repaired. Because cancer cells multiply rapidly, they take in a high concentration of alkylating agents, and their DNA is frequently exposed and rarely repaired. So they die off more often than most other cells, which have time to fix damaged DNA and don’t accumulate the same concentrations of alkylating agents. Another form of chemotherapy involves compounds called microtubule stabilizers. Cells have small tubes that assemble to help with cell division and DNA replication, then break back down. When microtubule stabilizers get inside a cell, they keep those tiny tubes from disassembling. That prevents the cell from completing its replication, leading to its death. These are just two examples of the six classes of chemotherapy drugs we use to treat cancer today. But despite its huge benefits, chemotherapy has one big disadvantage: it affects other healthy cells in the body that naturally have to renew rapidly. Hair follicles, the cells of the mouth, the gastrointestinal lining, the reproductive system, and bone marrow are hit nearly as hard as cancer. Similar to cancer cells, the rapid production of these normal cells means that they’re reaching for resources more frequently— and are therefore more exposed to the effects of chemo drugs. That leads to several common side effects of chemotherapy, including hair loss, fatigue, infertility, nausea, and vomiting. Doctors commonly prescribe options to help manage these side-effects, such as strong anti-nausea medications. For hair loss, devices called cold caps can help lower the temperature around the head and constrict blood vessels, limiting the amount of chemotherapy drugs that reach hair follicles. And once a course of chemo treatment is over, the healthy tissues that’ve been badly affected by the drug will recover and begin to renew as usual. In 2018 alone, over 17 million people world-wide received a cancer diagnosis. But chemotherapy and other treatments have changed the outlook for so many. Just take the fact that up to 95% of individuals with testicular cancer survive it, thanks to advances in treatment. Even in people with acute myeloid leukemia— an aggressive blood cancer— chemotherapy puts an estimated 60% of patients under 60 into remission following their first phase of treatment. Researchers are still developing more precise interventions that only target the intended cancer cells. That’ll help improve survival rates while leaving healthy tissues with reduced harm, making one of the best tools we have in the fight against cancer even better.

**P799 2019-12-04 Hacking bacteria to fight cancer - Tal Danino**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=799)

In 1884, a patient’s luck seemed to go from bad to worse. This patient had a rapidly growing cancer in his neck, and then came down with an unrelated bacterial skin infection. But soon, something unexpected happened: as he recovered from the infection, the cancer also began to recede. When a physician named William Coley tracked the patient down 7 years later, no visible signs of the cancer remained. Coley believed something remarkable was happening: that the bacterial infection had stimulated the patient’s immune system to fight off the cancer. Coley’s fortunate discovery led him to pioneer the intentional injection of bacteria to successfully treat cancer. Over a century later, synthetic biologists have found an even better way to use these once unlikely allies— by programming them to safely deliver drugs directly to tumors. Cancer occurs when normal functions of cells are altered, causing them to rapidly multiply and form growths called tumors. Treatments like radiation, chemotherapy, and immunotherapy attempt to kill malignant cells, but can affect the entire body and disrupt healthy tissues in the process. However, some bacteria like E. coli have the unique advantage of being able to selectively grow inside tumors. In fact, the core of a tumor forms an ideal environment where they can safely multiply, hidden from immune cells. Instead of causing infection, bacteria can be reprogrammed to carry cancer-fighting drugs, acting as Trojan Horses that target the tumor from within. This idea of programming bacteria to sense and respond in novel ways is a major focus of a field called Synthetic Biology. But how can bacteria be programmed? The key lies in manipulating their DNA. By inserting particular genetic sequences into bacteria, they can be instructed to synthesize different molecules, including those that disrupt cancer growth. They can also be made to behave in very specific ways with the help of biological circuits. These program different behaviors depending on the presence, absence, or combination of certain factors. For example, tumors have low oxygen and pH levels and over-produce specific molecules. Synthetic biologists can program bacteria to sense those conditions, and by doing so, respond to tumors while avoiding healthy tissue. One type of biological circuit, known as a synchronized lysis circuit, or SLC, allows bacteria to not only deliver medicine, but to do so on a set schedule. First, to avoid harming healthy tissue, production of anti-cancer drugs begins as bacteria grow, which only happens within the tumor itself. Next, after they’ve produced the drugs, a kill-switch causes the bacteria to burst when they reach a critical population threshold. This both releases the medicine and decreases the bacteria’s population. However, a certain percentage of the bacteria remain alive to replenish the colony. Eventually their numbers grow large enough to trigger the kill switch again, and the cycle continues. This circuit can be fine-tuned to deliver drugs on whatever periodic schedule is best to fight the cancer. This approach has proven promising in scientific trials using mice. Not only were scientists able to successfully eliminate lymphoma tumors injected with bacteria, but the injection also stimulated the immune system, priming immune cells to identify and attack untreated lymphomas elsewhere in the mouse. Unlike many other therapies, bacteria don’t target a specific type of cancer, but rather the general characteristics shared by all solid tumors. Nor are programmable bacteria limited to simply fighting cancer. Instead, they can serve as sophisticated sensors that monitor sites of future disease. Safe probiotic bacteria could perhaps lie dormant within our guts, where they’d detect, prevent, and treat disorders before they have the chance to cause symptoms. Advances in technology have created excitement around a future of personalized medicine driven by mechanical nanobots. But thanks to billions of years of evolution we may already have a starting point in the unexpectedly biological form of bacteria. Add synthetic biology to the mix, and who knows what might soon be possible.

**P800 2019-12-04 The Train Heist \_ Think Like A Coder, Ep 4**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=800)

Ethic, Hedge, and Adila, the leader of the revolution, plot out how they can steal an artifact called the Node of Power. It’s being used to run a heavily fortified train that runs all around the country, providing supplies to settlements and facilities. This armored behemoth undergoes a complex and unpredictable unloading procedure— a procedure which is displayed, in detail, on a screen within the engine car. Right means the train will go one car length forward, and left means the train will go the same distance backwards. While unloading, the train frequently moves back and forth, so a typical sequence might look like this. Also within the engine car is a button that can only be pressed once. When pressed, it lets down the force field over the artifact for 10 seconds. The engine car is tiny and designed for a robot. Of your team, only Hedge can fit. The members of the resistance have positioned a crane over the train tracks that can pluck the artifact once it’s exposed. They’ll know when to lower the crane by sight. But the only way Hedge can determine the train’s position and know when to lower the force field is by analyzing the unloading procedure, because he’ll be inside the windowless engine car. Hedge can’t program himself though, so it’s up to Ethic to tell him what to do. The artifact is in the car 10 positions behind the one that’s directly under the crane at the start. What instructions can Ethic give Hedge so that he hits the button at just the right moment? Here’s a hint to get you started. The key to this problem, as with many programming challenges, is to reframe the information in a way that a computer can work with. A computer doesn’t know what a train is, nor does it need to. It can, however, work with variables. Try making a variable that tracks the train’s position. How will it change as the train moves? Let’s start by breaking this problem into two objectives. The first is to know where the train will be as it carries out its instructions. The second is to hit the button when the train is in just the right position. For the first objective it’ll help to think of the train as a big number line. Let’s make 0 the car with the node, 1 the car in front of it, and so on. That means car 10 is under the crane at the start. When the train moves one car right, car 9 is under the crane. So a right arrow can be thought of as “subtract 1.” And when the train moves left from there, 10 is back under the crane, making a left arrow the same as “add 1." Let’s set our train position variable to 10, since that’s where we start. We can now use a loop to read the instructions one at a time, adding or subtracting as we go, to track which car is under the crane. The nice thing about setting up the variable this way is that it tells us how far the node is from the crane. So as soon as the variable hits 0, Hedge should hit the button. And here’s what happens. Ethic gets into position on the crane while Hedge rushes off and slips into the engine car unnoticed, just before the train lurches to life. It rolls 3 cars back. 1 forward, another 4 back. Then so far forward Ethic loses track before it reverses once more. When the artifact finally rolls into position, Adila lowers the crane, hoping Ethic and Hedge got it right. At the last possible moment, the force field sputters and falls. Ethic swoops in, and lifts the Node of Power to freedom. When Ethic gives the node to Hedge for safe keeping, something incredible happens. The artifact shimmers to life with a vision of the past: When the crystal was unearthed, no one could make the console inside work. The government put out a call for people to try their luck with it, one at a time. Ethic loved to figure out what made things tick, so she signed up. Within moments at the console, something clicked into place, and she created her first robot. The government hired Ethic as chief robotics engineer on the spot. Within a year her creations ran almost every aspect of society, and the nation and its people thrived, no longer needing to toil in the fields and factories. The vision ends, and Hedge detects the second artifact in the 198forest, to the southeast. Luckily, the train is going there next, and has just enough reserve fuel for the trip. Ethic and Hedge smuggle themselves aboard and find a hiding spot for the long journey ahead.

**P801 2019-12-05 Why should you read “Lord of the Flies” by William Golding - Jill Das**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=801)

William Golding was losing his faith in humanity. Serving aboard a British destroyer in World War II, the philosophy teacher turned Royal Navy lieutenant was constantly confronted by the atrocities of his fellow man. And when he returned to England to find Cold War superpowers threatening one another with nuclear annihilation, he was forced to interrogate the very roots of human nature. These musings on the inevitability of violence would inspire his first and most famous novel: "Lord of the Flies." After being rejected by 21 publishers, the novel was finally published in 1954. It takes its title from Beelzebub, a demon associated with pride and war— two themes very much at the heart of Golding’s book. The novel was a bleak satire of a classic island adventure story, a popular genre where young boys get shipwrecked in exotic locations. The protagonists in these stories are able to master nature while evading the dangers posed by their new environments. The genre also endorsed the problematic colonialist narrative found in many British works at the time, in which the boys teach the island’s native inhabitants their allegedly superior British values. Golding’s satire even goes so far as to explicitly use the setting and character names from R.M. Ballantyne’s "Coral Island"— one of the most beloved island adventure novels. But while Ballantyne’s book promised readers "pleasure... profit... and unbounded amusement,” Golding’s had darker things in store. "Lord of the Flies" opens with the boys already on the island, but snippets of conversation hint at their terrifying journey— their plane had been shot down in the midst of an unspecified nuclear war. The boys, ranging in age from 6 to 13, are strangers to each other. All except for a choir, clad in black uniforms and led by a boy named Jack. Just as in Ballantyne’s "Coral Island," the boy’s new home appears to be a paradise— with fresh water, shelter, and abundant food sources. But even from the novel’s opening pages, a macabre darkness hangs over this seemingly tranquil situation. The boys’ shadows are compared to “black, bat-like creatures” while the choir itself first appears as “something dark... fumbling along” the beach. Within hours of their arrival, the boys are already trading terrifying rumors of a vicious “beastie” lurking in the woods. From these ominous beginnings, Golding’s narrative reveals how quickly cooperation unravels without the presence of an adult authority. Initially, the survivors try to establish some sense of order. A boy named Ralph blows into a conch shell to assemble the group, and delegate tasks. But as Jack vies for leadership with Ralph, the group splinters and the boys submit to their darker urges. The mob of children soon forgets their plans for rescue, silences the few voices of reason, and blindly follows Jack to the edge of the island, and the edge of sanity. The novel’s universal themes of morality, civility, and society have made it a literary classic, satirizing both conventions of its time and long held beliefs about humanity. While island adventure stories often support colonialism, "Lord of the Flies" turns this trope on its head. Rather than cruelly casting native populations as stereotypical savages, Golding transforms his angelic British schoolboys into savage caricatures. And as the boys fight their own battle on the island, the far more destructive war that brought them there continues off the page. Even if the boys were to be rescued from themselves, what kind of world would they be returning to? With so few references to anchor the characters in a specific place or period, the novel feels truly timeless— an examination of human nature at its most bare. And though not all readers may agree with Golding’s grim view, "Lord of the Flies" is unsettling enough to challenge even the most determined optimist.

**P802 2019-12-12 Why should you read “Dune” by Frank Herbert - Dan Kwartler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=802)

A mother and her son trek across an endless desert. Wearing special skin-tight suits to dissipate heat and recycle moisture, the travelers aren’t worried about dying of thirst. Their fears are much greater. The pair try to walk without rhythm, letting the vibrations of their footsteps blend into the shifting sands. But soon, the sound of the desert is drowned out by a louder hissing. As a mound of sand races towards them, the pair’s unnatural gait turns into a sprint. The two clamber into a nearby rock face, as a sandworm 400 meters long bursts from the desert floor. This is the world of "Dune." Written by Frank Herbert and published in 1965, "Dune" takes place in a far-flung future, where humanity rules the stars in a giant feudal empire. This medieval motif goes beyond just the government. Unlike most interstellar sci-fi, Herbert's humans conquered the stars without any computers. Following an ancient war with robots, humanity has forbidden the construction of any machine “in the likeness of a human mind.” But rather than stifling their expansion, this edict forced humans to evolve in startling ways— becoming biological computers, psychic witches, and prescient space pilots. Members of these super-powered factions are regularly employed by various noble houses, all competing for power and new planets to add to their kingdoms. But almost all these superhuman skills rely on the same precious resource: the spice. This mystical crop also known as “melange” is essential for all space travel, making it the cornerstone of the galactic economy. And it only grows on the desert planet Arrakis, a dangerous and inhospitable world whose native inhabitants have long rebelled against the empire. Arrakis, also called Dune, is the setting for Herbert’s novel, which follows Paul of the noble House Atreides. The book begins with Paul’s family being assigned control of Dune as part of an elaborate plot by their sworn enemies: the sadistic slave drivers of House Harkonnen. The conflict between these houses upends the delicate political balance on Arrakis. Soon, Paul is catapulted into the middle of a planetary revolution, where he must prove himself capable of leading— and surviving— on this hostile desert world. But Arrakis is not simply an endless sea of sand. Herbert was an avid environmentalist, who spent over five years creating Dune’s complex ecosystem. The planet is checkered with climate belts and wind tunnels that have shaped its rocky topography. Different temperate zones produce varying desert flora. And almost every element of Dune’s ecosystem works together to produce the planet’s essential export. Herbert’s world building also includes a rich web of philosophy and religion. Paul’s mother Jessica, is a member of the Bene Gesserit, an ancient cult of spice-assisted psychics. Sometimes called “witches” for their mysterious powers, the Bene Gesserit have operated as a shadow government for millennia in an effort to guide society towards enlightenment. Similarly ancient are the Mentats— human computers capable of processing incredible amounts of data. While the Mentats are bastions of logic and reason, their results are not mere calculations, but rather, streams of constantly shifting possibilities. However, no group is more central to "Dune" than the Fremen. Natives of Arrakis, they are the keepers of the planet’s many secrets. Paul’s journey takes him deep into the Fremen’s exclusive brotherhood, where he must prove himself trustworthy in a series of increasingly deadly challenges. All these factions have deep histories that pervade the text, and Herbert also incorporates that sense of scale into the book’s structure. Each chapter begins with a quote from a future history book, recalling elements of the events that are about to unfold. The book also contains in-universe appendices that further explore the Empire’s history; alongside a glossary of words like “Gom jabbar” and “Shai-Hulud." Dune’s epic story continues to unfold over a six-book saga that spans millennia. But every story of Arrakis’ future begins here: as Paul pursues a path that is dangerous, demanding, and always on the verge of being consumed by the oncoming storm.

**P803 2019-12-13 The philosophy of cynicism - William D. Desmond**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=803)

In the 4th century BCE, a banker’s son threw the city of Sinope into scandal by counterfeiting coins. When the dust finally settled, the young man, Diogenes of Sinope, had been stripped of his citizenship, his money, and all his possessions. At least, that’s how the story goes. While many of the details of Diogenes’ life are shadowy, the philosophical ideas born out of his disgrace survive today. In exile, Diogenes decided that by rejecting the opinions of others and societal measures of success, he could be truly free. He would live self-sufficiently, close to nature, without materialism, vanity, or conformity. In practice, this meant he spent years wandering around Greek cities with nothing but a cloak, staff, and knapsack— outdoors year-round, forgoing technology, baths, and cooked food. He didn’t go about this new existence quietly, but is said to have teased passers-by and mocked the powerful, eating, urinating and even masturbating in public. The citizens called him a kyôn— a barking dog. Though meant as an insult, dogs were actually a good symbol for his philosophy— they’re happy creatures, free from abstractions like wealth or reputation. Diogenes and his growing number of followers became known as “dog philosophers,” or kynikoi, a designation that eventually became the word “Cynic.” These early Cynics were a carefree bunch, drawn to the freedom of a wandering lifestyle. As Diogenes’ reputation grew, others tried to challenge his commitment. Alexander the Great offered him anything he desired. But instead of asking for material goods, Diogenes only asked Alexander to get out of his sunshine. After Diogenes’ death, adherents to his philosophy continued to call themselves Cynics for about 900 years, until 500 CE. Some Greek philosophers, like the Stoics, thought everyone should follow Diogenes’ example. They also attempted to tone down his philosophy to be more acceptable to conventional society— which, of course, was fundamentally at odds with his approach. Others viewed the Cynics less charitably. In the Roman province of Syria in the 2nd century CE, the satirist Lucian described the Cynics of his own time as unprincipled, materialistic, self-promoting hypocrites, who only preached what Diogenes had once actually practiced. Reading Lucian’s texts centuries later, Renaissance and Reformation writers called their rivals cynics as an insult— meaning people who criticized others without having anything worthwhile to say. This usage eventually laid the groundwork for the modern meaning of the word “cynic:" a person who thinks everyone else is acting out of pure self-interest, even if they claim a higher motive. Still, the philosophy of cynicism had admirers, especially among those who wished to question the state of society. The 18th-century French philosopher Jean-Jacques Rousseau was called the “new Diogenes” when he argued that the arts, sciences, and technology, corrupt people. In 1882, Friedrich Nietzsche reimagined a story in which Diogenes went into the Athenian marketplace with a lantern, searching in vain for a single honest person. In Nietszche’s version, a so-called madman rushes into a town square to proclaim that “God is dead.” This was Nietzsche’s way of calling for a “revaluation of values,” and rejecting the dominant Christian and Platonic idea of universal, spiritual insights beyond the physical world. Nietzsche admired Diogenes for sticking stubbornly to the here-and-now. More recently, the hippies of the 1960s have been compared with Diogenes as counter-cultural rebels. Diogenes’ ideas have been adopted and reimagined over and over again. The original cynics might not have approved of these fresh takes: they believed that their values of rejecting custom and living closely with nature were the only true values. Whether or not you agree with that, or with any of the later incarnations, all have one thing in common: they questioned the status quo. And that’s an example we can still follow: not to blindly follow conventional or majority views, but to think hard about what is truly valuable.

**P804 2019-12-13 Why should you read “The Joy Luck Club” by Amy Tan - Sheila Marie Orf**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=804)

In her Auntie An-mei’s home, Jing-Mei reluctantly takes her seat at the eastern corner of the mahjong table. At the north, south, and west corners are her aunties, long-time members of the Joy Luck Club. This group of immigrant families comes together weekly to trade gossip, feast on wonton and sweet chaswei, and play mahjong. However, the club’s founder, Jing-Mei’s mother Suyuan, has recently passed away. At first, Jing-Mei struggles to fill her place at the table. But when her aunties reveal a deeply buried secret about Suyuan’s life, Jing-Mei realizes she still has a lot to learn about her mother, and herself. In Amy Tan’s 1989 debut novel, "The Joy Luck Club," this gathering at the mahjong table is the point of departure for a series of interconnected vignettes. The book itself is loosely structured to imitate the format of the Chinese game. Just as mahjong is played over four rounds with at least four hands each, the book is divided into four parts, each with four chapters. Alternately set in China or San Francisco, each chapter narrates a single story from one of the four matriarchs of the Joy Luck Club or their American-born daughters. These stories take the reader through war zones and villages of rural China, and into modern marriages and tense gatherings around the dinner table. They touch upon themes of survival and loss, love and the lack of it, ambitions and their unsatisfied reality. In one, Auntie Lin plots an escape from the hostile family of her promised husband, ultimately leading to her arrival in America. In another, the Hsu family’s all-American day at the beach turns dire when Rose is overwhelmed by the responsibility her mother assigns to her. The resulting tragedy traumatizes the family for years to come. These tales illustrate the common divides that can form between generations and cultures, especially in immigrant families. The mothers have all experienced great hardships during their lives in China, and they’ve worked tirelessly to give their children better opportunities in America. But their daughters feel weighed down by their parent’s unfulfilled hopes and high expectations. Jing-Mei feels this pressure as she plays mahjong with her mother’s friends. She worries, “In me, they see their own daughters, just as ignorant, just as unmindful of all the truths and hopes they have brought to America.” Time and again, the mothers strive to remind their daughters of their history and heritage. Meanwhile, their daughters struggle to reconcile their mothers’ perception of them with who they really are. "Does my daughter know me?" some of the stories ask. "Why doesn’t my mother understand?" others respond. In her interrogation of these questions, Tan speaks to anxieties that plague many immigrants, who often feel both alienated from their homeland and disconnected from their adopted country. But by weaving the tales of these four mothers and daughters together, Tan makes it clear that Jing-Mei and her peers find strength to tackle their present-day problems through the values their mothers passed on to them. When "The Joy Luck Club" was first published, Tan expected minimal success. But against her predictions, the book was a massive critical and commercial achievement. Today, these characters still captivate readers worldwide. Not only for the way they speak to Chinese American and immigrant experiences, but also for uncovering a deeper truth: the need to be seen and understood by the ones you love.

**P805 2019-12-20 Can you solve the dragon jousting riddle - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=805)

After centuries of war, the world’s kingdoms have come to an agreement. Every five years, teams representing the elves, goblins, and treefolk will compete in a grand tournament of dragon jousting. Every team will face each of the others once. The kingdom whose team wins the most matches will rule all of Center-Realm until the next tournament. To prevent any outside meddling, the games are to be conducted in absolute secret except for a group of wizards who will make sure nobody uses enchantments, hexes, or spells to cheat. You’ve been given the extremely important job of recording the scores for the first inaugural tournament. But the opening celebrations get a bit out of control, and when you wake up, you realize the games are already underway. Fortunately, no one has noticed your absence so far. However, you need to get up to speed quickly; if your boss, the head tournament official, finds out you’ve been sleeping on the job, you’ll lose your head. After weighing your options, you decide to offer your life’s savings to one of the regulation wizards in return for the information, giving him your blank scorecard to fill out. But before he can finish, your boss walks into the tent. You barely manage to hide the scorecard in time, and the wizard excuses himself. Your boss chuckles. “Hope you didn’t believe anything Gorbak’s been saying— he’s been cursed to tell only lies, even in writing. Anyway, can you believe how low-scoring the tournament’s been? Every team has played at least once, yet not a single match with a combined score of more than five hits! Anyhow, I’ll be back in a minute to review your scorecard.” You laugh along, and when he leaves you look at the partially completed card, now knowing every single number on it is wrong. You’ve only got one chance to save yourself, so what’s the real score of each match? Pause now to figure it out for yourself. The incredible thing about this riddle is that you can reach the solution despite an almost complete lack of correct information. And that’s possible because knowing that something is false is meaningful information in its own right. The first key is to realize that no team will play more than two matches, since there are only two other teams. So if the elves didn’t actually play one match, and the goblins didn’t actually play two, the truth must be that elves played two and goblins played one. For the elves to have played two matches, they must’ve faced each of the other teams once. And since goblins have only played one match so far— against the elves— that means the match between goblins and treefolk has not occurred yet. We know it’s false that the treefolk tied zero matches, which means their bout against the elves must’ve tied. We also know that the elves won at least one match, and since they tied against the treefolk, they must have beaten the goblins. But can we figure out the actual scores? Let’s start with the elf-treefolk tie. Because no more than five total hits were scored, the final tally must’ve been 0-0, 1-1, or 2-2. But the treefolk must’ve scored some hits, and it’s false that they only had one hit scored against them. The only option that leaves is 2-2. In the match between elves and goblins, the goblins must’ve scored at least one hit. And the elf score must be 2 or more for them to have won the match. This leaves only a few possibilities that add up to 5 or less. The elves couldn’t have scored three, so that eliminates these two. And their total hits scored across both matches can’t add up to six, so this one’s out too. So the score must’ve been 2-1. With one match remaining, you’ve managed to save your job— and your neck. Gorbak the wizard may have lied, but your deductive skills quickly evened the score.

**P806 2019-12-20 Could a breathalyzer detect cancer - Julian Burschka**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=806)

How is it that a breathalyzer can measure the alcohol content in someone’s blood, hours after they had their last drink, based on their breath alone? Exhaled breath contains trace amounts of hundreds, even thousands, of volatile organic compounds: small molecules lightweight enough to travel easily as gases. One of these is ethanol, which we consume in alcoholic drinks. It travels through the bloodstream to tiny air sacs in the lungs, passing into exhaled air at a concentration 2,000 times lower, on average, than in the blood. When someone breathes into a breathalyzer, the ethanol in their breath passes into a reaction chamber. There, it’s converted to another molecule, called acetic acid, in a special type of reactor that produces an electric current during the reaction. The strength of the current indicates the amount of ethanol in the sample of air, and by extension in the blood. In addition to the volatile organic compounds like ethanol we consume in food and drink, the biochemical processes of our cells produce many others. And when something disrupts those processes, like a disease, the collection of volatile organic compounds in the breath may change, too. So could we detect disease by analyzing a person’s breath, without using more invasive diagnostic tools like biopsies, blood draws, and radiation? In theory, yes, but testing for disease is a lot more complicated than testing for alcohol. To identify diseases, researchers need to look at a set of tens of compounds in the breath. A given disease may cause some of these compounds to increase or decrease in concentration, while others may not change— the profile is likely to be different for every disease, and could even vary for different stages of the same disease. For example, cancers are among the most researched candidates for diagnosis through breath analysis. One of the biochemical changes many tumors cause is a large increase in an energy-generating process called glycolysis. Known as the Warburg Effect, this increase in glycolysis results in an increase of metabolites like lactate which in turn can affect a whole cascade of metabolic processes and ultimately result in altered breath composition, possibly including an increased concentration of volatile compounds such as dimethyl sulfide. But the Warburg Effect is just one potential indicator of cancerous activity, and doesn’t reveal anything about the particular type of cancer. Many more indicators are needed to make a diagnosis. To find these subtle differences, researchers compare the breath of healthy people with the breath of people who suffer from a particular disease using profiles based on hundreds of breath samples. This complex analysis requires a fundamentally different, more versatile type of sensor from the alcohol breathalyzer. There are a few being developed. Some discriminate between individual compounds by observing how the compounds move through a set of electric fields. Others use an array of resistors made of different materials that each change their resistance when exposed to a certain mix of volatile organic compounds. There are other challenges too. These substances are present at incredibly low concentrations— typically just parts per billion, much lower than ethanol concentrations in the breath. Compounds’ levels may be affected by factors other than disease, including age, gender, nutrition, and lifestyle. Finally, there’s the issue of distinguishing which compounds in the sample were produced in the patient’s body and which were inhaled from the environment shortly before the test. Because of these challenges, breath analysis isn’t quite ready yet. But preliminary clinical trials on lung, colon, and other cancers have had encouraging results. One day, catching cancer early might be as easy as breathing in and out.

**P807 2019-12-23 A brief history of alcohol - Rod Phillips**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=807)

This chimpanzee stumbles across a windfall of overripe plums. Many of them have split open, drawing him to their intoxicating fruity odor. He gorges himself and begins to experience some… strange effects. This unwitting ape has stumbled on a process that humans will eventually harness to create beer, wine, and other alcoholic drinks. The sugars in overripe fruit attract microscopic organisms known as yeasts. As the yeasts feed on the fruit sugars they produce a compound called ethanol— the type of alcohol in alcoholic beverages. This process is called fermentation. Nobody knows exactly when humans began to create fermented beverages. The earliest known evidence comes from 7,000 BCE in China, where residue in clay pots has revealed that people were making an alcoholic beverage from fermented rice, millet, grapes, and honey. Within a few thousand years, cultures all over the world were fermenting their own drinks. Ancient Mesopotamians and Egyptians made beer throughout the year from stored cereal grains. This beer was available to all social classes, and workers even received it in their daily rations. They also made wine, but because the climate wasn’t ideal for growing grapes, it was a rare and expensive delicacy. By contrast, in Greece and Rome, where grapes grew more easily, wine was as readily available as beer was in Egypt and Mesopotamia. Because yeasts will ferment basically any plant sugars, ancient peoples made alcohol from whatever crops and plants grew where they lived. In South America, people made chicha from grains, sometimes adding hallucinogenic herbs. In what’s now Mexico, pulque, made from cactus sap, was the drink of choice, while East Africans made banana and palm beer. And in the area that’s now Japan, people made sake from rice. Almost every region of the globe had its own fermented drinks. As alcohol consumption became part of everyday life, some authorities latched onto effects they perceived as positive— Greek physicians considered wine to be good for health, and poets testified to its creative qualities. Others were more concerned about alcohol’s potential for abuse. Greek philosophers promoted temperance. Early Jewish and Christian writers in Europe integrated wine into rituals but considered excessive intoxication a sin. And in the middle east, Africa, and Spain, an Islamic rule against praying while drunk gradually solidified into a general ban on alcohol. Ancient fermented beverages had relatively low alcohol content. At about 13% alcohol, the by-products wild yeasts generate during fermentation become toxic and kill them. When the yeasts die, fermentation stops and the alcohol content levels off. So for thousands of years, alcohol content was limited. That changed with the invention of a process called distillation. 9th century Arabic writings describe boiling fermented liquids to vaporize the alcohol in them. Alcohol boils at a lower temperature than water, so it vaporizes first. Capture this vapor, cool it down, and what’s left is liquid alcohol much more concentrated than any fermented beverage. At first, these stronger spirits were used for medicinal purposes. Then, spirits became an important trade commodity because, unlike beer and wine, they didn’t spoil. Rum made from sugar harvested in European colonies in the Caribbean became a staple for sailors and was traded to North America. Europeans brought brandy and gin to Africa and traded it for enslaved people, land, and goods like palm oil and rubber. Spirits became a form of money in these regions. During the Age of Exploration, spirits played a crucial role in long distance sea voyages. Sailing from Europe to east Asia and the Americas could take months, and keeping water fresh for the crews was a challenge. Adding a bucket of brandy to a water barrel kept water fresh longer because alcohol is a preservative that kills harmful microbes. So by the 1600s, alcohol had gone from simply giving animals a buzz to fueling global trade and exploration— along with all their consequences. As time went on, its role in human society would only get more complicated.

**P808 2020-01-06 The mysterious life and death of Rasputin - Eden Girma**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=808)

On a cold winter night in 1916, Felix Yusupov anxiously prepared to pick up his dinner guest. If all went as planned, his guest would be dead by morning, though four others had already tried and failed to finish him off. The Russian monarchy was on the brink of collapse, and to Yusupov and his fellow aristocrats, the holy man they’d invited to dinner was the single cause of it all. But who was he, and how could a single monk be to blame for the fate of an empire? Grigori Yefimovich Rasputin began his life in Siberia, born in 1869 to a peasant family. He might have lived a life of obscurity in his small village, if not for his conversion to the Russian Orthodox Church in the 1890s. Inspired by the humbled monks that wandered endlessly from holy site to holy site, he spent years on pilgrimages across Russia. On his travels, strangers were captivated by Rasputin’s magnetic presence. Some even believed he had mystical gifts of prediction and healing. Despite Rasputin’s heavy drinking, petty theft, and promiscuity, his reputation as a monk quickly spread beyond Siberia and attracted both laypeople and powerful Orthodox clergymen. When he finally reached the capital, St. Petersburg, Rasputin used his charisma and connections to win favor with the imperial family’s spiritual advisor. In November 1905, Rasputin was finally introduced to Russian Tsar Nicholas II. Nicholas and his wife Alexandra devoutly believed in the Orthodox Church, as well as in mysticism and supernatural powers, and this Siberian holy man had them transfixed. It was a particularly tumultuous period for Russia and their family. The monarchy was barely clinging to control after the Revolution of 1905. Their political struggles were only intensified by personal turmoil: Alexei, the heir to the throne, had a life-threatening blood disease called hemophilia. When Alexei suffered a severe medical crisis in 1912, Rasputin advised his parents to reject treatment from doctors. Alexei’s health improved, cementing the royal family’s belief that Rasputin had magical healing powers, and guaranteeing his privileged place on the royal court. Today, we know that the doctors had prescribed aspirin, a drug that worsens hemophilia. After this incident, Rasputin made a prophecy: if he died, or the royal family deserted him, both their son and their crown would soon be gone. Outside the royal family, people had mixed views on Rasputin. On one hand, peasants regarded him as one of their own, amplifying their often-unheard voice to the monarchy. But nobles and clergymen came to despise his presence. Rasputin never ceased his scandalous behavior, and they were skeptical of his so-called powers and thought he was corrupting the royal family. By the end of World War I, they were convinced the only way to maintain order was to eliminate this sham of a holy man. With this conviction, Yusupov began to plot Rasputin’s assassination. Though the exact details remain mysterious, our best guess at how it all unfolded comes from Yusupov’s memoirs. He served Rasputin a number of pastries, believing they contained cyanide. But unbeknownst to Yusupov, one of his co-conspirators had a change of heart, and substituted the poison with a harmless substance. To Yusupov’s shock, Rasputin ate them without ill effect. In desperation, he shot Rasputin at point-blank range. But Rasputin recovered, punched his attacker, and fled. Yusupov and his accomplices pursued him, finally killing Rasputin with a bullet to the forehead and dumping his body in the Malaya Nevka river. But far from stabilizing the monarchy’s authority, Rasputin’s death enraged the peasantry. Just as Rasputin prophesied, his murder was swiftly followed by that of the royal family. Whether the downfall of the Russian monarchy was a product of the monk’s curse, or the result of political tensions decades in the making, well, we may never know.

**P810 2020-01-08 The Artists \_ Think Like A Coder, Ep 5**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=810)

Dawn and the train are both breaking when Ethic and Hedge arrive in the woods. The adventurers have recovered the first artifact— the Node of Power— and have come to the 198forest in search of the second. Here they’re welcomed by the director of the colony, Octavia. She established this treehouse sanctuary after the robots freed everyone from having to work. It was meant to be a haven where people could follow their passions, take up crafts, and find fulfillment. Which they did… at first. Some years ago everyone forgot the point. They abandoned arts and crafts and instead just painted and exhibited pictures of themselves over, and over, and over. The location of the second artifact is no secret; it’s in a tower, guarded by a garrison of bots, a bottomless ravine, and who knows what other traps. As soon as the tower went up with the node inside, human communication across the land went dark. Octavia’s been after it for years, but try as she might, the defenses thwart her. In order to even get to the tower, the team will need a distraction. Octavia has an idea: stir up the people through some well-intentioned vandalism. The residents’ paintings are all squares that come in different sizes, all an odd number of pixels across. Helper-bots pick up the finished portraits and hang them in public places for everyone to admire. There’s a slim margin of time when Hedge can access the paintings. If he were to deface each one with an X, the people would blame the helper-bots, creating just the distraction the team needs. If only it were so easy. Hedge can’t just paint an X— his painting processor requires very specific instructions. Treating the paintings as square grids, he can fill in one pixel, or little square, at a time. He can move forwards and make 90 degree turns over the canvas, but can’t move diagonally. How does Ethic program Hedge to paint an X over each portrait? Pause now to figure it out for yourself. Here’s a hint. Try drawing a square grid like this, and simulating Hedge’s path over it. What patterns can you find to guide him? Pause now to figure it out for yourself. The challenge here is to craft a set of instructions that will work for any square grid. Fortunately, one of the strengths of programming is the flexibility to solve not just one problem, but a whole class of them all at once. It often helps to start with one case, and work towards the general. Let’s say we had this square. Hedge can measure the length of its sides and store that number as a variable. Now, what we need is a plan for how Hedge will paint an X, pixel by pixel. There’s more than one right answer for how to do this; let’s look at two. First, what if Hedge went row by row, like a typewriter? If it’s a 9 pixel by 9 pixel painting, in the first row he’d paint, skip 7, and then paint again. In the second row he’d skip the first, paint, skip 5, and paint. And so on. The pattern here is that for each row the pixels skipped at the beginning go up by one, and the pixels skipped in the middle go down by 2. Things get more complicated when Hedge reaches the center. Here there’s a row with just one pixel painted. Then the whole thing reverses— the number of pixels skipped goes down by one each time on the left, and up by two each time in the middle. Instructing Hedge to do this with a series of loops will work and is a perfectly fine solution. The main drawback is that this requires quite a bit of logic— knowing what to do in the middle, when to reverse the process, and exactly how to reverse it. So how might we approach this so that the logic remains consistent from start to finish? The key insight is to look at a grid as a series of concentric squares. Each square follows the same pattern— painted pixels in the corners, and unaltered pixels in between. So if we can figure out a way to paint one nested square, transition to the next, and repeat, we can paint them all. Painting the outermost one is easy. Start in a corner and paint that pixel. If we call the length of the painting n, fly forward n minus 1 spaces. Paint another pixel, and turn right. Now do the whole thing again… and again. Now move forward one less space, turn right, fly forward once, and Hedge will be in the next concentric square and ready to repeat the whole process. Each square is n minus 2 pixels smaller than the last in length and width, and we can follow this spiral pattern all the way to the center with a loop and a variable that tracks how far Hedge should fly. Is one of these methods better than the other? It really depends on what you value. The strength of the spiral is the simplicity of finding a pattern and reusing the same logic from start to finish. The advantage of the typewriter approach is that it’s a more generalized solution, meaning it can be adapted much more simply to fill in any pattern. For Ethic’s sake, either will do just fine. So here’s what happens. Hedge rapidly defaces all of the portraits. And within moments cries of anguish break out all over the forest. The garrison guarding the tower abandon their posts to calm the agitated people, and Ethic, Hedge, and Octavia slip through— and nearly slip into the depths of the gorge standing between them and the tower.

**P811 2020-01-15 What's so special about Viking ships - Jan Bill**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=811)

The Vikings came from the rugged, inhospitable north known today as Scandinavia. As the Roman Empire flourished further south, Scandinavians had small settlements, no central government, and no coinage. Yet by the 11th century, the Vikings had spread far from Scandinavia, gaining control of trade routes throughout Europe, conquering kingdoms as far as Africa, and even building outposts in North America. The secret to their success was their ships. The formidable Viking longship had its origins in the humble dugout canoe, or log boat. For millennia, the inhabitants of Scandinavia had used these canoes for transportation. Dense forests and tall mountains made overland travel difficult, but long coastlines and numerous rivers, lakes, and fjords provided a viable alternative. The first canoes were simply hollowed out logs rowed with paddles. Over time, they added planks to the log boat base using the clinker, or "lapstrake," technique, meaning the planks overlapped and were fastened to each other along their edges. As the Roman Empire expanded north, some Scandinavians served in their new neighbors’ armies— and brought home Roman maritime technology. The Mediterranean cultures at the heart of the Roman Empire had large warships that controlled the sea, and cargo ships that transported goods along the waterways. These ships were powered by sail and oars and relied on a strong skeleton of internal timbers fastened to the outer planks with copper, iron, and wood nails. At first, Scandinavians incorporated this new technology by replacing their loose paddles with anchored oars. This change hugely improved the crew’s efficiency, but also required stronger ships. So boat builders began to use iron nails for fasteners rather than sewing. They abandoned the log boat base for a keel plank, and the boats became higher and more seaworthy. But these early ships retained the concept of the original log boat: their strength depended on the outer shell of wood, not internal frames and beams. They were built as shells— thin-walled but strong, and much lighter than the Roman ships. Competing chieftains quickly refined the new ships to be even more efficient. The lighter the boat, the more versatile it would be and the less investment of resources it would require— an essential advantage in a decentralized culture without large supplies of people. These ships still had no sails— sails were costly, and for now the rowed ships could meet their needs. That changed after the Western Roman Empire collapsed in the 5th century. Western Europe took a heavy economic blow, leveling the playing field a bit for the Scandinavians. As the region revived, new and vigorous trade routes extended into and through Scandinavia. The wealth that flowed along these routes helped create a new, more prosperous and powerful class of Scandinavians, whose members competed constantly with each other over trade routes and territory. By the 8th century, a sailing ship began to make sense: it could go further, faster, in search of newly available plunder. With the addition of sails, the already light and speedy ships became nearly unbeatable. The Viking ship was born. Viking longships could soon carry as many as 100 Vikings to battle. Fleets of them could land on open beaches, penetrate deep into river systems, and be moved over land if need be. When not at war, the vessels were used to transport goods and make trade journeys. There were smaller versions for fishing and local excursions, and larger adaptations for open sea voyages capable of carrying tens of tons of cargo. Thanks to their inventiveness in the face of difficult terrain and weak economies, the Vikings sailed west, settled the North Atlantic and explored the North American coast centuries before any other Europeans would set foot there.

**P812 2020-01-23 Why is cotton in everything - Michael R. Stiff**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=812)

Centuries ago, the Inca developed ingenuous suits of armor that could flex with the blows of sharp spears and maces, protecting warriors from even the fiercest physical attacks. These hardy structures were made not from iron or steel, but rather something unexpectedly soft: cotton. These thickly woven, layered quilts of cotton could distribute the energy from a blow across a large surface area, shielding warriors without restricting their mobility. These seemingly contradictory features— strength and flexibility, softness and durability— have their roots in the intricate biology of the nearly invisible cotton fiber. These fibers begin life deep within a cotton flower, on the surface of a seed. As many as 16,000 fibers will festoon a single seed, bulging from the seed’s surface like miniature water balloons. Each cotton fiber, no matter how large it grows, is made of just one cell. That cell has multiple layers of cell wall. After a few days, the sides of the first layer, called the primary cell wall, stiffen, pushing cell growth in one direction and causing the fiber to elongate. The fiber elongates quickly for about 16 days. Then it begins the next stage: strengthening the cell wall. It does this by making more of the carbohydrate cellulose. Cellulose will make up 34% of the cell wall at this stage and swiftly increases. This new growth also reinforces the cell wall by going against the grain of the existing wall. The strengthened wall is more rigid, restricting further growth. That means if the fiber remodels its walls too early, it will be short, and ultimately make rough, weak fabrics. But if cell wall strengthening begins too late, the wall won’t be sturdy enough— producing fibers that are too weak to hold fabrics together well. In ideal growing conditions— with the right temperature, water, fertilizer, pest control, and light— a cotton fiber can grow up to 3.6 centimeters long with only a 25 micrometer width. Long, fine fibers can wrap around one another better than shorter, less fine fibers, which means those long, fine fibers make stronger threads that hang together better as fabric. Cotton with these qualities has diverse uses— from soft textiles to the U.S. dollar bill, which is 75% cotton. The next crucial stage of the cotton fiber’s growth begins as it thickens its secondary cell wall by depositing large quantities of cellulose into the secondary layer. Cellulose goes on to make up over 90% of the fiber’s weight. The more cellulose that gets deposited, the denser that secondary layer becomes— and this determines the strength of the final fiber. This stage is essential for developing long-lasting material for the likes of, say, a t-shirt. The garment’s capacity to withstand years of washing and wear is largely determined by the density of that secondary cell wall. On the other hand, its softness is strongly influenced by the length of the fiber, established with the remodeling of the primary wall layer. Finally, after about 50 days, the fiber is fully grown. The living matter within the cell dies off, leaving behind only the cellulose. The dried cotton seed pod, or boll, that surrounds the fibers cracks open, unveiling a burst of several thousand fiber cells in a fluffy mass. The thread-like fibers we see— thinner than a human hair— are the remains of those dense, dried out walls of cellulose. Tens of thousands of these fibers spun into yarn will go on to make everything from fabric, to coffee filters, diapers, and fishing nets. And with the help of modern science, cotton might soon be softer, stronger, and more resilient than ever as researchers investigate how to optimize its growth based on nutrients, weather conditions, and genetics.

**P813 2020-01-24 How bones make blood - Melody Smith**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=813)

At any given moment, trillions of cells are traveling through your blood vessels, sometimes circling the body in just one minute. Each of these cells has its origins deep in your bones. Bones might seem rock-solid, but they’re actually quite porous inside. Large and small blood vessels enter through these holes. And inside most of the large bones of your skeleton is a hollow core filled with soft bone marrow. Marrow contains fat and other supportive tissue, but its most essential elements are blood stem cells. These stem cells are constantly dividing. They can differentiate into red blood cells, white blood cells, and platelets, and send about hundreds of billions of new blood cells into circulation every day. These new cells enter the bloodstream through holes in small capillaries in the marrow. Through the capillaries, they reach larger blood vessels and exit the bone. If there’s a problem with your blood, there’s a good chance it can be traced back to the bone marrow. Blood cancers often begin with genetic mutations in the stem cells. The stem cells themselves are not cancerous, but these mutations can interfere with the process of differentiation and result in malignant blood cells. So for patients with advanced blood cancers like leukemia and lymphoma, the best chance for a cure is often an allogeneic bone marrow transplant, which replaces the patient’s bone marrow with a donor’s. Here’s how it works. First, blood stem cells are extracted from the donor. Most commonly, blood stem cells are filtered out of the donor’s bloodstream by circulating the blood through a machine that separates it into different components. In other cases, the marrow is extracted directly from a bone in the hip, the iliac crest, with a needle. Meanwhile, the recipient prepares for the transplant. High doses of chemotherapy or radiation kill the patient’s existing marrow, destroying both malignant cells and blood stem cells. This also weakens the immune system, making it less likely to attack the transplanted cells. Then the donor cells are infused into the patient’s body through a central line. They initially circulate in the recipient’s peripheral bloodstream, but molecules on the stem cells, called chemokines, act as homing devices and quickly traffic them back to the marrow. Over the course of a few weeks, they begin to multiply and start producing new, healthy blood cells. Just a small population of blood stem cells can regenerate a whole body’s worth of healthy marrow. A bone marrow transplant can also lead to something called graft-versus-tumor activity, when new immune cells generated by the donated marrow can wipe out cancer cells the recipient’s original immune system couldn’t. This phenomenon can help eradicate stubborn blood cancers. But bone marrow transplants also come with risks, including graft-versus-host disease. It happens when the immune system generated by the donor cells attacks the patient’s organs. This life-threatening condition occurs in about 30–50% of patients who receive donor cells from anyone other than an identical twin, particularly when the stem cells are collected from the blood as opposed to the bone marrow. Patients may take immunosuppressant medications or certain immune cells may be removed from the donated sample in order to reduce the risk of graft-versus-host disease. But even if a patient avoids graft-versus-host disease, their immune system may reject the donor cells. So it’s crucial to find the best match possible in the first place. Key regions of the genetic code determine how the immune system identifies foreign cells. If these regions are similar in the donor and the recipient, the recipient’s immune system is more likely to accept the donor cells. Because these genes are inherited, the best matches are often siblings. But many patients who need a bone marrow transplant don’t have a matched family member. Those patients turn to donor registries of volunteers willing to offer their bone marrow. All it takes to be on the registry is a cheek swab to test for a genetic match. And in many cases, the donation itself isn’t much more complicated than giving blood. It’s a way to save someone’s life with a resource that’s completely renewable.

**P814 2020-01-27 Licking bees and pulping trees - The reign of a wasp queen - Kenny Co**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=814)

As the April sun rises on a pile of firewood, something royal stirs inside. This wasp queen is one of thousands who mated in late autumn and hibernated through the winter. Now she emerges into the spring air to begin her reign. Most of her sisters weren’t so lucky. While hibernating in compost piles and underground burrows, many sleeping queens were eaten by spiders. Warm winters caused by climate change led other queens to emerge early, only to find there was no available food. And some queens that survived the winter fell victim to the threats of spring, such as carnivorous plants, birds, and manmade pesticides. Our queen is the lone survivor of her old hive, and now, she must become the foundress of a new one. But first, breakfast. The queen heads for a citrus grove full of honeybee hives. The bees can be dangerous if provoked, but right now they’re paralyzed by the morning cold. Their hairy bodies are dripping with sugar water from an earlier feeding, and the resourceful queen licks them for a morning snack. Newly energized, our queen searches for a safe nesting area. This tree hollow, safe from rain, wind, and predators, is ideal. She chews the surrounding wood and plant fibers to make a paper-like pulp. Then she builds around 50 brood cells that comprise the beginning of her nest. Using sperm stored from last fall, the queen lays a fertilized egg into each cell, producing as many as 12 in 20 minutes. Within a week, these will hatch into female larva. But until then, the queen must hunt down smaller insects to feed her brood, all while expanding the hive, laying eggs, and defending against intruders. Fortunately, our queen is well prepared. Unlike bees, wasps can sting as many times as they need to. With such a busy schedule, the queen barely has time to feed herself. Luckily, she doesn’t have to. When she feeds an insect to her grubs, they digest the bug into a sugary substance that sustains their mother. By the end of July, these first larva have matured into adult workers, ready to take on foraging, building, and defense. The queen can now lay eggs full-time, sustaining herself on her worker’s spoils and their unfertilized eggs. Although each worker only lives for roughly 3 weeks, the queen’s continuous egg-laying swells their ranks. In just one summer, the nest reaches the size of a basketball, supporting thousands of workers. Such a large population needs to eat, and the nearby garden provides a veritable buffet. As the swarm descends, alarmed humans try to swat them. They even fight back with pesticides that purposefully poison wasps, and inadvertently impact a wide-range of local wildlife. But the wasps are actually vital to this ecosystem. Sitting at the top of the local invertebrate food chain, these insects keep spiders, mites, and centipedes, in check. Wasps consume crop-eating insects, making them particularly helpful for farms and gardens. They even pollinate fruits and vegetables, and help winemakers by biting into their grapes and jump-starting fermentation. This feast continues until autumn, when the foundress changes course. She begins grooming some eggs into a new generation of queens, while also laying unfertilized eggs that will mature into reproductive males called drones. This new crop of queens and males requires more food. But with summer over, the usual sources run dry, and the foraging wasps start taking more aggressive risks. By September, the hive’s organization deteriorates. Hungry workers no longer clean the nest and various scavengers move in. Just when it seems the hive can no longer sustain itself, the fertile queens and their drones depart in a massive swarm. As the days grow colder, the workers starve, and our queen reaches the end of her lifespan. But above, a swarm of reproductive wasps has successfully mated. The males die off shortly after, but the newly fertilized queens are ready to find shelter for their long sleep. And this woodpile looks like the perfect place to spend the winter.

**P815 2020-01-28 Do politics make us irrational - Jay Van Bavel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=815)

In 2013, a team of researchers held a math test. The exam was administered to over 1,100 American adults, and designed, in part, to test their ability to evaluate sets of data. Hidden among these math problems were two almost identical questions. Both problems used the same difficult data set, and each had one objectively correct answer. The first asked about the correlation between rashes and a new skin cream. The second asked about the correlation between crime rates and gun control legislation. Participants with strong math skills were much more likely to get the first question correct. But despite being mathematically identical, the results for the second question looked totally different. Here, math skills weren’t the best predictor of which participants answered correctly. Instead, another variable the researchers had been tracking came into play: political identity. Participants whose political beliefs aligned with a correct interpretation of the data were far more likely to answer the problem right. Even the study’s top mathematicians were 45% more likely to get the second question wrong when the correct answer challenged their political beliefs. What is it about politics that inspires this kind of illogical error? Can someone’s political identity actually affect their ability to process information? The answer lies in a cognitive phenomenon that has become increasingly visible in public life: partisanship. While it’s often invoked in the context of politics, partisanship is more broadly defined as a strong preference or bias towards any particular group or idea. Our political, ethnic, religious, and national identities are all different forms of partisanship. Of course, identifying with social groups is an essential and healthy part of human life. Our sense of self is defined not only by who we are as individuals, but also by the groups we belong to. As a result, we’re strongly motivated to defend our group identities, protecting both our sense of self and our social communities. But this becomes a problem when the group’s beliefs are at odds with reality. Imagine watching your favorite sports team commit a serious foul. You know that’s against the rules, but your fellow fans think it’s totally acceptable. The tension between these two incompatible thoughts is called cognitive dissonance, and most people are driven to resolve this uncomfortable state of limbo. You might start to blame the referee, complain that the other team started it, or even convince yourself there was no foul in the first place. In a case like this, people are often more motivated to maintain a positive relationship with their group than perceive the world accurately. This behavior is especially dangerous in politics. On an individual scale, allegiance to a party allows people to create a political identity and support policies they agree with. But partisan-based cognitive dissonance can lead people to reject evidence that’s inconsistent with the party line or discredits party leaders. And when entire groups of people revise the facts in service of partisan beliefs, it can lead to policies that aren’t grounded in truth or reason. This problem isn’t new— political identities have been around for centuries. But studies show that partisan polarization has increased dramatically in the last few decades. One theory explaining this increase is the trend towards clustering geographically in like-minded communities. Another is the growing tendency to rely on partisan news or social media bubbles. These often act like echo chambers, delivering news and ideas from people with similar views. Fortunately, cognitive scientists have uncovered some strategies for resisting this distortion filter. One is to remember that you’re probably more biased than you think. So when you encounter new information, make a deliberate effort to push through your initial intuition and evaluate it analytically. In your own groups, try to make fact-checking and questioning assumptions a valued part of the culture. Warning people that they might have been presented with misinformation can also help. And when you’re trying to persuade someone else, affirming their values and framing the issue in their language can help make people more receptive. We still have a long way to go before solving the problem of partisanship. But hopefully, these tools can help keep us better informed, and capable of making evidence-based decisions about our shared reality.

**P816 2020-01-29 Everything changed when the fire crystal got stolen - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=816)

Someone has tripped the magical alarms in the Element Temple. By the time you and the other monks arrive on the scene, you know you have a disaster on your hands. Overnight, four young apprentices broke into the temple’s inner chamber to steal the sacred element crystals. But when the alarm went off they panicked, and each of them swallowed the crystal they held right before they were caught. With no idea how to control the crystals’ vast powers, they’ll soon transform into uncontrollable elemental spirits. Improbably enough, the old monk next to you has seen something similar happen before. He explains: “You must determine who ate which crystal and get each into the proper containment field before they transform. The elements compel their masters: those who ate the Earth and Water Crystals must speak the truth, while those who consumed Fire and Air must lie." The youths are too scared to confess their own transgressions. Instead, they fall to accusing each other. “Rikku took the Water crystal!” Sumi blurts out. Rikku interrupts angrily. “It was Bella, she stole the Fire crystal!” So Bella yells: “Jonah ate the Air crystal, I saw him!” Jonah looks up timidly and shakes his head. “I… I don’t know what happened, but Sumi doesn’t have the Earth crystal.” So who ate which crystal? Pause now to figure it out for yourself. There’s no getting around it— this will take some trial and error. But that’s not a bad thing. If we make a wrong guess, we’ll eventually reach a point where our conclusions contradict each other. That would allow us to confirm that our initial guess was wrong and work from there. This is a technique known as proof by contradiction. The trick is in being strategic about where we begin our guessing. Some assumptions might not lead to contradictions without making further assumptions. We want to pick one that creates the most constraints on its own, and thus gives us the most information when it turns out to be right or wrong. Take, for example, Sumi’s statement. If we assume she’s telling the truth, we’d know the identity of both truth tellers. Rikku would have the Water crystal, and since she’s not lying about him, Sumi would have Earth. So Bella would have the Fire crystal, as Rikku says. But then Bella would have to be lying about Jonah having the Air crystal. And yet that’s the only remaining option. This is a contradiction, and it tells us our initial assumption was wrong. So now we can go back to the start, but with the added knowledge that Sumi is lying. As a liar, Sumi must either have the Fire or Air crystal. That means Jonah was telling the truth about her, so he can’t have taken either of those. And that means Bella was lying about him, so she must also have either Fire or Air. Since Sumi was lying, Rikku can’t have taken the Water crystal— the only one left who could have it is Jonah. And because we’ve already identified the two liars, Rikku must have the Earth crystal. That means Bella has the Fire crystal and Sumi has Air. You manage to get them all in the proper containment fields just as the crystals’ magic begins to manifest. Compared with the difficult task of training these kids to control their new powers, figuring out who had which crystal was elementary.

**P817 2020-01-29 The legend of Annapurna, Hindu goddess of nourishment - Antara Raycha**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=817)

Lord Shiva— primordial destroyer of evil, slayer of demons, protector, and omniscient observer of the universe— was testing his wife’s patience. Historically, the union between Shiva and Parvati was a glorious one. They maintained the equilibrium between thought and action on which the well-being of the world depended. Without Parvati as the agent of energy, growth, and transformation on Earth, Shiva would become a detached observer, and the world would remain static. But together, the two formed a divine union known as Ardhanarishvara–– a sacred combination which brought fertility and connection to all living things. For these reasons, Parvati was worshipped far and wide as the mother of the natural world–– and the essential counterpart to Shiva’s powers of raw creation. She oversaw humanity’s material comforts; and ensured that the Earth’s inhabitants were bonded to each other physically, emotionally, and spiritually. Yet a rift had grown between these two formidable forces. While Parvati sustained daily life with care and control, Shiva had begun to belittle his wife’s essential work— and insisted on quarreling about their roles in the universe. He believed that Brahma, the Creator of the world, had conceived the material plane purely for his own fancy. And therefore, all material things were merely distractions called māyā— nothing but a cosmic illusion. For millennia Parvati had merely smiled knowingly as Shiva dismissed the things she nurtured. But upon His latest rebuke, she knew she had to prove the importance of her work once and for all. She took flight from the world, withdrawing her half of the cosmic energy that kept the Earth turning. At her disappearance, a sudden, terrifying and all-encompassing scarcity enveloped the world in eerie silence. Without Parvati, the land became dry and barren. Rivers shrank and crops shriveled in the fields. Hunger descended on humanity. Parents struggled to console their starving children while their own stomachs rumbled. With nothing to eat, people no longer gathered over heaped bowls of rice, but withdrew and shrank from the darkening world. To His shock and awe, Shiva also felt the profound emptiness left by his wife’s absence. Despite His supreme power, He too realized that He was not immune to the need for sustenance, and His yearning felt bottomless and unbearable. As Shiva despaired over the desolate Earth, He came to realize that the material world could not be so easily dismissed. At her husband’s epiphany, the compassionate Parvati could no longer stand by and watch her devotees wasting away. To walk among them and restore their health, she took the form of a new avatar, carrying a golden bowl of porridge and armed with a jewel-encrusted ladle. As word of this hopeful figure spread, she was worshipped as Annapurna, the Goddess of food. With the arrival of Annapurna, the world blossomed anew. People rejoiced at fertility and food, and communed together to give thanks. Some believe that Annapurna first appeared in the sacred city of Kashi, or the Place of Freedom, on the banks of the Ganges— where she opened a kitchen to fill the bellies of the people until they could eat no more. But it was not only mere mortals who were served at her feast. Humbled at the scenes of earthly pleasure blooming all around him, Lord Shiva himself approached the goddess with an empty bowl and begged for food and forgiveness. For this reason, the supreme deity is sometimes portrayed as a poor beggar at the mercy of Annapurna; holding her golden bowl in her left hand, while the right forms the abhaya mudra–– a gesture of safety and assurance. With these symbols, this powerful avatar makes it clear that the material world is anything but an illusion. Rather, it is a cycle of life that must be sustained— from the feeding of open mouths and rumbling bellies, to the equilibrium of the Earth.

**P818 2020-01-29 The life, legacy & assassination of an African revolutionary - Lisa J**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=818)

In 1972, Thomas Sankara was swept into a revolution for a country not his own. Hailing from the West African nation of Burkina Faso— then known as Upper Volta— the 22-year-old soldier had travelled to Madagascar to study at their military academy. But upon arriving, he found a nation in conflict. Local revolutionaries sought to wrest control of Madagascar from France’s lingering colonial rule. These protestors inspired Sankara to read works by socialist leaders like Karl Marx and seek wisdom from military strategy. When he returned to Upper Volta in 1973, Sankara was determined to free his country from its colonial legacy. Born in 1949, Sankara was raised in a relatively privileged household as the third of ten children. His parents wanted him to be a priest, but like many of his peers, Sankara saw the military as the perfect institution to rid Upper Volta of corruption. After returning from Madagascar, he became famous for his charisma and transparent oratorial style— but he was less popular with the reigning government. Led by President Jean-Baptiste Ouédraogo, this administration came to power in the 3rd consecutive coup d’état in Upper Volta’s recent history. The administration’s policies were a far cry from the sweeping changes Sankara proposed, but, by 1981, Sankara’s popularity won out, earning him a role in Ouédraogo’s government. Nicknamed “Africa’s Che Guevara," Sankara rapidly rose through the ranks, and within two years, he was appointed Prime Minister. In his new role, he delivered rallying speeches to impoverished communities, women, and young people. He even tried to persuade other governments to form alliances based on their shared colonial legacy. But Ouédraogo and his advisors felt threatened by Sankara’s new position. They thought his communist beliefs would harm alliances with capitalist countries, and just months after becoming Prime Minister, Ouédraogo’s administration forced Sankara from the job and placed him on house arrest. Little did the President know this act would fuel Upper Volta’s 4th coup d’état in 17 years. Civilian protests ensued around the capital, and the government ground to a halt while Sankara tried to negotiate a peaceful transition. During this time, Blaise Compaoré, Sankara’s friend and fellow former soldier, foiled another coup that included an attempt on Sankara’s life. Eventually, Ouédraogo resigned without further violence, and on August 4, 1983, Thomas Sankara became the new President of Upper Volta. Finally in charge, Sankara launched an ambitious program for social and economic change. As one of his first agenda items, he renamed the country from its French colonial title "Upper Volta" to "Burkina Faso," which translates to “Land of Upright Men." Over the next four years he established a nation-wide literacy campaign, ordered the planting of over 10 million trees, and composed a new national anthem— all while cutting down inflated government employee salaries. But perhaps the most unique element of Sankara’s revolution was his dedication to gender equality. He cultivated a movement for women’s liberation, outlawing forced marriages, polygamy and genital mutilation. He was the first African leader to appoint women to key political positions and actively recruit them to the military. However, Sankara’s socialist policies were met with much resistance. Many students and elites believed his economic plans would alienate Burkina Faso from its capitalist peers. His crackdown on the misuse of public funds turned government officials against him as well. After four years, what began as an empowering revolution had isolated many influential Burkinabes. But Sankara was not ready to yield his power. He executed increasingly authoritarian actions, including banning trade unions and the free press. Eventually, his autocratic tendencies turned even his closest friends against him. On October 15, 1987, Sankara was conducting a meeting when a group of assailants swarmed his headquarters. Sankara was assassinated in the attack, and many believe the raid was ordered by his friend Blaise Compaoré. Though his legacy is complicated, many of Sankara’s policies have proven themselves to be ahead of their time. In the past decade, Burkinabe youth have celebrated Sankara’s political philosophy, and nearby countries like Ghana have even adopted Sankara’s economic models. On March 2, 2019 a statue of Sankara was erected in Burkina Faso’s capital, establishing his place as an icon of revolution for his country and throughout the world.

**P819 2020-01-30 The Chasm \_ Think Like A Coder, Ep 6**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=819)

Ethic, Hedge, and Octavia stand on the edge of a bottomless ravine. It’s the only thing between them and the tower that houses the second of three powerful artifacts. They’ve got a brief window of time to get across before the guards return. With Hedge’s fuel gauge on empty he won’t be able to fly Ethic across, so the only option is to make a bridge. Fortunately, the floating stacks of stones nearby are bridge components— invented by Octavia herself— called hover-blocks. Activate a pile with a burst of energy, and they’ll self-assemble to span the ravine as Ethic walks across. But there is, of course, a catch. The hover-blocks are only stable when they’re perfectly palindromic. Meaning they have to form a sequence that’s the same when viewed forwards and backwards. The stacks start in random orders, but will always put themselves into a palindromic configuration if they can. If they get to a point where a palindrome isn’t possible, the bridge will collapse, and whoever’s on it will fall into the ravine. Let’s look at an example. This stack would make itself stable. First the A blocks hold themselves in place. Then the B’s. And finally the C would nestle right between the B’s. However, suppose there was one more A. First two A blocks form up, then two B’s, but now the remaining C and A have nowhere to go, so the whole thing falls apart. The Node of Power enables Hedge to energize a single stack of blocks. What instructions can Ethic give Hedge to allow him to efficiently find and power a stable palindromic stack? Pause now to figure it out for yourself. Examples of palindromes include ANNA, RACECAR, and MADAM IM ADAM. Counting the number of times a given letter appears in a palindrome will reveal a helpful pattern. Pause now to figure it out for yourself. Let’s first look at a naïve solution to this problem. A naïve solution is a simple, brute-force approach that isn’t optimized— but will get the job done. Naïve solutions are helpful ways to analyze problems, and work as stepping stones to better solutions. In this case, a naïve solution is to approach a pile of blocks, try all the arrangements, and see if one is a palindrome by reading it forward and then backwards. The problem with this approach is that it would take a tremendous amount of time. If Hedge tried one combination every second, a stack of just 10 different blocks would take him 42 days to exhaust. That’s because the total time is a function of the factorial of the number of blocks there are. 10 blocks have over 3 million combinations. What this naïve solution shows is that we need a much faster way to tell whether a pile of blocks can form a palindrome. To start, it may be intuitively clear that a pile of all different blocks will never form one. Why? The first and last blocks can’t be the same if there are no repeats. So when can a given sequence become a palindrome? One way to figure that out is to analyze a few existing palindromes. In ANNA, there are 2 A’s and 2 N’s. RACECAR has 2 R’s, 2 A’s, 2 C’s, and 1 E. And MADAM IM ADAM has 4 M’s, 4 A’s, 2 D’s, and 1 I. The pattern here is that most of the letters occur an even number of times, and there’s at most 1 that occurs just once. Is that it? What if RACECAR had 3 E’s instead of 1? We could tack the new E’s onto the ends and still get a palindrome, so 3 is ok. But make that 3 E’s and 3 C’s, and there’s nowhere for the last C to go. So the most generalized insight is that at most one letter can appear an odd number of times, but the rest have to be even. Hedge can count the letters in each stack and organize them into a dictionary, which is a tidy way of storing information. A loop could then go through and count how many times odd numbers appear. If there are less than 2 odd characters, the stack can be made into a palindrome. This approach is much, much faster than the naïve solution. Instead of factorial time, it takes linear time. That’s where the time increases in proportion to the number of blocks there are. Now write a loop for Hedge to approach the piles individually, and stop when he finds a good one, and you’ll be ready to go. Here’s what happens: Hedge is fast, but there are so many piles it takes a long time. Too long. Ethic and Hedge are safe. But Octavia is not so lucky.

**P820 2020-01-31 The accident that changed the world - Allison Ramsey and Mary Staicu**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=820)

London, 1928: a group of mold spores surf a breeze through a lab. They drift onto a petri dish, and when they land, they germinate a medical revolution. This lab belongs to Alexander Fleming, a Scottish scientist investigating the properties of infectious bacteria. At this time, Fleming is away on vacation. When he returns, he finds a colony of mold growing on a petri dish he’d forgotten to place in his incubator. And around this colony of mold is a zone completely and unexpectedly clear of bacteria. In studying this mysterious phenomenon, Fleming came to realize that the mold was secreting some kind of compound that was killing the bacteria. The mold was a species in the Penicillium genus, so Fleming dubbed the antibacterial compound “penicillin.” What Fleming stumbled upon was a microbial defense system. The penicillium mold constantly produces penicillin in order to defend itself from threats, such as nearby bacterial colonies that might consume its resources. Penicillin destroys many types of bacteria by disrupting synthesis of their cell walls. These walls get their strength from a thick, protective mesh of sugars and amino acids, that are constantly being broken down and rebuilt. Penicillin binds to one of the compounds that weaves this mesh together and prevents the wall from being reconstructed at a critical phase. Meanwhile, penicillin stimulates the release of highly reactive molecules that cause additional damage. Eventually, the cell’s structure breaks down completely. This two-pronged attack is lethal to a wide range of bacteria, whether in petri-dishes, our bodies, or elsewhere. It’s not, however, harmful to our own cells, because those don’t have cell walls. For a decade or so after Fleming’s discovery, penicillin remained a laboratory curiosity. But during World War II, researchers figured out how to isolate the active compound and grow the mold in larger quantities. They then went on to win the Nobel Prize for their work. Teams at Oxford and several American drug companies continued development, and within a few years it was commercially available. Penicillin and similar compounds quickly transformed the treatment of infections. For the time being, they remain some of the most important, life-saving antibiotics used in medicine. However, the more we use any antibiotic, the more bacteria evolve resistance to it. In the case of penicillin, some bacteria produce compounds that can break down the key structure that interferes with cell wall synthesis. As antibiotic use has increased, more and more bacteria have evolved this defense, making these antibiotics ineffective against a growing number of bacterial infections. This means it’s essential that doctors not overprescribe the drug. Meanwhile, 5 to 15% of patients in developed countries self-identify as allergic to penicillin, making it the most commonly reported drug allergy. However, the vast majority— over 90%— of people who think they’re allergic to penicillin actually are not. Why the misperception? Many patients acquire the allergy label as children, when a rash appears after they’re treated for an infection with penicillin or closely related drugs. The rash is often blamed on penicillin, while the more likely culprit is the original infection, or a reaction between the infection and the antibiotic. However, genuine penicillin allergies, where our immune systems mistake penicillin for an attacker, do occur rarely and can be very dangerous. So if you think you’re allergic but don’t know for sure, your best bet is to visit an allergist. They’ll complete an evaluation that’ll confirm whether or not you have the allergy. Even if you do have a penicillin allergy, your immune cells that react to the drug may lose their ability to recognize it. In fact, about 80% of people who are allergic to penicillin outgrow their allergy within ten years. This is great news for people who currently identify as allergic to penicillin; the drug may one day save their lives, as it has done for so many others.

**P821 2020-02-03 How do blood transfusions work - Bill Schutt**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=821)

In 1881, doctor William Halsted rushed to help his sister Minnie, who was hemorrhaging after childbirth. He quickly inserted a needle into his arm, withdrew his own blood, and transferred it to her. After a few uncertain minutes, she began to recover. Halsted didn’t know how lucky they’d gotten. His transfusion only worked because he and his sister happened to have the same blood type— something that isn’t guaranteed, even among close relatives. Blood types hadn’t been discovered by Halsted’s time, though people had been experimenting with transfusions for centuries— mostly unsuccessfully. In 1667, a French physician named Jean-Baptiste Denis became the first to try the technique on a human. Denis transfused sheep’s blood into Antoine Mauroy, a man likely suffering from psychosis, in the hopes that it would reduce his symptoms. Afterward, Mauroy was in good spirits. But after a second transfusion, he developed a fever, severe pain in his lower back, intense burning in his arm, and he urinated a thick, black liquid. Though nobody knew it at the time, these were the signs of a dangerous immune response unfolding inside his body. This immune response starts with the production of proteins called antibodies, which distinguish the body’s own cells from intruders. They do so by recognizing the foreign proteins, or antigens, embedded in an intruder’s cell membrane. Antibodies latch onto the antigens, signaling other immune cells to attack and destroy the foreign cells. The destroyed cells are flushed from the body in urine. In extreme cases, the massive break down of cells causes clots in the bloodstream that disrupt the flow of blood to vital organs, overload the kidneys, and cause organ failure. Fortunately, Denis’s patient survived the transfusion. But, after other cross-species transfusions proved fatal, the procedure was outlawed across Europe, falling out of favor for several centuries. It wasn’t until 1901 that Austrian physician Karl Landsteiner discovered blood types, the crucial step in the success of human to human blood transfusions. He noticed that when different types were mixed together, they formed clots. This happens when antibodies latch on to cells with foreign antigens, causing blood cells to clump together. But if the donor cells are the same blood type as the recipient’s cells, the donor cells won’t be flagged for destruction, and won’t form clumps. By 1907, doctors were mixing together small amounts of blood before transfusing it. If there were no clumps, the types were a match. This enabled them to save thousands of lives, laying the foundation for modern transfusions. Up to this point, all transfusions had occurred in real time, directly between two individuals. That’s because blood begins to clot almost immediately after coming into contact with air— a defense mechanism to prevent excessive blood loss after injury. In 1914, researchers discovered that the chemical sodium citrate stopped blood coagulating by removing the calcium necessary for clot formation. Citrated blood could be stored for later use— the first step in making large scale blood transfusions possible. In 1916, a pair of American scientists found an even more effective anticoagulant called heparin, which works by deactivating enzymes that enable clotting. We still use heparin today. At the same time, American and British researchers developed portable machines that could transport donor blood onto the battlefields of World War I. Combined with the newly-discovered heparin, medics safely stored and preserved liters of blood, wheeling it directly onto the battlefield to transfuse wounded soldiers. After the war, this crude portable box would become the inspiration for the modern-day blood bank, a fixture of hospitals around the world.

**P822 2020-02-06 Vultures - The acid-puking, plague-busting heroes of the ecosystem -**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=822)

In the grasslands of Mauritania, a gazelle suffering from tuberculosis takes its last breath. Collapsing near a small pool, the animal’s corpse threatens to infect the water. But for the desert’s cleanup crew, this body isn’t a problem: it’s a feast. Weighing up to 10 kilograms and possessing a wingspan of nearly 3 meters, the lappet-faced vulture is the undisputed king of the carcass. This bird’s powerful beak and strong neck easily tear through tough hide and muscle tissue, opening entry points for weaker vultures to dig in. This colossal competition is too dangerous for the tiny Egyptian vulture. With a wingspan of only 180 centimeters, this vulture migrated to Africa from his family nest in Portugal, using thermal updrafts to stay aloft for hours at a time. But upon arrival, he finds himself near the bottom of the pecking order. Fortunately, what he lacks in size, he makes up for in intelligence. A short distance away, he spots an unguarded ostrich nest, full of immense, but impenetrable eggs. Using a large rock, he smashes one open for a well-earned meal— though he’ll circle back to the gazelle once the larger birds are gone. High above the commotion are Ruppell’s Griffon vultures. Soaring at an altitude of over 11,000 meters, these birds fly higher than any other animal. At this height, they can’t see individual carcasses. But the sight of their fellow vultures guides them to the feeding. Their featherless heads help them regulate the sudden rise in temperature as they descend— and keep them clean as they tear into the decaying gazelle. The carcass is stripped clean in hours, well before the rotting meat infects the water supply. And the tuberculosis doesn’t stand a chance at infecting the vultures. These birds have evolved the lowest gastric pH in the animal kingdom, allowing them to digest diseased carrion and waste without becoming sick. In fact, species like the mountain-dwelling bearded vulture have stomachs so acidic, they can digest most bones in just 24 hours. This adaptation helps smaller vultures supplement their diet with dung, while larger vultures can consume diseased meat up to 3 days old. Their acidic stomachs protect them from living animals too: their rancid vomit scares off most predators. These stomachs of steel are essential to removing pathogens like cholera, anthrax, and rabies from the African ecosystem. But while vultures can easily digest natural waste, man-made chemicals are another story. Diclofenac, a common veterinary drug used to treat cattle in India, is fatal to vultures. And because local religious beliefs prohibit eating beef, scavengers often consume cattle carcasses. Since the 1990s, the drug, along with threats from electricity pylons and habitat loss, has contributed to a 95% decline in the region’s vulture population. In nearby Africa, poachers intentionally poison carcasses to prevent the birds’ presence from alerting authorities to their location. One poisoned carcass can kill over 500 vultures. Today, more than 50% of all vulture species are endangered. In regions where vultures have gone extinct, corpses take three times longer to decay. These carcasses contaminate drinking water, while feral dogs and rats carry the diseases into human communities. The Asian and African Vulture Crisis has led to an epidemic of rabies in India, where infections kill roughly 20,000 people each year. Fortunately, some communities have already realized how important vultures are. Conservationists have successfully banned drugs like Diclofenac, while other researchers are working to repopulate vulture communities through breeding programs. Some regions have even opened vulture restaurants where farmers safely dispose of drug-free livestock. With help, vultures will be able to continue their role conserving the health of our planet— transforming death and decay into life.

**P823 2020-02-07 The secret messages of Viking runestones - Jesse Byock**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=823)

In the 8th century CE, Vikings surged across the misty seas. They came from Scandinavia in Northern Europe but would travel far and wide. Some plundered and settled in the British Isles and France; others braved Artic exploration or forged clever new trade routes to the Middle East. With their steely navigational skills, advanced long-ships and fearsome tactics, the Vikings sustained their seafaring for over three hundred years. But for all their might, they left few monuments. Instead, fragments of stone, bark, and bone provide the keys to their culture. Found in graves, bogs, and sites of ancient settlements, many of these objects are inscribed with messages in Old Norse written in runic letters. But the Vikings also scratched runes into household goods, jewellery, weapons, and even shoes. Deciphering these messages is no easy task. Runes are short, straight, and diagonal lines that make up an alphabet called the “futhark.” All classes of people spoke and wrote this language, in many different dialects. There was no standard spelling, they wrote the individual runic letters by pronouncing the sounds of their regional accents. Some of these inscriptions also bore the influence of other cultures the Vikings interacted with— the runic inscription “love conquers all,” for example, is originally a Latin phrase from the poet Virgil. Many, like the enigmatic Rok runestone, were carved in verse, highlighting the tradition of Old Norse poetry. So even though modern runologists can read runes, their meaning isn’t always obvious. Still, in spite of the remaining mysteries, many inscriptions memorializing the dead and recording local histories have been deciphered— along with some containing magical incantations. The Ramsund runes in Sweden are carved on a rocky outcrop beside a bridge for travelers passing over swampy ground. This causeway was commissioned by a prominent local woman named Sigríðr. She proclaimed both her importance and her family’s power by carving their names in stone, and even associated herself and her family with mythical heroism by carving illustrations of Sigurd the dragon slayer. In the town of Jelling in Denmark, two standing stones from the 10th century memorialize different generations of a royal family. The first was erected by King Gorm the Old in memory of his Queen Thyrvi, and the second by their son, Harald Bluetooth, after Gorm’s death. The stones announce the power of this Viking Age dynasty, and they are among the earliest historical documents of Denmark. They indicate that Denmark was the earliest major Viking Age kingdom, by telling that Harald controlled southern Norway, and that he converted to Christianity. Today, Harald Bluetooth’s initials make up the Bluetooth logo. The 10th century warrior poet Egil was a well-known carver of runes. According to poetic accounts, he once carved runes on a horn filled with poison, causing the horn to shatter. In another story, Egil saves a young girl’s life by placing a piece of whale bone carved with healing runes under her pillow. Norse poetry tells of runic spells, cast to ensure calm seas, safe childbirth and triumphant battles. But the exact nature of these spells isn’t fully understood— many of the inscriptions on swords, axes, and spears are indecipherable. Other objects, like the Lindholm amulet, have inscriptions that could be incantations, riddles, or religious messages. While it’s difficult to pinpoint the end of the Viking era, by 1100 CE their sea-borne expansion had mostly come to an end. However, people continued to speak versions of Old Norse throughout Scandinavia; and runes remained in use in rural areas into the 19th century. Today, many runestones remain standing at their original sites. The inscription on the Danish Glavendrup stone has fearsomely declared for a thousand years: “A warlock be he who damages this stone or drags it in memory of another!”

**P824 2020-02-10 One of the most epic engineering feats in history - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=824)

In the mid-19th century, suspension bridges were collapsing all across Europe. Their industrial cables frayed during turbulent weather and snapped under the weight of their decks. So when a German-American engineer named John Roebling proposed building the largest and most expensive suspension bridge ever conceived over New York’s East River, city officials were understandably skeptical. But Manhattan was increasingly overcrowded, and commuters from Brooklyn clogged the river. In February of 1867, the government approved Roebling’s proposal. To avoid the failures of European bridges, Roebling designed a hybrid bridge model. From suspension bridges, he incorporated large cables supported by central pillars and anchored at each bank. This design was ideal for supporting long decks, which hung from smaller vertical cables. But Roebling’s model also drew from cable-stayed bridges. These shorter structures held up their decks with diagonal cables that ran directly to support towers. By adding these additional cables, Roebling improved the bridge’s stability, while also reducing the weight on its anchor cables. Similar designs had been used for some other bridges but the scope of Roebling’s plan here dwarfed them all. His new bridge’s deck spanned over 480 meters— 1.5 times longer than any previously built suspension bridge. Since standard hemp rope would tear under the deck’s 14,680 tons, his proposal called for over 5,600 kilometers of metal wire to create the bridge’s cables. To support all this weight, the towers would need to stand over 90 meters above sea level— making them the tallest structures in the Western Hemisphere. Roebling was confident his design would work, but while surveying the site in 1869, an incoming boat crushed his foot against the dock. Within a month, tetanus had claimed his life. Fortunately, John Roebling's son, Washington, was also a trained engineer and took over his father’s role. The following year, construction on the tower foundations finally began. This first step in construction was also the most challenging. Building on the rocky river bed involved the use of a largely untested technology: pneumatic caissons. Workers lowered these airtight wooden boxes into the river, where a system of pipes pumped pressurized air in and water out. Once established, air locks allowed workers to enter the chamber and excavate the river bottom. They placed layers of stone on top of the caisson as they dug. When it finally hit the bedrock, they filled it with concrete, becoming the tower’s permanent foundation. Working conditions in these caissons were dismal and dangerous. Lit only by candles and gas lamps, the chambers caught fire several times, forcing them to be evacuated and flooded. Even more dangerous was a mysterious ailment called "the bends." Today, we understand this as decompression sickness, but at the time, it appeared to be an unexplainable pain or dizziness that killed several workmen. In 1872, it nearly claimed the life of the chief engineer. Washington survived, but was left paralyzed and bedridden. Yet once again, the Roeblings proved indomitable. Washington’s wife Emily not only carried communications between her husband and the engineers, but soon took over day-to-day project management. Unfortunately, the bridge’s troubles were far from over. By 1877, construction was over budget and behind schedule. Worse still, it turned out the bridge’s cable contractor had been selling them faulty wires. This would have been a fatal flaw if not for the abundant failsafes in John Roebling’s design. After reinforcing the cables with additional wires, they suspended the deck piece by piece. It took 14 years, the modern equivalent of over 400 million dollars, and the life’s work of three different Roeblings, but when the Brooklyn Bridge finally opened on May 24, 1883, its splendor was undeniable. Today, the Brooklyn Bridge still stands atop its antique caissons, supporting the gothic towers and intersecting cables that frame a gateway to New York City.

**P825 2020-02-11 The Egyptian myth of Isis and the seven scorpions - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=825)

A woman in rags emerged from the swamp flanked by seven giant scorpions. Carrying a baby, she headed for the nearest village to beg for food. She approached a magnificent mansion, but the mistress of the house took one look at her grimy clothes and unusual companions and slammed the door in her face. So she continued down the road until she came to a cottage. The woman there took pity on the stranger and offered her what she could: a simple meal and a bed of straw. Her guest was no ordinary beggar. She was Isis, the most powerful goddess in Egypt. Isis was in hiding from her brother Set, who murdered her husband and wanted to murder her infant son, Horus. Set was also a powerful god, and he was looking for them. So to keep her cover, Isis had to be very discreet— she couldn’t risk using her powers. But she was not without aid. Serket, goddess of venomous creatures, had sent seven of her fiercest servants to guard Isis and her son. As Isis and Horus settled into their humble accommodation, the scorpions fumed at how the wealthy woman had offended their divine mistress. They all combined their venom and gave it to one of the seven, Tefen. In the dead of night, Tefen crept over to the mansion. As he crawled under the door, he saw the owner’s young son sleeping peacefully and gave him a mighty sting. Isis and her hostess were soon awakened by loud wailing. As they peered out of the doorway of the cottage, they saw a mother running through the street, weeping as she cradled her son. When Isis recognized the woman who had turned her away, she understood what her scorpions had done. Isis took the boy in her arms and began to recite a powerful spell: "O poison of Tefen, come out of him and fall upon the ground! Poison of Befen, advance not, penetrate no farther, come out of him, and fall upon the ground! For I am Isis, the great Enchantress, the Speaker of spells. Fall down, O poison of Mestet! Hasten not, poison of Mestetef! Rise not, poison of Petet and Thetet! Approach not, poison of Matet!" With each name she invoked, that scorpion’s poison was neutralized. The child stirred, and his mother wept with gratitude and lamented her earlier callousness, offering all her wealth to Isis in repentance. The woman who had taken Isis in watched in awe— she had had no idea who she’d brought under her roof. And from that day on, the people learned to make a poultice to treat scorpion bites, speaking magical incantations just as the goddess had.

**P826 2020-02-11 Why do people fear the wrong things - Gerd Gigerenzer**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=826)

A new drug reduces the risk of heart attacks by 40%. Shark attacks are up by a factor of two. Drinking a liter of soda per day doubles your chance of developing cancer. These are all examples of relative risk, a common way risk is presented in news articles. Risk evaluation is a complicated tangle of statistical thinking and personal preference. One common stumbling block is the difference between relative risks like these and what are called absolute risks. Risk is the likelihood that an event will occur. It can be expressed as either a percentage— for example, that heart attacks occur in 11% of men between the ages of 60 and 79— or as a rate— that one in two million divers along Australia’s western coast will suffer a fatal shark bite each year. These numbers express the absolute risk of heart attacks and shark attacks in these groups. Changes in risk can be expressed in relative or absolute terms. For example, a review in 2009 found that mammography screenings reduced the number of breast cancer deaths from five women in one thousand to four. The absolute risk reduction was about .1%. But the relative risk reduction from 5 cases of cancer mortality to four is 20%. Based on reports of this higher number, people overestimated the impact of screening. To see why the difference between the two ways of expressing risk matters, let’s consider the hypothetical example of a drug that reduces heart attack risk by 40%. Imagine that out of a group of 1,000 people who didn’t take the new drug, 10 would have heart attacks. The absolute risk is 10 out of 1,000, or 1%. If a similar group of 1,000 people did take the drug, the number of heart attacks would be six. In other words, the drug could prevent four out of ten heart attacks— a relative risk reduction of 40%. Meanwhile, the absolute risk only dropped from 1% to 0.6%— but the 40% relative risk decrease sounds a lot more significant. Surely preventing even a handful of heart attacks, or any other negative outcome, is worthwhile— isn’t it? Not necessarily. The problem is that choices that reduce some risks can put you in the path of others. Suppose the heart-attack drug caused cancer in one half of 1% of patients. In our group of 1,000 people, four heart attacks would be prevented by taking the drug, but there would be five new cases of cancer. The relative reduction in heart attack risk sounds substantial and the absolute risk of cancer sounds small, but they work out to about the same number of cases. In real life, everyone’s individual evaluation of risk will vary depending on their personal circumstances. If you know you have a family history of heart disease you might be more strongly motivated to take a medication that would lower your heart-attack risk, even knowing it provided only a small reduction in absolute risk. Sometimes, we have to decide between exposing ourselves to risks that aren’t directly comparable. If, for example, the heart attack drug carried a higher risk of a debilitating, but not life-threatening, side effect like migraines rather than cancer, our evaluation of whether that risk is worth taking might change. And sometimes there isn’t necessarily a correct choice: some might say even a minuscule risk of shark attack is worth avoiding, because all you’d miss out on is an ocean swim, while others wouldn’t even consider skipping a swim to avoid an objectively tiny risk of shark attack. For all these reasons, risk evaluation is tricky at baseline, and reporting on risk can be misleading, especially when it shares some numbers in absolute terms and others in relative terms. Understanding how these measures work will help you cut through some of the confusion and better evaluate risk.

**P827 2020-02-12 Can you solve the death race riddle - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=827)

The night before the Death Race across the Wastelands is set to begin, your uncle, the great inventor Slate Kanoli, got kidnapped by the ruthless No-Side gang. The only way to get him back is to race his Coil Runner against the gang yourself. Win and they’ll give back your uncle. Lose and you’ll forfeit the Coil Runner and all his other creations. As the grueling race gets underway, you find yourself falling further and further behind. Your only chance is to take a shortcut your uncle told you about–– the Flux Ravine gambit. Fortunately, the Coil Runner comes equipped with emergency turbo thrusters. Unfortunately, your uncle was a notorious tinkerer, and the system still had some kinks to work out. Just minor things like the ignition exploding, the reactor leaking, or the oxygen levels depleting— any of which would end your racing career immediately. Before his kidnapping, Uncle Slate determined that each of these critical failures was the ultimate result of a chain reaction originating in the thrusters. He was also certain that while one factor could trigger two different effects, and two factors could each independently lead to the same effect, no effect is caused by two factors in conjunction. However, Uncle Slate never got around to pinpointing which thruster was responsible for which error. All you have are the notes from his test runs: 1. When thrusters B and C are on, the Fuel gauge glows. 2. When thrusters A, B, and D are on, the Fuel gauge glows and the Helium tank rattles. 3. When thrusters C, D, and E are on, the Fuel gauge glows and the Gravitometer spins. 4. When thrusters A, D, and E are on, the Gravitometer spins and the Helium tank rattles. 5. Shortly after the Helium tank rattles and the Gravitometer spins, the Ignition explodes and the Oxygen levels deplete. 6. Shortly after the Fuel gauge glows and the Gravitometer spins, the Reactor leaks. You need to use as many thrusters as possible to give yourself the best chance at clearing the gap, without triggering any of the three catastrophic failures. Which thrusters should you activate? Answer in 3 Answer in 2 Answer in 1 The most important thing to remember here is that even if we know that one thing causes another, the converse is not necessarily true. For example, this panic switch shuts off the coil runner’s engine. But the engine being off doesn’t necessarily mean the panic switch was engaged— the coil runner could be out of fuel, or damaged— or turned off normally. We can, however, conclude that if the engine is running, the panic switch hasn’t been engaged. With that in mind, one way we can start is to work backwards from the three defects that could knock you out of the race. So let’s look at Slate’s last two notes, since they give direct information about those. The Gravitometer spins in both cases, but the results are different. That means the spinning Gravitometer can’t be the cause of any particular malfunction. If it were, the same thing would happen each time. So we can conclude that a glowing Fuel gauge makes the reactor leak, while a rattling Helium tank makes the Ignition explode and depletes the Oxygen levels. Once we know which two errors we need to avoid, we can make a table and use the logic of cause and effect to see which thrusters trigger them. Since the Helium tank is fine during the first test run when thrusters B and C are active, we can assume neither makes it rattle. And from the third run we know that D and E don’t either. That leaves thruster A, which was indeed used in the second and fourth test runs where the Helium tank rattled. Now what causes the glowing Fuel gauge? From the fourth test run we know it can’t be thrusters A, D, or E. So is the culprit, B, C, or each of them separately? The answer can be found in the second and third test runs: the fuel tank glowed in both, but B was activated in one, and C in the other. That means the B and C thrusters each independently make the Fuel tank glow. It looks like the A, B, and C thrusters are off limits. Fortunately, the other two are just enough to clear the jump. You rocket into first place and the gang begrudgingly hands over your uncle. He thanks you profusely, and decides to celebrate your victory with a cup of tea from his latest contraption...

**P828 2020-02-12 NASA’s first software engineer - Margaret Hamilton - Matt Porter & Ma**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=828)

At roughly 4pm on July 20, 1969, mankind was just minutes away from landing on the surface of the moon. But before the astronauts began their final descent, an emergency alarm lit up. Something was overloading the computer, and threatened to abort the landing. Back on Earth, Margaret Hamilton held her breath. She'd led the team developing the pioneering in-flight software, so she knew this mission had no room for error. But the nature of this last-second emergency would soon prove her software was working exactly as planned. Born 33 years earlier in Paoli, Indiana, Hamilton had always been inquisitive. In college, she studied mathematics and philosophy, before taking a research position at the Massachusetts Institute of Technology to pay for grad school. Here, she encountered her first computer while developing software to support research into the new field of chaos theory. Next at MIT's Lincoln Laboratory, Hamilton developed software for America’s first air defense system to search for enemy aircraft. But when she heard that renowned engineer Charles Draper was looking for help sending mankind to the moon, she immediately joined his team. NASA looked to Draper and his group of over 400 engineers to invent the first compact digital flight computer, the Apollo Guidance Computer. Using input from astronauts, this device would be responsible for guiding, navigating and controlling the spacecraft. At a time when unreliable computers filled entire rooms, the AGC needed to operate without any errors, and fit in one cubic foot of space. Draper divided the lab into two teams, one for designing hardware and one for developing software. Hamilton led the team that built the on-board flight software for both the Command and Lunar Modules. This work, for which she coined the term “software engineering," was incredibly high stakes. Human lives were on the line, so every program had to be perfect. Margaret’s software needed to quickly detect unexpected errors and recover from them in real time. But this kind of adaptable program was difficult to build, since early software could only process jobs in a predetermined order. To solve this problem, Margaret designed her program to be “asynchronous,” meaning the software's more important jobs would interrupt less important ones. Her team assigned every task a unique priority to ensure that each job occurred in the correct order and at the right time— regardless of any surprises. After this breakthrough, Margaret realized her software could help the astronauts work in an asynchronous environment as well. She designed Priority Displays that would interrupt astronaut’s regularly scheduled tasks to warn them of emergencies. The astronaut could then communicate with Mission Control to determine the best path forward. This marked the first time flight software communicated directly— and asynchronously— with a pilot. It was these fail safes that triggered the alarms just before the lunar landing. Buzz Aldrin quickly realized his mistake— he’d inadvertently flipped the rendezvous radar switch. This radar would be essential on their journey home, but here it was using up vital computational resources. Fortunately, the Apollo Guidance Computer was well equipped to manage this. During the overload, the software restart programs allowed only the highest priority jobs to be processed— including the programs necessary for landing. The Priority Displays gave the astronauts a choice— to land or not to land. With minutes to spare, Mission Control gave the order. The Apollo 11 landing was about the astronauts, Mission Control, software and hardware all working together as an integrated system of systems. Hamilton’s contributions were essential to the work of engineers and scientists inspired by President John F. Kennedy’s goal to reach the Moon. And her life-saving work went far beyond Apollo 11— no bugs were ever found in the in-flight software for any crewed Apollo missions. After her work on Apollo, Hamilton founded a company that uses its unique universal systems language to create breakthroughs for systems and software. In 2003, NASA honored her achievements with the largest financial award they’d ever given to an individual. And 47 years after her software first guided astronauts to the moon, Hamilton was awarded the Presidential Medal of Freedom for changing the way we think about technology.

**P829 2020-02-20 The Tower of Epiphany \_ Think Like A Coder, Ep 7**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=829)

Ethic and Hedge are on the ground floor of a massive tower. Barriers of energy separate them from their quest’s second goal: the Node of Creation. To reach it, Ethic must use three energy streams to climb the tower. As soon as she steps forward a timer will begin counting down from 60 seconds. At the back of the room there’s a basin made of invisible towers that can hold energy between them. After one minute, a torrent of energy will pour down from above, filling one unit at a time, with a force field preventing it from spilling out the front or back. During the 60 calm seconds, Ethic and Hedge must decide exactly how many units of energy will fall. For each of the three challenges, they must choose the amount that will fill the basin exactly. If they do so, the energy will propel them further upwards. But if they get the amount at all wrong, the energy lift will fail, dropping them. Diagrams on the walls illustrate some examples. This configuration will capture exactly 2 units of energy. This configuration will capture 4— 3 here, and 1 here. And this one will also capture 4, because any energy on the right would spill out. The energy will rain down in such a way that it’ll only overflow if there’s no space that could hold it. Hedge can make one tower of blocks visible at a time and count how tall it is, but he can’t look at the whole structure all at once. How does Ethic program Hedge to figure out exactly how much energy each basin can hold? Pause now to figure it out for yourself. Here’s one way of thinking about what’s happening: each unoccupied cell will hold energy if and only if there is a wall eventually to its left, and a wall eventually to its right. But it would take a long time for Hedge to check this for each individual cell. So what if he were to consider a whole column of blocks at a time? How many units of energy can this hold, for instance? Pause now to figure it out for yourself. Let’s analyze the problem by looking at our example. There are 5 columns of blocks here. The leftmost one can’t hold any energy, because there’s nothing higher than it. The 2nd stack can have 3 units above it, as they would be trapped between these two 4 block stacks. We get 3 units by taking the height where the energy would level off— 4, and subtracting the height of the stack— so that’s 4 minus 1. The 3rd stack is similar— 4 to the left, 4 to the right, and it’s 3 high, so it’ll hold 4 minus 3 equals 1 unit. The 4th stack and 5th stacks have nothing higher than them to the right, so they can’t hold any energy. We can adapt this idea into an algorithm. Considering one column at a time as the point of reference, Hedge can look to the left stack by stack to find the height of the tallest one, look to the right to find the height of the tallest one, and take the smaller of the two as the height the energy can fill up to. If the result is higher than the column in question, subtract the height of the original column, and the result will be the number of units that column can hold. If it's equal to or below the level of the column in question, the energy would spill off. Hedge can apply that to an entire basin with a loop that starts on the left-most column and moves right, one column at a time. For each column, he’ll run the same steps— look all the way left for the tallest, do the same to the right, take the lower height of the two, subtract the original column height, and increase the grand total if that number is positive. His loop will repeat as many times as there are columns. That will work, but it’ll take a long time for a large basin. At every step Hedge repeats the action of looking left and looking right. If there are N stacks, he’ll look at all N stacks N times. Is there a faster way? Here’s one time saver: before doing anything else, Hedge can start on the left, and keep a running tally of what the highest stack is. Here that would be 2, 2 again, since the first was higher, then 4, 4, 4. He can then find the highest right-most stacks by doing the same going right-to-left: 1, 3, 4, 4, 4. In the end he’ll have a table like this in his memory. Now, Hedge can take one more pass to calculate how much energy there will be above every stack with the same equation from before: take the smaller of the stored left and right values, and subtract the height of the current tower. Instead of looking at N stacks N times, he’ll look at N stacks just 3 times— which is what’s called linear time. There are ways to optimize the solution even further, but this is good enough for our heroes. Ethic and Hedge work as one. The first cascade is a breeze, and they rise up the tower. The second is a little tougher. The third is huge, with dozens of stacks of blocks. The timer ticks down towards zero, but Ethic’s program is fast. She gets the wheel in position just in time, and the energy lifts them to the Node of Creation. Like the first, it reveals a vision: memories of years gone by. The world machine changed everything, and Ethic, in her position as chief robotics engineer, grew troubled by what she saw. When the Bradbarrier went up to keep the people in, she knew something was seriously wrong. So she created three artifacts with the ability to restore people’s power, creativity, and memory, and smuggled them to three communities. Before she could tell people how to use them, the government discovered her efforts and sent bots to arrest her and the other programmers. The last thing Ethic used the world machine to create was a robot that would protect the ancient device from the forces of ignorance by enclosing it in a giant maze. She named her creation Hedge. Without warning, the energy lift flickers, then fizzles out.

**P830 2020-02-21 What’s a squillo, and why do opera singers need it - Ming Luke**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=830)

Gripped with vengeful passion, The Queen of the Night tears across the stage. She begins to sing her titular aria, one of the most famous sections from Mozart’s beloved opera, "The Magic Flute." The orchestra fills the hall with music, but the queen’s voice soars above the instruments. Its melody rings out across thousands of patrons, reaching seats 40 meters away— all without any assistance from a microphone. How is it possible that this single voice can be heard so clearly, above the strains of dozens of instruments? The answer lies in the physics of the human voice, and the carefully honed technique of an expert opera singer. All the music in this opera house originates from the vibrations created by instruments— whether it’s the strings of a violin or the vocal folds of a performer. These vibrations send waves into the air, which our brains interpret as sound. The frequency of these vibrations–– specifically, the number of waves per second–– is how our brains determine the pitch of a single note. But in fact, every note we hear is actually a combination of multiple vibrations. Imagine a guitar string vibrating at its lowest frequency. This is called the fundamental, and this low pitch is what our ears mostly use to identify a note. But this lowest vibration triggers additional frequencies called overtones, which layer on top of the fundamental. These overtones break down into specific frequencies called harmonics, or partials— and manipulating them is how opera singers work their magic. Every note has a set of frequencies that comprise its harmonic series. The first partial vibrates at twice the frequency of the fundamental. The next partial is three times the fundamental’s frequency, and so on. Virtually all acoustic instruments produce harmonic series, but each instrument’s shape and material changes the balance of its harmonics. For example, a flute emphasizes the first few partials, but in a clarinet’s lowest register, the odd-numbered partials resonate most strongly. The strength of various partials is part of what gives each instrument its unique sonic signature. It also affects an instrument’s ability to stand out in a crowd, because our ears are more strongly attuned to some frequencies than others. This is the key to an opera singer’s power of projection. An operatic soprano— the highest of the four standard voice parts— can produce notes with fundamental frequencies ranging from 250 to 1,500 vibrations per second. Human ears are most sensitive to frequencies between 2,000 and 5,000 vibrations per second. So if the singer can bring out the partials in this range, she can target a sensory sweet spot where she’s most likely to be heard. Higher partials are also advantageous because there’s less competition from the orchestra, whose overtones are weaker at those frequencies. The result of emphasizing these partials is a distinctive ringing timbre called a singer’s squillo. Opera singers work for decades to create their squillo. They can produce higher frequencies by modifying the shape and tension in their vocal folds and vocal tract. And by shifting the position of their tongues and lips, they accentuate some overtones while dampening others. Singers also increase their range of partials with vibrato— a musical effect in which a note slightly oscillates in pitch. This creates a fuller sound that rings out over the instruments’ comparatively narrow vibratos. Once they have the right partials, they employ other techniques to boost their volume. Singers expand their lung capacity and perfect their posture for consistent, controlled airflow. The concert hall helps as well, with rigid surfaces that reflect sound waves towards the audience. All singers take advantage of these techniques, but different vocal signatures demand different physical preparation. A Wagnerian singer needs to build up stamina to power through the composer’s four-hour epics. While bel canto singers require versatile vocal folds to vault through acrobatic arias. Biology also sets some limits— not every technique is feasible for every set of muscles, and voices change as singers age. But whether in an opera hall or a shower stall, these techniques can turn un-amplified voices into thundering musical masterpieces.

**P831 2020-02-28 The tale of the doctor who defied Death - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=831)

In their ramshackle hut on the edge of the woods, a husband and wife were in despair. The woman had just given birth to their thirteenth child, and the growing family was quickly running out of food and money. The father walked into the woods to ponder their problem. After hours spent wandering through the trees, he encountered two shadowy silhouettes. The first figure appeared to be the man’s God, while the second resembled the Devil. Both figures offered to lighten the man’s burden, and act as Godfather to his most recent child. But the man refused their offer— he wouldn’t entrust his son to those who passed judgment on human life. He ventured deeper into the tangled thicket. Here in the darkest part of the woods, the father made out a third figure. Sunken eyes stared out of its gaunt face, which broke into a crooked smile. This was Death himself, come to offer his services as Godfather. He promised to return when the child came of age, to bring him happiness and prosperity. The father— knowing that all people are equal in the eyes of Death— accepted his offer. Years later, when the child had grown into an ambitious young man, his skeletal Godfather came for his promised visit. In his gnarled hand he held a flask containing the cure for all human ailments. Death had brought this flask for his Godson, promising to make him a successful doctor. But the powerful potion came with very strict rules. If his Godson encountered a sick person and Death was hovering at the top of their bed, the doctor could heal them with just a waft of the antidote’s fumes. But if Death lingered at the foot of the bed, he’d already claimed the patient as his own— and the doctor could do nothing for them. In time, the doctor’s potent potion and uncanny instincts became known throughout the land. He grew rich and famous, casting off the hardships of his early life. When the king fell ill, he summoned the famous physician to treat him. The doctor swept into the palace, ready to show off his skills. But when he entered the king’s chamber, he was dismayed to see Death settled at the foot of the bed. The doctor desperately wanted the glory of saving the king— even if it meant deceiving his Godfather. And so, he swiftly spun the bed around and reversed Death’s position, leaving the doctor free to administer the antidote. Death was livid. He warned his arrogant Godson that if he ever cheated Death again, he would pay for it with his life. Death and the doctor continued their travels. After some time, the king’s messengers came to collect the doctor yet again. The princess was gravely ill, and the king had promised incredible riches to anyone who could cure her. The doctor approached the princesses’ chamber with gold in his eyes. But upon seeing the sleeping princess, his greed fell away. He was so struck by her grace, that he failed to notice Death lurking by her feet. He swiftly healed the princess, but before she could even utter her thanks, Death had dragged his lovesick Godson away. In an instant, the palace dissolved around them. The doctor found himself in an immense cave lined with countless quivering candles, each representing the duration of a life. As punishment for his Godson’s foolish attempt to master mortality, Death whittled his candle down to its wick. Seeing his own dwindling light, the doctor felt the fear he’d often glimpsed in his patients’ eyes. Desperately, he begged Death to transfer his dying light onto a new candle. His Godfather considered the request— but the doctor’s betrayal was too great. He loosened his bony grip, and his Godson’s candle fell to the floor. Death stood motionless, his inscrutable face fixed on the sputtering flame— until all that was left of the doctor was a wisp of smoke.

**P832 2020-03-05 The meaning of life according to Simone de Beauvoir - Iseult Gillespi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=832)

At the age of 21, Simone de Beauvoir became the youngest person to take the philosophy exams at France’s most esteemed university. She passed with flying colors. But as soon as she mastered the rules of philosophy, she wanted to break them. She’d been schooled on Plato’s Theory of Forms, which dismissed the physical world as a flawed reflection of higher truths and unchanging ideals. But for de Beauvoir, earthly life was enthralling, sensual, and anything but static. Her desire to explore the physical world to its fullest would shape her life, and eventually, inspire a radical new philosophy. Endlessly debating with her romantic and intellectual partner Jean Paul Sartre, de Beauvoir explored free will, desire, rights and responsibilities, and the value of personal experience. In the years following WWII, these ideas would converge into the school of thought most closely associated with their work: existentialism. Where Judeo-Christian traditions taught that humans are born with preordained purpose, de Beauvoir and Sartre proposed a revolutionary alternative. They argued that humans are born free, and thrown into existence without a divine plan. As de Beauvoir acknowledged, this freedom is both a blessing and a burden. In "The Ethics of Ambiguity" she argued that our greatest ethical imperative is to create our own life’s meaning, while protecting the freedom of others to do the same. As de Beauvoir wrote, “A freedom which is interested only in denying freedom must be denied.” This philosophy challenged its students to navigate the ambiguities and conflicts our desires produce, both internally and externally. And as de Beauvoir sought to find her own purpose, she began to question: if everyone deserves to freely pursue meaning, why was she restricted by society’s ideals of womanhood? Despite her prolific writing, teaching and activism, de Beauvoir struggled to be taken seriously by her male peers. She’d rejected her Catholic upbringing and marital expectations to study at university, and write memoirs, fiction and philosophy. But the risks she was taking by embracing this lifestyle were lost on many of her male counterparts, who took these freedoms for granted. They had no intellectual interest in de Beauvoir’s work, which explored women’s inner lives, as well the author’s open relationship and bisexuality. To convey the importance of her perspective, de Beauvoir embarked on her most challenging book yet. Just as she’d created the foundations of existentialism, she’d now redefine the limits of gender. Published in 1949, "The Second Sex" argues that, like our life’s meaning, gender is not predestined. As de Beauvoir famously wrote, “one is not born, but rather becomes, woman.” And to “become” a woman, she argued, was to become the Other. De Beauvoir defined Othering as the process of labeling women as less than the men who’d historically defined, and been defined as, the ideal human subjects. As the Other, she argued that women were considered second to men, and therefore systematically restricted from pursuing freedom. "The Second Sex" became an essential feminist treatise, offering a detailed history of women’s oppression and a wealth of anecdotal testimony. "The Second Sex"’s combination of personal experience and philosophical intervention provided a new language to discuss feminist theory. Today, those conversations are still informed by de Beauvoir’s insistence that in the pursuit of equality, “there is no divorce between philosophy and life.” Of course, like any foundational work, the ideas in "The Second Sex" have been expanded upon since its publication. Many modern thinkers have explored additional ways people are Othered that de Beauvoir doesn’t acknowledge. These include racial and economic identities, as well as the broader spectrum of gender and sexual identities we understand today. De Beauvoir’s legacy is further complicated by accusations of sexual misconduct by two of her university students. In the face of these accusations, she had her teaching license revoked for abusing her position. In this aspect and others, de Beauvoir’s life remains controversial— and her work represents a contentious moment in the emergence of early feminism. She participated in those conversations for the rest of her life; writing fiction, philosophy, and memoirs until her death in 1986. Today, her work offers a philosophical language to be reimagined, revisited and rebelled against— a response this revolutionary thinker might have welcomed.

**P833 2020-03-11 How one scientist took on the chemical industry - Mark Lytle**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=833)

In 1958, Rachel Carson received a letter describing songbirds suddenly dropping from tree branches. The writer blamed their deaths on a pesticide called DDT that exterminators had sprayed on a nearby marsh. The letter was the push Carson needed to investigate DDT. She had already heard from scientists and conservationists who were worried that rampant use of the pesticide posed a threat to fish, birds, and possibly humans. She began to make inquiries through government contacts from her years working in the United States Bureau of Fisheries. She asked: “what has already silenced the voices of spring?” In 1962, Carson published her findings in "Silent Spring." Her book documented the misuse of chemicals and their toll on nature and human health. "Silent Spring" immediately drew both applause and impassioned dissent— along with vicious personal attacks on the author. How did this mild-mannered biologist and writer ignite such controversy? Carson began her career as a hardworking graduate student, balancing her studies in biology at John Hopkins University with part time jobs. Still, she had to leave school before completing her doctorate to provide for her ailing father and sister. Carson found part time work with the Bureau of Fisheries writing for a radio program on marine biology. Her ability to write materials that could hold the general public’s attention impressed her superiors, and in 1936, she became the second woman to be hired at the Bureau full time. In 1941, she published the first of three books on the ocean, combining science with lyrical meditations on underwater worlds. These explorations resonated with a wide audience. In "Silent Spring," Carson turned her attention to the ways human actions threaten the balance of nature. DDT was originally used during World War II to shield crops from insects and protect soldiers from insect-borne diseases. After the war, it was routinely sprayed in wide swaths to fight pests, often with unforeseen results. One attempt to eradicate fire ants in the southern U.S. killed wildlife indiscriminately, but did little to eliminate the ants. In spite of this and other mishaps, the US Department of Agriculture and chemical companies extolled the benefits of DDT. There was little regulation or public awareness about its potential harm. But Carson showed how the overuse of chemicals led to the evolution of resistant species— which, in turn, encouraged the development of deadlier chemicals. Since DDT does not dissolve in water, she asserted that over time it would accumulate in the environment, the bodies of insects, the tissues of animals who consume those insects, and eventually humans. She suggested that exposure to DDT might alter the structure of genes, with unknown consequences for future generations. The response to "Silent Spring" was explosive. For many people the book was a call to regulate substances capable of catastrophic harm. Others objected that Carson hadn’t mentioned DDT’s role controlling the threat insects posed to human health. Former Secretary of Agriculture Ezra Taft Benson demanded to know “why a spinster with no children was so concerned about genetics?” and dismissed Carson as “probably a Communist.” A lawyer for a pesticide manufacturer alluded to Carson and her supporters as “sinister influences” aiming to paint businesses as “immoral.” In reality, Carson had focused on the dangers of chemicals because they weren’t widely understood, while the merits were well publicized. She rejected the prevailing belief that humans should and could control nature. Instead, she challenged people to cultivate “maturity and mastery, not of nature, but of ourselves.” Carson died of cancer in 1964, only two years after the publication of "Silent Spring." Her work galvanized a generation of environmental activists. In 1969, under pressure from environmentalists, Congress passed the National Environmental Policy Act that required federal agencies to evaluate environmental impacts of their actions. To enforce the act, President Richard Nixon created the Environmental Protection Agency. And in 1972, the EPA issued a partial ban on the use of DDT. Long after her death, Rachel Carson continued to advocate for nature through the lingering impact of her writing.

**P834 2020-03-12 How can we solve the antibiotic resistance crisis - Gerry Wright**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=834)

Antibiotics: behind the scenes, they enable much of modern medicine. We use them to cure infectious diseases, but also to safely facilitate everything from surgery to chemotherapy to organ transplants. Without antibiotics, even routine medical procedures can lead to life-threatening infections. And we’re at risk of losing them. Antibiotics are chemicals that prevent the growth of bacteria. Unfortunately, some bacteria have become resistant to all currently available antibiotics. At the same time, we’ve stopped discovering new ones. Still, there’s hope that we can get ahead of the problem. But first, how did we get into this situation? The first widely used antibiotic was penicillin, discovered in 1928 by Alexander Fleming. In his 1945 Nobel Prize acceptance speech, Fleming warned that bacterial resistance had the potential to ruin the miracle of antibiotics. He was right: in the 1940s and 50s, resistant bacteria already began to appear. From then until the 1980s, pharmaceutical companies countered the problem of resistance by discovering many new antibiotics. At first this was a highly successful— and highly profitable— enterprise. Over time, a couple things changed. Newly discovered antibiotics were often only effective for a narrow spectrum of infections, whereas the first ones had been broadly applicable. This isn’t a problem in itself, but it does mean that fewer doses of these drugs could be sold— making them less profitable. In the early days, antibiotics were heavily overprescribed, including for viral infections they had no effect on. Scrutiny around prescriptions increased, which is good, but also lowered sales. At the same time, companies began to develop more drugs that are taken over a patient’s lifetime, like blood pressure and cholesterol medications, and later anti-depressants and anti-anxiety medications. Because they are taken indefinitely, these drugs more profitable. By the mid-1980s, no new chemical classes of antibiotics were discovered. But bacteria continued to acquire resistance and pass it along by sharing genetic information between individual bacteria and even across species. Now bacteria that are resistant to many antibiotics are common, and increasingly some strains are resistant to all our current drugs. So, what can we do about this? We need to control the use of existing antibiotics, create new ones, combat resistance to new and existing drugs, and find new ways to fight bacterial infections. The largest consumer of antibiotics is agriculture, which uses antibiotics not only to treat infections but to promote the growth of food animals. Using large volumes of antibiotics increases the bacteria’s exposure to the antibiotics and therefore their opportunity to develop resistance. Many bacteria that are common in animals, like salmonella, can also infect humans, and drug-resistant versions can pass to us through the food chain and spread through international trade and travel networks. In terms of finding new antibiotics, nature offers the most promising new compounds. Organisms like other microbes and fungi have evolved over millions of years to live in competitive environments— meaning they often contain antibiotic compounds to give them a survival advantage over certain bacteria. We can also package antibiotics with molecules that inhibit resistance. One way bacteria develop resistance is through proteins of their own that degrade the drug. By packaging the antibiotic with molecules that block the degraders, the antibiotic can do its job. Phages, viruses that attack bacteria but don’t affect humans, are one promising new avenue to combat bacterial infections. Developing vaccines for common infections, meanwhile, can help prevent disease in the first place. The biggest challenge to all these approaches is funding, which is woefully inadequate across the globe. Antibiotics are so unprofitable that many large pharmaceutical companies have stopped trying to develop them. Meanwhile, smaller companies that successfully bring new antibiotics to market often still go bankrupt, like the American start up Achaogen. New therapeutic techniques like phages and vaccines face the same fundamental problem as traditional antibiotics: if they’re working well, they’re used just once, which makes it difficult to make money. And to successfully counteract resistance in the long term, we’ll need to use new antibiotics sparingly— lowering the profits for their creators even further. One possible solution is to shift profits away from the volume of antibiotics sold. For example, the United Kingdom is testing a model where healthcare providers purchase antibiotic subscriptions. While governments are looking for ways to incentivize antibiotic development, these programs are still in the early stages. Countries around the world will need to do much more— but with enough investment in antibiotic development and controlled use of our current drugs, we can still get ahead of resistance.

**P835 2020-03-13 The imaginary king who changed the real world - Matteo Salvadore**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=835)

In 1165, copies of a strange letter began to circulate throughout Western Europe. It spoke of a fantastical realm, containing the Tower of Babel and the Fountain of Youth— all ruled over by the letter’s mysterious author: Prester John. Today, we know that this extraordinary king never existed. But the legend of this mythical kingdom and its powerful ruler would impact the decisions of European leaders for the next 400 years. Prester John’s myth would propel the age of exploration, inspire intercontinental diplomacy, and indirectly begin a civil war. When Prester John’s letter appeared, Europe was embroiled in the Crusades. In this series of religious wars, Europeans campaigned to seize what they regarded as the Christian Holy Land. The Church vilified any faith outside of Christianity, including that of the Jewish and Muslim communities populating the region. Crusaders were eager to find Christian kingdoms to serve as allies in their war. And they were particularly interested in rumors of a powerful Christian king who had defeated an enormous Muslim army in the Far East. In fact, it was a Mongol horde including converted Christian tribes that had routed the army. But news of this victory traveled unreliably. Merchants and emissaries filled gaps in the story with epic poems and Biblical fragments. By the time the story reached Europe, the Mongol horde had been replaced with a great Christian army, commanded by a king who shared the Crusader’s vision of marching on Jerusalem. And when a letter allegedly written by this so-called “Prester John” appeared, European rulers were thrilled. While the letter’s actual author remains unknown, its stereotypes about the East and alignment with European goals indicate it was a Western forgery. But despite the letter’s obvious origins as European propaganda, the appeal of Prester John’s myth was too great for the Crusaders to ignore. Before long, European mapmakers were guessing the location of his mythical kingdom. In the 13th and 14th centuries, European missionaries went East, along the newly revived Silk Road. They weren’t searching for the letter’s author, who would have been over a century old; but rather, for his descendants. The title of Prester John was briefly identified with several Central Asian rulers, but it soon became clear that the Mongols were largely non-Christian. And as their Empire began to decline, Europeans began pursuing alternate routes to the Far East, and new clues to Prester John’s location. At the same time these explorers went south, Ethiopian pilgrims began traveling north. In Rome, these visitors quickly attracted the interest of European scholars and cartographers. Since Ethiopia had been converted to Christianity in the 4th century, the stories of their African homeland fit perfectly into Prester John’s legend. Portuguese explorers scoured Africa for the kingdom, until a mix of confusion and diplomacy finally turned myth into reality. The Ethiopians graciously received their European guests, who were eager to do business with the ruler they believed to be Prester John. Though the Ethiopians were initially confused by the Portuguese’s unusual name for their Emperor, they were savvy enough to recognize the diplomatic capital it afforded them. The Ethiopian diplomats played the part of Prester John’s subjects, and the Portuguese triumphantly announced an alliance with the fabled sovereign— over 350 years after the European letter had begun the search. But this long-awaited partnership was quickly tested. A decade later, the Sultanate of Adal, a regional power supported by the Ottoman Empire, invaded Ethiopia. The Portuguese sent troops that helped Ethiopians win this conflict. But by this time, it was clear that Ethiopia was not the powerful ally Europe had hoped. Worse still, the increasingly intolerant Roman Catholic Church now deemed the Ethiopian sect of Christianity heretical. Their subsequent attempts to convert the people they once revered as ideal Christians would eventually spark a civil war, and in the 1630s, Ethiopia cut ties with Europe. Over the next two centuries, the legend of Prester John slowly faded into oblivion— ending the reign of a king who made history despite having never existed.

**P836 2020-03-17 Who was the world's first author - Soraya Field Fiorio**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=836)

4,300 years ago in ancient Sumer, the most powerful person in the city of Ur was banished to wander the vast desert. Her name was Enheduanna. She was the high priestess of the moon god and history’s first known author. By the time of her exile, she had written 42 hymns and three epic poems— and Sumer hadn’t heard the last of her. Enheduanna lived 1,700 years before Sappho, 1,500 years before Homer, and about 500 years before the biblical patriarch Abraham. She was born in Mesopotamia, the land between the Tigris and Euphrates rivers, and the birthplace of the first cities and high cultures. Her father was King Sargon the Great, history’s first empire builder, who conquered the independent city-states of Mesopotamia under a unified banner. Sargon was a northern Semite who spoke Akkadian, and the older Sumerian cities in the south viewed him as a foreign invader. They frequently revolted to regain their independence, fracturing his new dynasty. To bridge the gap between cultures, Sargon appointed his only daughter, Enheduanna, as high priestess in the empire’s most important temple. Female royalty traditionally served religious roles, and she was educated to read and write in both Sumerian and Akkadian, and make mathematical calculations. The world's first writing started in Sumer as a system of accounting, allowing merchants to communicate over long distances with traders abroad. Their pictogram system of record keeping developed into a script about 300 years before Enheduanna’s birth. This early writing style, called cuneiform, was written with a reed stylus pressed into soft clay to make wedge-shaped marks. But until Enheduanna, this writing mostly took the form of record keeping and transcription, rather than original works attributable to individual writers. Enheduanna’s Ur was a city of 34,000 people with narrow streets, multi-storied brick homes, granaries, and irrigation. As high priestess, Enheduanna managed grain storage for the city, oversaw hundreds of temple workers, interpreted sacred dreams, and presided over the monthly new moon festival and rituals celebrating the equinoxes. Enheduanna set about unifying the older Sumerian culture with the newer Akkadian civilization. To accomplish this, she wrote 42 religious hymns that combined both mythologies. Each Mesopotamian city was ruled by a patron deity, so her hymns were dedicated to the ruling god of each major city. She praised the city’s temple, glorified the god’s attributes, and explained the god’s relationship to other deities within the pantheon. In her writing, she humanized the once aloof gods— now they suffered, fought, loved, and responded to human pleading. Enheduanna’s most valuable literary contribution was the poetry she wrote to Inanna, goddess of war and desire, the divinely chaotic energy that gives spark to the universe. Inanna delighted in all forms of sexual expression and was considered so powerful that she transcended gender boundaries, as did her earthly attendants, who could be prostitutes, eunuchs or cross-dressers. Enheduanna placed Inanna at the top of the pantheon as the most powerful deity. Her odes to Inanna mark the first time an author writes using the pronoun “I,” and the first time writing is used to explore deep, private emotions. After the death of Enheduanna’s father, King Sargon, a general took advantage of the power vacuum and staged a coup. As a powerful member of the ruling family, Enheduanna was a target, and the general exiled her from Ur. Her nephew, the legendary Sumerian king Naram-Sin, ultimately crushed the uprising and restored his aunt as high priestess. In total, Enheduanna served as high priestess for 40 years. After her death, she became a minor deity, and her poetry was copied, studied, and performed throughout the empire for over 500 years. Her poems influenced the Hebrew Old Testament, the epics of Homer, and Christian hymns. Today, Enheduanna’s legacy still exists, on clay tablets that have stood the test of time.

**P837 2020-03-18 What is schizophrenia - Anees Bahji**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=837)

Schizophrenia was first identified more than a century ago, but we still don’t know its exact causes. It remains one of the most misunderstood and stigmatized illnesses today. So, let’s walk through what we do know— from symptoms to causes and treatments. Schizophrenia is considered a syndrome, which means it may encompass a number of related disorders that have similar symptoms but varying causes. Every person with schizophrenia has slightly different symptoms, and the first signs can be easy to miss— subtle personality changes, irritability, or a gradual encroachment of unusual thoughts. Patients are usually diagnosed after the onset of psychosis, which typically occurs in the late teens or early twenties for men and the late twenties or early thirties for women. A first psychotic episode can feature delusions, hallucinations, and disordered speech and behavior. These are called positive symptoms, meaning they occur in people with schizophrenia but not in the general population. It’s a common misperception that people with schizophrenia have multiple personalities, but these symptoms indicate a disruption of thought processes, rather than the manifestation of another personality. Schizophrenia also has negative symptoms, these are qualities that are reduced in people with schizophrenia, such as motivation, expression of emotion, or speech. There are cognitive symptoms as well, like difficulty concentrating, remembering information, and making decisions. So what causes the onset of psychosis? There likely isn’t one single cause, but a combination of genetic and environmental risk factors that contribute. Schizophrenia has some of the strongest genetic links of any psychiatric illness. Though about 1% of people have schizophrenia, children or siblings of people with schizophrenia are ten times likelier to develop the disease, and an identical twin of someone with schizophrenia has a 40% chance of being affected. Often, immediate relatives of people with schizophrenia exhibit milder versions of traits associated with the disorder— but not to an extent that requires treatment. Multiple genes almost certainly play a role, but we don’t know how many, or which ones. Environmental factors like exposure to certain viruses in early infancy might increase the chance that someone will develop schizophrenia, and use of some drugs, including marijuana, may trigger the onset of psychosis in highly susceptible individuals. These factors don’t affect everyone the same way. For those with very low genetic risk, no amount of exposure to environmental risk factors will lead them to develop schizophrenia; for those with very high risk, moderate additional risk might tip the balance. The antipsychotic drugs used to treat schizophrenia have helped researchers work backwards to trace signatures of the disorder in the brain. Traditional antipsychotics block dopamine receptors. They can be very effective in reducing positive symptoms, which are linked to an excess of dopamine in particular brain pathways. But the same drugs can make negative symptoms worse, and we’ve found that negative symptoms of schizophrenia may be tied to too little dopamine in other brain areas. Some people with schizophrenia show a loss of neural tissue, and it’s unclear whether this atrophy is a result of the disease itself or drug-induced suppression of signaling. Fortunately, newer generations of antipsychotics aim to address some of these issues by targeting multiple neurotransmitters, like serotonin in addition to dopamine. It’s clear that no one transmitter system is responsible for all symptoms, and because these drugs affect signaling throughout the brain and body, they can have other side effects like weight gain. In spite of these complications, antipsychotics can be very effective, especially when combined with other interventions like cognitive-behavioral therapy. Electroconvulsive therapy, though it provides relatively short-lived relief, is also re-emerging as an effective treatment, especially when other options have failed. Early intervention is also extremely important. After months or years of untreated psychosis, certain psychoses can become embedded in someone’s personality. And yet, the dehumanizing stigma attached to this diagnosis can prevent people from seeking help. People with schizophrenia are often perceived as dangerous, but are actually much more likely to be the victims of violence than the perpetrators. And proper treatment may help reduce the likelihood of violence associated with schizophrenia. That’s why education— for patients, their families, and their communities— helps erode the stigma and improves access to treatment.

**P838 2020-03-20 Can you solve the sea monster riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=838)

According to legend, once every thousand years a host of sea monsters emerges from the depths to demand tribute from the floating city of Atlantartica. As the ruler of the city, you’d always dismissed the stories… until today, when 7 Leviathan Lords rose out of the roiling waters and surrounded your city. Each commands 10 giant kraken, and each kraken is accompanied by 12 mermites. Your city’s puny army is hopelessly outmatched. You think back to the legends. In the stories, the ruler of the city saved his people by feeding the creatures a ransom of pearls. The pearls would be split equally between the leviathans lords. Each leviathan would then divide its share into 11 equal piles, keeping one, and giving the other 10 to their kraken commanders. Each kraken would then divide its share into 13 equal piles, keeping one, and distributing the other twelve to their mermite minions. If any one of these divisions left an unequal pile or leftover pearl, the monsters would pull everyone to the bottom of the sea. Such was the fate of your fabled sister city. You rush to the ancient treasure room and find five chests, each containing a precisely counted number of pearls prepared by your ancestors for exactly this purpose. Each of the chests bears a number telling how many pearls it contains. Unfortunately, the symbols they used to write digits 1,000 years ago have changed with time, and you don’t know how to read the ancient numbers. With hundreds of thousands of pearls in each chest, there’s no time to recount. One of these chests will save your city and the rest will lead to its certain doom. Which do you choose? Pause the video to figure it out yourself. Answer in 3 Answer in 2 Answer in 1 There isn’t enough information to decode the ancient Atlantartican numeral system. But all hope is not lost, because there’s another piece of information those symbols contain: patterns. If we can find a matching pattern in arabic numerals, we can still pick the right chest. Let’s take stock of what we know. A quantity of pearls that can appease the sea monsters must be divisible by 7, 11, and 13. Rather than trying out numbers at random, let’s examine ones that have this property and see if there are any patterns that unite them. Being divisible by 7, 11, and 13 means that our number must be a multiple of 7, 11, and 13. Those three numbers are all prime, so multiplying them together will give us their least common multiple: 1001. That’s a useful starting place because we now know that any viable offering to the sea monsters must be a multiple of 1001. Let’s try multiplying it by a three digit number, just to get a feel for what we might get. If we try 861 times 1001, we get 861,861, and we see something similar with other examples. It’s a peculiar pattern. Why would multiplying a three-digit number by 1001 end up giving you two copies of that number, written one after the other? Breaking down the multiplication problem can give us the answer. 1001 times any number x is equal to 1000x + x. For example, 725 times 1000 is 725,000, and 725 x 1 is 725. So 725 x 1001 will be the sum of those two numbers: 725,725. And there’s nothing special about 725. Pick any three-digit number, and your final product will have that many thousands, plus one more. Even though you don’t know how to read the numbers on the chests, you can read which pattern of digits represents a number divisible by 1001. As with many problems, trying concrete examples can give you an intuition for behavior that may at first look abstract and mysterious. The monsters accept your ransom and swim back down to the depths for another thousand years. With the proper planning, that should give you plenty of time to prepare for their inevitable return.

**P839 2020-03-20 History vs. Sigmund Freud - Todd Dufresne**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=839)

Working in Vienna at the turn of the 20th century, he began his career as a neurologist before pioneering the discipline of psychoanalysis. He proposed that people are motivated by unconscious desires and repressed memories, and their problems can be addressed by making those motivations conscious through talk therapy. His influence towers above that of all other psychologists in the public eye. But was Sigmund Freud right about human nature? And were his methods scientific? Order, order. Today on the stand we have… Dad? Ahem, no, your honor. This is Doctor Sigmund Freud, one of the most innovative thinkers in the history of psychology. An egomaniac who propagated pseudoscientific theories. Well, which is it? He tackled issues medicine refused to address. Freud’s private practice treated women who suffered from what was called hysteria at the time, and their complaints hadn’t been taken seriously at all. From the women with depression he treated initially to World War I veterans with PTSD, Freud’s talking cure worked, and the visibility he gave his patients forced the medical establishment to acknowledge their psychological disorders were real. He certainly didn’t help all his patients. Freud was convinced that our behavior is shaped by unconscious urges and repressed memories. He invented baseless unconscious or irrational drivers behind the behavior of trauma survivors— and caused real harm. How’s that? He misrepresented some of his most famous case studies, claiming his treatment had cured patients when in fact they had gotten worse. Later therapists influenced by his theories coaxed their patients into "recovering" supposedly repressed memories of childhood abuse that never happened. Lives and families were torn apart. You can’t blame Freud for later misapplications of his work— that would be projecting. Plenty of his ideas were harmful without any misapplication. He viewed homosexuality as a developmental glitch. He coined the term penis envy— meaning women are haunted for life by their lack of penises. Freud was a product of his era. Yes, some of the specifics were flawed, but he created a new space for future scientists to explore, investigate, and build upon. Modern therapy techniques that millions of people rely on came out of the work he started with psychoanalysis. And today everyone knows there’s an unconscious— that idea was popularized Freud. Psychologists today only believe in a “cognitive unconscious,” the fact that you aren’t aware of everything going on at a given moment. Freud took this idea way too far, ascribing deep meaning to everything. He built his theories on scientific ideas that were outdated even in his own time, not just by today’s standards— for example, he thought individual psychology is derived from the biological inheritance of events in ancient history. And I mean ancient— like the Ice Age or the killing of Moses. Freud and his closest allies actually believed these prehistorical traumas had ongoing impacts on human psychology. He thought that the phase of cold indifference to sexuality during pubescence was literally an echo of the Ice Age. With fantastical beliefs like these, how can we take him seriously? Any renowned thinker from centuries past has ideas that seem fantastical by today’s standards, but we can’t discount their influence on this basis. Freud was an innovator linking ideas across many fields. His concepts have become everyday terms that shape how we understand and talk about our own experiences. The Oedipus complex? Ego and id? Defense mechanisms? Death wishes? All Freud. But Freud didn’t present himself as a social theorist— he insisted that his work was scientific. Are you saying he… repressed inconvenient facts? Freud’s theories were unfalsifiable. Wait, so you’re saying he was right? No, his ideas were framed so that there’s no way to empirically verify them. Freud didn’t even necessarily believe in the psychoanalysis he was peddling. He was pessimistic about the impact of therapy. What! I think I need to lie down! Many of Sigmund Freud’s ideas don’t hold up to modern science, and his clinical practices don’t meet today’s ethical standards. At the same time, he sparked a revolution in psychology and society, and created a vocabulary for discussing emotion. Freud made his share of mistakes. But is a thinker responsible for how subsequent generations put their ideas to use? Do they deserve the blame, credit, or redemption when we put history on trial?

**P840 2020-03-20 Why isn’t the Netherlands underwater - Stefan Al**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=840)

In January of 1953, a tidal surge shook the North Sea. The titanic waves flooded the Dutch coastline, killing almost 2,000 people. 54 years later, a similar storm threatened the region. But this time, the Netherlands were ready. As the water swelled, state-of-the-art computer sensors activated emergency protocols. Over the next 30 minutes, a pair of 240-meter steel arms swung shut, protecting the channel ahead. Using 680-tonne ball joints, the barrier moved in rhythm with the shifting wind and waves. By morning, the storm had passed with minimal flooding. The first field activation of the Maeslantkering had been a resounding success. As one of the planet’s largest mobile structures, this storm surge barrier is a marvel of human engineering. But the Maeslantkering is just one part of a massive, interlocking system of water controls known as the Delta Works— the most sophisticated flood prevention project in the world. The Netherlands has a long history with water management. The country lies along the delta of three major European rivers, and nearly a quarter of its territory is below sea level. This geography makes the region extremely prone to flooding. So much so, that some of the earliest Dutch governing bodies were informal “water boards” that coordinated flood protection projects. But after the storms of 1953, the Dutch government took more official measures. They established the Delta Commission, and tasked them with protecting the entire southwestern region. Focusing on densely populated cities, their aim was to reduce the annual odds of flooding below 1 in 10,000— about 100 times as safe as the average coastal city. Accomplishing this lofty goal required various infrastructure projects along the southwestern coast. The first line of defense was to dam the region’s flood-prone estuaries. These large inlets fed many of the country’s rivers into the North Sea, and during storms they allowed flood water to surge inland. Using a series of dams, the Delta Commission transformed these estuaries into expansive lakes that serve as nature preserves and community parks. However, this solution wouldn’t work for the Nieuwe Waterweg. As the lifeblood of the local shipping industry, this passage had to be kept open in safe conditions, and barricaded during storm surges. In 1998, the completed Maeslantkering provided the flexible protection necessary. Alongside additional barriers, like grassy dikes and concrete seawalls, these fortifications made up the bulk of the Delta Works project, which was primarily focused on holding back ocean storms. But in the following decades, the Dutch pursued additional plans to complement the Delta Works and protect against floods further inland. Under the "Room for the River" plan, farms and dikes were relocated away from the shore. This left more space for water to collect in low-lying floodplains, creating reservoirs and habitats for local wildlife. This strategic retreat not only decreased flood risk, but allowed for the redeveloped settlements to be built more densely and sustainably. Perhaps no city embodies the Netherlands' multi-pronged approach to water management as much as Rotterdam, a thriving city almost entirely below sea level. When a storm threatens, densely populated older districts are protected by traditional dikes. Meanwhile, newer districts have been artificially elevated, often sporting green roofs that store rainwater. Numerous structures around the city transform into water storage facilities, including parking garages and plazas which normally serve as theaters and sports arenas. Meanwhile in the harbor, floating pavilions rise with the water level. These are the first of several planned amphibious structures, some of which house water purification systems and solar collectors. These strategies are just some of the technologies and policies that have put the Netherlands at the cutting edge of water management. The country continues to find new ways to make cities more resilient to natural disasters. And as the rising sea levels caused by climate change threaten low-lying cities across the world, the Netherlands offers an exceptional example of how to go with the flow.

**P841 2020-03-25 How the world's longest underwater tunnel was built - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=841)

Flanked by two powerful European nations, the English Channel has long been one of the world’s most important maritime passages. Yet for most of its history, the channel’s rocky shores and stormy weather made crossing a dangerous prospect. Engineers of the early 1800's proposed numerous plans for spanning the 33 kilometer gap. Their designs included artificial islands linked by bridges, submerged tubes suspended from floating platforms, and an underwater passage more than twice the length of any existing tunnel. By the end of the century, this last proposal had captured European imagination. The invention of the tunnel boring machine and the discovery of a stable layer of chalk marl below the seabed made this fantastic tunnel more feasible. But the project’s most urgent obstacles were ones no engineer could solve. At the time, Britons viewed their geographic isolation as a strategic advantage, and fears about French invasion shut down plans for the tunnel. The rise of aerial warfare rendered these worries obsolete, but new economic concerns arose to replace them. Finally, 100 years after the initial excavation, the two countries reached an agreement— the tunnel would proceed with private funding. In 1985, a group of French and British companies invested the modern equivalent of 14 billion pounds, making the tunnel the most expensive infrastructure project to date. The design called for three separate tunnels— one for trains to France, one for trains to England, and one service tunnel between them. Alongside crossover chambers, emergency passages, and air ducts, this amounted to over 200 kilometers of tunnels. In 1988, workers began excavating from both sides, planning to meet in the middle. Early surveys of the French coast revealed the site was full of fault lines. These small cracks let water seep into the rock, so engineers had to develop waterproof boring machines. The British anticipated drier conditions, and forged ahead with regular borers. But only months into the work, water flooded in through undetected fissures. To drill in this wet chalk, the British had to use grout to seal the cracks created in the borer’s wake, and even work ahead of the main borer to reinforce the chalk about to be drilled. With these obstacles behind them, both teams began drilling at full speed. Boring machines weighing up to 1,300 tons drilled at nearly 3.5 meters per hour. As they dug, they installed lining rings to stabilize the tunnel behind them, making way for support wagons following each machine. Even at top speed, work had to proceed carefully. The chalk layer followed a winding path between unstable rock and clay, punctured by over 100 boring holes made by previous surveyors. Furthermore, both teams had to constantly check their coordinates to ensure they were on track to meet within 2 centimeters of each other. To maintain this delicate trajectory, the borers employed satellite positioning systems, as well as paleontologists who used excavated fossils to confirm they were at the right depth. During construction, the project employed over 13,000 people and cost the lives of ten workers. But after two and a half years of tunneling, the two sides finally made contact. British worker Graham Fagg emerged on the French side, becoming the first human to cross the channel by land since the Ice Age. There was still work to be done— from installing crossover chambers and pumping stations, to laying over a hundred miles of tracks, cables, and sensors. But on May 6, 1994, an opening ceremony marked the tunnel’s completion. Full public service began 16 months later, with trains for passengers and rail shuttles for cars and trucks. Today, the Channel Tunnel services over 20 million passengers a year, transporting riders across the channel in just 35 minutes. Unfortunately, not everyone has the privilege of making this trip legally. Thousands of refugees have tried to enter Britain through the tunnel in sometimes fatal attempts. These tragedies have transformed the tunnel’s southern entrance into an ongoing site of conflict. Hopefully, the structure’s history can serve as a reminder that humanity is at their best when breaking down barriers.

**P842 2020-04-01 How does alcohol make you drunk - Judy Grisel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=842)

Ethanol: this molecule, made of little more than a few carbon atoms, is responsible for drunkenness. Often simply referred to as alcohol, ethanol is the active ingredient in alcoholic beverages. Its simplicity helps it sneak across membranes and nestle into a many different nooks, producing a wide range of effects compared to other, clunkier molecules. So how exactly does it cause drunkenness, and why does it have dramatically different effects on different people? To answer these questions, we’ll need to follow alcohol on its journey through the body. Alcohol lands in the stomach and is absorbed into the blood through the digestive tract, especially the small intestine. The contents of the stomach impact alcohol’s ability to get into the blood because after eating, the pyloric sphincter, which separates the stomach from the small intestine, closes. So the level of alcohol that reaches the blood after a big meal might only be a quarter that from the same drink on an empty stomach. From the blood, alcohol goes to the organs, especially those that get the most blood flow: the liver and the brain. It hits the liver first, and enzymes in the liver break down the alcohol molecule in two steps. First, an enzyme called ADH turns alcohol into acetaldehyde, which is toxic. Then, an enzyme called ALDH converts the toxic acetaldehyde to non-toxic acetate. As the blood circulates, the liver eliminates alcohol continuously— but this first pass of elimination determines how much alcohol reaches the brain and other organs. Brain sensitivity is responsible for the emotional, cognitive, and behavioral effects of alcohol— otherwise known as drunkenness. Alcohol turns up the brain’s primary brake, the neurotransmitter GABA, and turns down its primary gas, the neurotransmitter glutamate. This makes neurons much less communicative, and users feel relaxed at moderate doses, fall asleep at higher doses, and can impede the brain activity necessary for survival at toxic doses. Alcohol also stimulates a small group of neurons that extends from the midbrain to the nucleus accumbens, a region important for motivation. Like all addictive drugs, it prompts a squirt of dopamine in the nucleus accumbens which gives users a surge of pleasure. Alcohol also causes some neurons to synthesize and release endorphins. Endorphins help us to calm down in response to stress or danger. Elevated levels of endorphins contribute to the euphoria and relaxation associated with alcohol consumption. Finally, as the liver’s breakdown of alcohol outpaces the brain’s absorption, drunkenness fades away. Individual differences at any point in this journey can cause people to act more or less drunk. For example, a man and a woman who weigh the same and drink the same amount during an identical meal will still have different blood alcohol concentrations, or BACs. This is because women tend to have less blood— women generally have a higher percentage of fat, which requires less blood than muscle. A smaller blood volume, carrying the same amount of alcohol, means the concentration will be higher for women. Genetic differences in the liver’s alcohol processing enzymes also influence BAC. And regular drinking can increase production of these enzymes, contributing to tolerance. On the other hand, those who drink excessively for a long time may develop liver damage, which has the opposite effect. Meanwhile, genetic differences in dopamine, GABA, and endorphin transmission may contribute to risk for developing an alcohol use disorder. Those with naturally low endorphin or dopamine levels may self-medicate through drinking. Some people have a higher risk for excessive drinking due to a sensitive endorphin response that increases the pleasurable effects of alcohol. Others have a variation in GABA transmission that makes them especially sensitive to the sedative effects of alcohol, which decreases their risk of developing disordered drinking. Meanwhile, the brain adapts to chronic alcohol consumption by reducing GABA, dopamine, and endorphin transmission, and enhancing glutamate activity. This means regular drinkers tend to be anxious, have trouble sleeping, and experience less pleasure. These structural and functional changes can lead to disordered use when drinking feels normal, but not drinking is uncomfortable, establishing a vicious cycle. So both genetics and previous experience impact how a person experiences alcohol— which means that some people are more prone to certain patterns of drinking than others, and a history of consumption leads to neural and behavioral changes.

**P843 2020-04-03 How the Monkey King escaped the underworld - Shunan Teng**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=843)

In the depths of their underwater kingdom, the mighty Dragon Lords quaked with fear. Before them pranced Sun Wukong, the Monkey King. The legendary troublemaker been hatched from a stone, schooled in divine magic, and was currently brandishing the Dragon Lord’s most treasured weapon. This magical staff, originally large enough to measure the depth of a great flood, now obeyed the Monkey King’s will and shrank at his touch. Terrified of this bewildering power, the Dragons graciously allowed Sun Wukong to keep the staff. The Monkey King stowed the weapon away, and gleefully sped back to his kingdom to show this treasure to his tribe of warrior monkeys. After a lavish celebration, Sun Wukong fell into a deep sleep. But just as he began to dream, the Monkey King quickly realized two things. The first was that this was no ordinary slumber. The second was that he wasn’t alone. Suddenly, he found himself caught in the clutches of two grisly figures. At first the Monkey King didn’t know who his captors were. But as they dragged him toward their city’s gates, Sun Wukong realized his deathly predicament. These were soul collectors tasked with transporting mortals to the Realm of the Dead. This was the domain of the Death Lords, who mercilessly sorted souls and designed gruesome punishments. From here, the kingdom of death was laid out before him. He could see the Death Lord’s palaces, and the fabled bridge across the river Nai He. Manning the bridge was an old woman who offered worthy souls a bowl of soup. After drinking, the spirits forgot their previous life, and were sent back to the world of the living in a new form. Further below were the souls not worthy of reincarnation. In this twisting maze of chambers, unfortunate spirits endured endless rooms of punishment— from mountains spiked with sharp blades, to pools of blood and vats of boiling oil. But Sun Wukong was not about to accept torture or reincarnation. As the soul collectors attempted to drag him through the gates, the Monkey King whipped out his staff and swung himself out of their clutches. His battle cries and the clang of weapons echoed throughout the underworld. Sensing a disturbance, the ten Death Lords swooped upon him. But they had never met such resistance from a mortal soul. What was this unusual creature? And was he a mortal, a god— or something else? The Lords consulted the Book of Death and Life— a tome which showed the time of every living soul’s death. Not knowing what category this strange being was under, the Death Lords struggled to find Sun Wukong at first; but the Monkey King knew just where to look. Unfortunately, the records confirmed the Death Lord’s claim— Sun Wukong was scheduled to die this very night. But the Monkey King was not afraid. This was far from the first time he’d defied destiny in his quest for wisdom and power. His past rebellions had earned him the power to transfigure his body, ride clouds at dizzying speeds, and govern his tribe with magic and martial arts. In this crisis, he saw yet another opportunity. With a flash of his nimble fingers, the Monkey King struck his own name from the Book. Before the Death Lords could respond, he found the names of his monkey tribe and swept them away as well. Liberated from the bonds of death, Sun Wukong began to battle his way out of the underworld. He deftly defeated endless swarms of angry spirits— before tripping on his way out of the kingdom. Just before he hit the ground, Sun Wukong suddenly awoke in his bed. At first he thought the journey might have been a dream, but the Monkey King felt his new immortality surging from the top of his head to the tip of his tail. With a cry of triumph, he woke his warriors to share his latest adventure— and commence another round of celebration.

**P844 2020-04-03 The hidden life of Rosa Parks -** **Riché D. Richardson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=844)

In 1944, 11 years before her fateful decision on a Montgomery Bus, Rosa Parks was investigating a vicious crime. As an emissary for the National Association for the Advancement of Colored People, she had traveled to rural Alabama to meet with Recy Taylor, a young woman who had been sexually assaulted by six white men. It would be difficult enough to convince an Alabama court that even one of these men was guilty, but Rosa was undeterred. She formed a committee to defend Recy in court, flooding the media with testimony and sparking protests throughout the South. When a jury failed to indict the attackers, Parks demanded the governor assemble a new grand jury. She wrote, “I know that you will not fail to let the people of Alabama know that there is equal justice for all of our citizens.” Throughout her life, Parks repeatedly challenged racial violence and the prejudiced systems protecting its perpetrators. But this work came at an enormous risk— and a personal price. Born in 1913, Rosa was raised by her mother and grandparents in rural Alabama. But outside this loving home, the fear of racial violence cast a long shadow. The Ku Klux Klan frequently drove past their home, and Jim Crow laws segregated public spaces. At 19 she settled in Montgomery and married Raymond Parks, a barber who shared her growing fury at racial injustice. He was involved with the local chapter of the NAACP; a role many avoided for fear of persecution. At first Raymond was eager to keep Rosa safe from the potential dangers of activism. But as she grew more incensed at the limitations imposed on African Americans, she could no longer stand by. When she officially joined the NAACP in 1943, Parks and Johnnie Rebecca Carr were the only women in the Montgomery chapter. She began keeping minutes for their meetings, and soon found herself elected secretary of the chapter— formally beginning her secret double life. By day, Rosa worked as a seamstress to support her mother and husband. By night, she researched and documented numerous civil rights cases, from local policy disputes to high-profile murder cases and hate crimes. As secretary, she prepared public responses on behalf of the Montgomery chapter, battling the harsh sentencing, false accusation and smear campaigns frequently used against African Americans. In addition to her legal work, Parks was a brilliant local strategist. As advisor to the NAACP youth group council, she helped young people navigate segregated systems including voter registration and whites-only libraries. Through the cover of the NAACP, Parks strived to bring clandestine civil rights activities into the open. She advocated for civil disobedience training and spoke out against racial violence, particularly the murder of Emmet Till. In 1955, her refusal to move to the back of a segregated bus helped ignite the grassroots movement she had hoped for. Parks was arrested and jailed for her one-woman protest, where she was visited by local activists. Together they planned a twenty-four hour bus boycott. It lasted for three hundred and eighty-one days. Park’s simple act had transformed nascent civil rights activism into a national movement. In 1956, the boycott ended when the Supreme Court ruled in favor of desegregating public transport. But this victory for the movement had come at a great cost. Rosa had been receiving vicious death threats throughout the campaign, and was unable to find work in Montgomery because of her political reputation. In 1957, she moved to Detroit to continue working as a seamstress, until being hired by Congressman John Conyers to help support his burgeoning civil rights campaigns. Ever vigilant in the fight against racial inequality, Parks remained active for the next 40 years. She wrote several books, traveled across the country giving talks to support other activists, and established an institute for the education of young people in her late husband’s memory. Today, Rosa Parks is remembered as a radical spirit who railed against the most powerful people and policies. Her call to action continues to resound: “knowing what must be done does away with fear.”

**P845 2020-04-09 The Gauntlet \_ Think Like A Coder, Ep 8**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=845)

Their fall from the tower sends Ethic and Hedge spinning into the rapids of a river of pure energy. This torrent flows from the Bradbarrier all the way to Huxenborg. There an entire city’s worth of factories build the robots and house the Node of Memory, the last of the three powerful artifacts Ethic needs to collect. After a long day and a longer night they find themselves in a canyon of brick and steel. Just when they’re about to reach the end of the line, a rope catches them. Their savior, Lemma, has been waiting for them. When Ethic claimed the Node of Creation from the forest tower, radios all across the land came back to life. Adila, the resistance leader, immediately started contacting her allies, none more important than Lemma, a brilliant scientist working from within Huxenborg to bring down the machines. Unfortunately, the radios also tipped off the robots. So they’ve taken defensive measures to protect the final artifact in its home in the very heart of the city. There’s only one way to get there: the gauntlet of forking paths. It’s a deadly series of luminous conveyors that wind underneath Huxenborg. Starting from the current position, each section runs for a distance, then splits in two. Every branch does the same thing, again and again. There are thousands of branches. Only one path leads to the artifact; all the others to destruction. Fortunately, the Node of Creation has granted Hedge a strange power: he can produce slightly smaller versions of himself. Each version can do only two things: radio information back to its parent, and produce slightly smaller versions of itself… which can do the same two things, as can their children, for as many generations as needed. A patrol is closing in on their position, so Ethic’s time is limited. What instructions should she give Hedge to find the one safe path? Pause the video to figure it out yourself. Hint in 3 Hint in 2 Hint in 1 Programmers have an elegant tool in their arsenal called recursion. Recursion is when you have a set of instructions that refers back to itself. It’s like using a word in its own definition, except where that’s frowned upon, this is incredibly effective. Recursion involves repetition, but in a different way than loops. Where a loop takes one action and repeats it again and again, recursion will start an action, and before it’s finished, use it again, and before that’s finished, use it again, and so on. It keeps doing this until some end state is reached. It then passes the information back up, layer after layer, until it reaches the top and ends the cycle. Recursion is ideal for problems that involve self-similarity, where each part resembles the larger whole. Like, for example, a deadly defense system designed to end any person or thing who dares tread upon it. Pause the video to figure it out yourself. Solution in 3 Solution in 2 Solution in 1 Ethic’s conundrum seems sprawling on the surface, but there’s a remarkably simple solution to it using recursion. In order to find it, let’s first look at the simplest version of this puzzle: what if the entire maze were just two paths? If Hedge copies himself, the copy that goes the wrong way will be destroyed. So the other one, which will reach the artifact, can radio back the path it took, and then no matter which way is correct, that’s the answer Hedge will receive. This is called the "base case" of the recursion. Now, suppose the maze branches twice from the starting point, and at every intersection, Hedge’s copies— let’s call them Twig 1 and Twig 2— make more copies— let’s call them Leaves 1 through 4. Three Leaves will be destroyed. The one that reaches the artifact will radio back the right answer, but only to its parent. So if Twig 1 or 2 is waiting at an intersection and hears something over the radio, that’s the right way to go to the artifact from where it is. To tell Hedge the right answer from his perspective, the Twig should say which way it went, and then the route it just heard over the radio. This same process will work no matter how many times the maze branches. Any answer a copy hears on the radio must be the way to the control room from its location, and if it then adds the branch it took, it can tell its parent how to get there as well. We can sum up the instructions in an action called Pathfinder that every version of Hedge will follow: 1. If you’ve reached the artifact, radio to your parent whether you got there by going left or right. 2. When you reach an intersection, move off the conveyor and send new copies down the left and right paths. Have them each run Pathfinder. This is where recursion comes in, and this may happen many times before the last instruction triggers, which is: 3. If you hear anything over the radio, you should radio to your parent whether you got to your spot by going left or right, then repeat everything you just heard. Pathfinder is an example of what programmers call functions, subroutines, or procedures. No matter the terminology, the idea is the same— it’s a set of instructions given a label so that it can be easily reused— perhaps even by itself. And in our case that’ll work perfectly— an entire network of paths mapped using just three instructions. So here's what happens. By the time the patrol rounds the corner, Ethic and Lemma have improvised disguises. They try to confuse the bots long enough to buy Hedge time. Finally, Hedge’s radio crackles to life with a series of directions. The three dive onto the conveyor and flee for their lives, with a squadron of enforcer bots in hot pursuit.

**P846 2020-04-13 The bug that poops candy - George Zaidan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=846)

This is Mabel. Mabel is an aphid, a small insect in the same order as cicadas, stink bugs, and bed bugs. All these bugs pierce their prey and suck out vital fluids. Aphids’ prey are plants. And what aphids are after is buried within the plant, flowing in tubes made from single cells strung end-to-end. These are called sieve tubes and together they form the plumbing system for a plant’s most valuable resource: sap. Sap is mostly water and sugar. Some species’ sap has as much sugar per liter as a can of soda. Photosynthesis is constantly producing sugar. You can think of it as a chemical “pump” which generates incredibly high pressure— up to 9 times that of a car tire— in the sieve tubes. To feed, Mabel uses her stylet, which is a long, flexible needle. She slowly worms it into the tissue, between the plant’s cells, until she pierces one of those sieve tubes. Because the sap is under so much pressure, Mabel doesn’t even have to suck it out of the plant. She just opens a valve in her head and lets the pressure push the sap through her digestive system. We’ll come back to what comes out of her butt, but for now, you should know that plants don’t want to be punctured and sipped. So they try to defend themselves. One defense is the sap itself. To see how that works, let’s hypothetically hook up some other insect’s digestive tract to a steady stream of sap. When that sap touches the insect’s cells, its high sugar content encourages the water in the cells to come out by osmosis… exactly like salt encourages water to come out of a slug. The more sap that passes through the insect, the more water it loses. Eventually, it shrivels up and dies. Mabel’s gut, however, is packed with an enzyme called sucrase, which takes two molecules of sucrose and converts them into one molecule of fructose and one of… this three-unit sugar. Mabel burns the fructose for energy, leaving the three-unit-sugar behind. Now, how does that help her? The more molecules of sugar that are dissolved in the sap, the more water it can suck out of Mabel’s cells. By reducing the number of molecules of sugar in the sap, Mabel reduces its ability to suck water out of her cells. Plant sap neutralized. Now that means Mabel can feed for days, getting all the energy she needs to reproduce. Some aphid species have an incredible life cycle. For example, the green peach aphid. During the fall, males and females mate, and the females lay eggs. But in the spring, when the eggs hatch, all the nymphs that emerge are female. When those females reach maturity, they don’t lay eggs. Instead, they give birth to live young… that are clones of themselves… and already pregnant… with their own clones. So, these female aphids have two generations of baby aphid clones forming inside themselves at the same time. Scientists call this telescopic development. That means that aphids can make more of themselves fast— there can be 20 generations within a single season— and that means lots of aphid poop. Mabel can poop her entire body weight every two hours, making her one of the most prolific poopers on the planet. Some aphid populations can produce hundreds of kilograms of poop per acre. Now, aphid poop is not like your poop. Chemically, it’s not all that different from sap; it’s a clear and colorless sweet, syrupy liquid. You might already know it by a different name: honeydew. Other species love honeydew. Some species of ants love it so much they sort of herd and defend entire aphid colonies. In return, the ants get a steady supply of sweet honeydew, which they can drink directly from the aphids’ butts. Bottom’s up! Humans love honeydew, too. Several Native American tribes used to harvest it from tall reeds and make it into cake. And some species of bee make honey from honeydew, which humans then harvest and eat. So plants make the sap, which is eaten and pooped out by aphids, regurgitated by bees, harvested by humans, and dolloped into a cup of Earl Grey tea.

**P847 2020-04-16 What’s the point(e) of ballet - Ming Luke**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=847)

A baby cursed at birth. A fierce battle of good and evil. A true love awoken with a kiss. Sleeping Beauty is one of the world’s favorite folktales. But one of its most famous renditions tells the story without a single word. Since premiering in 1890, "The Sleeping Beauty" has become one of the most frequently staged ballets in history. So what makes this piece so beloved? And what exactly does ballet bring to this— or any other story? At the heart of ballet are dozens of gestures that dancers painstakingly perfect over thousands of hours of practice. This unique set of gestures has been used for centuries, each movement rich with meaning and history. But you don’t need to study them to understand ballet, any more than you need to study music to be moved by a song. And just as composers combine notes and phrases to form pieces of music, choreographers string these gestures together with new movements to form expressive combinations. Working alongside the orchestra’s live score, ballerinas precisely perform these combinations to convey narrative, emotion, and character. In "The Sleeping Beauty’s" opening scene, a flurry of techniques depicts the fairy court bestowing gifts on baby Princess Aurora. The Fairy of Generosity delicately walks “en pointe”— meaning on the tips of her toes— in step with the light plucking of violins. The ballerina moves in perfect harmony with the music, even mimicing the violins’ trill with an elegant bourrée. The Fairy of Temperance, bestowing the gift of strong will on Aurora, is choreographed as if shooting bolts of electricity from her fingers. She bounds across the stage, spinning with quick chaînés before decisively jetéing. Some movements are even more literal than this. The evil fairy Carabosse curses the princess with a lethal “X,” and the benevolent Lilac Fairy counters that curse. Of course, the relationship between music and movement isn’t always this straightforward. While classical ballet gestures often respond to musical elements, the degree to which the dancers and orchestra align is another choreographic tool. Some characters and scenes move in sync to create rhythmic clarity, while others deliberately diverge from the orchestra. Dancers and musicians maintain this delicate balance throughout each performance, engaging in a live negotiation of speed and rhythm. But prior to the performance, a ballet’s most important relationship is between the choreographer and the music. Choreographer Marius Petipa and composer Piotr Ilyich Tchaikovsky worked together on every second of "The Sleeping Beauty." This is particularly noticeable in Princess Aurora’s exuberant entrance on her 16th birthday. Tchaikovsky’s enthusiastic music tumbles forward in fits and starts, even cutting short some musical phrases to capture her impatience. Petipa choreographs Aurora bouncing back and forth with “pas de chat”— French for "cat steps"— as she waits for her party to begin. Once the celebration starts, it’s up to the dancers to deliver on the physical spectacle of performing these gestures with grace. Aurora has the hardest part of all: her famous Rose Adagio. As four suitors vie for her hand, the Princess performs a dizzying array of balances, all en pointe. She briefly takes each suitor’s hand, but then balances unassisted— a breath-taking display of physical strength and skill. However, it’s not just technique that carries meaning, but also style and personality. Like an actor delivering their lines, ballerinas can execute their movements to convey a wide range of emotion. Aurora can be elegant and restrained, throwing her arms in independence from her suitors. Or she can be coy and flirtatious, descending from en pointe with grace and knowing confidence. "The Sleeping Beauty" offers a showcase for so much of what ballet can do. Its graceful spectacle, dramatic physical vocabulary, and enchanting coordination of music and movement perfectly reflect the themes of this fantastical romance. But ballet isn’t just for epic fairytales. Ballets can be non-narrative emotional journeys, experimental deconstructions of form, or pure demonstrations of skill. The artform is always experimenting with a centuries old set of rules, making it the perfect medium for stories old and new.

**P848 2020-04-20 The dark history of IQ tests - Stefan C. Dombrowski**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=848)

In 1905, psychologists Alfred Binet and Théodore Simon designed a test for children who were struggling in school in France. Designed to determine which children required individualized attention, their method formed the basis of the IQ test. Beginning in the late 19th century, researchers hypothesized that cognitive abilities like verbal reasoning, working memory, and visual-spatial skills reflected an underlying general intelligence, or g factor. Simon and Binet designed a battery of tests to measure each of these abilities and combine the results into a single score. Questions were adjusted for each age group, and a child’s score reflected how they performed relative to others their age. Dividing someone’s score by their age and multiplying the result by 100 yielded the intelligence quotient, or IQ. Today, a score of 100 represents the average of a sample population, with 68% of the population scoring within 15 points of 100. Simon and Binet thought the skills their test assessed would reflect general intelligence. But both then and now, there’s no single agreed upon definition of general intelligence. And that left the door open for people to use the test in service of their own preconceived assumptions about intelligence. What started as a way to identify those who needed academic help quickly became used to sort people in other ways, often in service of deeply flawed ideologies. One of the first large-scale implementations occurred in the United States during WWI, when the military used an IQ test to sort recruits and screen them for officer training. At that time, many people believed in eugenics, the idea that desirable and undesirable genetic traits could and should be controlled in humans through selective breeding. There were many problems with this line of thinking, among them the idea that intelligence was not only fixed and inherited, but also linked to a person’s race. Under the influence of eugenics, scientists used the results of the military initiative to make erroneous claims that certain racial groups were intellectually superior to others. Without taking into account that many of the recruits tested were new immigrants to the United States who lacked formal education or English language exposure, they created an erroneous intelligence hierarchy of ethnic groups. The intersection of eugenics and IQ testing influenced not only science, but policy as well. In 1924, the state of Virginia created policy allowing for the forced sterilization of people with low IQ scores— a decision the United States Supreme Court upheld. In Nazi Germany, the government authorized the murder of children based on low IQ. Following the Holocaust and the Civil Rights Movement, the discriminatory uses of IQ tests were challenged on both moral and scientific grounds. Scientists began to gather evidence of environmental impacts on IQ. For example, as IQ tests were periodically recalibrated over the 20th century, new generations scored consistently higher on old tests than each previous generation. This phenomenon, known as the Flynn Effect, happened much too fast to be caused by inherited evolutionary traits. Instead, the cause was likely environmental— improved education, better healthcare, and better nutrition. In the mid-twentieth century, psychologists also attempted to use IQ tests to evaluate things other than general intelligence, particularly schizophrenia, depression, and other psychiatric conditions. These diagnoses relied in part on the clinical judgment of the evaluators, and used a subset of the tests used to determine IQ— a practice later research found does not yield clinically useful information. Today, IQ tests employ many similar design elements and types of questions as the early tests, though we have better techniques for identifying potential bias in the test. They’re no longer used to diagnose psychiatric conditions. But a similarly problematic practice using subtest scores is still sometimes used to diagnose learning disabilities, against the advice of many experts. Psychologists around the world still use IQ tests to identify intellectual disability, and the results can be used to determine appropriate educational support, job training, and assisted living. IQ test results have been used to justify horrific policies and scientifically baseless ideologies. That doesn’t mean the test itself is worthless— in fact, it does a good job of measuring the reasoning and problem-solving skills it sets out to. But that isn’t the same thing as measuring a person’s potential. Though there are many complicated political, historical, scientific, and cultural issues wrapped up in IQ testing, more and more researchers agree on this point, and reject the notion that individuals can be categorized by a single numerical score.

**P849 2020-04-20 What happens if you cut down all of a city's trees - Stefan Al**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=849)

This is the tale of two ancient cities and the trees that determined their destinies. In 3,000 BC Uruk was more densely populated than modern day New York City. This crowded capital had to continually expand their irrigation system to feed its growing population. 2,500 years later in Sri Lanka, the city of Anuradhapura had a similar problem. They were also growing constantly, and like Uruk, their city relied heavily on an elaborate irrigation system. As Uruk grew, its farmers began chopping down trees to make space for more crops. In Anuradhapura, however, trees were sacred. Their city housed an offshoot of the Bodhi tree under which Buddha himself was said to have attained enlightenment. Religious reverence slowed farmer’s axes and even led the city to plant additional trees in urban parks. Initially, Uruk’s expansion worked well. But without trees to filter their water supply, Uruk’s irrigation system became contaminated. Evaporating water left mineral deposits, which rendered the soil too salty for agriculture. Conversely, Anuradhapura’s irrigation system was designed to work in concert with the surrounding forest. Their city eventually grew to more than twice Uruk’s population, and today, Anuradhapura still cares for a tree planted over 2,000 years ago. We may think of nature as being unconnected to our urban spaces, but trees have always been an essential part of successful cities. Trees act like a natural sponge, absorbing storm water runoff before releasing it back into the atmosphere. The webs of their roots protect against mudslides while allowing soil to retain water and filter out toxins. Roots help prevent floods, while reducing the need for storm drains and water treatment plants. Their porous leaves purify the air by trapping carbon and other pollutants, making them essential in the fight against climate change. Humanity has been uncovering these arboreal benefits for centuries. But trees aren’t just crucial to the health of a city’s infrastructure; they play a vital role in the health of its citizens as well. In the 1870’s, Manhattan had few trees outside the island’s parks. Without trees to provide shade, buildings absorbed up to nine times more solar radiation during deadly summer heat waves. Combined with the period’s poor sanitation standards, the oppressive heat made the city a breeding ground for bacteria like cholera. In modern day Hong Kong, tall skyscrapers and underground infrastructure make it difficult for trees to grow. This contributes to the city’s dangerously poor air quality, which can cause bronchitis and diminished lung function. Trees affect our mental health as well. Research indicates that the presence of green foliage increases attention spans and decreases stress levels. It’s even been shown that hospital patients with views of brick walls recover more slowly than those with views of trees. Fortunately, many cities are full of views like this— and that’s no accident. As early as the 18th century, city planners began to embrace the importance of urban trees. In 1733, Colonel James Oglethorpe planned the city of Savannah, Georgia to ensure that no neighborhood was more than a 2-minute walk from a park. After World War II, Copenhagen directed all new development along five arteries— each sandwiched between a park. This layout increased the city’s resilience to pollution and natural disasters. And urban trees don’t just benefit people. Portland’s Forest Park preserves the region’s natural biodiversity, making the city home to various local plants, 112 bird species, and 62 species of mammals. No city is more committed to trees than Singapore. Since 1967, Singapore’s government has planted over 1.2 million trees, including those within 50-meter tall vertical gardens called supertrees. These structures sustain themselves and nearby conservatories with solar energy and collected rainwater. Trees and vegetation currently cover over 50% of Singapore’s landmass, reducing the need for air conditioning and encouraging low-pollution transportation. By 2050, it’s estimated that over 65% of the world will be living in cities. City planners can lay an eco-friendly foundation, but it’s up to the people who live in these urban forests to make them homes for more than humans.

**P850 2020-04-21 The wildly complex anatomy of a sneaker - Angel Chang**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=850)

Australians call them “runners." The British know them as “trainers." Americans refer to them as “tennis shoes” or “sneakers." Whatever you call them, these rubber-soled, casual shoes are worn by billions of people around the world. Originally invented in the late 19th century, these simple canvas and rubber creations have changed a lot since they first hit the pavement. Today, sneaker consumption is at an all-time high. No country buys more sneakers than the United States, where people purchase 3 pairs a year on average. To meet this demand, roughly 23 billion shoes are produced each year, mostly in factories across China and Southeast Asia. But making shoes has become more complicated, more labor-intensive, and in some ways, more dangerous, for the workers involved and for our planet. Shoe manufacturing accounts for roughly one-fifth of the fashion industry’s carbon emissions. Sneakers alone generate 313 million metric tons of carbon dioxide every year, which is equivalent to the annual emissions of 66 million cars. To better understand your shoe’s carbon footprint, let’s dive into the anatomy of a sneaker. For starters, the heel, insole, midsole, and upper layer are usually made from synthetic textiles like polyester, nylon, latex, and polyurethane. Mining the fossil fuels that make up these materials emits tons of greenhouse gases. And processing those raw ingredients into synthetic textiles also uses a lot of energy, further compounding that pollution. Some sneaker tops are made from natural sources like leather, but tanning this material relies on chromium; a carcinogenic chemical that can damage freshwater ecosystems. The outer soles of most shoes are made of rubber that’s gone through a process called vulcanization. This technique adds sulfur to superheated raw rubber to create a material that’s both elastic and sturdy. Until recently, sneakers used natural rubber for this process. But today, most outer soles are made with a synthetic blend of natural rubber and byproducts from coal and oil. Producing these materials accounts for 20% of a sneaker’s carbon footprint. But more than two-thirds of the shoe’s carbon impact comes from the next step: manufacturing. A typical sneaker is comprised of 65 discrete parts, each of which is produced by specialized machinery. This means it’s cheaper for factories to mass-produce each piece separately rather than manufacturing every part under one roof. But the transportation required to ship these pieces to one assembly plant emits even more CO2. Once the components arrive at the assembly line, they undergo cutting, pouring, melting, baking, cooling, and gluing, before the final products can be stitched together. The assembly of a typical sneaker requires more than 360 steps, and accounts for the remaining 20% of a sneaker’s environmental impact. The dispersion of factories fuels another problem as well: labor abuse. Most brands don’t own or operate their factories, so the plants they work with are in countries with little to no worker protection laws. As a result, many laborers earn below the living wage, and are exposed to harmful chemicals, like toxic glue fumes. When manufacturing is complete, the shoes are packaged and transported to stores around the globe. For many, these shoes could last years. But for someone running 20 miles a week, a pair of running shoes will start wearing out after roughly 6 months. Since the shoes are made of so many different materials, they’re almost impossible to break down into recyclable components. 20% of these shoes are incinerated, while the rest are tossed into landfills where they can take up to 1,000 years to degrade. So, how can we balance our love of sneakers with the need for sustainability? First, designers should streamline design elements and focus on eco-friendly materials. Factories need to develop energy efficient manufacturing processes that consolidate steps and sneaker parts. And consumers should support companies using clean energy and ethical manufacturing processes. We can also buy fewer shoes, wear them for longer, and donate those we no longer need. So no matter what your style, we can all take steps towards a sustainable future.

**P851 2020-04-21 This sea creature breathes through its butt - Cella Wright**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=851)

Can you guess what you’re looking at? Is it a fuzzy sock? An overripe banana? A moldy tube of toothpaste? In fact, this is the humble sea cucumber, and while it might look odd, its daily toil paves the way for entire ecosystems to thrive. Sea cucumbers are members of the phylum Echinodermata, along with sea urchins, starfish and other radially symmetrical, “spiny-skinned” marine invertebrates. Some sea cucumbers have feathery tentacles flowing from their mouths, some are puffed like bloated balloons, and others simply look like Headless Chicken Monsters— the actual name given to a rare deep-sea species. But they are generally characterized by their long, cylindrical shape. A sea cucumber is essentially a brainless, fleshy form surrounding a digestive tract, bookended by a mouth and an anus. Adhesive tube feet run the length of their bodies and allow them to scoot along the seafloor. Specialized tube feet can be used for feeding and respiration, though many sea cucumbers actually breathe through their anuses. Rhythmically contracting and relaxing their muscles, they draw water in and out over an internal lung-like structure called a respiratory tree that extracts oxygen from seawater. Certain species of crabs and pearlfish take advantage of this rhythmic action and, once the sea cucumber’s anus is dilated, they shimmy in and take shelter. The rear end of a single sea cucumber can harbor up to fifteen pearlfish at a time. However, it seems that not all sea cucumbers put up with this intrusive behavior. Some species are equipped with five teeth around their anus, suggesting that they may have taken an evolutionary stand against unwanted guests. But even sea cucumbers that lack anal teeth are outfitted with tools to defend themselves. They evade threats and launch counter-attacks using their mutable collagenous tissue, or MCT. This gel-like tissue contains bundles of collagen, called “fibrils.” Proteins can interact with these fibrils to slide them together, stiffening the tissue, or apart, softening it. This versatile tissue has many advantages: it aids in efficient locomotion, enables sea cucumbers to fit into small spaces, and allows them to reproduce asexually by splitting apart. But MCT’s most explosive application is employed when a predator attacks. By loosening the attachments of internal tissues then quickly softening and contracting their muscles, many species are capable of shooting a wide range of organs out of their anuses. This act is called “evisceration” and it’s a surprisingly effective defense mechanism. In addition to startling and distracting predators, the innards of some sea cucumber species are sticky and toxic. Evisceration may seem drastic, but sea cucumbers are able to regenerate what they’ve lost to their gut reaction in just a few weeks’ time. Aside from the few species that have evolved to swim and those that feed without moving, many of these cumbersome creatures pass their time grazing the seabed. Sea cucumbers are found everywhere from shallow shores to abyssal trenches 6,000 meters below sea level. On the deep sea floor, they comprise the majority of animal biomass, reaching up to 95% in some areas. As these sausage-shaped wonders trudge along, they vacuum up sand, digest the organic matter it contains, and excrete the byproduct. In this process, sea cucumbers clean and oxygenate the seafloor by breaking down detritus and recycling nutrients. This creates the conditions for sea grass beds and shellfish to thrive. Sea cucumber excretions can also aid in coral formation and may play a role in buffering marine environments from ocean acidification. As the ocean’s vacuum cleaners, they are very good at their job: about half of the sandy seafloor is thought to have passed through the digestive tract of a sea cucumber. So next time you’re rejoicing in the feeling of sand crunching between your toes, consider this: those very grains of sand might have, at one point or another, been excreted by a pickle that breathes through its butt.

**P852 2020-04-24 The electrifying speeches of Sojourner Truth - Daina Ramey Berry**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=852)

In early 1828, Sojourner Truth approached the Grand Jury of Kingston, New York. She had no experience with the legal system, no money, and no power in the eyes of the court. Ignoring the jury’s scorn, Truth said she was there to fight for custody of her five-year-old son Peter, who’d been illegally sold to an enslaver in Alabama. As the trial played out over the next several months, Truth raised funds, strategized with lawyers, and held her faith. Finally in the spring of 1828, Peter was returned to her care— but Truth’s work was far from over. She would dedicate the rest of her life to pursuing justice and spiritual understanding. Truth was born into slavery as Isabella Baumfree in the late 18th century in Ulster County, New York. Although New York state had announced the abolition of slavery in 1799, the emancipation act was gradual. Those who were currently enslaved were forced to serve a period of indentured servitude until their mid-20s. Throughout this period, enslavers repeatedly sold Baumfree, tearing her from her loved ones. Often, she was explicitly prevented from pursuing new relationships. Eventually, she married an enslaved man named Thomas, with whom she had three children. She was desperate to keep her new family together— but the slow progress of abolition threatened this hope. Baumfree’s enslaver, John Dumont, had promised to free her by 1826. When he failed to keep his word, Baumfree fled for her safety. During the escape, she was only able to rescue her youngest daughter Sophia, while her other children remained in bondage. It would be two years before she regained custody of Peter. After that, she would wait another two years before she saw any of her other children. During this time, Baumfree found solace in her faith and became increasingly dedicated to religious reflection. After settling in Kingston, New York, she joined a Methodist community that shared her political views. She continued her practice of speaking aloud to God in private, and one night, her evening prayers took on even more sacred significance. Baumfree claimed to hear the voice of God, telling her to leave Kingston, and share her holy message with others. Though she never learned to read or write, Baumfree became known as an electrifying orator, whose speeches drew on Biblical references, spiritual ideals, and her experience of slavery. Her sermons denounced the oppression of African Americans and women in general, and became prominent in campaigns for both abolition and women’s rights. In 1843, she renamed herself Sojourner Truth and embarked on a legendary speaking tour. Truth saw her journey as a mission from God. Her faith often led her to the nation’s most hostile regions, where she spoke to bigoted audiences as the only Black woman in the crowd. Truth was confident God would protect her, but some crowds responded to her bravery with violence. During one of her sermons, a mob of white men threatened to set fire to the tent where she was speaking. In her memoir, Truth recalled steeling herself to confront them: “Have I not faith enough to go out and quell that mob… I felt as if I had three hearts! And that they were so large, my body could hardly hold them!” She placated the men with song and prayer, until they had no desire to harm her. Truth’s speeches impacted thousands of people in communities across the nation, but her activism went far beyond public speaking. During the Civil War, she became involved with the Union Army, recruiting soldiers and organizing supplies for Black troops. Her work was so well regarded that she was invited to meet President Lincoln. She took the occasion to argue that all formerly enslaved people should be granted land by the government. Truth continued to travel and speak well into her 80s. Until her death in 1883, she remained an outspoken critic who fought for her right to be heard in a hostile world. As Truth once said, “I feel safe even in the midst of my enemies; for the truth is powerful and will prevail."

**P853 2020-04-28 What really happened during the Salem Witch Trials - Brian A. Pavlac**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=853)

You’ve been accused of a crime you did not commit. It’s impossible to prove your innocence. If you insist that you’re innocent anyway, you’ll likely be found guilty and executed. But if you confess, apologize, and implicate others for good measure, you’ll go free. Do you give a false confession— or risk a public hanging? This was the choice facing those accused of witchcraft in the village of Salem, Massachusetts between February 1692 and May 1693. They were the victims of paranoia about the supernatural, misdirected religious fervor— and a justice system that valued repentance over truth. Salem was settled in 1626 by Puritans, a group of English protestants. Life was strict and isolated for the people of Salem. Battles with their Native American neighbors and groups of French settlers were commonplace. People feared starvation and disease, and relations between villagers were strained. To make matters worse, 1692 brought one of the coldest winters on record. That winter, two cousins, 9 year old Betty Parris and 11 year old Abigail Williams started behaving very strangely. A physician found nothing physically wrong — but diagnosed the girls as under “an evil hand.” Puritans believed that the Devil wreaked havoc in the world through human agents, or witches, who blighted nature, conjured fiendish apparitions, and tormented children. As news swept through the village, the symptoms appeared to spread. Accounts describe 12 so-called “afflicted” girls contorting their bodies, having fits, and complaining of prickling skin. Four of the girls soon accused three local women of tormenting them. All three of the accused were considered outsiders in some way. On February 29th, the authorities arrested Sarah Good, a poor pregnant mother of a young daughter, Sarah Osbourne, who had long been absent from church and was suing the family of one of her accusers, and Tituba, an enslaved woman in Betty Parris’s home known by her first name only. Tituba denied harming the girls at first. But then she confessed to practicing witchcraft on the Devil’s orders, and charged Good and Osbourne with having forced her. Osbourne and Good both maintained their innocence. Osbourne died in prison, while Good’s husband turned against her in court, testifying that she "was a witch or would be one very quickly." Good’s 4 year old daughter was imprisoned and eventually gave testimony against her mother. Meanwhile, Good gave birth in jail. Her baby died, and she was convicted and hanged shortly thereafter. Tituba was held in custody until May, and then released. These three victims were just the beginning. As accusations multiplied, others, like Tituba, made false confession to save themselves. The authorities even reportedly told one accused witch that she would be hanged if she did not confess, and freed if she did. They were not particularly interested in thoroughly investigating the charges— in keeping with their Church’s teachings, they preferred that the accused confessed, asked for forgiveness, and promised not to engage in more witchcraft. The court accepted all kinds of dubious evidence, including so-called “spectral evidence” in which the girls began raving when supposedly touched by invisible ghosts. Complicating matters further, many of the jurors in the trials were relatives of the accusers, compromising their objectivity. Those who dared to speak out, such as Judge Nathanial Saltonstall, came under suspicion. By the spring of 1693, over a hundred people had been imprisoned, and 14 women and 6 men had been executed. By this time, accusations were starting to spread beyond Salem to neighboring communities, and even the most powerful figures were targets. When his own wife was accused, the governor of Massachusetts colony suspended the trials. Sentences were amended, prisoners released, and arrests stopped. Some have speculated that the girls were suffering from hallucinations caused by fungus; or a condition that caused swelling of the brain. But ultimately, the reason for their behavior is unknown. What we do know is that adults accepted wild accusations by children as hard evidence. Today, the Salem Witch Trials remain a cautionary tale of the dangers of groupthink and scapegoating, and the power of fear to manipulate human perception.

**P854 2020-04-29 Which is better - Soap or hand sanitizer - Alex Rosenthal and Pall Th**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=854)

Your hands, up close, are anything but smooth. With peaks and valleys, folds and rifts, there are plenty of hiding places for a virus to stick. If you then touch your face, the virus can infect you. But there are two extraordinarily simple ways you can keep that from happening: soap and water, and hand sanitizer. So which is better? The coronavirus that causes COVID-19 is one of many viruses whose protective outer surface is made of a lipid bilayer. These lipids are pin shaped molecules whose heads are attracted to water, and tails are repulsed by it. So in water-rich environments, lipids naturally form a shell like this, with the heads outside and the tails inside. Their shared reaction to water makes the lipids stick loosely together— this is called the hydrophobic effect. This outer structure helps the molecular machinery of the virus break through cellular membranes and hijack our cells. But it has thousands upon thousands of weak points where the right molecules could pry it apart. And this is where soap comes in. A single drop of any brand of soap contains quadrillions of molecules called amphiphiles, which resemble biological lipids. Their tails, which are similarly repulsed by water, compete for space with the lipids that make up the virus’s shell. But they’re just different enough to break up the regularity of the virus’s membrane, making the whole thing come crashing down. Those amphiphiles then form bubbles of their own around particles including the virus’s RNA and proteins. Apply water, and you’ll wash that whole bubble away. Hand sanitizers work less like a crowbar, and more like an earthquake. When you surround a coronavirus with water, the hydrophobic effect gives the bonds within the membrane their strength. That same effect also holds the big proteins that form coronavirus’s spikes in place and in the shape that enables them to infect your cells. If you dry the virus out in air, it keeps its stability. But now surround it with a high concentration of an alcohol, like the ethanol or isopropanol found in most hand-sanitizers. This makes the hydrophobic effect disappear, and gives the molecules room to move around. The overall effect is like removing all of the nails and mortar from a house and then hitting it with an earthquake. The cell’s membrane collapses and those spike proteins crumble. In either method, the actual process of destroying the virus happens in just a second or two. But doctors recommend at least 20 seconds of hand-washing because of the intricate landscape that is your hand. Soap and sanitizer need to get everywhere, including your palms, fingertips, the outsides of your hands, and between your fingers, to protect you properly. And when it comes to a coronavirus outbreak, doctors recommend washing your hands with soap and water whenever possible. Even though both approaches are similarly effective at killing the virus, soap and water has two benefits: first it washes away any dirt which could otherwise hide virus particles. But more importantly, it’s simply easier to fully cover your hands with soap and water for 20 seconds. Of course, hand sanitizer is more convenient to use on the go. In the absence of a sink, use the sanitizer as thoroughly as possible and rub your hands together until they’re dry. Unfortunately, there are billions of people who don’t have access to clean drinking water, which is a huge problem at any time but especially during an outbreak. Researchers and aid groups are working to provide solutions for these communities. One example is a device that uses salt, water, and a car battery to make chlorinated water that kills harmful pathogens and is safe for hand-washing. So wherever possible, soap and water are recommended for a coronavirus, but does that mean it's best for every viral outbreak? Not necessarily. Many common colds are caused by rhinoviruses that have a geometric protein structure called a capsid instead of a lipid membrane. The capsid doesn't have nearly as many weak points where soap amphiphiles can pry it apart, so it takes longer for soap to be effective. However some of its surface proteins are still vulnerable to the destabilizing effect of hand sanitizer. In this and similar cases, hand sanitizer may be more effective, especially if you then wash your hands to remove residual particles. The best way to know which to use for any given outbreak is to do what's best for all things illness-related: follow the advice of accredited medical professionals.

**P855 2020-05-05 A day in the life of an Aztec midwife - Kay Read**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=855)

Lord Sun dawns on the day called 7-Monkey, his fingers slowly spreading a rosy sheen that mixes softly with smoke rising from Tenochtitlan’s many hearth fires. The midwife, Xoquauhtli, has a difficult choice to make. A momentous shift from rainy season to dry season is underway. All summer, the gods have kept the people fed with corn, but the fertile summer months are disappearing. This day occurs during the festival that marks the shift between the summer season, when the gods feed the people, and the winter season, when the people feed the gods in return. Xoquauhtli owes a debt to her patron, Teteoinnan, the female warrior goddess at the center of this festival. Teteoinnan wages war both on women’s battlefields of birth and in men’s battles with Tenochtilan’s enemies. She must be kept happy or she will bring bad luck. The midwife should participate in the festival today, but one of her patients could go into labor any minute. Xoquauhtli decides to check on her patient first. The expecting mother hasn’t worked too hard, chewed gum, or lifted heavy things. Her family is taking good care of her. Surely Xoquauhtli can take a little time to honor her goddess. She leaves her apprentice in charge and heads to the center of the city. Along the way, she sees women sweeping the roads and hanging gourds in preparation for the festival. Finally, she reaches the Great Pyramid. On top are two temples: the north, where rituals honor the rain god in the summer, and the south one is where rituals honor the war god in the winter. On the equinox, the sun rises between the two sides. The ceremony begins with a mock battle between the midwives and the other physicians. Xoquauhtli’s team battles heartily, throwing nochtles, marigolds, and balls made of reed and moss. They joke, call their rivals names, and laugh. But then, a girl comes running with a message for Xoquauhtli. Her patient is in labor! She hurries back to the house. All the old women from the extended family have already gathered for the birth— their experience is very valuable if anything goes wrong. She readies herself with a prayer praising her most important tools, her fingers. Then she doses the patient with cihuapatli to help expel the baby, massages her in the sweathouse, and rubs her stomach with tobacco. Offering Teteoinnan a short prayer, she urges her patient to act like a warrior. A strong baby girl slips into her waiting hands and the old women shout triumphant cries. Xoquauhtli takes a few drops of water from a jade bowl, breaths on them, and places them on the baby’s tiny tongue. She calls her a precious greenstone, a little warrior, and tells her how the Lord and Lady of the Ninth Sky breathed life into her, sending her to this place of burden and torment. She then turns to the new mother, praising her, telling her she acted like an eagle warrior, a jaguar warrior. By the time they finish, it’s late, and the flames of the fire have died down. Xoquauhtli piles the remaining hot coals in the center of the hearth, stoking them to keep them going. She lays the baby in a woven basket, head facing the warming fire. This will warm her tonalli, an important “soul” center in the body central to health and well-being. It’s almost midnight— if Xoquauhtli hurries, she can get back to the temple for the culmination of the festival. She makes her way to the city center, where a priest carries a woman on his back to the top of the pyramid. To begin the new season and feed the gods, she will be beheaded, symbolizing how corn is cut in the fields. Afterward, she will be reborn as Lady Teteoinnan, and preside over the induction of new warriors.

**P856 2020-05-05 Can you solve the world’s most evil wizard riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=856)

The evil wizard MoldeVort has been trying to kill you for years, and today it looks like he’s going to succeed. But your friends are on their way, and if you can survive until they arrive, they should be able to help stop him. The evil wizard’s protective charms ward off every spell you know, so in an act of desperation you throw the only object in reach at him: Pythagoras’s cursed chessboard. It works, but with a catch. MoldeVort starts in one corner of the 5x5 board. You have a few minutes to choose four distinct positive whole numbers. MoldeVort gets to say one of them, and if you can pick a square on the board whose center is exactly that distance away, the curse will force him to move to that spot. Then he’ll have to choose any of the four numbers, and the process repeats until you can’t keep him inside the board with legal moves. Then he’ll break free of the spell and almost certainly kill you. What four numbers can you choose to keep MoldeVort trapped by your spell long enough for help to arrive? And what’s your strategy? Pause the video to figure it out yourself. Answer in 3 Answer in 2 Answer in 1 The trick here is to keep MoldeVort where you want him. And one way to figure out how to do that is to play out the game as MoldeVort would: always trying to escape. You’re dealing with a relatively small board, so the numbers can’t be too big. Let’s start by trying 1, 2, 3, 4 to see what happens. Moldevort could escape those numbers in just three moves. By saying 2, then 3, he would force you to let him into one of the middle points of the grid, and then a 4 would break him free. But that means you’ll need to allow a number larger than 4, which is the distance from one end of a row to another. How is that even possible? Through diagonal moves. There are, in fact, points that are distance 5 from each other, which we know thanks to the Pythagorean Theorem. That states that the squares of the sides of a right triangle add up to the square of its hypotenuse. One of the most famous Pythagorean triples is 3, 4, 5, and that triangle is hiding all over your chessboard. So if MoldeVort was here, and he said 5, you could move him to these spaces. There’s another insight that will help. The board is very symmetrical: If MoldeVort is in a corner, it doesn’t really matter to you which corner it is. So we can think of the corners as being functionally the same, and color them all blue. Similarly, the spaces neighboring the corners behave the same as each other, and we’ll make them red. Finally, the midpoints of the sides are a third type. So instead of having to develop a strategy for each of the 16 spaces on the outside of the board, we can reduce the problem to just three. Meanwhile, all the inside spaces are bad for us, because if MoldeVort ever reaches one, he’ll be able to say any number larger than 3 and go free. Orange spaces are trouble too, since any number except 1, 2, or 4 would take him to an inside space or off the board. So orange is out and you’ll need to keep him on blue and red. That means 2 is bad, since it could take MoldeVort to orange on the first turn. But the four other smallest numbers, 1, 3, 4, and 5, might work. Let’s try them and see what happens. If MoldeVort says 1, you can make him go from blue to red or red to blue. And the same works if he says 3. Thanks to our diagonals, this is even true if he says 5. If he says 4, you can keep him on the color he’s already on by moving the length of a row or column. So these four numbers work! Even if your friends don’t get here right away, you’ll be able to keep the world’s most evil wizard contained for as long as you need.

**P857 2020-05-05 What causes opioid addiction, and why is it so tough to combat - Mike**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=857)

More than 3,000 years ago, a flower began to appear in remedies in Ancient Egyptian medical texts. Across the Mediterranean, the ancient Minoans likely found ways to use the same plant for its high. Both ancient civilizations were on to something— opium, an extract of the poppy in question, can both induce pleasure and reduce pain. Though opium has remained in use ever since, it wasn’t until the 19th century that one of its chemical compounds, morphine, was identified and isolated for medical use. Morphine, codeine, and other substances made directly from the poppy are called opiates. In the 20th century, drug companies created a slew of synthetic substances similar to these opiates, including heroin, hydrocodone, oxycodone, and fentanyl. Whether synthetic or derived from opium, these compounds are collectively known as opioids. Synthetic or natural, legal or illicit, opioid drugs are very effective painkillers, but they are also highly addictive. In the 1980s and 90s, pharmaceutical companies began to market opioid painkillers aggressively, actively downplaying their addictive potential to both the medical community and the public. The number of opioid painkillers prescriptions skyrocketed, and so did cases of opioid addiction, beginning a crisis that continues today. To understand why opioids are so addictive, it helps to trace how these drugs affect the human body from the first dose, through repeated use, to what happens when long-term use stops. Each of these drugs has slightly different chemistry, but all act on the body’s opioid system by binding to opioid receptors in the brain. The body’s endorphins temper pain signals by binding to these receptors, and opioid drugs bind much more strongly, for longer. So opioid drugs can manage much more severe pain than endorphins can. Opioid receptors also influence everything from mood to normal bodily functions. With these functions, too, opioids’ binding strength and durability mean their effects are more pronounced and widespread than those of the body’s natural signaling molecules. When a drug binds to opioid receptors, it triggers the release of dopamine, which is linked to feelings of pleasure and may be responsible for the sense of euphoria that characterizes an opioid high. At the same time, opioids suppress the release of noradrenaline, which influences wakefulness, breathing, digestion, and blood pressure. A therapeutic dose decreases noradrenaline enough to cause side effects like constipation. At higher doses opioids can decrease heart and breathing rates to dangerous levels, causing loss of consciousness and even death. Over time, the body starts to develop a tolerance for opioids. It may decrease its number of opioid receptors, or the receptors may become less responsive. To experience the same release of dopamine and resulting mood effects as before, people have to take larger and larger doses— a cycle that leads to physical dependence and addiction. As people take more opioids to compensate for tolerance, noradrenaline levels become lower and lower, to a point that could impact basic bodily functions. The body compensates by increasing its number of noradrenaline receptors so it can detect much smaller amounts of noradrenaline. This increased sensitivity to noradrenaline allows the body to continue functioning normally— in fact, it becomes dependent on opioids to maintain the new balance. When someone who is physically dependent on opioids stops taking them abruptly, that balance is disrupted. Noradrenaline levels can increase within a day of ceasing opioid use. But the body takes much longer to get rid of all the extra noradrenaline receptors it made. That means there’s a period of time when the body is too sensitive to noradrenaline. This oversensitivity causes withdrawal symptoms, including muscle aches, stomach pains, fever, and vomiting. Though temporary, opioid withdrawal can be incredibly debilitating. In serious cases, someone in withdrawal can be violently ill for days or even weeks. People who are addicted to opioids aren't necessarily using the drugs to get high anymore, but rather to avoid being sick. Many risk losing wages or even jobs while in withdrawal, or may not have anyone to take care of them during withdrawal. If someone goes back to using opioids later, they can be at particularly high risk for overdose, because what would have been a standard dose while their tolerance was high, can now be lethal. Since 1980, accidental deaths from opioid overdose have grown exponentially in the United States, and opioid addictions have also exploded around the world. While opioid painkiller prescriptions are becoming more closely regulated, cases of overdose and addiction are still increasing, especially among younger people. Many of the early cases of addiction were middle-aged people who became addicted to painkillers they had been prescribed, or received from friends and family members with prescriptions. Today, young people are often introduced to prescription opioid drugs in those ways but move on to heroin or illicit synthetic opioids that are cheaper and easier to come by. Beyond tighter regulation of opioid painkillers, what can we do to reverse the growing rates of addiction and overdose? A drug called naloxone is currently our best defense against overdose. Naloxone binds to opioid receptors but doesn’t activate them. It blocks other opioids from binding to the receptors, and even knocks them off the receptors to reverse an overdose. Opioid addiction is rarely a stand-alone illness; frequently, people with opioid dependence are also struggling with a mental health condition. There are both inpatient and outpatient programs that combine medication, health services, and psychotherapy. But many of these programs are very expensive, and the more affordable options can have long waiting lists. They also often require complete detoxification from opioids before beginning treatment. Both the withdrawal period and the common months-long stay in a facility can be impossible for people who risk losing jobs and housing in that timeframe. Opioid maintenance programs aim to address some of these obstacles and eliminate opioid abuse using a combination of medication and behavior therapy. These programs avoid withdrawal symptoms with drugs that bind to opioid receptors but don’t have the psychoactive effects of painkillers, heroin, and other commonly abused opioids. Methadone and buprenorphine are the primary opioid maintenance drugs available today, but doctors need a special waiver to prescribe them— even though no specific training or certification is required to prescribe opioid painkillers. Buprenorphine can be so scarce that there’s even a growing black market for it. There’s still a long way to go with combating opioid addiction, but there are great resources for making sense of the treatment options. If you or someone you know is struggling with opioid use in the United States, the Department of Health and Human Services operates a helpline: 800-662-4357 and a database of more than 14,000 substance abuse facilities in the US: www.hhs.gov/opioids

**P858 2020-05-08 What is a coronavirus - Elizabeth Cox**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=858)

For almost a decade, scientists chased the source of a deadly new virus through China’s tallest mountains and most isolated caverns. They finally found it here: in the bats of Shitou Cave. The virus in question was a coronavirus that caused an epidemic of severe acute respiratory syndrome, or SARS, in 2003. Coronaviruses are a group of viruses covered in little protein spikes that look like a crown— or "corona" in Latin. There are hundreds of known coronaviruses. Seven of them infect humans, and can cause disease. The coronavirus SARS-CoV causes SARS, MERS-CoV causes MERS, and SARS-CoV-2 causes the disease COVID-19. Of the seven human coronaviruses, four cause colds, mild, highly contagious infections of the nose and throat. Two infect the lungs, and cause much more severe illnesses. The seventh, which causes COVID-19, has features of each: it spreads easily, but can severely impact the lungs. When an infected person coughs, droplets containing the virus spray out. The virus can infect a new person when the droplets enter their nose or mouth. Coronaviruses transmit best in enclosed spaces, where people are close together. Cold weather keeps their delicate casing from drying out, enabling the virus to survive for longer between hosts, while UV exposure from sunlight may damage it. These seasonal variations matter more for established viruses. But because no one is yet immune to a new virus, it has so many potential hosts that it doesn’t need ideal conditions to spread. In the body, the protein spikes embed in the host’s cells and fuse with them— enabling the virus to hijack the host cell’s machinery to replicate its own genes. Coronaviruses store their genes on RNA. All viruses are either RNA viruses or DNA viruses. RNA viruses tend to be smaller, with fewer genes, meaning they infect many hosts and replicate quickly in those hosts. In general, RNA viruses don’t have a proofreading mechanism, whereas DNA viruses do. So when an RNA virus replicates, it’s much more likely to have mistakes called mutations. Many of these mutations are useless or even harmful. But some make the virus better suited for certain environments— like a new host species. Epidemics often occur when a virus jumps from animals to humans. This is true of the RNA viruses that caused the Ebola, Zika, and SARS epidemics, and the COVID-19 pandemic. Once in humans, the virus still mutates— usually not enough to create a new virus, but enough to create variations, or strains, of the original one. Coronaviruses have a few key differences from most RNA viruses. They’re some of the largest, meaning they have the most genes. That creates more opportunity for harmful mutations. To counteract this risk, coronaviruses have a unique feature: an enzyme that checks for replication errors and corrects mistakes. This makes coronaviruses much more stable, with a slower mutation rate, than other RNA viruses. While this may sound formidable, the slow mutation rate is actually a promising sign when it comes to disarming them. After an infection, our immune systems can recognize germs and destroy them more quickly if they infect us again so they don’t make us sick. But mutations can make a virus less recognizable to our immune systems— and therefore more difficult to fight off. They can also make antiviral drugs and vaccines less effective, because they’re tailored very specifically to a virus. That’s why we need a new flu vaccine every year— the influenza virus mutates so quickly that new strains pop up constantly. The slower mutation rate of coronaviruses means our immune systems, drugs, and vaccines might be able to recognize them for longer after infection, and therefore protect us better. Still, we don’t know how long our bodies remain immune to different coronaviruses. There’s never been an approved treatment or vaccine for a coronavirus. We haven’t focused on treating the ones that cause colds, and though scientists began developing treatments for SARS and MERS, the epidemics ended before those treatments completed clinical trials. As we continue to encroach on other animals’ habitats, some scientists say a new coronavirus jumping to humans is inevitable— but if we investigate these unknowns, it doesn’t have to be devastating.

**P859 2020-05-08 Why should you read “Moby Dick” - Sascha Morrell**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=859)

A mountain separating two lakes. A room papered floor to ceiling with bridal satins. The lid of an immense snuffbox. These seemingly unrelated images take us on a tour of a sperm whale’s head in Herman Melville’s "Moby Dick." On the surface, the book is the story of Captain Ahab’s hunt for revenge against Moby Dick, the white whale who bit off his leg. But though the book features pirates, typhoons, high-speed chases, and giant squid, you shouldn’t expect a conventional seafaring adventure. Instead, it’s a multilayered exploration of not only the intimate details of life aboard a whaling ship, but also subjects from across human and natural history, by turns playful and tragic, humorous, and urgent. The narrator guiding us through these explorations is a common sailor called Ishmael. Ishmael starts out telling his own story as he prepares to escape the “damp and drizzly November in [his] soul” by going to sea. But after he befriends the Pacific Islander Queequeg and joins Ahab’s crew aboard the Pequod, Ishmael becomes more of an omniscient guide for the reader than a traditional character. While Ahab obsesses over revenge and first mate Starbuck tries to reason with him, Ishmael takes us on his own quest for meaning throughout “the whole universe, not excluding its suburbs.” In his telling, life’s biggest questions loom large, even in the smallest details. Like his narrator, Melville was a restless and curious spirit, who gained an unorthodox education working as a sailor on a series of grueling voyages around the world in his youth. He published "Moby Dick" in 1851, when the United States’ whaling industry was at its height. Nantucket, where the Pequod sets sail, was the epicenter of this lucrative and bloody global industry which decimated the world’s whale populations. Unusually for his time, Melville doesn’t shy away from the ugly side of this industry, even taking the whale’s perspective at one point, when he speculates on how terrifying the huge shadows of the ships must be to the creature swimming below. The author’s first-hand familiarity with whaling is evident over and over again in Ishmael’s vivid descriptions. In one chapter, the skin of a whale’s penis becomes protective clothing for a crewman. Chapters with titles as unpromising as “Cistern and Buckets” become some of the novel’s most rewarding as Ishmael compares bailing out a sperm-whale’s head to midwifery, which leads to reflections on Plato. Tangling whale-lines provoke witty reflections on the “ever-present perils” entangling all mortals. He draws on diverse branches of knowledge, like zoology, gastronomy, law, economics, mythology, and teachings from a range of religious and cultural traditions. The book experiments with writing style as much as subject matter. In one monologue, Ahab challenges Moby Dick in Shakespearean style: “Towards thee I roll, thou all-destroying but unconquering whale; to the last I grapple with thee; from hell’s heart I stab at thee; for hate’s sake I spit my last breath at thee.” One chapter is written as a playscript, where members of the Pequod’s multi-ethnic crew chime in individually and in chorus. African and Spanish sailors trade insults while a Tahitian seaman longs for home, Chinese and Portuguese crewmembers call for a dance, and one young boy prophesies disaster. In another chapter, Ishmael sings the process of decanting whale oil in epic style, as the ship pitches and rolls in the midnight sea and the casks rumble like landslides. A book so wide-ranging has something for everyone. Readers have found religious and political allegory, existential enquiry, social satire, economic analysis, and representations of American imperialism, industrial relations and racial conflict. As Ishmael chases meaning and Ahab chases the white whale, the book explores the opposing forces of optimism and uncertainty, curiosity and fear that characterize human existence no matter what it is we’re chasing. Through "Moby Dick’s" many pages, Melville invites his readers to leap into the unknown, to join him on the hunt for the “ungraspable phantom of life.”

**P860 2020-05-15 How do you know if you have a virus - Cella Wright**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=860)

A new virus emerges and spreads like wildfire. In order to contain it, researchers must first collect data about who’s been infected. Two main viral testing techniques are critical: one tells you if you have the virus and the other shows if you’ve already had it. So, how exactly do these tests work? PCR, or polymerase chain reaction testing, targets the virus’s genetic material in the body and is used to diagnose someone who is currently infected. Yet, this genetic material may be present in such imperceptible amounts that actually detecting it is difficult. This is where PCR comes in: it’s widely used to amplify genetic information to large enough quantities that it can be readily observed. To develop a PCR test for a never-before-seen virus, researchers first sequence its genetic material, or genome, and identify regions that are unique to that specific virus. PCR then targets these particular segments. A PCR test begins by collecting a sample: this can be blood for hepatitis viruses, feces for poliovirus, and samples from the nose or throat for coronaviruses. The sample is taken to a central laboratory where PCR is performed to test for the presence of the virus’ genome. Genetic information can be encoded via DNA or RNA. HPV, for example, uses DNA, while SARS-CoV-2, the cause of COVID-19, uses RNA. Before running the PCR, the viral RNA— if present— must be reverse transcribed to make a strand of complementary DNA. Researchers then run the PCR. If the virus is present in the sample, its unique regions of genetic code will be identified by complementary primers and copied by enzymes. One strand of DNA becomes hundreds of millions, which are detected using probes marked with fluorescent dye. If the PCR machine senses fluorescence, the sample has tested positive for the virus, meaning the individual is infected. Immunoassays, on the other hand, tap into the immune system’s memory of the virus, showing if someone has previously been infected. They work by targeting virus-specific antibodies generated by the immune system during infection. These are specialized classes of proteins that identify and fight foreign substances, like viruses. Immunoassays may detect IgG antibodies, the most abundant class, and IgM antibodies, the type that’s first produced in response to a new infection. The presence of IgM antibodies suggests a recent infection, but since it can take the body over a week to produce a detectable amount, they’re unreliable in diagnosing current infections. Meanwhile, IgG antibodies circulate for an extended period after infection; their presence usually indicates that someone was exposed and recovered. Before the immunoassay, health professionals draw blood from an individual. This sample then comes into contact with a portion of the virus of interest. If the body has, in fact, been exposed to the virus in the past, the body’s virus-specific antibodies will bind to it during the test. This reaction produces a change in color, indicating that the sample tested positive and that the individual has been exposed to the virus. Immunoassays are especially important when it comes to retroactively diagnosing people who were infected but went untested. And there’s exciting potential for those who have developed immunity to a virus: in some cases, their blood plasma could be used as treatment in people who are currently fighting it. PCR and immunoassays are always in the process of becoming more accurate and efficient. For example, innovations in PCR have led to the use of self-contained testing devices that relay results within one hour. Digital PCR, which quantifies individual pieces of target DNA, shows promise in further boosting accuracy. And although immunoassays are difficult to develop quickly, researchers in Singapore were able to create one for SARS-CoV-2 even before COVID-19 was declared a pandemic. These tests— along with the scientists who develop them and the health professionals who administer them— are absolutely essential. And when deployed early, they can save millions of lives.

**P861 2020-05-16 How to see more and care less - The art of Georgia O'Keeffe - Iseult**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=861)

A canvas drenched in sunset hues, colors radiating like flame. At first glance, this painting may appear to be an impossible, abstract image. But a closer look reveals the tender stems, lush petals and velvety texture of a Canna Lily. This metamorphosis of natural subjects into abstract geometry is commonplace in the work of Georgia O’Keeffe— the revolutionary American painter and sculptor. But the magic behind this transformation remains just as elusive as the artist herself. Born in Wisconsin in 1887, O’Keeffe spent her childhood plucking wildflowers and arranging fruits to paint. At seventeen, she moved to Chicago to study at the prestigious Art Institute. Her teachers trained her to faithfully reproduce reality in the conventions of European masters. Although she enjoyed the solitude and precision of this work, O’Keeffe felt little personal connection to it. After moving to New York, she was increasingly drawn to the clean lines, striking composition and vivid colors of Japanese art. O’Keeffe soon found a teacher whose lessons inspired her to put those interests into practice. Unlike her previous teachers, Arthur Wesley Dow urged his students to focus on more abstract representations of light, shape, and color. These lessons manifested in O’Keeffe’s first series of abstract drawings. Rendered in charcoal, they present a series of undulating lines, bold shading and billowing clouds. These drawings defy easy classification— suggesting, but never quite matching, any specific natural reference. Earlier European painters in the Cubist tradition had employed rigid geometry to abstract external subjects. But here, O’Keeffe employed the shapes and rhythms of nature to capture her internal feelings. Experiments like these would soon become a cornerstone of an artistic movement called American Modernism. Although no single style defines Modernist painting, its proponents shared a desire to challenge the realist traditions that dominated art education. Beginning in the late 1910’s, Modernist painting often used geometric shapes and bold colors to probe the American psyche. O’Keeffe threw herself into these experiments — but she was reluctant to share her new work. However, when a friend sent her charcoals to the art dealer Alfred Stieglitz, he became entranced. In 1916, he arranged for a grand exhibition in New York. This marked the beginning of O’Keeffe’s career as a popular artist— and a relationship that would lead to marriage in 1924. Marriage didn’t diminish O’Keeffe’s taste for solitude. She travelled widely to teach, and often retreated to paint for months at a time. Whether she was exploring the craggy canyons of Texas, the quiet forests of South Carolina, or the sun-bleached desert of New Mexico, her creative process was based on ritual and close observation. She paid meticulous attention to small details, and spent hours mixing paints to create exactly the right colors. When she found the perfect hue, she’d record it in her ever-growing collection of handmade color cards. O’Keeffe also experimented with perspective to celebrate objects that were often overlooked. In "Rams Head with Hollyhock," she places a weathered skull and a delicate flower high above the hills below. This massive skull overshadows the landscape, casting both the skeleton and the mountains in a new, eerie light. The public was captivated by her unique perspective and secretive behavior. She was particularly praised for her massive flower paintings, ranging from fiery poppies to ghostly calla lillies. Stieglitz and other critics of the time were infatuated by Freudian psychology, and were quick to link these paintings to female genitalia. But O’Keeffe dismissed such interpretations. She resented the male gaze that dominated the art world, and demanded her work be respected for its emotional evocation of the natural world. Eventually, O’Keeffe settled down in New Mexico, near one of her favorite artist retreats. In her 70’s, her eyesight began to fail, but she continued to mine the landscape’s mysteries in new, tactile mediums. O’Keeffe kept creating until her death at 98, and is remembered as the “Mother of American Modernism.” Decades on, her work retains its wild energy— and O’Keeffe her personal mystique.

**P862 2020-05-19 How do ventilators work - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=862)

In the 16th century, Flemish physician Andreas Vesalius described how a suffocating animal could be kept alive by inserting a tube into its trachea and blowing air to inflate its lungs. In 1555, this procedure didn’t warrant much acclaim. But today, Vesalius’s treatise is recognized as the first description of mechanical ventilation— a crucial practice in modern medicine. To appreciate the value of ventilation, we need to understand how the respiratory system works. We breathe by contracting our diaphragms, which expands our chest cavities. This allows air to be drawn in, inflating the alveoli— millions of small sacs inside our lungs. Each of these tiny balloons is surrounded by a mesh of blood-filled capillaries. This blood absorbs oxygen from the inflated alveoli and leaves behind carbon dioxide. When the diaphragm is relaxed, the CO2 is exhaled alongside a mix of oxygen and other gases. When our respiratory systems are working correctly, this process happens automatically. But the respiratory system can be interrupted by a variety of conditions. Sleep apnea stops diaphragm muscles from contracting. Asthma can lead to inflamed airways which obstruct oxygen. And pneumonia, often triggered by bacterial or viral infections, attacks the alveoli themselves. Invading pathogens kill lung cells, triggering an immune response that can cause lethal inflammation and fluid buildup. All these situations render the lungs unable to function normally. But mechanical ventilators take over the process, getting oxygen into the body when the respiratory system cannot. These machines can bypass constricted airways, and deliver highly oxygenated air to help damaged lungs diffuse more oxygen. There are two main ways ventilators can work— pumping air into the patient’s lungs through positive pressure ventilation, or allowing air to be passively drawn in through negative pressure ventilation. In the late 19th century, ventilation techniques largely focused on negative pressure, which closely approximates natural breathing and provides an even distribution of air in the lungs. To achieve this, doctors created a tight seal around the patient’s body, either by enclosing them in a wooden box or a specially sealed room. Air was then pumped out of the chamber, decreasing air pressure, and allowing the patient’s chest cavity to expand more easily. In 1928, doctors developed a portable, metal device with pumps powered by an electric motor. This machine, known as the iron lung, became a fixture in hospitals through the mid-20th century. However, even the most compact negative pressure designs heavily restricted a patient’s movement and obstructed access for caregivers. This led hospitals in the 1960’s to shift towards positive pressure ventilation. For milder cases, this can be done non-invasively. Often, a facemask is fitted over the mouth and nose, and filled with pressurized air which moves into the patient’s airway. But more severe circumstances require a device that takes over the entire breathing process. A tube is inserted into the patient’s trachea to pump air directly into the lungs, with a series of valves and branching pipes forming a circuit for inhalation and exhalation. In most modern ventilators, an embedded computer system allows for monitoring the patient’s breathing and adjusting the airflow. These machines aren’t used as a standard treatment, but rather, as a last resort. Enduring this influx of pressurized air requires heavy sedation, and repeated ventilation can cause long-term lung damage. But in extreme situations, ventilators can be the difference between life and death. And events like the COVID-19 pandemic have shown that they’re even more essential than we thought. Because current models are bulky, expensive, and require extensive training to operate, most hospitals only have a few in supply. This may be enough under normal circumstances, but during emergencies, this limited cache is stretched thin. The world urgently needs more low-cost and portable ventilators, as well as a faster means of producing and distributing this life-saving technology.

**P863 2020-05-20 What can DNA tests really tell us about our ancestry - Prosanta Chakr**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=863)

Two sisters take the same DNA test. The results show that one sister is 10% French, the other 0%. Both sisters share the same two parents, and therefore the same set of ancestors. So how can one be 10% more French than the other? Tests like these rely on our DNA to answer questions about our ancestry, but our DNA actually can’t tell us everything about who we are or where we’re from. DNA tests are great at answering some questions, like who your parents are, but can provide baffling results to others, like whether you have ancestors from a particular region. To understand why, it helps to know where our DNA comes from in the first place. Each person’s DNA consists of about 6 billion base pairs stored in 23 pairs of chromosomes— 46 total. That may seem like a dizzying amount of information, but 99% of our genome is shared among all humans. The remaining 1% contains everything distinct about an individual’s ancestry. Commercial DNA tests utilize less than 1% of that 1%. One chromosome in each pair comes from each parent. These halves join at conception: when a sperm and egg, each with only 23 chromosomes, combine. The story of our ancestry becomes muddled before conception. That’s because the 23 chromosomes in a sperm or egg aren’t identical to the chromosomes of every other cell in the body. As they go from a cell with 46 chromosomes to a sex cell with only 23, the chromosomes within each pair swap some sections. This process is called recombination, and it means that every sperm or egg contains single chromosomes that are a unique mash up of each pair. Recombination occurs uniquely in each sex cell— making two sisters’ chromosomes different not only from their parents’, but from each other’s. Recombination happens before conception, so you get exactly half of your DNA from each parent, but going further back things get more complicated. Without recombination, you would get 1/4 from each grandparent, 1/8 from each great-grandparent, and so on, but because recombination happens every generation, those numbers vary. The more generations removed an ancestor is, the more likely they won’t be represented in your DNA at all. For example, without recombination, just 1/64 of your DNA would come from each ancestor six generations back. Because of recombination, that number can be higher, though we don’t know for sure how high— or it can as low as 0. So one sister isn’t more French in the sense of having more ancestors from France. Instead, the French ancestors are simply more represented in her DNA. But the story doesn’t end there. Tests don’t trace the DNA of the sisters' actual French ancestors— we don’t have access to the genomes of deceased individuals from previous generations. Instead, these results are based on a comparison to the DNA of people living in France today. The tests look for genetic markers, or combinations of genetic markers. These markers are short sequences that appear in specific places. The sister deemed "more French" shares genetic markers with people currently living in France. The assumption is that these shared markers indicate ancestors from the same place: France. It’s important to note that results are based on people who’ve had their genomes sequenced— 80-90% of which are of European descent. Many indigenous peoples are barely represented, if at all. The test won’t reveal heritage from people not represented in the database, and shouldn’t be used to prove race or ethnicity. And as more people get sequenced, your results might change. Looking further back, you may get a result like 2% Neanderthal. Though Neanderthals were a separate species from humans, that 2% doesn’t come out of the 99% of our genome shared among all humans, but the 1% that varies. That’s because about 40,000 years ago, certain human populations interbred with Neanderthals, meaning some people alive today have Neanderthal ancestors. Many Neanderthal ancestors, in fact: there are so many generations in 40,000 years that a single Neanderthal’s genetic contribution would be untraceable. You can be both 100% French and 2% Neanderthal— though both come from the 1% of DNA that makes us different, they’re accounting for different things. Looking for traces of our ancestry in our DNA gets complicated very quickly. Both the way we inherit DNA and the information available for testing makes it difficult to say certain things with 100% certainty.

**P864 2020-05-20 When is a pandemic over**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=864)

Consider this unfortunately familiar scenario. Several months ago a highly infectious, sometimes deadly respiratory virus infected humans for the first time. It then proliferated faster than public health measures could contain it. Now the World Health Organization (WHO) has declared a pandemic, meaning that it’s spreading worldwide. The death toll is starting to rise and everyone is asking the same question: when will the pandemic end? The WHO will likely declare the pandemic over once the infection is mostly contained and rates of transmission drop significantly throughout the world. But exactly when that happens depends on what global governments choose to do next. They have three main options: Race through it, Delay and Vaccinate, or Coordinate and Crush. One is widely considered best, and it may not be the one you think. In the first, governments and communities do nothing to halt the spread and instead allow people to be exposed as quickly as possible. Without time to study the virus, doctors know little about how to save their patients, and hospitals reach peak capacity almost immediately. Somewhere in the range of millions to hundreds of millions of people die, either from the virus or the collapse of health care systems. Soon the majority of people have been infected and either perished or survived by building up their immune responses. Around this point herd immunity kicks in, where the virus can no longer find new hosts. So the pandemic fizzles out a short time after it began. But there’s another way to create herd immunity without such a high cost of life. Let’s reset the clock to the moment the WHO declared the pandemic. This time, governments and communities around the world slow the spread of the virus to give research facilities time to produce a vaccine. They buy this crucial time through tactics that may include widespread testing to identify carriers, quarantining the infected and people they’ve interacted with, and physical distancing. Even with these measures in place, the virus slowly spreads, causing up to hundreds of thousands of deaths. Some cities get the outbreak under control and go back to business as usual, only to have a resurgence and return to physical distancing when a new case passes through. Within the next several years, one or possibly several vaccines become widely, and hopefully freely, available thanks to a worldwide effort. Once 40-90% of the population has received it— the precise amount varying based on the virus— herd immunity kicks in, and the pandemic fizzles out. Let’s rewind the clock one more time, to consider the final strategy: Coordinate and Crush. The idea here is to simultaneously starve the virus, everywhere, through a combination of quarantine, social distancing, and restricting travel. The critical factor is to synchronize responses. In a typical pandemic, when one country is peaking, another may be getting its first cases. Instead of every leader responding to what’s happening in their jurisdiction, here everyone must treat the world as the giant interconnected system it is. If coordinated properly, this could end a pandemic in just a few months, with low loss of life. But unless the virus is completely eradicated— which is highly unlikely— there will be risks of it escalating to pandemic levels once again. And factors like animals carrying and transmitting the virus might undermine our best efforts altogether. So which strategy is best for this deadly, infectious respiratory virus? Racing through it is a quick fix, but would be a global catastrophe, and may not work at all if people can be reinfected. Crushing the virus through Coordination alone is also enticing for its speed, but only reliable with true and nearly impossible global cooperation. That’s why vaccination, assisted by as much global coordination as possible, is generally considered to be the winner; it’s the slow, steady, and proven option in the race. Even if the pandemic officially ends before a vaccine is ready, the virus may reappear seasonally, so vaccines will continue to protect people. And although it may take years to create, disruptions to most people’s lives won’t necessarily last the full duration. Breakthroughs in treatment and prevention of symptoms can make viruses much less dangerous, and therefore require less extreme containment measures. Take heart: the pandemic will end. Its legacy will be long-lasting, but not all bad; the breakthroughs, social services, and systems we develop can be used to the betterment of everyone. And if we take inspiration from the successes and lessons from the failures, we can keep the next potential pandemic so contained that our children’s children won’t even know its name.

**P866 2020-06-02 A day in the life of a Peruvian shaman - Gabriel Prieto**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=866)

At the temple of the fisherman, Quexo, the village shaman, looks out over the ocean and frowns. It’s a still morning– unusually still, and the lack of wind is the latest in a series of troubling signs. The year is 1400 BCE. Quexo’s village sits in the dusty, treeless desert between the towering Andes and Pacific Ocean. The villagers live off the sea, harvesting reeds, drying them in the sun, and using them to build fishing boats. Every day in the summer, the men set out on these boats to hunt shark and other fish while the women harvest shellfish and sea urchins. In winter, storms bring powerful waves, which cross the vast ocean unobstructed to detonate on these shores. Most years, Quexo’s village catches more than enough fish. But this year, the winds have died and the fish have dwindled. Quexo has seen this pattern before: the fish disappear, then the violent rains arrive, causing flash floods that dissolve mud bricks and wash away settlements. He needs to stop the bad weather before the storms come— his only hope is a special ritual he’s been planning. Quexo spends much less time in the ocean than the other villagers. He became a shaman after seeing a sign in the sea one morning— like his father and grandfather before him. This morning, he walks to the nearby sacred mountain as the sun rises. There, he gathers ceremonial cactus and herbs like “horse tail,” “stonebreaker," and valerian, along with the mineral hematite. Back in the village, everyone is preparing to leave for a religious festival at a large temple inland. The festival marks the beginning of what is usually the season of abundance, but with the signs pointing to storms, Quexo isn’t feeling too celebratory. Whole families travel to the festival, where they camp for a few days. They’ve packed seaweed, carved bones, gourd bowls, reed mats, and other goods to trade in the market around the temple. Quexo inspects the goods to make sure everything is of the finest quality. He brings the herbs he gathered to trade for cinnabar, a mineral that comes from the highlands in the Andes. He needs cinnabar for his ritual to ward off the storms. Around lunchtime, the sprawling temple rises out of the desert ahead. People have come from all along the coast and the foothills. The women handle trade transactions— they’re looking for cotton and ceramics. Men aren’t usually allowed to do the trading, but shamans are an exception. Though Quexo is a man, during rituals he becomes half man, half woman, and this ambiguity makes his role more flexible outside ceremonies too. Quexo can’t find any cinnabar in the market, so he heads to the main temple, dodging children playing in the plaza. He puts on his ceremonial garb: red face paint, earrings, and a necklace of shark’s teeth and vertebrae. Inside, the ceremonies are already underway, and the shamans have drunk the sacred cactus drink. Many of them are Quexo’s friends from festivals over the years, but he doesn’t see the mountain shamans who would have cinnabar. He begins to panic. If the highland shamans don’t show up, his only option will be to make the long walk into the mountains. It’s a dangerous journey that takes five days, precious time he doesn’t have to waste. But perhaps he has no choice. He refuses the sacred cactus and sets off toward the mountains. As he leaves the settlement behind, he sees a group approaching. He recognizes them as highlanders by their llamas. He dashes toward their shaman. Barely pausing to say hello, he offers him hematite, dried seaweed, and empty shells to grind up for lime and chew with coca leaves. In return, the other shaman gives him the precious cinnabar. With the key to his ritual in hand, Quexo heads home to the temple of the fisherman in hopes of turning the tide.

**P867 2020-06-02 The last chief of the Comanches and the fall of an empire - Dustin Ta**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=867)

Late one night in 1871, a group of riders descended on a sleeping army camp. In minutes they stirred the camp into a panic, stole about 70 horses, and disappeared. Led by a young chief named Quanah Parker, the raid was the latest in a long series of altercations along the Texas frontier between the indigenous people known as the Numunu, or Comanches, and the United States forces sent to steal Comanche lands for white settlers. Though the conflict was decades old, U.S. Colonel Ranald MacKenzie led the latest iteration. From summer to winter, he tracked Quanah. But Quanah was also tracking him, and each time the colonel drew near his targets, they disappeared without a trace into the vast plains. The Comanches had controlled this territory for nearly 200 years, hunting buffalo and moving whole villages around the plains. They suppressed Spanish and Mexican attacks from the south, attempts to settle the land by the United States from the east, and numerous other indigenous peoples’ bids for power. The Comanche Empire was not one unified group under central control, but rather a number of bands, each with its own leaders. What all of these bands had in common was their prowess as riders— every man, woman, and child was adept on horseback. Their combat skills on horseback far surpassed those of both other indigenous peoples and colonists, allowing them to control an enormous area with relatively few people— probably about 40,000 at their peak and only about 4-5,000 by the time Quanah Parker and Ranald Mackenzie faced off. Born around 1848, Quanah was the eldest child of Peta Nocona, a leader of the Nokoni band, and Cynthia Ann Parker, a kidnapped white settler who assimilated with the Comanches and took the name Naduah. When Quanah was a preteen, U.S. forces ambushed his village, capturing his mother and sister. Quanah and his younger brother sought refuge with a different Comanche band, the Quahada. In the years that followed, Quanah proved himself as a warrior and leader. In his early twenties, he and a young woman named Weakeah eloped, enraging her powerful father and several other leaders. They stayed on the run for a year, attracting followers and establishing Quanah as a paraibo, or chief, at an exceptionally young age. Under his leadership the Quahada band was able to elude the U.S. military and continue their way of life. But in the early 1870s, the East Coast market for buffalo hides became lucrative, and hunters slaughtered millions of buffalo in just a few years. Meanwhile, U.S. forces led a surprise attack, killing nearly all the Quahada band’s 1,400 horses and stealing the rest. Though he had vowed to never surrender, Quanah knew that without bison or horses, the Comanches faced certain starvation in winter. So in 1875 Quanah and the Quahada band moved to the Fort Sill reservation in Oklahoma. As hunter-gatherers, they could not transition easily to an agricultural way of life on the reservation. The U.S. government had promised rations and supplies, but what they provided was wildly insufficient. Quanah, meanwhile, was suddenly in a weak political position: he had no wealth or power compared to others who had been on the reservation longer. Still, he saw an opportunity. The reservation included ample grasslands— useless to the Comanches but perfect for cattle ranchers to graze their herds. He began a profitable arrangement leasing the land to cattle ranchers, quietly at first. Eventually, he negotiated leasing rights with the U.S. government, which ensured a steady source of income for the Comanches on the reservation. As Quanah’s status on the reservation and recognition from government officials grew, he secured better rations, advocated for the construction of schools and houses, and became one of three tribal judges on the reservation court. Tired of speaking with multiple leaders, the U.S. government wanted to appoint one chief of all Comanches— a role that hadn’t existed outside the reservation. Still, many Comanches supported Quanah for this role, just as several older leaders had supported him to lead them against the U.S. armed forces. Even Quanah’s former adversary, Ranald MacKenzie, advocated for his appointment. Quanah acted in Hollywood movies and befriended American politicians, riding in Theodore Roosevelt’s inauguration parade. Still, he never cut his long braids and advocated for the Native American Church and the use of peyote. He began to go by Quanah Parker, adopting his mother’s surname, and tried to track down his mother and sister, eventually learning they had both died shortly after their capture. Quanah adapted again and again— to different worlds, different roles, and circumstances that would seem insurmountable to most. Though he wasn’t without critics, after Quanah’s passing, Comanches began using the term “chairman” to designate the top elected official in the tribe, recognizing him as the last chief of the Comanches and a model of cultural survival and adaptation. In that spirit, today’s Comanche Nation looks towards the future, with over 16,000 enrolled citizens and countless descendants.

**P868 2020-06-03 Which voting system is the best - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=868)

Imagine we want to build a new space port at one of four recently settled Martian bases, and are holding a vote to determine its location. Of the hundred colonists on Mars, 42 live on West Base, 26 on North Base, 15 on South Base, and 17 on East Base. For our purposes, let’s assume that everyone prefers the space port to be as close to their base as possible, and will vote accordingly. What is the fairest way to conduct that vote? The most straightforward solution would be to just let each individual cast a single ballot, and choose the location with the most votes. This is known as plurality voting, or "first past the post." In this case, West Base wins easily, since it has more residents than any other. And yet, most colonists would consider this the worst result, given how far it is from everyone else. So is plurality vote really the fairest method? What if we tried a system like instant runoff voting, which accounts for the full range of people’s preferences rather than just their top choices? Here’s how it would work. First, voters rank each of the options from 1 to 4, and we compare their top picks. South receives the fewest votes for first place, so it’s eliminated. Its 15 votes get allocated to those voters’ second choice— East Base— giving it a total of 32. We then compare top preferences and cut the last place option again. This time North Base is eliminated. Its residents’ second choice would’ve been South Base, but since that’s already gone, the votes go to their third choice. That gives East 58 votes over West’s 42, making it the winner. But this doesn’t seem fair either. Not only did East start out in second-to-last place, but a majority ranked it among their two least preferred options. Instead of using rankings, we could try voting in multiple rounds, with the top two winners proceeding to a separate runoff. Normally, this would mean West and North winning the first round, and North winning the second. But the residents of East Base realize that while they don’t have the votes to win, they can still skew the results in their favor. In the first round, they vote for South Base instead of their own, successfully keeping North from advancing. Thanks to this "tactical voting" by East Base residents, South wins the second round easily, despite being the least populated. Can a system be called fair and good if it incentivizes lying about your preferences? Maybe what we need to do is let voters express a preference in every possible head-to-head matchup. This is known as the Condorcet method. Consider one matchup: West versus North. All 100 colonists vote on their preference between the two. So that's West's 42 versus the 58 from North, South, and East, who would all prefer North. Now do the same for the other five matchups. The victor will be whichever base wins the most times. Here, North wins three and South wins two. These are indeed the two most central locations, and North has the advantage of not being anyone’s least preferred choice. So does that make the Condorcet method an ideal voting system in general? Not necessarily. Consider an election with three candidates. If voters prefer A over B, and B over C, but prefer C over A, this method fails to select a winner. Over the decades, researchers and statisticians have come up with dozens of intricate ways of conducting and counting votes, and some have even been put into practice. But whichever one you choose, it's possible to imagine it delivering an unfair result. It turns out that our intuitive concept of fairness actually contains a number of assumptions that may contradict each other. It doesn’t seem fair for some voters to have more influence than others. But nor does it seem fair to simply ignore minority preferences, or encourage people to game the system. In fact, mathematical proofs have shown that for any election with more than two options, it’s impossible to design a voting system that doesn’t violate at least some theoretically desirable criteria. So while we often think of democracy as a simple matter of counting votes, it’s also worth considering who benefits from the different ways of counting them.

**P869 2020-06-04 “What happened when we all stopped” narrated by Jane Goodall**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=869)

Today we have something a little different. Dr. Jane Goodall is going to tell you a story. Stay tuned after the animation to learn how to download this as a free children's book. Ready? Let's begin. It starts as a whisper, a word on the air. It can't quite be heard, but you know that it's there. As gentle as sunlight, as tenacious as hale, in its route to the heart, it could not but prevail. And the people looked up from their day-to-day tasks, their day-to-day jobs and their day-to-day masks. They heard or they felt where the whisper could lead, and they looked with eyes wide at what that might mean. And once they could see it, they hadn't a chance To resist the sweet song of the deep spell it cast. But the feeling it brought them at first glance was pain, as they lifted their eyes on the land they had claimed. Since they saw at last as if raised from a dream, they were almost alone on the land and the sea. For the trees had almost gone, and the bees had almost gone, and the creatures in their shells by the seas had almost gone. And the people felt sad as they saw their new Earth, but they knew this was it, one wild chance for rebirth. Breaking new ground, seeds rolling down, smell of the earth on your hands and your brow. No time for sorrow, we're building tomorrow. The sound of things growing now keeps us around. As the wildness grows, and the deep wood grows, and the sense that the future's come to meet you grows, There's no chance we can rest. We must do our best. This moment can lead us back home, that's our test. It starts as a whisper, a word on the air. It can't quite be heard, but you know that it's there. It then spoke like thunder. Until we all moved. And we could. And we did. And it's done. She's renewed. Help turn the whisper into a roar by sharing this poem today. You can download the illustrated book for free at ed.ted.com/whisper or keep your soul aflutter with one of these animated poems.

**P870 2020-06-05 First person vs. Second person vs. Third person - Rebekah Bergman**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=870)

“I am an invisible man.” “Mrs. Dalloway said she would buy the flowers herself.” “You are about to begin reading Italo Calvino's new novel.” These three opening lines, from Ralph Ellison’s "Invisible Man," Virginia Woolf’s "Mrs. Dalloway," and Italo Calvino’s "If on a winter’s night a traveler," each establish a different point of view. Who is telling a story, and from what perspective, are some of the most important choices an author makes. Told from a different point of view, a story can transform completely. Take this fairytale: "Rapunzel, Rapunzel," the Prince called, "let down your hair." Rapunzel unbraided her hair and slung it out the window. The prince climbed her tresses into the tower. Rapunzel is typically told like this, with the narrator outside the story. This point of view is called third person. But Rapunzel can also be told by a character in the story— a first person narrator. The tail end of Rapunzel’s locks plopped down at my feet. I grabbed on and began to climb… ugh! I couldn’t untangle myself. Strands came off all over me, sticking to my sweat. In a first person narrative, the story can change dramatically depending on which character is the narrator. Say Rapunzel was narrating instead of the prince: I hope he appreciates how long it takes to unbraid 25 feet of hair, I thought. OUCH! I'll be honest; I thought my scalp would stretch off of my skull. "Can you climb any faster?" I yelled. In second person, the narrator addresses the story to the reader: He calls your name. He wants you to let your hair down. You just finished braiding it, but hey– you don't get a lot of visitors. Third person, first person, and second person perspectives each have unique possibilities and constraints. So how do you choose a point of view for your story? Constraints aren’t necessarily a bad thing— they can help focus a story or highlight certain elements. For example, a third person narrator is necessarily a bit removed from the characters. But that can be good for stories where a feeling of distance is important. A third person narrator can be either limited, meaning they stick close to one character’s thoughts and feelings, or they can be omniscient, able to flit between characters’ minds and give the reader more information. A first person story creates closeness between the reader and the narrator. It’s also restricted by the narrator’s knowledge. This can create suspense as the reader finds out information along with the character. A first person narrator doesn’t necessarily have to represent the character’s experience faithfully— they can be delusional or dishonest. In Kazuo Ishiguro’s novel "The Remains of the Day," Stevens, an aging British butler in 1956, recounts his many years of service, but fails to acknowledge the flaws of the man he serves. The cracks in his narrative eventually draw the reader’s attention to the under-acknowledged failings of the culture and class system he inhabits. Justin Torres’s novel, "We the Animals," begins with a plural first person narrator: “We were six snatching hands, six stomping feet; we were brothers, boys, three little kings locked in a feud for more.” Partway through the story, the point of view shifts to first person singular, from we to I, as the boys come of age and one brother feels alienated from the others. Second person is a less common choice. It requires the writer to make the reader suspend disbelief to become another “you.” Placing the reader in a character’s perspective can build urgency and suspense. Sometimes, though, second person is intended to distance the narrator from their own story, rather than bring the reader closer to the story. In these cases, second person narrators refer to themselves as “you” rather than “I.” Writers are constantly experimenting with fresh variations on point of view. New virtual and augmented reality technologies may expand the possibilities for this experimentation. By placing people at a particular vantage point in virtual space, how might we change the way we tell and experience stories?

**P871 2020-06-05 How fast can a vaccine be made - Dan Kwartler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=871)

When a new pathogen emerges, our bodies and healthcare systems are left vulnerable. In times like these, there’s an urgent need for a vaccine to create widespread immunity with minimal loss of life. So how quickly can we develop vaccines when we need them most? Vaccine development can generally be split into three phases. In exploratory research, scientists experiment with different approaches to find safe and replicable vaccine designs. Once these are vetted in the lab, they enter clinical testing, where vaccines are evaluated for safety, efficacy, and side effects across a variety of populations. Finally, there’s manufacturing, where vaccines are produced and distributed for public use. Under regular circumstances, this process takes an average of 15 to 20 years. But during a pandemic, researchers employ numerous strategies to move through each stage as quickly as possible. Exploratory research is perhaps the most flexible. The goal of this stage is to find a safe way to introduce our immune system to the virus or bacteria. This gives our body the information it needs to create antibodies capable of fighting a real infection. There are many ways to safely trigger this immune response, but generally, the most effective designs are also the slowest to produce. Traditional attenuated vaccines create long lasting resilience. But they rely on weakened viral strains that must be cultivated in non-human tissue over long periods of time. Inactivated vaccines take a much faster approach, directly applying heat, acid, or radiation to weaken the pathogen. Sub-unit vaccines, that inject harmless fragments of viral proteins, can also be created quickly. But these faster techniques produce less robust resilience. These are just three of many vaccine designs, each with their own pros and cons. No single approach is guaranteed to work, and all of them require time-consuming research. So the best way to speed things up is for many labs to work on different models simultaneously. This race-to-the-finish strategy produced the first testable Zika vaccine in 7 months, and the first testable COVID-19 vaccine in just 42 days. Being testable doesn’t mean these vaccines will be successful. But models that are deemed safe and easily replicable can move into clinical testing while other labs continue exploring alternatives. Whether a testable vaccine is produced in four months or four years, the next stage is often the longest and most unpredictable stage of development. Clinical testing consists of three phases, each containing multiple trials. Phase I trials focus on the intensity of the triggered immune response, and try to establish that the vaccine is safe and effective. Phase II trials focus on determining the right dosage and delivery schedule across a wider population. And Phase III trials determine safety across the vaccine’s primary use population, while also identifying rare side effects and negative reactions. Given the number of variables and the focus on long-term safety, it’s incredibly difficult to speed up clinical testing. In extreme circumstances, researchers run multiple trials within one phase at the same time. But they still need to meet strict safety criteria before moving on. Occasionally, labs can expedite this process by leveraging previously approved treatments. In 2009, researchers adapted the seasonal flu vaccine to treat H1N1— producing a widely available vaccine in just six months. However, this technique only works when dealing with familiar pathogens that have well-established vaccine designs. After a successful Phase III trial, a national regulatory authority reviews the results and approves safe vaccines for manufacturing. Every vaccine has a unique blend of biological and chemical components that require a specialized pipeline to produce. To start production as soon as the vaccine is approved, manufacturing plans must be designed in parallel to research and testing. This requires constant coordination between labs and manufacturers, as well as the resources to adapt to sudden changes in vaccine design— even if that means scrapping months of work. Over time, advances in exploratory research and manufacturing should make this process faster. Preliminary studies suggest that future researchers may be able to swap genetic material from different viruses into the same vaccine design. These DNA and mRNA based vaccines could dramatically expedite all three stages of vaccine production. But until such breakthroughs arrive, our best strategy is for labs around the world to cooperate and work in parallel on different approaches. By sharing knowledge and resources, scientists can divide and conquer any pathogen.

**P872 2020-06-09 The greatest mathematician that never lived - Pratik Aghor**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=872)

When Nicolas Bourbaki applied to the American Mathematical Society in the 1950s, he was already one of the most influential mathematicians of his time. He’d published articles in international journals and his textbooks were required reading. Yet his application was firmly rejected for one simple reason— Nicolas Bourbaki did not exist. Two decades earlier, mathematics was in disarray. Many established mathematicians had lost their lives in the first World War, and the field had become fragmented. Different branches used disparate methodology to pursue their own goals. And the lack of a shared mathematical language made it difficult to share or expand their work. In 1934, a group of French mathematicians were particularly fed up. While studying at the prestigious École normale supérieure, they found the textbook for their calculus class so disjointed that they decided to write a better one. The small group quickly took on new members, and as the project grew, so did their ambition. The result was the "Éléments de mathématique," a treatise that sought to create a consistent logical framework unifying every branch of mathematics. The text began with a set of simple axioms— laws and assumptions it would use to build its argument. From there, its authors derived more and more complex theorems that corresponded with work being done across the field. But to truly reveal common ground, the group needed to identify consistent rules that applied to a wide range of problems. To accomplish this, they gave new, clear definitions to some of the most important mathematical objects, including the function. It’s reasonable to think of functions as machines that accept inputs and produce an output. But if we think of functions as bridges between two groups, we can start to make claims about the logical relationships between them. For example, consider a group of numbers and a group of letters. We could define a function where every numerical input corresponds to the same alphabetical output, but this doesn’t establish a particularly interesting relationship. Alternatively, we could define a function where every numerical input corresponds to a different alphabetical output. This second function sets up a logical relationship where performing a process on the input has corresponding effects on its mapped output. The group began to define functions by how they mapped elements across domains. If a function’s output came from a unique input, they defined it as injective. If every output can be mapped onto at least one input, the function was surjective. And in bijective functions, each element had perfect one to one correspondence. This allowed mathematicians to establish logic that could be translated across the function’s domains in both directions. Their systematic approach to abstract principles was in stark contrast to the popular belief that math was an intuitive science, and an over-dependence on logic constrained creativity. But this rebellious band of scholars gleefully ignored conventional wisdom. They were revolutionizing the field, and they wanted to mark the occasion with their biggest stunt yet. They decided to publish "Éléments de mathématique" and all their subsequent work under a collective pseudonym: Nicolas Bourbaki. Over the next two decades, Bourbaki’s publications became standard references. And the group’s members took their prank as seriously as their work. Their invented mathematician claimed to be a reclusive Russian genius who would only meet with his selected collaborators. They sent telegrams in Bourbaki’s name, announced his daughter’s wedding, and publicly insulted anyone who doubted his existence. In 1968, when they could no longer maintain the ruse, the group ended their joke the only way they could. They printed Bourbaki’s obituary, complete with mathematical puns. Despite his apparent death, the group bearing Bourbaki’s name lives on today. Though he’s not associated with any single major discovery, Bourbaki’s influence informs much current research. And the modern emphasis on formal proofs owes a great deal to his rigorous methods. Nicolas Bourbaki may have been imaginary— but his legacy is very real.

**P873 2020-06-09 What do all languages have in common - Cameron Morin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=873)

Language is endlessly variable. Each of us can come up with an infinite number of sentences in our native language, and we’re able to do so from an early age— almost as soon as we start to communicate in sentences. How is this possible? In the early 1950s, Noam Chomsky proposed a theory based on the observation that the key to this versatility seems to be grammar: the familiar grammatical structure of an unfamiliar sentence points us toward its meaning. He suggested that there are grammatical rules that apply to all languages, and that the rules are innate— the human brain is hardwired to process language according to these rules. He labelled this faculty universal grammar, and it launched lines of inquiry that shaped both the field of linguistics and the emerging field of cognitive science for decades to come. Chomsky and other researchers set out to investigate the two main components of universal grammar: first, whether there are, in fact, grammar rules that are universal to all languages, and, second, whether these rules are hardwired in the brain. In attempts to establish the universal rules of grammar, Chomsky developed an analytical tool known as generative syntax, which represents the order of words in a sentence in hierarchical syntax trees that show what structures are possible. Based on this tree, we could suggest a grammar rule that adverbs must occur in verb phrases. But with more data, it quickly becomes clear that adverbs can appear outside of verb phrases. This simplified example illustrates a major problem: it takes a lot of data from each individual language to establish the rules for that language, before we can even begin to determine which rules all languages might have in common. When Chomsky proposed universal grammar, many languages lacked the volume of recorded samples necessary to analyze them using generative syntax. Even with lots of data, mapping the structure of a language is incredibly complex. After 50 years of analysis, we still haven’t completely figured out English. As more linguist data was gathered and analyzed, it became clear that languages around the world differ widely, challenging the theory that there were universal grammar rules. In the 1980s, Chomsky revised his theory in an attempt to accommodate this variation. According to his new hypothesis of principles and parameters, all languages shared certain grammatical principles, but could vary in their parameters, or the application of these principles. For example, a principle is “every sentence must have a subject," but the parameter of whether the subject must be explicitly stated could vary between languages. The hypothesis of principles and parameters still didn’t answer the question of which grammatical principles are universal. In the early 2000s, Chomsky suggested that there’s just one shared principle, called recursion, which means structures can be nested inside each other. Take this sentence, which embeds a sentence within a sentence within a sentence. Or this sentence, which embeds a noun phrase in a noun phrase in a noun phrase. Recursion was a good candidate for a universal grammar rule because it can take many forms. However, in 2005 linguists published findings on an Amazonian language called Piraha, which doesn’t appear to have any recursive structures. So what about the other part of Chomsky’s theory, that our language faculty is innate? When he first proposed universal grammar, the idea that there was a genetically determined aspect of language acquisition had a profound, revolutionary impact. It challenged the dominant paradigm, called behaviorism. Behaviorists argued that all animal and human behaviors, including language, were acquired from the outside by the mind, which starts out as a blank slate. Today, scientists agree that behaviorism was wrong, and there is underlying, genetically encoded biological machinery for language learning. Many think the same biology responsible for language is also responsible for other aspects of cognition. So they disagree with Chomsky’s idea that there is a specific, isolated, innate language faculty in the brain. The theory of universal grammar prompted the documentation and study of many languages that hadn’t been studied before. It also caused an old idea to be reevaluated and eventually overthrown to make room for our growing understanding of the human brain.

**P874 2020-06-10 The Factory \_ Think Like A Coder, Ep 9**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=874)

After a harrowing chase, Ethic, Hedge, and their new ally Lemma find themselves in a cavernous control room. Here the last artifact— the Node of Memory— is suspended within a force field and powering a supercomputer. Ethic is about to deactivate the force field when Lemma stops her. She explains, a decade ago, she was assigned a research task: to use the world machine to create something that would make everyone happy. After many failed attempts, Lemma discovered a compound that, when ingested, made people motivated, happy, creative, loving… in short, their best selves. It was rushed into production. Soon, the entire nation’s food supply came from Huxenborg, with the compound mixed in. The first year was paradise. The second, not so much. Side-effects began to emerge: memory-loss, listlessness, and self-absorption. In the third year, the government dissolved, leaving the robots running everything in a self-sustaining loop. By this point things were too far gone for Lemma to reverse. People had become dependent on the compound, and the few who refused it formed a resistance to try to fix things. It took 10 years for Lemma to find a cure. This factory contains everything she’ll need to make it, but the second they take the Node of Memory, the security system will alert the robots, and they’ll have to run. If, instead, they first reconfigure the factory to manufacture the cure, the people can be saved. Lemma has the whole factory redesign planned out. The problem is… it’s a little hard to read. Her schematic shows all the steps in the manufacturing process needed to make the cure. An arrow from “add nitric acid” to “shake vigorously” means that the acid addition has to happen before shaking. If a single step is performed out of order, the cure won’t work, or worse. There aren’t any circular references, where step A requires step B and step B eventually requires step A. Here’s where Ethic and Hedge come in. Lemma needs Hedge to translate the tangled diagram into a sequence of steps. That’ll be the order that things happen in the factory. Once input into the central computer, the factory will reassemble itself as instructed. Hedge’s ability to store information in a table will help here. So how does Ethic program Hedge to turn out a correct sequence that can reconfigure the factory? Pause now to figure it out yourself. Rules in 3 Rules in 2 Rules in 1 Hint in 3 Hint in 2 Hint in 1 It may help to first think about this problem as a human, rather than a machine. Given this diagram, it’s clear to start with getting a bowl, since no arrows point to it. How might you mark up the diagram to figure out what to do next? Pause now to figure it out yourself. Solution in 3 Solution in 2 Solution in 1 Diagrams like the one Lemma has drawn are called directed acyclic graphs. A graph is a representation of data that shows different elements and how they’re related to each other. Directed means that direction matters— as indicated by the arrows. Here A leads to B, but B doesn’t lead to A. And acyclic means that there aren’t any loops. Which is fortunate, because if there were, this problem wouldn’t be solvable. There’s a simple way to navigate the graph as a human: start with a step that doesn’t have any arrows pointing to it. Once you do that, cross out that step and all arrows leading from it. Choose another step with no arrows pointing to it, and repeat until you’ve hit every step. There are two things here that are tricky to translate for a robot. First, how do you keep track of the information? And second, what do you do if there are multiple options at the same time? For the first challenge, a convenient way for machines to store information is in a table. In this case, you can have Hedge list every step in the headers of both the rows and columns. Then he can go through the rows one at a time. On the schematic, what points to mix? Both shake and titrate. So Hedge should make a mark in both of their columns. He can do the same for every row, one at a time, to make a table like this. Of course the full table will be much bigger. Like a human, Hedge will also want to start from one of the steps that has no arrows pointing to it— which is the same as having no marks in its row. If there’s more than one, a convenient way to choose is to pick the one that’s alphabetically earliest, though other selection methods can work just as well. Next, Hedge can add that step to his running-order list, delete its entire column from the table— thus removing all the times it was a dependency–– and loop back to the start. Because there are no circular references in the graph, each time we get here there’ll be at least one step with no remaining dependencies. Hedge can add the alphabetically earliest to his running-order list, remove it from the table, and loop back to the start again. So now we have a working loop, and it’ll run through all the elements in our table until none are left. Hedge drifts back and forth over the schematics, and soon he starts spitting out instructions, which Ethic uses to configure the assembly lines. With the three working together, they churn out thousands of doses of the cure in no time. Ethic finally plucks the Node of Memory from its holding field and trips the alarm. Within seconds bots are everywhere. As Ethic falls in shock, the Node restores not only her own memories, but reveals the last, missing pieces of the puzzle. Ethic built Hedge with a singular purpose: to construct a maze that would protect the world machine from a corrupt government. But in her haste, she made a critical mistake. She forgot to set the condition that would end the loop which told Hedge how large the maze should be. So Hedge built and built until he could build no longer. And then he was conflicted. He had to build a maze. But he couldn’t build further without hurting people or flying over the Bradbarrier, both forbidden by his programming. So he wandered the land and searched for a solution, until he happened upon the Node of Power, the Node of Creation, and the Node of Memory. He recognized their true, collective power to grant self-awareness to those who lack it. With all three he’d be able to change his programming and fulfill his drive to transform the entire world into a giant maze. It wouldn’t be easy: the Nodes had safeguards to prevent robots from taking and using them. But if Hedge could find the right human and manipulate her with the promise of a heroic quest… well that would be a different story. A very different story.

**P875 2020-06-10 What yoga does to your body and brain - Krishna Sudhir**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=875)

At some point between the 1st and 5th century CE, the Hindu sage Patañjali began to codify the ancient, meditative traditions practiced throughout India. He recorded techniques nearly as old as Indian civilization itself in 196 manuals called the Yoga Sutras. These texts defined yoga as the ‘yoking’ or restraining of the mind from focusing on external objects in efforts to reach a state of pure consciousness. Over time, yoga came to incorporate physical elements from gymnastics and wrestling. Today, there are a multitude of approaches to modern yoga— though most still maintain the three core elements of Patañjali’s practice: physical postures, breathing exercises, and spiritual contemplation. This blend of physical and mental exercise is widely believed to have a unique set of health advantages. Such as improving strength and flexibility, boosting heart and lung function, and enhancing psychological well-being. But what have contemporary studies shown regarding the benefits of this ancient tradition? Despite attempts by many researchers, it's tough to make specific claims about yoga's advantages. Its unique combination of activities makes it difficult to determine which component is producing a specific health benefit. Additionally, yoga studies are often made up of small sample sizes that lack diversity, and the heavy reliance on self-reporting makes results subjective. However, there are some health benefits that have more robust scientific support than others. Let’s start with flexibility and strength. Twisting your body into yoga’s physical postures stretches multiple muscle groups. In the short term, stretching can change the water content of these muscles, ligaments, and tendons to make them more elastic. Over time, regular stretching stimulates stem cells which then differentiate into new muscle tissue and other cells that generate elastic collagen. Frequent stretching also reduces the body’s natural reflex to constrict muscles, improving your pain tolerance for feats of flexibility. Researchers haven’t found that any one form of yoga improves flexibility more than another, so the impact of specific postures is unclear. But like other low-impact exercises, yoga reliably improves fitness and flexibility in healthy populations. The practice has also been shown to be a potentially powerful therapeutic tool. In studies involving patients with a variety of musculo-skeletal disorders, yoga was more helpful at reducing pain and improving mobility than other forms of low-impact exercise. Adding yoga to an existing exercise routine can improve strength and flexibility for hard to treat conditions like chronic lower back pain, rheumatoid arthritis, and osteoporosis. Yoga’s mix of physical exercise and regimented breathing has proven similarly therapeutic for lung health. Lung diseases like chronic bronchitis, emphysema, and asthma shrink the passageways that carry oxygen, while weakening the membrane that brings oxygen into the blood. But breathing exercises like those found in yoga relax the muscles constricting those passageways and improve oxygen diffusion. Increasing the blood’s oxygen content is especially helpful for those with weak heart muscles who have difficulty pumping enough oxygen throughout the body. And for those with healthy hearts, this practice can lower blood pressure and reduce risk factors for cardiovascular disease. Yoga’s most widely celebrated benefit may be the most difficult to prove: its psychological effects. Despite the longstanding association between yoga and psychological wellbeing, there’s little conclusive evidence on how the practice affects mental health. One of the biggest claims is that yoga improves symptoms of depression and anxiety disorders. Since diagnosis of these conditions varies widely as do their origin and severity, it’s difficult to quantify yoga’s impact. However, there is evidence to suggest that yoga can help reduce the symptoms of stress, as well as meditation or relaxation. Research on the effects of yoga is still evolving. In the future, we’ll need larger studies, incorporating diverse participants, which can measure yoga’s impact on heart attacks, cancer rates, cognitive function and more. But for now, yoga can continue its ancient tradition as a way to exercise, reflect, and relax.

**P876 2020-06-11 Can steroids save your life - Anees Bahji**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=876)

Steroids: they’re infamous for their use in sports. But they’re also found in inhalers, creams to treat poison ivy and eczema, and shots to ease inflammation. The steroids in these medicines aren’t the same as the ones used to build muscle. In fact, they’re all based on yet another steroid— one our body produces naturally, and we can’t live without. Taking a step back, the reason there are so many different steroids is because the term refers to substances with a shared molecular structure, rather than shared effects on the body. Steroids can be naturally occurring or synthetic, but what all steroids have in common is a molecular structure that consists of a base of four rings made of 17 carbon atoms arranged in three hexagons and one pentagon. A molecule must contain this exact arrangement to be a steroid, though most also have side chains— additional atoms that can dramatically impact the molecule’s function. Steroids get their name from the fatty molecule cholesterol. In fact, our bodies make steroids out of cholesterol. That fatty cholesterol base means that steroids are able to cross fatty cell membranes and enter cells. Within the cell, they can directly influence gene expression and protein synthesis. This is different from many other types of signaling molecules, which can’t cross the cell membrane and have to create their effects from outside the cell, through more complicated pathways. So steroids can create their effects faster than those other molecules. Back to the steroids in anti-inflammatory medications: all of these are based on a naturally occurring steroid called cortisol. Cortisol is the body’s primary stress signal, and it has a huge range of functions. When we experience a stressor— anything from a fight with a friend, to spotting a bear, to an infection or low blood sugar— the brain reacts by sending a signal from the hypothalamus to the pituitary gland. The pituitary gland then sends a signal to the adrenal glands. The adrenal glands produce cortisol, and release some constantly. But when they receive the signal from the pituitary gland, they release a burst of cortisol, which spurs the body to generate more glucose for energy, decrease functions not immediately related to survival, like digestion, and can activate a fight-flight-or-freeze response. This is helpful in the short term, but can cause undesirable side effects like insomnia and lowered mood if they last too long. Cortisol also interacts with the immune system in complex ways— depending on the situation, it can increase or decrease certain immune functions. In the process of fighting infection, the immune system often creates inflammation. Cortisol suppresses the immune system’s ability to produce inflammation, which, again, can be useful in the short term. But too much cortisol can have negative impacts, like reducing the immune system’s ability to regenerate bone marrow and lymph nodes. To prevent levels from staying high for too long, cortisol suppresses the signal that causes the adrenal glands to release more cortisol. Medicinal corticosteroids channel cortisol’s effects on the immune system to fight allergic reactions, rashes, and asthma. All these things are forms of inflammation. There are many synthetic steroids that share the same basic mechanism: they enhance the body’s cortisol supply, which in turn shuts down the hyperactive immune responses that cause inflammation. These corticosteroids sneak into cells and can turn off the “fire alarm” by suppressing gene expression of inflammatory signals. The steroids in inhalers and creams impact only the affected organ— the skin, or the lungs. Intravenous or oral versions, used to treat chronic autoimmune conditions like lupus or inflammatory bowel disease, impact the whole body. With these conditions, the body’s immune system attacks its own cells, a process analogous to a constant asthma attack or rash. A constant low dose of steroids can help keep this renegade immune response under control— but because of the negative psychological and physiological effects of longterm exposure, higher doses are reserved for emergencies and flare-ups. While an asthma attack, poison ivy welts, and irritable bowel syndrome might seem totally unrelated, they all have something in common: an immune response that’s doing more harm than good. And while corticosteroids won’t give you giant muscles, they can be the body’s best defense against itself.

**P877 2020-06-12 Prohibition - Banning alcohol was a bad idea... - Rod Phillips**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=877)

On January 17, 1920, six armed men robbed a Chicago freight train. But it wasn’t money they were after. Less than one hour after spirits had become illegal throughout the United States, the robbers made off with thousands of dollars worth of whiskey. It was a first taste of the unintended consequences of Prohibition. The nationwide ban on the production and sale of alcohol in the United States came on the heels of a similar ban in Russia that started as a wartime measure during World War I. But the view in the Western world of alcohol as a primary cause of social ills was much older. It first gained traction during the Industrial Revolution as new populations of workers poured into cities and men gathered in saloons to drink. By the 19th century, anti-drinking groups called temperance movements began to appear in the United States and parts of Europe. Temperance groups believed that alcohol was the fundamental driver behind problems like poverty and domestic violence, and set out to convince governments of this. While some simply advocated moderate drinking, many believed alcohol should be banned entirely. These movements drew support from broad sectors of society. Women’s organizations were active participants from the beginning, arguing that alcohol made men neglect their families and abuse their wives. Religious authorities, especially Protestants, denounced alcohol as leading to temptation and sin. Progressive labor activists believed alcohol consumption harmed workers’ ability to organize. Governments weren’t strangers to the idea of prohibition, either. In the United States and Canada, white settlers introduced hard liquors like rum to Native communities, then blamed alcohol for disrupting these communities— though there were many other destructive aspects of their interactions. The American and Canadian governments banned the sale of alcohol to Native populations and on reservation land. American temperance movements gained their first victories at the state and local levels, with Maine and several other states banning the sale and production of liquor in the 1850s. In 1919 the 18th Amendment to the US Constitution banned the manufacture, sale, and transportation of all alcoholic beverages. The amendment took effect a year later under the Volstead Act. Since the act did not ban personal consumption, wealthy people took the opportunity to stock up while restaurants and bars rushed to sell their remaining supply. Workers lost their jobs as distilleries, breweries, and wineries closed down. Meanwhile, organized crime groups rushed to meet the demand for alcohol, establishing a lucrative black market in producing, smuggling, and selling illicit liquor. Often they worked side-by side with corrupt policemen and government officials, even bombing the 1928 primary election for Illinois state attorney in support of a particular political faction. Tens of thousands of illegal bars, known as "speakeasies," began serving alcohol. They ranged from dingy basement bars to elaborate dance-halls. People could also make alcohol at home for their own consumption, or obtain it legally with a doctor’s prescription or for religious purposes. To prevent industrial alcohol from being consumed, the government required manufacturers to add harmful chemicals, leading to thousands of poisoning deaths. We don’t know exactly how much people were drinking during Prohibition because illegal alcohol wasn’t regulated or taxed. But by the late 1920s, it was clear that Prohibition had not brought the social improvements it had promised. Instead it contributed to political corruption and organized crime and was flouted by millions of citizens. At one raid on an Detroit beer hall, the local sheriff, mayor and a congressman were arrested for drinking. With the start of the Great Depression in 1929, the government sorely needed the tax revenue from alcohol sales, and believed that lifting Prohibition would stimulate the economy. In 1933, Congress passed the 21st Amendment repealing the 18th— the only amendment to be fully repealed. Members of the temperance movements believed that alcohol was the root of society’s problems, but the reality is more complicated. And while banning it completely didn’t work, the health and social impacts of alcohol remain concerns today.

**P878 2020-06-15 Can you solve the Ragnarok riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=878)

Ragnarok. The fabled end of the world, when giants, monsters, and Norse gods battle for the future. The gods were winning handily until the great serpent Jörmungandr emerged. It swallowed Valhalla, contorted itself across the land, and then merged into one continuous body with no head and no tail. As it begins to digest Valhalla, an exhausted Odin explains that he has just enough power to strike the creature with one final bolt of lightning. If you magnify his blast with your fabled hammer, Mjölnir, it should pierce the massive serpent. You’ll run with super-speed along the serpent’s body. When you hold your hammer high, Odin will strike it with lightning and split Jörmungandr open at that point. Then, you’ll need to continue running along its body until every part of it is destroyed. You can’t run over the same section twice or you’ll fall into the already blasted part of the snake. But you can make multiple passes through points where the creature intersects its own body. If you leave any portion un-zapped, Jörmungandr will magically regenerate, Odin’s last power will be spent, and Valhalla will fall forever. What path can you take to destroy the serpent? Pause now to figure it out yourself! Answer in 3 2 1 One powerful way to solve problems is to simplify. And in this case, we can focus our attention on the two things that are important for our path: intersections and the stretches of snake between them. Or, as they’re referred to in graph theory, nodes and edges. The edges are important because they’re what we need to travel. And the nodes matter because they connect the edges, and are where we may need to make choices as we run from edge to edge. This simplification into nodes and edges leaves us with a ubiquitous and important mathematical object known as a graph, or network. We just need to figure out how to travel what mathematicians call an Eulerian path, which traces every edge exactly once. Instead of looking at the path as a whole, let’s zoom in on a single node. During some moment in your run, you’ll enter that node, and then exit it. That takes care of two edges. If you enter again, you’ll need to exit again too, which requires another pair of edges. So every point along your path will have edges that come in pairs. One edge in each pair will function as entrance; the other as exit. And that means that the number of edges coming out of every node must be even. There are just two exceptions: the start and end points, where you can exit without entering, or vice versa. If we look at the network formed by the serpent again, and number how many edges emerge from each node, a pattern jumps out that fits what we just saw. Every node has an even number of edges emerging from it, except two. So one of these must be the start of your route, and the other the end. Interestingly enough, any connected network that has exactly 2 nodes with an odd number of edges will also contain an Eulerian path. The same is true if there are no nodes with an odd number of edges— in that case the path starts and ends in the same spot. So knowing that, let’s return to our full graph. We can begin by taking care of this edge here. Now we can zig-zag back and forth across the whole snake until we reach the end. And that's just one solution— it helps to be systematic, but you’re likely to happen upon many others once you know where to begin and end your run. You hold your hammer high at the opportune moment, and Odin sends the world-saving surge of lightning at you. Then you run like you’ve never run before. If you can pull this off, surely nothing could stop the might of the Norse Gods. And if something like that were out there, slouching its way towards you… well, that would be a story for another day.

**P879 2020-06-18 A day in the life of a teenage samurai - Constantine N. Vaporis**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=879)

It’s just after sunrise, and 16-year-old Mori Banshirô is already hard at work practicing drills with his long sword. Banshirô is an ambitious samurai in training, and today he must impress his teachers more than ever. Today he’ll make his request to travel to the capital city of Edo for a year of martial and scholarly studies, and he needs their support, along with his father’s. The year is 1800 in the castle town of Kôchi, capital of the Tosa domain in Japan. The daimyo rules the domain, and about 1,500 samurai retainers serve him. For 200 years, Japan has been at peace, and the samurai, once primarily warriors, now play a much wider range of roles— they are also government officials, scholars, teachers, and even masters of the tea ceremony or artists. To prepare for these diverse responsibilities, young samurai like Banshirô study the “twin paths” of literary learning and the martial arts. At 15, he went through the rites of adulthood and received the daishô— a pair of swords. The long sword is for training and combat, while the short sword has a sole, solemn purpose— to commit ritual suicide, or seppuku, if he dishonors himself, his family, or the daimyo. Banshirô idolizes the legendary samurai Miyamoto Musashi, a renowned swordsman who lived 150 years earlier. But Banshirô doesn’t admire his swordsmanship alone. Miyamoto Musashi was also a master calligrapher and painter. That’s the real reason Banshirô wants to go to Edo— he secretly wants to be a painter, too. After finishing his practice at home, he bids his father goodbye and walks to school. His father is preparing to accompany the daimyo to the capital. The Tokugawa shogun, head of the Japanese military government, requires all the regional rulers to alternate years between their castle town in the home domain and the capital city. The costly treks back and forth keep the daimyo subordinate and prevent them from building up their own military forces to challenge the shogunate. The daimyo’s wife and children live in the capital full time, where they serve as hostages to ensure his loyalty. But the practice doesn’t just affect the daimyo— it determines much of the rhythm of life in Japan. Samurai must accompany the daimyo to Edo. This year it’s Banshirô’s father’s turn to go, and Banshirô is desperate to go with him; but given that he’s still in training, he’ll need permission from both his father and the domain. At school, Banshirô’s first lesson is in swordfighting. Under his teacher’s stern eye, he pairs up with his classmates and goes through the routines he’s been practicing. At the end of the lesson, he reminds the instructor of his request to go to Edo. The instructor cracks his first smile of the day, and Banshirô feels confident he will gain his support. Next, Banshirô practices archery, horsemanship, and swimming before his academic courses in the afternoon. Courses cover Confucian philosophy, morality, and history. When the instructor calls on him, he has the response on the tip of his tongue, ensuring another supporter for his campaign. By the end of the day, Banshirô feels confident that his formal request will be approved, but the greatest challenge is still ahead of him: convincing his father. His father believes the martial arts are more important than the literary arts, so Banshirô doesn’t mention his artistic ambitions. Instead, he talks about renowned sword instructors he can train with, and teaching certifications he can earn to improve his professional prospects back in Kôchi. Then, he makes his final, strongest argument: if he goes this time and succeeds, his father can retire and send him instead in the future. It’s this last point that finally sells him— Banshirô’s father agrees to take him on his tour of duty. In the bustle of the capital city, Banshirô will finally have the opportunity to pursue his secret ambition to become a painter.

**P880 2020-06-18 The tale of the boy who tricked the Devil - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=880)

In the sun-dappled streets of a small town, a proud mother showed off her newborn son. Upon noticing his lucky birthmark, townsfolk predicted he would marry a princess. But soon, these rumors reached the ears of the wicked king. Enraged, the king stole the child away, and sent him hurtling down the river. But the infant’s luck proved greater than the king’s plan. Years later, the king was traveling his realm, when he spotted a strapping young man with an uncanny birthmark. After confirming the child’s origins, the sly king entrusted the boy with a letter for the queen. The youth eagerly set out to deliver the message— not knowing he was carrying his own death sentence. That night, roaming bandits stumbled upon his camp. Yet when they read the brutal letter, they were filled with pity. Deciding to make trouble for the king instead, they scribbled a new note. As soon as the youth arrived at the palace, he locked eyes with the princess. The two felt destined for each other. And when the queen read that the king approved this union, she joyfully organized a whirlwind wedding. When the king returned, he was furious. But he couldn’t execute his daughter’s beloved without reason. So he devised a diabolical trial. He ordered the youth to travel to Hell itself, and return with three golden hairs freshly plucked from the Devil’s head. Only upon succeeding could he return to his bride. The youth searched across the land for the entrance to Hell, until he finally reached an eerie village. Here, he saw some villagers gathered around a well. They closed in on the youth, refusing to let him pass until he answered their question: why was the well dry? The youth replied, “I will answer when I return.” They directed him further into town, where he came across another set of villagers contemplating a gnarled tree. They refused to let him pass until he answered their question: why was the tree barren? Again, the youth responded, “I will answer when I return." These villagers guided him to the dock, where an elderly ferryman awaited. As he paddled through the black water, the ferryman rasped a third question: how can I escape my interminable task? Once more, the youth promised, “I will answer when I return.” At last, they reached a hut sinking into the swampy banks of Hell. Reluctantly, the youth knocked on the rotting door. The devil’s grandmother answered his call. She was known to help some visiting souls, and harm others. The youth had just finished his story when they heard the devil’s footsteps. Without warning, the boy’s world appeared to shrink. The devil’s grandmother lifted him into the folds of her sleeve, and welcomed her grandson. The old woman set to work, lavishing the devil with food and drink. When he fell asleep, she deftly plucked three gleaming hairs from his head. With each plucked hair, the Devil briefly awoke and complained about his dreams, full of nearby villagers and their problems. The next morning, the youth departed— armed with three golden hairs, and three pieces of information. He shared the devil’s first dream with the ferryman. If the boatman could hand his oars to a willing passenger, he would be free from his task. Back at the village, the youth declared that there was a mouse gnawing at the root of the tree, and an enormous toad blocking the well. The villagers rewarded him handsomely for his help. Back from his journey, the youth thrust the devil’s hairs at the king— but his greedy father-in-law only had eyes for the gold. The sly youth told the king that even greater wealth awaited him across the river. Immediately, the king hastened to the riverbank. Eager to claim his riches, he held out his hands impatiently to the grinning ferryman— who happily handed over his oars.

**P881 2020-06-24 The race to decode a mysterious language - Susan Lupack**

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In the early 1900s on the island of Crete, British archaeologist Sir Arthur Evans uncovered nearly 3,000 tablets inscribed with strange symbols. He thought these symbols represented the language spoken by Europe’s oldest civilization. Their meaning would elude scholars for 50 years. Evans discovered these tablets amid the colorful frescoes and maze-like hallways of the palace of Knossos. He called the civilization Minoan— after the mythical Cretan ruler, King Minos. He thought the script, dubbed Linear B, represented the Minoan language, and scholars all over the world came up with their own theories. Was it the lost language of the Etruscans? Or perhaps it represented an early form of Basque? The mystery intensified because Evans guarded the tablets closely–– only 200 of the inscriptions were published during his lifetime–– but he couldn’t decipher the script. However, he did make two accurate observations: the tablets were administrative records, and the script was a syllabary, where each symbol represented both a consonant and a vowel, mixed with characters that each represented a whole word. Evans worked on Linear B for three decades before a scholar from Brooklyn, New York, named Alice Kober set out to solve the mystery. Kober was a professor of Classics at Brooklyn College when few women held such positions. To help in her quest, she taught herself many languages–– knowledge she knew she would need to decipher Linear B. For the next two decades, she analyzed the symbols. Working from the few available inscriptions, she recorded how often each symbol appeared. Then she recorded how frequently each symbol appeared next to another. She stored her findings on scrap paper in cigarette cartons because writing supplies were scarce during the Second World War. By analyzing these frequencies, she discovered that Linear B relied on word endings to give its sentences grammar. From this she began to build a chart of the relations between the signs, coming closer than anyone before to deciphering Linear B. But she died, probably of cancer, in 1950 at the age of 43. While Kober was analyzing the Knossos tablets, an architect named Michael Ventris was also working to crack Linear B. He had become obsessed with Linear B as a schoolboy after hearing Evans speak. He even worked on deciphering the script while serving in World War II. After the war, Ventris built on Kober’s grid using a newly published cache of Linear B inscriptions excavated from a different archeological site called Pylos, on mainland Greece. His real breakthrough came when he compared the tablets from Pylos with those from Knossos and saw that certain words appeared on tablets from one site but not the other. He wondered if those words represented the names of places specific to each location. He knew that over centuries, place names tend to remain constant, and decided to compare Linear B to an ancient syllabary from the island of Cyprus. The Cypriot script was used hundreds of years after Linear B, but some of the symbols were similar— he wondered if the sounds would be similar, too. When Ventris plugged some of the sounds of the Cypriot syllabary into the Linear B inscriptions, he came up with the word Knossos, the name of the city where Evans had discovered his tablets. In a domino effect, Ventris unraveled Linear B, with each word revealing more clearly that the language of Linear B was not Minoan, but Greek. Ventris died in a car crash four years later, at the age of 34. But his discovery rewrote a chapter of history. Evans had insisted that the Minoans conquered the mainland Greeks, and that was why examples of Linear B were found on the mainland. But the discovery that Linear B represented Greek, and not Minoan, showed that the opposite had happened: mainland Greeks invaded Crete and adopted the Minoan script for their own language. But the story isn’t over yet. The actual language of the Minoans, represented by another script called Linear A, has yet to be deciphered. It remains a mystery— at least for now.

**P882 2020-06-25 The rise and fall of the Celtic warriors - Philip Freeman**

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One summer evening in 335 BCE, Alexander the Great was resting by the Danube River after a day of fighting the Scythian tribes when a band of strangers approached his camp. Alexander had never seen anything like these tall, fierce-looking warriors with huge golden neck rings and colorful cloaks— so he invited them to feast with him. They proudly said they were Keltoi or Celts who came from the far-away Alps. Alexander asked what they feared the most in the world, hoping they would say him. They laughed and said they feared nothing at all. This is one of the earliest stories about the ancient Celts. While we don’t know where the first Celts came from, by Alexander’s time they had spread across Europe from Asia Minor in the east to Spain and the Atlantic islands of Britain and Ireland in the west. The Celts were never one unified empire, and they didn’t build cities or monuments. Instead, they were hundreds of independent tribes who spoke the same language. Each had its own warrior-king and religious center. The tribes fought each other as enthusiastically as they fought their enemies. Few armies could stand up to them. Somewhat unusually for the time, the Celts believed in reincarnation— that they would be reborn on Earth to live and feast and fight again, which may have contributed to their fearlessness in battle. Some of them fought naked, scoffing at their enemies’ armor. The greatest trophy a Celtic warrior could possess was the severed head of a foe. They preserved these heads in jars of cedar oil and showed them to guests who visited their homes. Celtic warriors were so valued in the ancient world that foreign kings often hired them as mercenary soldiers to serve in their armies. But the Celts were much more than just warriors. Among them were many skilled craftsmen, artists, and great poets called bards. The bards sang of the brave deeds of their ancestors and praised the accomplishments of warrior kings— and composed biting satires about cowardly or selfish leaders. The Celts worshipped many gods, and priests known as druids oversaw this worship. Anyone could become a druid, but the training required many years of study and memorization— the druids were not allowed to record any of their teachings in writing. Druids supervised religious practices and sacrifices to the gods, but they were also teachers, healers, judges, and scientists. They were so respected that they could step between warring tribes in the middle of a battle and call an end to the fighting. No Celt would dare to harm a druid, or question their decisions. In the 2nd century BCE, the Romans began to encroach on Celtic territory, conquering the tribes of northern Italy. Rather than unite against the Roman legions in response to this defeat, the Celts maintained their tribal divisions. The tribes of Spain fell soon after. In the 1st century BCE, Julius Caesar marched his armies across France, using bribery, threats, and lies to turn tribes against each other. Only in the closing days of this great war did the Celts unite against their common enemy under the leadership of king Vercingetorix, but it was too late. Countless warriors and their families died or were enslaved as the Romans conquered France. Protected by the surrounding waters, the Celtic tribes of Britain and Ireland were the last holdouts. When the Romans finally invaded Britain, the queen Boudicca united her tribe in a revolt after her husband was killed. She almost succeeded in driving the Roman legions out of Britain before dying as she led a final battle against the enemy. By the end of the 1st century CE, Ireland alone, far out at sea, remained unconquered by Rome. There, the ways of the ancient Celts survived untouched by the outside world long after Rome itself lay in ruins.

**P883 2020-06-26 The Egyptian myth of the death of Osiris - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=883)

It was a feast like Egypt had never seen before. The warrior god Set and his wife, the goddess Nephtys, decorated an extravagant hall for the occasion, with a beautiful wooden chest as the centerpiece. They invited all the most important gods, dozens of lesser deities, and foreign monarchs. But no one caused as big a stir as Set and Nephtys’s older brother Osiris, the god who ruled all of Egypt and had brought prosperity to everyone. Set announced a game— whoever could fit perfectly in the chest could have it as a gift. One by one, the guests clambered in, but no one fit. Finally, it was Osiris’s turn. As he lay down, everyone could see it was a perfect fit— another win for the god who could do no wrong. Then Set slammed the lid down with Osiris still inside, sealed it shut, and tossed it into the Nile. The chest was a coffin. Set had constructed it specifically to trap his brother and planned the party to lure him into it. Set had long been jealous of his brother’s successful reign, and hoped to replace him as the ruler of all Egypt. The Nile bore the coffin out to sea and it drifted for many days before washing ashore near Byblos, where a great cedar grew around it. The essence of the god within gave the tree a divine aura, and when the king of Byblos noticed it, he ordered the tree cut down and brought to his palace. Unbeknownst to him, the coffin containing Egypt’s most powerful god was still inside. Set’s victory seemed complete, but he hadn’t counted on his sisters. Set’s wife Nephtys was also his sister, while their other sister, the goddess Isis, was married to their brother Osiris. Isis was determined to find Osiris, and enlisted Nephtys’s help behind Set’s back. The two sisters took the shape of falcons and travelled far and wide. Some children who had seen the coffin float by pointed them to the palace of Byblos. Isis adopted a new disguise and approached the palace. The queen was so charmed by the disguised goddess that she entrusted her with nursing the baby prince. Isis decided to make the child immortal by bathing him in flame. When the horrified queen came upon this scene, Isis revealed herself and demanded the tree. When she cut the coffin from the trunk and opened it, Osiris was dead inside. Weeping, she carried his body back to Egypt and hid it in a swamp, while she set off in search of a means of resurrecting him. But while she was gone, Set found the body and cut it into many pieces, scattering them throughout Egypt. Isis had lost Osiris for the second time, but she did not give up. She searched all over the land, traveling in a boat of papyrus. One by one, she tracked down the parts of her husband’s dismembered body in every province of Egypt, holding a funeral for each piece. At long last, she had recovered every piece but one— his penis, which a fish in the Nile had eaten. Working with what she had, Isis reconstructed and revived her husband. But without his penis, Osiris was incomplete. He could not remain among the living, could not return to his old position as ruler of Egypt. Instead, he would have to rule over Duat, the realm of the dead. Before he went, though, he and Isis conceived a son to bear Osiris’s legacy— and one day, avenge him.

**P884 2020-07-01 Volcanic eruption explained - Steven Anderson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=884)

In February of 1942, Mexican farmer Dionisio Pulido thought he heard thunder coming from his cornfield. However, the sound wasn’t coming from the sky. The source was a large, smoking crack emitting gas and ejecting rocks. This fissure would come to be known as the volcano Paricutin, and over the next 9 years, its lava and ash would cover over 200 square km. But where did this new volcano come from, and what triggered its unpredictable eruption? The story of any volcano begins with magma. Often, this molten rock forms in areas where ocean water is able to slip into the Earth’s mantle and lower the layer’s melting point. The resulting magma typically remains under the Earth’s surface thanks to the delicate balance of three geological factors. The first is lithostatic pressure. This is the weight of the Earth’s crust pushing down on the magma below. Magma pushes back with the second factor, magmastatic pressure. The battle between these forces strains the third factor: the rock strength of the Earth’s crust. Usually, the rock is strong enough and heavy enough to keep the magma in place. But when this equilibrium is thrown off, the consequences can be explosive. One of the most common causes of an eruption is an increase in magmastatic pressure. Magma contains various elements and compounds, many of which are dissolved in the molten rock. At high enough concentrations, compounds like water or sulfur no longer dissolve, and instead form high-pressure gas bubbles. When these bubbles reach the surface, they can burst with the force of a gunshot. And when millions of bubbles explode simultaneously, the energy can send plumes of ash into the stratosphere. But before they pop, they act like bubbles of C02 in a shaken soda. Their presence lowers the magma’s density, and increases the buoyant force pushing upward through the crust. Many geologists believe this process was behind the Paricutin eruption in Mexico. There are two known natural causes for these buoyant bubbles. Sometimes, new magma from deeper underground brings additional gassy compounds into the mix. But bubbles can also form when magma begins to cool. In its molten state, magma is a mixture of dissolved gases and melted minerals. As the molten rock hardens, some of those minerals solidify into crystals. This process doesn’t incorporate many of the dissolved gasses, resulting in a higher concentration of the compounds that form explosive bubbles. Not all eruptions are due to rising magmastatic pressure— sometimes the weight of the rock above can become dangerously low. Landslides can remove massive quantities of rock from atop a magma chamber, dropping the lithostatic pressure and instantly triggering an eruption. This process is known as “unloading” and it’s been responsible for numerous eruptions, including the sudden explosion of Mount St. Helens in 1980. But unloading can also happen over longer periods of time due to erosion or melting glaciers. In fact, many geologists are worried that glacial melt caused by climate change could increase volcanic activity. Finally, eruptions can occur when the rock layer is no longer strong enough to hold back the magma below. Acidic gases and heat escaping from magma can corrode rock through a process called hydrothermal alteration, gradually turning hard stone into soft clay. The rock layer could also be weakened by tectonic activity. Earthquakes can create fissures allowing magma to escape to the surface, and the Earth’s crust can be stretched thin as continental plates shift away from each other. Unfortunately, knowing what causes eruptions doesn’t make them easy to predict. While scientists can roughly determine the strength and weight of the Earth’s crust, the depth and heat of magma chambers makes measuring changes in magmastatic pressure very difficult. But volcanologists are constantly exploring new technology to conquer this rocky terrain. Advances in thermal imaging have allowed scientists to detect subterranean hotspots. Spectrometers can analyze gases escaping magma. And lasers can precisely track the impact of rising magma on a volcano’s shape. Hopefully, these tools will help us better understand these volatile vents and their explosive eruptions.

**P885 2020-07-07 The myth of Jason, Medea, and the Golden Fleece - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=885)

In the center of Colchis in an enchanted garden, the hide of a mystical flying ram hung from the tallest oak, guarded by a dragon who never slept. Jason would have to tread carefully to pry it from King Aeetes’ clutches and win back his promised throne. But diplomacy was hardly one of the Argonauts’ strengths. Jason would have to navigate this difficult task alone. Or so he thought. Leaving most of his bedraggled crew to rest, Jason made for the palace with some of his more even-tempered men. His first instinct was to simply ask the king for his prized possession. But Aeetes was enraged at the hero’s presumption. If this outsider wanted his treasure, he would have to prove his worth by facing three perilous tasks. The trials would begin the following day, and Jason was dismissed to prepare. But another member of the royal family was also plotting something. Thanks to the encouragement of Jason’s guardians on Mount Olympus, Medea, princess of Colchis and priestess of the witch goddess Hecate, had fallen in love with the challenger. She intended to protect her beloved from her father’s tricks — at any cost. After a sleepless night, Jason somberly marched to the castle— but was intercepted. The princess armed him with strange vials and trinkets, in exchange for a promise of eternal devotion. As they whispered and planned their victory, both hero and princess fell deeply under each other’s spell. Unaware of his daughter’s scheming, the king confidently led Jason to face his first task. The hero was brought to a huge field of oxen that lay between him and the fleece, and told that he had to plough the land around the crowds of oxen. A simple task— or so Jason thought. But Medea had concocted a fire-proof ointment, and so he plowed the flickering fields unscathed. For the second task, he was given a box of serpent’s teeth to plant into the scorched earth. As soon as Jason scattered them, each seed sprouted into a bloodthirsty warrior. They burst up around him, barricading his way forward, but Medea had prepared him for this task as well. Hurling a heavy stone she had given him into their midst, the fighters turned on themselves as they scrabbled for it, letting him slip by the fray. For the third task, Jason was finally face to face with the guardian of the Fleece. Dodging sharp claws and singeing breath, Jason scrambled up the tree and sprinkled a sweet-smelling concoction over the dragon. As the strains of Medea’s incantations reached its ears and the potion settled in its eyes, the dragon sank into a deep sleep. Elated, Jason climbed to the top of the tallest oak, where he slipped the gleaming fleece off its branch. When the king saw the hero sprinting away— not only with the fleece, but his daughter in tow— he realized he had been betrayed. Furious, he sent an army led by his son Absyrtus to bring the ill-gotten prize and his conniving daughter home. But all the players in this tale had underestimated the viciousness of these disgraced lovers. To the horror of the Gods, Jason ran his sword through Absyrtus in cold blood. Medea then helped him scatter pieces of the body along the shore, distracting her grieving father while the Argonauts escaped. As Colchis and their pursuers grew smaller on the horizon, a solemn silence fell aboard the Argo. Jason could now return to Thessaly victorious— but his terrible act had tarnished his crew’s honor, and turned the Gods against them. Buffeted by hostile winds, the wretched crew washed up on the island of Circe the sorceress. Medea begged her aunt to absolve them of wrongdoing— but bloody deeds are not so easily forgotten, and fallen heroes not so rapidly redeemed.

**P886 2020-07-10 How do our brains process speech - Gareth Gaskell**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=886)

The average 20 year old knows between 27,000 and 52,000 different words. By age 60, that number averages between 35,000 and 56,000. Spoken out loud, most of these words last less than a second. So with every word, the brain has a quick decision to make: which of those thousands of options matches the signal? About 98% of the time, the brain chooses the correct word. But how? Speech comprehension is different from reading comprehension, but it’s similar to sign language comprehension— though spoken word recognition has been studied more than sign language. The key to our ability to understand speech is the brain’s role as a parallel processor, meaning that it can do multiple different things at the same time. Most theories assume that each word we know is represented by a separate processing unit that has just one job: to assess the likelihood of incoming speech matching that particular word. In the context of the brain, the processing unit that represents a word is likely a pattern of firing activity across a group of neurons in the brain’s cortex. When we hear the beginning of a word, several thousand such units may become active, because with just the beginning of a word, there are many possible matches. Then, as the word goes on, more and more units register that some vital piece of information is missing and lose activity. Possibly well before the end of the word, just one firing pattern remains active, corresponding to one word. This is called the "recognition point." In the process of honing in on one word, the active units suppress the activity of others, saving vital milliseconds. Most people can comprehend up to about 8 syllables per second. Yet, the goal is not only to recognize the word, but also to access its stored meaning. The brain accesses many possible meanings at the same time, before the word has been fully identified. We know this from studies which show that even upon hearing a word fragment— like "cap"— listeners will start to register multiple possible meanings, like captain or capital, before the full word emerges. This suggests that every time we hear a word there’s a brief explosion of meanings in our minds, and by the recognition point the brain has settled on one interpretation. The recognition process moves more rapidly with a sentence that gives us context than in a random string of words. Context also helps guide us towards the intended meaning of words with multiple interpretations, like "bat," or "crane," or in cases of homophones like "no" or "know." For multilingual people, the language they are listening to is another cue, used to eliminate potential words that don’t match the language context. So, what about adding completely new words to this system? Even as adults, we may come across a new word every few days. But if every word is represented as a fine-tuned pattern of activity distributed over many neurons, how do we prevent new words from overwriting old ones? We think that to avoid this problem, new words are initially stored in a part of the brain called the hippocampus, well away from the main store of words in the cortex, so they don’t share neurons with others words. Then, over multiple nights of sleep, the new words gradually transfer over and interweave with old ones. Researchers think this gradual acquisition process helps avoid disrupting existing words. So in the daytime, unconscious activity generates explosions of meaning as we chat away. At night, we rest, but our brains are busy integrating new knowledge into the word network. When we wake up, this process ensures that we’re ready for the ever-changing world of language.

**P887 2020-07-14 No one can figure out how eels have sex - Lucy Cooke**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=887)

From Ancient Greece to the 20th century, Aristotle, Sigmund Freud, and numerous other scholars were all looking for the same thing: eel testicles. Freshwater eels, or Anguilla Anguilla, could be found in rivers across Europe, but no one had ever seen them mate. And despite countless dissections, no researcher could find eel eggs or identify their reproductive organs. Devoid of data, naturalists proposed various eel origin stories. Aristotle suggested that eels spontaneously emerged from mud. Pliny the Elder argued eels rubbed themselves against rocks, and the subsequent scrapings came to life. Eels were said to hatch on rooftops, manifest from the gills of other fish, and even emerge from the bodies of beetles. But the true story of eel reproduction is even more difficult to imagine. And to solve this slippery mystery, scholars would have to rethink centuries of research. Today, we know the freshwater eel lifecycle has five distinct stages: larval leptocepheli, miniscule glass eels, adolescent elvers, older yellow eels, and adult silver eels. Given the radical physical differences between these phases, you’d be forgiven for assuming these are different animals. In fact, that’s exactly what European naturalists thought. Researchers were aware of leptocepheli and glass eels, but no one guessed they were related to the elvers and yellow eels living hundreds of kilometers upstream. Confusing matters more, eels don’t develop sex organs until late in life. And the entirety of their time in the rivers of Europe is essentially eel adolescence. So when do eels reproduce, and where do they do it? Despite its name, the life of a freshwater eel actually begins in the salty waters of the Bermuda Triangle. At the height of the annual cyclone season, thousands of three-millimeter eel larvae drift out of the Sargasso Sea. From here, they follow migration paths to North America and Europe— continents that were much closer when eels established these routes 40 million years ago. Over the next 300 days, Anguilla Anguilla larvae ride the ocean currents 6,500 km to the coast of Europe— making one of the longest known marine migrations. By the time they arrive, they’ve grown approximately 45 mm, and transformed into semi-transparent glass eels. It’s not just their appearance that’s changed. If most marine fish entered brackish coastal waters, their cells would swell with freshwater in a lethal explosion. But when glass eels reach the coast, their kidneys shift to retain more salt and maintain their blood’s salinity levels. Swarms of these newly freshwater fish migrate up streams and rivers, sometimes piling on top of each other to clear obstacles and predators. Those that make it upstream develop into opaque elvers. Having finally arrived in their hunting grounds, elvers begin to eat everything they can fit into their mouths. These omnivores grow in proportion to their diets, and over the next decade they develop into larger yellow eels. In this stage, they grow to be roughly 80 cm, and finally develop sexual organs. But the last phase of eel life— and the secret of their reproduction— remains mysterious. In 1896, researchers identified leptocepheli as larval eels, and deduced that they had come to Europe from somewhere in the Atlantic. However, to find this mysterious breeding ground, someone would have to perform an unthinkable survey of the ocean for larvae no larger than 30mm. Enter Johannes Schmidt. For the next 18 years, this Danish oceanographer trawled the coasts of four continents, hunting down increasingly tiny leptocepheli. Finally, in 1921, he found the smallest larvae yet, on the southern edge of the Sargasso Sea. Despite knowledge of their round trip migration, scientists still haven’t observed mating in the wild, or found a single eel egg. Leading theories suggest that eels reproduce in a flurry of external fertilization, in which clouds of sperm fertilize free-floating eggs. But the powerful currents and tangling seaweed of the Sargasso Sea have made this theory difficult to confirm. Researchers don’t even know where to look, since they’ve yet to successfully track an eel over the course of its return migration. Until these challenges can be met, the eel’s ancient secret will continue to slip through our fingers.

**P888 2020-07-16 The myth of Ireland's two greatest warriors - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=888)

Cú Chulainn, hero of Ulster, stood at the ford at Cooley, ready to face an entire army singlehandedly— all for the sake of a single bull. The army in question belonged to Queen Meadhbh of Connaught. Enraged at her husband’s possession of a white bull of awesome strength, she had set out to capture the fabled brown bull of Ulster at any cost. Unfortunately, the King of Ulster had chosen this moment to force the goddess Macha to race her chariot while pregnant. In retaliation, she struck down him and his entire army with stomach cramps that eerily resembled childbirth— all except Cú Chulainn. Though he was the best warrior in Ulster, Cú Chulainn knew he could not take on Queen Meadhbh’s whole army at once. He invoked the sacred rite of single combat in order to fight the intruders one by one. But as Queen Meadhbh’s army approached, one thing worried him more than the grueling ordeal ahead. Years before, Cú Chulainn had travelled to Scotland to train with the renowned warrior Scáthach. There, he met a young warrior from Connaught named Ferdiad. They lived and trained side-by-side, and soon became close friends. When they returned to their respective homes, Cú Chulainn and Ferdiad found themselves on opposite sides of a war. Cú Chulainn knew Ferdiad was marching in Meadhbh’s army, and that if he succeeded in fending off her troops, they would eventually meet. Day after day, Cú Chulainn defended Ulster alone. He sent the heads of some of his adversaries back to Meadhbh’s camp, while the rushing waters of the ford carried others away. At times, he slipped into a trance and slayed hundreds of soldiers in a row. Whenever he saw the queen in the distance, he hurled stones at her— never quite hitting her, but once coming close enough to knock a squirrel off her shoulder. Back at the Connaught camp, Ferdiad was laying low, doing everything he could to avoid the moment when he’d have to face his best friend in combat. But the Queen was impatient to get her hands on the prize bull, and she knew Ferdiad was her best chance to defeat Cú Chulainn. So she goaded him and questioned his honor until he had no choice but to fight. The two faced off at the ford, matching each other exactly in strength and skill no matter what weapons they used. Then, on the third day of their fight, Ferdiad began to gain the upper hand over the exhausted Cu Chulainn. But Cú Chulainn had one last trick up his sleeve: their teacher had shared a secret with him alone. She told him how to summon the Gáe Bulg, a magical spear fashioned from the bones of sea monsters that lay at the bottom of the ocean. Cu Chulainn called the spear, stabbed Ferdiad to death, and collapsed. Meadhbh seized her chance and swooped in with the rest of her army to capture the brown bull. At last, the men of Ulster were recovering from their magical illness, and they surged out in pursuit. But they were too late: Queen Meadhbh crossed the border unscathed, dragging the brown bull with her. Once home, Meadhbh demanded another battle, this time between the brown bull and her husband’s white bull. The bulls were well matched, and struggled into the night, dragging each other all over Ireland. At long last, the brown bull killed the white bull, and Queen Meadhbh was finally satisfied. But the brown bull’s victory meant nothing to him. He was tired, injured, and devastated. Soon after, he died of a broken heart, leaving behind a land that would remain ravaged by Meadhbh’s war for years to come.

**P889 2020-07-17 Can you solve the honeybee riddle - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=889)

You’re a biologist on a mission to keep the rare honeybee Apis Trifecta from going extinct. The last 60 bees of the species are in your terrarium. You’ve already constructed wire frames of the appropriate size and shape. Now you need to turn them into working beehives by helping the bees fill every hex with wax. There are two ways to fill a given hex. The first is to place a bee into it. Once placed, a bee cannot be removed without killing it. The second: if at any point an unfilled hex has three or more neighboring wax-filled hexes, the bees already in the hive will move in and transform it. Once the bees have transformed every hex in a hive, you can place an additional bee inside and it’ll specialize into a queen. The hive, if well cared for, will eventually produce new bees and continue the species. If there are no hexes with three or more transformed neighbors, the bees will just sit and wait. And once a bee transforms a hex, it can never become a queen. You could put 59 bees in one wire hive, wait till they transform all the hexes, and then create a queen. But then just one collapse would end the species. The more viable hives you can make now, the better. So how many can you make with 60 bees? Pause the video to figure it out yourself Answer in 3 Answer in 2 Answer in 1 Answer in 0 What you're looking for here is some kind of self-sustaining chain reaction, where a small number of bees will transform an entire hive. The lower the number of bees needed, the better. So how low can we go, and how can we engineer a chain reaction? Let’s start with the first question. There's a really clever approach to this, which involves counting the sides of the filled-in hexes, and examining their total perimeter. Let’s suppose we put bees in these three hexes. The total transformed perimeter has 18 sides. But the middle hex has three transformed neighbors, so the bees will transform it too. What happens to the perimeter? It’s still 18! And even after the bees transform the next sets of hexes with three neighbors, it still won’t change. What’s going on here? Each hex that has at least three sides touching the bee-friendly space will remove those sides from the perimeter when it transforms. Then it adds at most three new sides to the perimeter. So the perimeter of the transformed hexes will either stay the same or shrink. The final perimeter of the entire hive is 54, so the total perimeter of the hexes we place bees in at the start must be at least 54 as well. Dividing that 54 by the six sides on each non-adjacent hex tells us it’ll take at least 9 bees to transform the entire hive. That’s a great start, but we still have the tough question of where the nine bees should go, and if we’ll need more. Let’s think smaller. We already know that three bees could completely transform a hive this big. What about a slightly bigger one? The perimeter of this hive is 30, which means we’ll need at least 5 bees to fill it in. With 6 it’d be easy. Placing them like this would fill out the whole hive in just three steps. But we can do better! We don’t actually need to place a bee on this hex, since the other bees will transform that spot on their own. It looks like we have the beginning of a pattern. Can we extend it to our full hive? That would mean placing our 9 bees like so. Once they get to work, they’ll create a chain reaction that fills in the center of the hive and extend it to its edges. Add a 10th bee to the completed hive and it becomes a queen. Repeat that process five more times and you’ve helped the last 60 members of Apis trifecta create 6 producing hives. All in all, it’s a pretty good bee-ginning.

**P890 2020-07-17 Ethical dilemma - The burger murders - George Siedel and Christine La**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=890)

A few years ago, you founded a company that manufactures meatless burgers. Your product is now sold in stores worldwide. But you’ve recently received awful news: three unrelated people in one city died after eating your burgers. The police concluded that a criminal targeted your brand, injecting poison into your product in at least two grocery stores. The culprit used an ultrafine instrument that left no trace on the packaging, making it impossible to determine which products were compromised. Your burgers were immediately removed from the two stores where the victims bought them. The deaths are headline news, the killer is still at large, and sales have plummeted. You must quickly develop a strategy to deal with the crisis. Your team comes up with three options: 1. Do nothing. 2. Pull the products from grocery stores citywide and destroy them. Or 3. Pull and destroy the product worldwide. Which do you choose? Your company lawyer explains that a recall is not required by law because the criminal is fully responsible. She recommends the first option— doing nothing— because recalling the product could look like an admission of fault. But is that the most ethical strategy? To gauge the ethicality of each choice, you could perform a “stakeholder analysis.” This would allow you to weigh the interests of some key stakeholders— investors, employees, and customers— against one another. With the first option your advisors project that the crisis will eventually blow over. Sales will then improve but probably stay below prior levels because of damage to the brand. As a result, you’ll have to lay off some employees, and investors will suffer minor losses. But more customers could die if the killer poisoned packages elsewhere. The second option is expensive in the short-term and will require greater employee layoffs and additional financial loss to investors. But this option is safer for customers in the city and could create enough trust that sales will eventually rebound. The third option is the most expensive in the short-term and will require significant employee layoffs and investor losses. Though you have no evidence that these crimes are an international threat, this option provides the greatest customer protection. Given the conflict between the interests of your customers versus those of your investors and employees, which strategy is the most ethical? To make this decision, you could consider these tests: First is the Utilitarian Test: Utilitarianism is a philosophy concerned with maximizing the greatest amount of good for the greatest number of people. What would be the impact of each option on these terms? Second is the Family Test: How would you feel explaining your decision to your family? Third is the Newspaper Test: how would you feel reading about it on the front page of the local newspaper? And finally, you could use the Mentor Test: If someone you admire were making this decision, what would they do? Johnson & Johnson CEO James Burke faced a similar challenge in 1982 after a criminal added the poison cyanide to bottles of Tylenol in Chicago. Seven people died and sales dropped. Industry analysts said the company was done for. In response, Burke decided to pull Tylenol from all shelves worldwide, citing customer safety as the company’s highest priority. Johnson & Johnson recalled and destroyed an estimated 32 million bottles of Tylenol valued at 250 million in today’s dollars. 1.5 million of the recalled bottles were tested and 3 of them— all from the Chicago area— were found to contain cyanide. Burke’s decision helped the company regain the trust of its customers, and product sales rebounded within a year. Prompted by the Tylenol murders, Johnson & Johnson became a leader in developing tamper-resistant packaging and the government instituted stricter regulations. The killer, meanwhile, was never caught. Burke’s decision prevented further deaths from the initial poisoning, but the federal government investigated hundreds of copycat tampering incidents involving other products in the following weeks. Could these have been prevented with a different response? Was Burke acting in the interest of the public or of his company? Was this good ethics or good marketing? As with all ethical dilemmas, this has no clear right or wrong answer. And for your meatless burger empire, the choice remains yours.

**P891 2020-07-17 Is the weather actually becoming more extreme - R. Saravanan**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=891)

From 2016 to 2019, meteorologists saw record-breaking heat waves around the globe, rampant wildfires in California and Australia, and the longest run of category 5 tropical cyclones on record. The number of extreme weather events has been increasing for the last 40 years, and current predictions suggest that trend will continue. But are these natural disasters simply bad weather? Or are they due to our changing climate? To answer this question we need to understand the differences between weather and climate— what they are, how we predict them, and what those predictions can tell us. Meteorologists define weather as the conditions of the atmosphere at a particular time and place. Currently, researchers can predict a region’s weather for the next week with roughly 80% accuracy. Climate describes a region’s average atmospheric conditions over periods of a month or more. Climate predictions can forecast average temperatures for decades to come, but they can’t tell us what specific weather events to expect. These two types of predictions give us such different information because they’re based on different data. To forecast weather, meteorologists need to measure the atmosphere’s initial conditions. These are the current levels of precipitation, air pressure, humidity, wind speed and wind direction that determine a region’s weather. Twice every day, meteorologists from over 800 stations around the globe release balloons into the atmosphere. These balloons carry instruments called radiosondes, which measure initial conditions and transmit their findings to international weather centers. Meteorologists then run the data through predictive physics models that generate the final weather forecast. Unfortunately, there’s something stopping this global web of data from producing a perfect prediction: weather is a fundamentally chaotic system. This means it’s incredibly sensitive and impossible to perfectly forecast without absolute knowledge of all the system’s elements. In a period of just ten days, even incredibly small disturbances can massively impact atmospheric conditions— making it impossible to reliably predict weather beyond two weeks. Climate prediction, on the other hand, is far less turbulent. This is partly because a region’s climate is, by definition, the average of all its weather data. But also because climate forecasts ignore what’s currently happening in the atmosphere, and focus on the range of what could happen. These parameters are known as boundary conditions, and as their name suggests, they act as constraints on climate and weather. One example of a boundary condition is solar radiation. By analyzing the precise distance and angle between a location and the sun, we can determine the amount of heat that area will receive. And since we know how the sun behaves throughout the year, we can accurately predict its effects on temperature. Averaged across years of data, this reveals periodic patterns, including seasons. Most boundary conditions have well-defined values that change slowly, if at all. This allows researchers to reliably predict climate years into the future. But here’s where it gets tricky. Even the slightest change in these boundary conditions represents a much larger shift for the chaotic weather system. For example, Earth’s surface temperature has warmed by almost 1 degree Celsius over the last 150 years. This might seem like a minor shift, but this 1-degree change has added the energy equivalent of roughly one million nuclear warheads into the atmosphere. This massive surge of energy has already led to a dramatic increase in the number of heatwaves, droughts, and storm surges. So, is the increase in extreme weather due to random chance, or changing climate? The answer is that— while weather will always be a chaotic system— shifts in our climate do increase the likelihood of extreme weather events. Scientists are in near universal agreement that our climate is changing and that human activity is accelerating those changes. But fortunately, we can identify what human behaviors are impacting the climate most by tracking which boundary conditions are shifting. So even though next month’s weather might always be a mystery, we can work together to protect the climate for centuries to come.

**P892 2020-07-18 Newton’s three-body problem explained - Fabio Pacucci**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=892)

In 2009, two researchers ran a simple experiment. They took everything we know about our solar system and calculated where every planet would be up to 5 billion years in the future. To do so they ran over 2,000 numerical simulations with the same exact initial conditions except for one difference: the distance between Mercury and the Sun, modified by less than a millimeter from one simulation to the next. Shockingly, in about 1 percent of their simulations, Mercury’s orbit changed so drastically that it could plunge into the Sun or collide with Venus. Worse yet, in one simulation it destabilized the entire inner solar system. This was no error; the astonishing variety in results reveals the truth that our solar system may be much less stable than it seems. Astrophysicists refer to this astonishing property of gravitational systems as the n-body problem. While we have equations that can completely predict the motions of two gravitating masses, our analytical tools fall short when faced with more populated systems. It’s actually impossible to write down all the terms of a general formula that can exactly describe the motion of three or more gravitating objects. Why? The issue lies in how many unknown variables an n-body system contains. Thanks to Isaac Newton, we can write a set of equations to describe the gravitational force acting between bodies. However, when trying to find a general solution for the unknown variables in these equations, we’re faced with a mathematical constraint: for each unknown, there must be at least one equation that independently describes it. Initially, a two-body system appears to have more unknown variables for position and velocity than equations of motion. However, there’s a trick: consider the relative position and velocity of the two bodies with respect to the center of gravity of the system. This reduces the number of unknowns and leaves us with a solvable system. With three or more orbiting objects in the picture, everything gets messier. Even with the same mathematical trick of considering relative motions, we’re left with more unknowns than equations describing them. There are simply too many variables for this system of equations to be untangled into a general solution. But what does it actually look like for objects in our universe to move according to analytically unsolvable equations of motion? A system of three stars— like Alpha Centauri— could come crashing into one another or, more likely, some might get flung out of orbit after a long time of apparent stability. Other than a few highly improbable stable configurations, almost every possible case is unpredictable on long timescales. Each has an astronomically large range of potential outcomes, dependent on the tiniest of differences in position and velocity. This behaviour is known as chaotic by physicists, and is an important characteristic of n-body systems. Such a system is still deterministic— meaning there’s nothing random about it. If multiple systems start from the exact same conditions, they’ll always reach the same result. But give one a little shove at the start, and all bets are off. That’s clearly relevant for human space missions, when complicated orbits need to be calculated with great precision. Thankfully, continuous advancements in computer simulations offer a number of ways to avoid catastrophe. By approximating the solutions with increasingly powerful processors, we can more confidently predict the motion of n-body systems on long time-scales. And if one body in a group of three is so light it exerts no significant force on the other two, the system behaves, with very good approximation, as a two-body system. This approach is known as the “restricted three-body problem.” It proves extremely useful in describing, for example, an asteroid in the Earth-Sun gravitational field, or a small planet in the field of a black hole and a star. As for our solar system, you’ll be happy to hear that we can have reasonable confidence in its stability for at least the next several hundred million years. Though if another star, launched from across the galaxy, is on its way to us, all bets are off.

**P893 2020-07-20 The big-beaked, rock-munching fish that protect coral reefs - Mike Gi**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=893)

As the sun rises over a quiet coral reef, one animal breaks the morning silence. Named for their vibrant scales and beak-like teeth, these parrotfish are devouring a particularly crunchy breakfast: rocks. It may not be immediately clear why any creature would take bites out of the seafloor. But the diet of these flashy foragers actually plays a key role in defending the coral reef’s complex ecosystem. Massive coral reefs begin with tiny coral larvae, which settle on the seafloor’s hard surfaces and metamorphasize into coral polyps. Over time, these polyps generate rock-like skeletons made of calcium carbonate. Together, colonies of polyps produce large three-dimensional structures, which form the basis of an underwater metropolis. These coral complexes are full of nooks and crannies that house and protect countless life forms. Even though coral reefs occupy less than one percent of the ocean floor, these dense ecosystems are home to more than twenty-five percent of marine life. Many fish use corals as shelters for sleeping and to hide from large predators between their trips foraging for seaweed. As the primary food source for many of the reef’s fish and invertebrates, seaweed is vital to this ecosystem. But in high densities, seaweed can become problematic, and even lethal to corals. Seaweed grows on the same hard open surfaces that coral larvae rely on, and their growth prevents new coral from settling and expanding. These competitors have also evolved a variety of ways to kill existing corals, including smothering and abrasion. Some seaweed species even engage in chemical warfare— synthesizing compounds that destroy coral on contact. This is where parrotfish come in. Like many reef fish, these colorful creatures eat seaweed. But unlike their neighbors, parrotfish can completely remove even the tiniest scraps of seaweed from the ocean floor. Their so-called beak is actually a mosaic of tightly-packed teeth which can scrape and grind rock, allowing them to consume every bit of seaweed covering a stony surface. This helps parrotfish reach seaweed other fish can’t consume, while simultaneously clearing out open space for new corals to settle and existing colonies to expand. Eating rocks is just one way parrotfish help manage seaweed. Through a dynamic system of social networks, parrotfish can convey information to other coral dwelling fish. Each fish’s presence and simple routine behaviors produce sensory information that nearby fish can see, hear, or smell. They can even detect changes in water pressure produced by their neighbors using a special sensory organ. All these factors can inform the behavior of nearby fish. For example, a fish safely entering an open feeding ground and not getting attacked means it’s safe to forage. Conversely, a fish rapidly leaving a location can provide an early warning that a threat is approaching. By simply trying to stay alive, these reef fish can incidentally help their neighbors survive— and more of these fish means less seaweed. Unfortunately, human activities over the last several decades have disrupted almost every part of this complex system. In many coral reefs, overfishing has reduced the number of parrotfish, as well as other seaweed eaters, such as surgeonfish and rabbitfish. This has led to unchecked seaweed growth, which threatens to degrade entire coral reefs. The parrotfish that remain live in much smaller communities. Their reduced numbers can weaken their social network, making surviving fish more timid and less effective at controlling seaweed. Today, climate change and pollution are lowering coral’s natural defenses while contributing to runaway seaweed growth— leaving reef ecosystems more fragile than ever. Our reefs are vitally important to both marine and human life. Their unparalleled biodiversity offers unique opportunities for ecotourism, sustainable fishing, and scientific research, while their rocky structures guard coastlines from waves and storm surges. Fortunately, continued research into reef species like the quirky and critical parrotfish can inform new strategies for preserving these essential ecosystems.

**P894 2020-07-25 Can you solve the cheating royal riddle - Dan Katz**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=894)

You’re the chief advisor to an eccentric king who needs to declare his successor. He wants his heir to be good at arithmetic, lucky, and above all else, honest. So he’s devised a competition to test his children, and ordered you to choose the winner. Each potential heir will be given the same two six-sided dice. The red die has the numbers 2, 7, 7, 12, 12, and 17. The blue one has 3, 8, 8, 13, 13, and 18. The dice are fair, so each side is equally likely to come up. Each contestant will be sent into a Royal Rolling Room, where they’ll roll both dice 20 times. A contestant’s score starts at zero, and each turn, they should add the total of the two numbers rolled to their score. After 20 turns, they should report their final score. The rooms are secure, and no one observes the rolls. That means a contestant could add incorrectly, or worse, be dishonest and make up a score they didn’t achieve. This is where you come in. The king has instructed you that if you’re at least 90% sure a contestant mis-added or cheated, you should disqualify them. The highest-scoring player who remains will be the new heir to the throne. After you explain the rules, the children run to their rooms. When they return, Alexa announces her score is 385. Bertram says 840. Cassandra reports 700. And Draco declares 423. The future of the kingdom is in your hands. Whom do you proclaim to be the worthiest successor? Pause now to figure it out for yourself. Upon inspection, most of these scores are concerning. Let’s start with the highest. Bertram scored 840. That’s impressive… but is it even possible? The highest numbers on the two dice are 17 and 18. 17 plus 18 is 35, so in 20 rolls, the greatest possible total is 20 times 35, or 700. Even if Bertram rolled all the highest numbers, he couldn’t have scored 840. So he’s disqualified. Cassandra, the next-highest roller, reported 700. That’s theoretically possible… but how hard is it to be that lucky? In order to get 700, Cassandra would have to roll the highest number out of six on 40 separate occasions. The probability of this is 1 over 6 to the 40th power, or 1 in about 13 nonillion— that’s 13 followed by 30 zeros. To put that in perspective, there are about 7.5 billion people in the world, and 7.5 billion squared is a lot less than 13 nonillion. Rolling the highest number all 40 times is much less likely than if you picked a completely random person on Earth, and it turned out to be actor Paul Rudd… and then you randomly picked again, and got Paul Rudd again! You can’t be 100% sure that Cassandra’s score didn’t happen by chance… but you can certainly be 90% sure, so she should be disqualified. Next up is Draco, with 423. This score isn’t high enough to be suspicious. But it’s impossible for a different reason. Pick a number from each die, and add them up. No matter which combination you choose, the result ends in a 0 or a 5. That’s because every red number is 2 more than a multiple of 5, and every blue number is 3 more than a multiple of 5. This means that when you add them together, you’ll always get an exact multiple of 5. And when you add rolls that are multiples of 5, the result will also be a multiple of 5. These sorts of relationships between integers are studied in a branch of math called number theory. Here number theory shows us that Draco’s score, which is not a multiple of 5, cannot be achieved. So he should be disqualified as well. This leaves Alexa, whose score is a multiple of 5 and is in the achievable range. In fact, the most likely score is 400, so she was a little bit unlucky. But with everyone else disqualified, she’s the last heir standing. All hail Queen Alexa, the worthiest successor! At least if you agree that the best way to organize your government is a roll of the dice...

**P895 2020-07-29 Evolution’s great mystery - Michael Corballis**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=895)

In the 1980s, a bonobo named Kanzi learned to communicate with humans to an unprecedented extent— not through speech or gestures, but using a keyboard of abstract symbols representing objects and actions. By pointing to several of these in order, he created sequences to make requests, answer verbal questions from human researchers, and refer to objects that weren’t physically present. Kanzi’s exploits ignited immediate controversy over one question: had Kanzi learned language? What we call language is something more specific than communication. Language is about sharing what’s in our minds: stories, opinions, questions, the past or future, imagined times or places, ideas. It is fundamentally open-ended, and can be used to say an unlimited number of things. Many researchers are convinced that only humans have language, that the calls and gestures other species use to communicate are not language. Each of these calls and gestures generally corresponds to a specific message, for a limited total number of messages that aren’t combined into more complex ideas. For example, a monkey species might have a specific warning call that corresponds to a particular predator, like a snake— but with language, there are countless ways to say “watch out for the snake.” So far no animal communication seems to have the open-endedness of human language. We don’t know for sure what’s going on in animals’ heads, and it's possible this definition of language, or our ways of measuring it, don’t apply to them. But as far as we know, only humans have language. And while humans speak around 7,000 distinct languages, any child can learn any language, indicating that the biological machinery underlying language is common to all of us. So what does language mean for humanity? What does it allow us to do, and how did we come to have it? Exactly when we acquired this capacity is still an open question. Chimps and bonobos are our closest living relatives, but the lineage leading to humans split from the other great apes more than four million years ago. In between, there were many species— all of them now extinct, which makes it very difficult to know if they had language or anything like it. Great apes give one potential clue to the origins of language, though: it may have started as gesture rather than speech. Great apes gesture to each other in the wild much more freely than they vocalize. Language may have begun to take shape during the Pleistocene, 2 to 3 million years ago, with the emergence of the genus Homo that eventually gave rise to our own species, homo sapiens. Brain size tripled, and bipedalism freed the hands for communication. There may have been a transition from gestural communication to gestural language— from pointing to objects and pantomiming actions— to more efficient, abstract signing. The abstraction of gestural communication would have removed the need for visuals, setting the stage for a transition to spoken language. That transition would have likely come later, though. Articulate speech depends on a vocal tract of a particular shape. Even our closest ancestors, the Neanderthals and Denisovans, had vocal tracts that were not optimal, though they likely had some vocal capacity, and possibly even language. Only in humans is the vocal tract optimal. Spoken words free the hands for activities such as tool use and transport. So it may have been the emergence of speech, not of language itself, that led to the dominance of our species. Language is so intimately tied to complex thought, perception, and motor functions that it’s difficult to untangle its biological origins. Some of the biggest mysteries remain: to what extent did language as a capacity shape humanity, and to what extent did humanity shape language? What came first, the vast number of possible scenarios we can envisage, or our ability to share them?

**P896 2020-08-05 Can you outsmart the fallacy that fooled a generation of doctors - El**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=896)

Oh the humanity! Ah... humanity... It’s a trainwreck, but I can’t look away. It’s 1843, and a debate is raging among physicians about one of the most common killers of women: childbed fever. Childbed fever strikes within days of giving birth, killing more than 70% of those infected— and nobody knows what causes it. Obstetrician Charles Meigs has a theory. Having observed abdominal inflammation in patients who go on to develop the fever, he claims this inflammation is the cause of childbed fever. Much of the medical establishment supports his theory. Oh, come on! They really leave me no choice but to teach them some skepticism. That’s better. Now, Meigs, your argument is based on a fallacy— the false cause fallacy. Correlation does not imply causation: When two phenomena regularly occur together, one does not necessarily cause the other. So you say women who have inflammation also come down with childbed fever, therefore the inflammation caused the fever. But that’s not necessarily true. Yes, yes, the inflammation comes first, then the fever, so it seems like the inflammation causes the fever. But by that logic, since babies usually grow hair before teeth, hair growth must cause tooth growth. And we all know that’s not true, right? Actually, don’t answer that. A couple of different things could be going on here. First, it’s possible that fever and inflammation are correlated purely by coincidence. Or, there could be a causal relationship that’s the opposite of what you think— the fever causes the inflammation, rather than the inflammation causing the fever. Or both could share a common underlying cause you haven’t thought of. If I may, just what do you think causes inflammation? Nothing? It just is? Really? Humor me for a moment in discussing one of your colleague’s ideas— Dr. Oliver Wendell Holmes. I know, I know, you don’t like his theory— you already wrote a scathing letter about it. But let’s fill your students in, shall we? Holmes noticed a pattern: when a patient dies of childbed fever, a doctor performs an autopsy. If the doctor then treats a new patient, that patient often comes down with the fever. Based on this correlation between autopsies of fever victims and new fever patients, he proposes a possible cause. Since there’s no evidence that the autopsy causes the fever beyond this correlation, he doesn’t jump to the conclusion that autopsy causes fever. Instead, he suggests that doctors are infecting their patients via an invisible contaminant on their hands and surgical instruments. This idea outrages most doctors, who see themselves as infallible. Like Meigs here, who refuses to consider the possibility that he’s playing a role in his patients’ plight. His flawed argument doesn’t leave any path forward for further investigation— but Holmes’ does. It’s 1847, and physician Ignaz Semmelweis has reduced the number of childbed fever deaths in a clinic from 12% to 1% by requiring all medical personnel to disinfect their hands after autopsies and between patient examinations. With this initiative, he has proven the contagious nature of childbed fever. Ha! It’s 1879, and Louis Pasteur has identified the contaminant responsible for many cases of childbed fever: Hemolytic streptococcus bacteria. Hmm, my fries are cold. Must be because my ice cream melted.

**P897 2020-08-05 Why people fall for misinformation - Joseph Isaac**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=897)

In 1901, David Hänig published a paper that forever changed our understanding of taste. His research led to what we know today as the taste map: an illustration that divides the tongue into four separate areas. According to this map, receptors at the tip of our tongues capture sweetness, bitterness is detected at the tongue’s base, and along the sides, receptors capture salty and sour sensations. Since its invention, the taste map has been published in textbooks and newspapers. The only problem with this map, is that it’s wrong. In fact, it’s not even an accurate representation of what Hänig originally discovered. The tongue map is a common misconception— something widely believed but largely incorrect. So where do misconceptions like this come from, and what makes a fake fact so easy to believe? It’s true that the tongue map’s journey begins with David Hänig. As part of his dissertation at Leipzig University, Hänig analyzed taste sensitivities across the tongue for the four basic flavors. Using sucrose for sweet, quinine sulfate for bitter, hydrochloric acid for sour, and salt for salty, Hänig applied these stimuli to compare differences in taste thresholds across a subject’s tongue. He hoped to better understand the physiological mechanisms that affected these four flavors, and his data suggested that sensitivity for each taste did in fact vary across the tongue. The maximum sensation for sweet was located at the tongue’s tip; bitter flavors were strongest at the back; salt was strongest in this area, and sour at the middle of the tongue’s sides. But Hänig was careful to note that every sensation could also be tasted across the tongue, and that the areas he identified offered very small variations in intensity. Like so many misconceptions, the tongue map represents a distortion of its original source, however the nature of that distortion can vary. Some misconceptions are comprised of disinformation— false information intentionally designed to mislead people. But many misconceptions, including the tongue map, center on misinformation— false or misleading information that results from unintentional inaccuracy. Misinformation is most often shaped by mistakes and human error, but the specific mistakes that lead to a misconception can be surprisingly varied. In the case of the tongue map, Hänig’s dissertation was written in German, meaning the paper could only be understood by readers fluent in German and well versed in Hanig’s small corner of academia. This kicked off a game of telephone that re-shaped Häing’s research every time it was shared with outside parties. Less than a decade after his dissertation, newspapers were falsely insisting that experiments could prove sweetness was imperceptible on the back of the tongue. The second culprit behind the tongue map’s spread were the images that Hänig’s work inspired. In 1912, a rough version of the map appeared in a newspaper article that cautiously described some of the mysteries behind taste and smell research. Featuring clear labels across the tongue, the article’s illustration simplified Hänig’s more-complicated original diagrams. Variations of this approachable image became repeatedly cited, often without credit or nuanced consideration for Hänig’s work. Eventually this image spread to textbooks and classrooms as a purported truth of how we experience taste. But perhaps the factor that most contributed to this misconception was its narrative simplicity. In many ways, the map complements our desire for clear stories about the world around us— a quality not always present in the sometimes-messy fields of science. For example, even the number of tastes we have is more complicated than Hänig’s work suggests. Umami— also known as savory— is now considered the fifth basic taste, and many still debate the existence of tastes like fatty, alkaline, metallic, and water-like. Once we hear a good story, it can be difficult to change how we see that information, even in the face of new evidence. So, next time you see a convenient chart or read a surprising anecdote, try to maintain a healthy skepticism— because misconceptions can leave a bitter taste on every part of your tongue.

**P898 2020-08-06 The last living members of an extinct species - Jan Stejskal**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=898)

In the savannahs of Kenya, two female northern white rhinos, Nájin and Fatu, munch contentedly on the grass. At the time of this video’s publication, these are the last two known northern white rhinos left on Earth. Their species is functionally extinct— without a male, Nájin and Fatu can’t reproduce. And yet, there’s still hope to revive the northern white rhino. How can that be? The story starts about 50 years ago, when poachers began illegally hunting thousands of rhinos across Africa for their horns. This, combined with civil wars in their territory, decimated northern white rhino populations. Concerned conservationists began trying to breed them in captivity in the 1970s, collecting and storing semen from males. Only four rhinos were ultimately born through the ambitious breeding program. Nájin, and her daughter Fatu were the last two. In 2014, conservationists discovered that neither can have a calf. Though Nájin gave birth to Fatu, she now has weak hindlegs, which could harm her health if she became pregnant again. Fatu, meanwhile, has a degenerated uterine lining. Then, the last northern white rhino male of the species, Sudan, died in 2018. But there was one glimmer of hope: artificial reproduction. With no living males and no females able to carry a pregnancy, this is a complicated and risky process to say the least. Though scientists had stored semen, they would have to collect the eggs— a complex procedure that requires a female to be sedated for up to two hours. Then, they’d create a viable embryo in the lab— something that had never been done before, and no one knew how to do. Even that was just the beginning— a surrogate mother of another rhino species would have to carry the embryo to term. Females of a closely related species, the southern white rhino, became both the key to developing a rhino embryo in a lab and the leading candidates for surrogate mothers. Northern and southern white rhinos diverged about a million of years ago into separate— though still closely-related— species. They inhabit different regions, and have slightly different physical traits. In a fortunate coincidence, several female southern white rhinos needed treatment for their own reproductive problems, and researchers could collect eggs as part of that treatment. In Dvůr Králové Zoo in October 2015, experts of IZW Berlin began collecting eggs from southern white rhinos and sending them to Avantea, an animal reproduction laboratory in Italy. There, scientists developed and perfected a technique to create a viable embryo. Once they mastered the technique, researchers extracted Nájin and Fatu’s eggs on August 22, 2019 and flew them to Italy. Three days later, they fertilized the eggs with sperm from a northern white rhino male. After another week, two of the eggs made it to the stage of development when the embryo can be frozen and preserved for future. Another collection in December 2019 produced one more embryo. As of early 2020, the plan is to collect Nájin and Fatu’s eggs three times a year if they’re healthy enough. In the meantime, researchers are looking for promising southern white rhino surrogate mothers— ideally who’ve carried a pregnancy to term before. The surrogacy plan is somewhat of a leap of faith— southern and northern white rhinos have interbred both during the last glacial period and more recently in 1977, so researchers are optimistic a southern white rhino would be able to carry a northern white rhino to term. Also, the two species’ pregnancies are the same length. Still, transferring an embryo to a rhino is tricky because of the shape of the cervix. The ultimate goal, which will take decades, is to establish a breeding population of northern white rhinos in their original range. Studies suggest that we have samples from enough individuals to recreate a population with the genetic diversity the species had a century ago. Though the specifics of this effort are unique, as more species face critical endangerment or functional extinction, it’s also an arena for big questions: do we have a responsibility to try to bring species back from the brink, especially when human actions brought them there in the first place? Are there limits to the effort we should expend on saving animals threatened with extinction?

**P899 2020-08-06 What’s that ringing in your ears - Marc Fagelson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=899)

Arriving home after a long day, you settle in for a quiet evening alone. But instead of the sound of silence, you hear a constant ringing— even though there’s nothing making any noise. What you’re experiencing is called tinnitus, the perception of a noise like ringing, buzzing, hissing or clicking that occurs without any external source of sound. Tinnitus has been bothering humanity since Ancient Babylon, plaguing everyone from Leonardo da Vinci to Charles Darwin. Today, roughly one in seven people worldwide experiences this auditory sensation. So where does this persistent sound come from? When you normally hear something, sound waves hit various areas of your ear, creating vibrations that displace fluid inside the cochlea. If the vibrations are large enough, they elicit a chemical response that transforms them into bioelectrical signals. These nerve impulses are then relayed through the hearing pathway to the brain, where they result in the sounds we perceive. However, in the vast majority of tinnitus cases, the nerve signals that produce these mysterious sounds don’t travel through your ear at all. Instead, they’re generated internally, by your own central nervous system. Under usual circumstances, these self-produced signals are an essential part of hearing. All mammals demonstrate on-going neural activity throughout their hearing pathways. When there are no sounds present, this activity is at a baseline that establishes your neural code for silence. When a sound does appear, this activity changes, allowing the brain to distinguish between silence and sound. But the auditory system’s health can affect this background signal. Loud noises, diseases, toxins, and even natural aging can damage your cochlear cells. Some of these may heal in a matter of hours. However, if enough cells die, either over time or all at once, the auditory system becomes less sensitive. With fewer cochlear cells relaying information, incoming sounds generate weaker nerve signals. And many environmental sounds can be lost completely. To compensate, your brain devotes more energy to monitoring the hearing pathway. Just like you might adjust the knobs of a radio, the brain modifies neural activity while also tweaking the tuning knob to get a clearer signal. Increasing this background neural activity is intended to help you process weak auditory inputs. But it can also modify your baseline for silence— such that a lack of sound no longer sounds silent at all. This is called subjective tinnitus, and it accounts for the vast majority of tinnitus cases. Subjective tinnitus is a symptom associated with practically every known ear disorder, but it isn’t necessarily a bad thing. While its appearance can be surprising, subjective tinnitus has no inherently negative consequences. But for some, tinnitus episodes can trigger traumatic memories or otherwise distressing feelings, which increase the sound’s intrusiveness. This psychological loop often leads to what’s known as “bothersome tinnitus," a condition that can exacerbate the symptoms of PTSD, insomnia, anxiety, and depression. There’s no known cure for subjective tinnitus. So the most important thing doctors can do is help people understand this auditory event, and develop neutral associations with these often-distressing sounds. For example, sound therapy uses noises like rain, birdsong, or music to mask tinnitus and reduce stress. One form, called informational masking, uses soothing, complex auditory signals that distract the brain from the tinnitus sound. Another, called energetic masking, uses sounds with the same frequency as the patient’s tinnitus to occupy the neurons that would otherwise deliver the tinnitus signal. Practiced alongside counseling, these interventions allow people to re-evaluate their relationship with tinnitus. Losing the sound of silence can be troubling to say the least. Tinnitus reveals that your brain is constantly analyzing the world around you, even as it fails to filter its own internal noise. In a sense, experiencing tinnitus is like eavesdropping on your brain talking to itself— though it may not be a conversation you want to hear.

**P900 2020-08-17 The rise of modern populism - Takis S. Pappas**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=900)

In the mid-1970s, after decades of political turmoil, Greece finally seemed to be on the path to stability. With the introduction of a new constitution and negotiations underway to enter European institutions, many analysts expected Greek politics to follow the pattern of the larger Western world. Then in 1981, a political party called PASOK came to power. Its charismatic leader Andreas Papandreou railed against the new constitution, and accused those in power of “national betrayal.” Opposing Greece’s membership in NATO and the European Economic Community, Papandreou promised to govern for the betterment of the “common people" above all else. He famously declared, “there are no institutions, only the people exist.” Papandreou’s rise to power isn’t a unique story. In many democratic countries around the world, charismatic leaders vilify political opponents, disparage institutions, and claim the mantle of the people. Some critics label this approach as authoritarian or fascist, and many argue that these leaders are using emotions to manipulate and deceive voters. But whether or not this style of politics is ethical, it's certainly democratic, and it goes by the name of populism. The term populism has been around since Ancient Rome, and has its roots in the Latin word “populus” meaning “the people." But since then populism has been used to describe dozens of political movements, often with counterintuitive and sometimes contradictory goals. Populist movements have rebelled against monarchies, monopolies, and a wide variety of powerful institutions. It’s not possible to cover the full history of this term here. Instead, we’re focusing on one specific type of populism— the kind that describes Papandreou’s administration and numerous other governments over the last 70 years: modern populism. But to understand how political theorists define this phenomenon we first need to explore what it’s responding to. In the aftermath of World War Two, many countries wanted to move away from totalitarian ideologies. They sought a new political system that prioritized individual and social rights, aimed at political consensus, and respected the rule of law. As a result, most Western nations adopted a longstanding form of government called liberal democracy. In this context, “liberal” doesn’t refer to any political party, but rather a type of democracy that has three essential components. First, liberal democracies accept that society is full of many, often crosscutting divisions that generate conflict. Second, it requires that society’s many factions seek common ground across those divisions. Finally, liberal democracies rely on the rule of law and the protection of minority rights, as specified in constitutions and legal statutes. Taken together, these ideals propose that tolerance and institutions that protect us from intolerance, are the bedrock of a functional and diverse democratic society. Liberal democracies helped bring stability to the nations that adopted them. But like any system of government, they didn’t solve everything. Among other issues, an ever-increasing wealth gap led to underserved communities who distrusted both their wealthy neighbors and their political leaders. In some cases, political corruption further damaged the public's trust. Growing suspicion and resentment around these politicians primed citizens to look for a new kind of leader who would challenge established institutions and put the needs of the people first. In many ways, this reaction highlights democracy in action: if the majority of a population feels their interests are underrepresented, they can elect leaders to change that using existing democratic systems. But this is where assertive, modern populist candidates can subvert democracy. Modern populists identify themselves as embodying the "will of the people," and they place those interests above the institutions that protect individual and social rights. Modern populists argue these institutions are run by a self-serving ruling minority, who seek to control the vast majority of virtuous common people. As a result, politics is no longer about seeking compromise and consensus through tolerant democratic institutions. Instead, these leaders seek to overturn what they see as a broken system. This means that where a liberal democracy has the utmost respect for institutions like courtrooms, free press, and national constitutions, modern populists disparage any establishment that disagrees with the so-called “common will." Modern populist parties have arisen in many places, but the leaders of these movements are remarkably similar. They’re often charismatic individuals who identify themselves as embodying the “will of the people." They make exorbitant promises to their supporters, while casting their opponents as traitors actively undermining the country. But whether these politicians are sincere believers or manipulative opportunists, the dynamics they unleash can be profoundly destabilizing for liberal democracy. Even when modern populist leaders don’t follow through with their most extreme promises, their impact on political discourse, the rule of law, and public trust can long outlast their time in office.

**P901 2020-08-23 How to outsmart the Prisoner’s Dilemma - Lucas Husted**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=901)

Two perfectly rational gingerbread men, Crispy and Chewy, are out strolling when they’re caught by a fox. Seeing how happy they are, he decides that, instead of simply eating them, he’ll put their friendship to the test with a cruel dilemma. He’ll ask each gingerbread man whether he’d opt to Spare or Sacrifice the other. They can discuss, but neither will know what the other chose until their decisions are locked in. If both choose to spare the other, the fox will eat just one of each of their limbs; if one chooses to spare while the other sacrifices, the sparer will be fully eaten, while the traitor will run away with all his limbs intact. Finally, if both choose to sacrifice, the fox will eat 3 limbs from each. In game theory, this scenario is called the “Prisoner's Dilemma.” To figure out how these gingerbread men will act in their perfect rationality, we can map the outcomes of each decision. The rows represent Crispy’s choices, and the columns are Chewy’s. Meanwhile, the numbers in each cell represent the outcomes of their decisions, as measured in the number of limbs each would keep: So do we expect their friendship to last the game? First, let’s consider Chewy’s options. If Crispy spares him, Chewy can run away scot-free by sacrificing Crispy. But if Crispy sacrifices him, Chewy can keep one of his limbs if he also sacrifices Crispy. No matter what Crispy decides, Chewy always experiences the best outcome by choosing to sacrifice his companion. The same is true for Crispy. This is the standard conclusion of the Prisoner's Dilemma: the two characters will betray one another. Their strategy to unconditionally sacrifice their companion is what game theorists call the “Nash Equilibrium," meaning that neither can gain by deviating from it. Crispy and Chewy act accordingly and the smug fox runs off with a belly full of gingerbread, leaving the two former friends with just one leg to stand on. Normally, this is where the story would end, but a wizard happened to be watching the whole mess unfold. He tells Crispy and Chewy that, as punishment for betraying each other, they’re doomed to repeat this dilemma for the rest of their lives, starting with all four limbs at each sunrise. Now what happens? This is called an Infinite Prisoner’s Dilemma, and it’s a literal game changer. That’s because the gingerbread men can now use their future decisions as bargaining chips for the present ones. Consider this strategy: both agree to spare each other every day. If one ever chooses to sacrifice, the other will retaliate by choosing “sacrifice” for the rest of eternity. So is that enough to get these poor sentient baked goods to agree to cooperate? To figure that out, we have to factor in another consideration: the gingerbread men probably care about the future less than they care about the present. In other words, they might discount how much they care about their future limbs by some number, which we’ll call delta. This is similar to the idea of inflation eroding the value of money. If delta is one half, on day one they care about day 2 limbs half as much as day 1 limbs, day 3 limbs 1 quarter as much as day 1 limbs, and so on. A delta of 0 means that they don’t care about their future limbs at all, so they’ll repeat their initial choice of mutual sacrifice endlessly. But as delta approaches 1, they’ll do anything possible to avoid the pain of infinite triple limb consumption, which means they’ll choose to spare each other. At some point in between they could go either way. We can find out where that point is by writing the infinite series that represents each strategy, setting them equal to each other, and solving for delta. That yields 1/3, meaning that as long as Crispy and Chewy care about tomorrow at least 1/3 as much as today, it’s optimal for them to spare and cooperate forever. This analysis isn’t unique to cookies and wizards; we see it play out in real-life situations like trade negotiations and international politics. Rational leaders must assume that the decisions they make today will impact those of their adversaries tomorrow. Selfishness may win out in the short-term, but with the proper incentives, peaceful cooperation is not only possible, but demonstrably and mathematically ideal. As for the gingerbread men, their eternity may be pretty crumby, but so long as they go out on a limb, their friendship will never again be half-baked.

**P902 2020-08-27 Can you solve the sorting hat riddle - Dan Katz and Alex Rosenthal**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=902)

An albatross delivered your invitation, you’ve acquired your wand, ridden the enchanted zeppelin, made some fast friends, and are finally ready for the adventure you’ve dreamed of your entire life: your first day at Magnificent Marigold’s Magical Macademy. But before you can learn your first spell you must get through the most nerve-wracking moment of the year: the sorting ceremony. When you put on the sorting hat, you hear a voice. “Ah, you’re an interesting one. Every year I choose one student for a special challenge, and I choose you. The Magical Macademy had 8 founders, and they established our four houses two by two by two by two. I alone know which witches founded which. But there was once a mysterious fifth house, lost to time but full of secrets and powerful artifacts. MMMMMM? If you can tell me who founded each house, I’ll sort you into whichever you want. However, if you can also tell me the name of the secret 5th house, I’ll let you sort into it, and you’ll inherit everything you discover. “The two founders of each house wore different colored hats with non-matching symbols. No founder started more than one house. Of Funflame and Imaginez, one was a founder of Gianteye and the other of Longmous. And of Miraculo and Rimbleby, one established Longmous and the other Meramaid. Finally, Septimus didn’t found Vidopnir.” So… who founded what, and what’s the name of the secret house? Pause the video now to figure it out for yourself! Answer in 3 Answer in 2 Answer in 1 The hardest part of solving this logic puzzle is knowing where to start. No rule by itself is enough to assign a founder to his or her house, so the next best thing would be to combine a pair of rules to learn something. 4 and 5 are good candidates to try that with, because they contain a lot of constraints and both mention Longmous. Miraculo and Rimbleby’s hats both have moons, which means that no matter who ends up in Longmous, moons will be accounted for. That means Imaginez, who also has moons, can’t have founded Longmous, so she’s in Gianteye and Funflame founded Longmous. Miraculo’s hat is red, so he can’t be there, so he must be in Meramaid and Rimbleby in Longmous. Halfway there! Now we can place Septimus–– rule 6 keeps him out of Vidopnir, and his yellow hat out of Gianteye, so he must be in Meramaid. Of the founders left, Deepmire and Hypnotum both have stars. So each must go into a different house, taking up the remaining space in Gianteye and leaving one spot open in Vidopnir, which Tremenda must fill. Tremenda’s blue hat keeps Deepmire out of Vidopnir, so we can easily place her and, finally, Hypnotum. Now that those founders are sorted, we can start to search for the secret house. If you don’t have it yet, here are a few hints: Pause the video now if you want to figure it out yourself! One good strategy for a puzzle like this is to look for patterns or unusual pieces of information. First of all, there’s the school’s obsession with the letter M, right down to its motto, which translates from Latin to “M is a magic letter.” Curiously, every founder has exactly one M in their name, and each M is in a different position. That means that the M’s can put them in order, 1 through 8. We know we needed to solve the logic puzzle before finding the secret house, so there must be something critical about the connection between the founders and their houses. Here’s where a pattern emerges: every founder and house have exactly the same number of letters. This allows the founders to line up with their houses quite nicely. The first letters don’t spell anything, but let’s look at the M’s in the names again and the letters they line up with: M, I, N, O, T, A, U, R. You shout out “MINOTAUR” to a stunned dining hall, and a secret passage grinds open. The wonders of house Minotaur are yours if you want them. But being the first and only resident of the secret house would come at a high price: loneliness. So which will it be: riches or friendship?

**P903 2020-08-27 The fish that walk on land - Noah R. Bressman**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=903)

This pond is the only home this fish has ever known. But lately, it’s gotten crowded and food is scarce. Luckily, it has an option many don’t: as a walking catfish, it can dance its way out of the water and onto bigger and better things. However, it faces many challenges on its terrestrial journey: it’s now in danger of suffocating, drying up, suffering physical damage from rough terrain, and being hunted by land predators. We think of fish as completely aquatic animals. But the walking catfish is just one of hundreds of fish species that are actually amphibious, meaning that they possess adaptations that enable them to survive on land. Fish amphibiousness is a spectrum. At one end are species like the mosquitofish that’ll only move on land when forced. And at the other end are species like mudskippers that nonchalantly hop around mudflats for days at a time. But why do fish make the exodus from water to land? And how do they cope with this drastic transition? If temperatures get too high for the mangrove rivulus in the shallow tropical pools it inhabits, it’ll flip itself onto a bank and cool off in the shade. During the dry period, it can survive for two months out of the water by staying in moist environments. Meanwhile, the eel catfish makes its onshore voyage to satisfy its hearty craving for beetles. And for others, the terrestrial draw is more ritualistic. Every year under the cover of night, masses of California grunion flop their way onto sandy beaches, where females deposit thousands of eggs into the sand before re-entering the ocean. Underwater, fish breathe with gills, which are feathery organs packed with blood vessels that absorb dissolved oxygen from the water. But in the open air, their gills collapse and are rendered useless, so amphibious fishes need other ways to breathe. The armored catfish’s stomach is packed with blood vessels, so it can gulp down air and breathe through its stomach lining. And lungfish, being related to the ancestors of all tetrapods, or four-limbed vertebrates, are equipped with true lungs. They’ll actually drown if they’re kept underwater too long. Fish have thin, permeable skin that allows for essential compounds to diffuse into and out of their bodies while they’re underwater. But this works against them on land as their bodily moisture diffuses into the air. To dodge dehydration, mudskippers roll in the mud like puppies. But the lungfish takes the cake: the rivers it inhabits disappear during dry seasons, so it buries itself in the earth and coats its body in a mucus cocoon. It can survive like this for years until being resuscitated by the next big rainstorm. Amphibious fishes use powerful fins to move on land and clever tools to navigate as they go. The Nopoli rock-climbing goby, no bigger than a few centimeters, scales hundred-meter-tall Hawaiian waterfalls, inching its way up by alternately attaching the suction cups on its mouth and pelvic fins. To find water while on land, the mummichog, like most amphibious fishes, is on the lookout for reflective surfaces. Other species, like mosquitofish, exercise their inner ear to determine where they’re oriented on a slope, relying on the probability that they’ll find water by moving downhill. Our walking catfish, meanwhile, uses the taste buds that coat its body for navigation. These taste buds are concentrated in its whiskers, which whip through the air, sensing compounds that signal the proximity and quality of nearby water— and prey. The walking catfish will shimmy towards attractive volatile amino acids while steering clear of foul waters emanating hydrogen sulfide. While amphibious fishes face a multitude of new challenges upon leaving the water, they’ve evolved ingenious ways to overcome them. They’re resilient in the face of droughts and floods and have access to new prey as well as a plan B if they need to escape competitive, polluted, or unhealthy environments. While being a “fish out of water” is generally regarded as a bad thing, for these species, it offers an undisputed edge.

**P904 2020-09-03 Are all of your memories real - Daniel L. Schacter**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=904)

In a study in the 1990s, participants recalled getting lost in a shopping mall as children. Some shared these memories in vivid detail— one even remembered that the old man who rescued him was wearing a flannel shirt. But none of these people had actually gotten lost in a mall. They produced these false memories when the psychologists conducting the study told them they’d gotten lost, and although they might not remember the incident, their parents had confirmed it. And it wasn’t just one or two people who thought they remembered getting lost— a quarter of the participants did. These findings may sound unbelievable, but they actually reflect a very common experience. Our memories are sometimes unreliable. And though we still don’t know precisely what causes this fallibility on a neurological level, research has highlighted some of the most common ways our memories diverge from what actually happened. The mall study highlights how we can incorporate information from outside sources, like other people or the news, into our personal recollections without realizing it. This kind of suggestibility is just one influence on our memories. Take another study, in which researchers briefly showed a random collection of photographs to a group of participants, including images of a university campus none of them had ever visited. When shown the images three weeks later, a majority of participants said that they had probably or definitely visited the campus in the past. The participants misattributed information from one context— an image they’d seen— onto another— a memory of something they believed they actually experienced. In another experiment, people were shown an image of a magnifying glass, and then told to imagine a lollipop. They frequently recalled that they saw the magnifying glass and the lollipop. They struggled to link the objects to the correct context— whether they actually saw them, or simply imagined them. Another study, where a psychologist questioned over 2,000 people on their views about the legalization of marijuana, highlights yet another kind of influence on memory. Participants answered questions in 1973 and 1982. Those who said they had supported marijuana legalization in 1973, but reported they were against it in 1982, were more likely to recall that they were actually against legalization in 1973— bringing their old views in line with their current ones. Our current opinions, feelings, and experiences can bias our memories of how we felt in the past. In another study, researchers gave two groups of participants background information on a historical war and asked them to rate the likelihood that each side would win. They gave each group the same information, except that they only told one group who had actually won the war— the other group didn’t know the real world outcome. In theory, both groups’ answers should be similar, because the likelihood of each side winning isn’t effected by who actually won— if there’s a 20% chance of thunderstorms, and a thunderstorm happens, the chance of thunderstorms doesn’t retroactively go up to 100%. Still, the group that knew how the war ended rated the winning side as more likely to win than the group who did not. All of these fallibilities of memory can have real-world impacts. If police interrogations use leading questions with eye witnesses or suspects, suggestibility could result in incorrect identifications or unreliable confessions. Even in the absence of leading questions, misattribution can lead to inaccurate eyewitness testimony. In a courtroom, if a judge rules a piece of evidence inadmissible and tells jurors to disregard it, they may not be able to do so. In a medical setting, if a patient seeks a second opinion and the second physician is aware of the first one’s diagnosis, that knowledge may bias their conclusion. Our memories are not ironclad representations of reality, but subjective perceptions. And there’s not necessarily anything wrong with that— the problems arise when we treat memory as fact, rather than accepting this fundamental truth about the nature of our recollections.

**P905 2020-09-04 A day in the life of an ancient Greek architect - Mark Robinson**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=905)

As dawn breaks over Athens, Pheidias is already late for work. The year is 432 BCE, and he’s the architekton, or chief builder, for the Parthenon— Athens’ newest and largest temple. When completed, his masterpiece will be an enormous shrine to the goddess Athena, and a testament to the glory of the Athenians. But when he arrives onsite he finds five epistatai, or city officials, waiting to confront him. They accuse Pheidias of embezzling gold designated for the temple’s sacred central statue. He has until sundown to provide all the temple’s expenses and account for every flake of gold— or face the judgement of the courts. Though he’s insulted by these false charges, Pheidias isn’t surprised. Pericles, the politician who commissioned the Parthenon, has many enemies in city government, and this project is somewhat controversial. The public is expecting a classic temple in the Doric style: simple columns supporting a horizontal entablature, crowned with a triangular roof. But Pheidias’ plans are far more radical by Athenian standards. His designs combine Doric columns with a sweeping Ionic frieze, hosting a vast panorama of the city’s Great Panathenaic festival. Not only will this sculpture show humans and gods side by side— something never before seen in a temple’s décor— it will also cost much more than the traditional approach. Praying to the Gods that his colleagues have been keeping track of their spending, Pheidias sets off to prove his innocence. First, he checks in with his architects Iktinos and Callicrates. Rather than using a blueprint, they pore over the syngraphai, or general plan, and paradeigma, a 3D model. Without an exact blueprint, the team often has to resolve issues in real time, guided only by careful calculation and their instinct for symmetry. Maintaining this symmetry has proven especially difficult. The Parthenon is built on a curve with the columns leaning slightly inwards. To project strength, and potentially keep the columns looking straight from a distance, the architects incorporated entasis, or slight bulging, in each column. For the temple’s other elements, the team calculates symmetry by employing relatively consistent proportions across the design. But their shifting plans require constant recalculations. After helping solve one such computation, Pheidias collects his colleagues’ gold records and heads off to receive a special delivery. Immense marble blocks for the Parthenon’s pediment have just arrived from quarries at Mount Pentelikon. The usual ramps would collapse under the weight of these 2 to 3 ton stone blocks, so Pheidias orders the construction of new pulleys. After recording the additional expense and supervising the construction all afternoon, he finally arrives at the sculpture workshop. His sculptors are carving 92 mythical scenes, or metopes, to decorate the temple. Every carving depicts fighting from different epic battles— each a mythical representation of Greece’s victory over Persia about 40 years earlier. No temple has ever used so many metopes before, and each scene adds to the temple’s ballooning expenses. Finally, Pheidias turns to his primary responsibility, and the focal point of the entire temple. Covered in thick layers of gold, minutely decorated, and towering above her worshippers, this will be a statue of the city’s patron and protector: Athena Parthenos. When the temple is complete, throngs will gather on its perimeter— offering prayers, performing sacrifices, and pouring libations for the goddess of wisdom. Pheidias spends the rest of the day designing finishing touches for the statue, and as the light fades, the epistatai arrive to confront him. After looming over his records, they look up triumphantly. Pheidias may have accounted for the temple’s general spending, but his records show no mention of the statue’s gold. At that moment, Pericles himself arrives to save his chief builder. The temple’s sponsor tells them that all the gold on the statue can be removed and weighed individually to prove Pheidias’ innocence. Assigning laborers to the task— and charging the officials to watch them late into the night— Pheidias and his patron leave their adversaries to the mercy of mighty Athena.

**P906 2020-09-04 The Japanese folktale of the selfish scholar - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=906)

In ancient Kyoto, a devout Shinto scholar lived a simple life, but he was often distracted from his prayers by the bustling city. He felt that his neighbors were polluting his soul, and he sought to perform some kind of personal harae— a purification ritual that would cleanse his body and his mind. He decided to travel to the revered Hie Shrine. The trip was an arduous climb that took all day. But he was glad for the solitude it afforded him, and the peace he felt upon returning home was profound. The scholar was determined to maintain this clarity for as long as possible, and resolved to make this pilgrimage another 99 times. He would walk the path alone, ignoring any distractions in his quest for balance, and never straying from his purpose. The man was true to his word, and as days stretched into weeks, he walked through driving rain and searing sun. Over time, his devotion revealed the invisible world of spirits which exists alongside our own. He began to sense the kami, which animated the rocks underfoot, the breeze that cooled him, and the animals grazing in the fields. Still he spoke to no one, spirit or human. He was determined to avoid contact with those who had strayed from the path and become polluted with kegare. This taboo of defilement hung over the sick and deceased, as well as those who defiled the land or committed violent crimes. Of all of the threats to the scholar’s quest for spiritual purity, kegare was by far the greatest. After paying his respects for the 80th time, he set out for home once more. But as darkness fell, he heard strained sobs in the night air. The scholar tried to push forward and ignore the moans. But the desperate cries overwhelmed him. Grimacing, he left his path to follow the sound to its source. He soon came to a cramped cottage, with a woman crumpled outside. Filled with pity, the scholar implored the woman to share her sorrow. She explained that her mother had just died— but no one would help her with the burial. At that news, his heart sank. Touching the body would defile his spirit, draining his life force and leaving him forsaken by the kami. But as he listened to her cries, his sympathy soared. And so, they buried the old woman together, to ensure her safe passage into the spirit world. The burial was complete, but the taboo of death weighed heavily on the scholar. How could he have been so foolish, to shirk his most important rule and corrupt his divine journey? After a tormented night, he resolved to go back to the shrine to cleanse himself. To his surprise, the usually quiet temple was filled with people, all gathering around a medium who communicated directly with the kami. The man hid himself, not daring approach in case anyone glimpse his polluted soul. But the medium had other ways of seeing, and called him forward from the crowd. Ready to be forsaken, the scholar approached the holy woman. But the medium merely smiled. She took his impure hand in hers, and whispered a blessing only he could hear— thanking him for his kindness. In that moment, the scholar discovered a great spiritual secret: contamination and corruption are two very different things. Filled with insight, the scholar set himself back on his journey. But this time, he stopped to help those he met. He began to see the beauty of the spirit world everywhere he went, even in the city he'd previously shunned. Others cautioned that he risked kegare— but he never told them why he so freely mingled with the sick and disadvantaged. For he knew that people could only truly understand harae through a journey of their own.

**P907 2020-09-10 A brief history of plastic**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=907)

Today, plastics are everywhere. All of this plastic originated from one small object— that isn’t even made of plastic. For centuries, billiard balls were made of ivory from elephant tusks. But when excessive hunting caused elephant populations to decline in the 19th century, billiard balls makers began to look for alternatives, offering huge rewards. So in 1863 an American named John Wesley Hyatt took up the challenge. Over the next five years, he invented a new material called celluloid, made from cellulose, a compound found in wood and straw. Hyatt soon discovered celluloid couldn’t solve the billiard ball problem–– the material wasn’t heavy enough and didn’t bounce quite right. But it could be tinted and patterned to mimic more expensive materials like coral, tortoiseshell, amber, and mother-of-pearl. He had created what became known as the first plastic. The word ‘plastic’ can describe any material made of polymers, which are just the large molecules consisting of the same repeating subunit. This includes all human-made plastics, as well as many of the materials found in living things. But in general, when people refer to plastics, they’re referring to synthetic materials. The unifying feature of these is that they start out soft and malleable and can be molded into a particular shape. Despite taking the prize as the first official plastic, celluloid was highly flammable, which made production risky. So inventors began to hunt for alternatives. In 1907 a chemist combined phenol— a waste product of coal tar— and formaldehyde, creating a hardy new polymer called bakelite. Bakelite was much less flammable than celluloid and the raw materials used to make it were more readily available. Bakelite was only the beginning. In the 1920s, researchers first commercially developed polystyrene, a spongy plastic used in insulation. Soon after came polyvinyl chloride, or vinyl, which was flexible yet hardy. Acrylics created transparent, shatter-proof panels that mimicked glass. And in the 1930s nylon took centre stage— a polymer designed to mimic silk, but with many times its strength. Starting in 1933, polyethylene became one of the most versatile plastics, still used today to make everything from grocery bags, to shampoo bottles, to bulletproof vests. New manufacturing technologies accompanied this explosion of materials. The invention of a technique called injection-moulding made it possible to insert melted plastics into molds of any shape, where they would rapidly harden. This created possibilities for products in new varieties and shapes— and a way to inexpensively and rapidly produce plastics at scale. Scientists hoped this economical new material would make items that once had been unaffordable accessible to more people. Instead, plastics were pushed into service in World War Two. During the war, plastic production in the United States quadrupled. Soldiers wore new plastic helmet liners and water-resistant vinyl raincoats. Pilots sat in cockpits made of plexiglass, a shatterproof plastic, and relied on parachutes made of resilient nylon. Afterwards, plastic manufacturing companies that had sprung up during wartime turned their attention to consumer products. Plastics began to replace other materials like wood, glass, and fabric in furniture, clothing, shoes, televisions, and radios. Versatile plastics opened up possibilities for packaging— mainly designed to keep food and other products fresh for longer. Suddenly, there were plastic garbage bags, stretchy plastic wrap, squeezable plastic bottles, takeaway cartons, and plastic containers for fruit, vegetables, and meat. Within just a few decades, this multifaceted material ushered in what became known as the “plastics century.” While the plastics century brought convenience and cost-effectiveness, it also created staggering environmental problems. Many plastics are made of nonrenewable resources. And plastic packaging was designed to be single-use, but some plastics take centuries to decompose, creating a huge build up of waste. This century we’ll have to concentrate our innovations on addressing those problems— by reducing plastic use, developing biodegradable plastics, and finding new ways to recycle existing plastic.

**P908 2020-09-10 Is human evolution speeding up or slowing down - Laurence Hurst**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=908)

The Tibetan high plateau lies about 4500 meters above sea level, with only 60% of the oxygen found below. While visitors and recent settlers struggle with altitude sickness, native Tibetans sprint up mountains. This ability comes not from training or practice, but from changes to a few genes that allow their bodies to make the most of limited oxygen. These differences are apparent from birth— Tibetan babies have, on average, higher birth weights, higher oxygen saturation, and are much likelier to survive than other babies born in this environment. These genetic changes are estimated to have evolved over the last 3,000 years or so, and are ongoing. That may sound like a long time, but would be the fastest an adaptation has ever evolved in a human population. It’s clear that human evolution isn’t over— so what are other recent changes? And will our technological and scientific innovations impact our evolution? In the past few thousand years, many populations have evolved genetic adaptations to their local environments. People in Siberia and the high arctic are uniquely adapted to survive extreme cold. They’re slower to develop frostbite, and can continue to use their hands in subzero temperatures much longer than most people. They’ve undergone selection for a higher metabolic rate that increases heat production. Further south, the Bajau people of southeast Asia can dive 70 meters and stay underwater for almost fifteen minutes. Over thousands of years living as nomadic hunters at sea, they have genetically-hardwired unusually large spleens that act as oxygen stores, enabling them to stay underwater for longer— an adaptation similar to that of deep diving seals. Though it may seem pedestrian by comparison, the ability to drink milk is another such adaptation. All mammals can drink their mother’s milk as babies. After weaning they switch off the gene that allows them to digest milk. But communities in sub-Saharan Africa, the middle east and northwest Europe that used cows for milk have seen a rapid increase in DNA variants that prevent the gene from switching off over the last 7 to 8000 years. At least in Europe, milk drinking may have given people a source of calcium to aid in vitamin D production, as they moved north and sunlight, the usual source of vitamin D, decreased. Though not always in obvious ways, all of these changes improve people’s chance of surviving to reproductive age— that’s what drives natural selection, the force behind all these evolutionary changes. Modern medicine removes many of these selective pressures by keeping us alive when our genes, sometimes combined with infectious diseases, would have killed us. Antibiotics, vaccines, clean water and good sanitation all make differences between our genes less important. Similarly, our ability to cure childhood cancers, surgically extract inflamed appendixes, and deliver babies whose mothers have life-threatening pregnancy-specific conditions, all tend to stop selection by allowing more people to survive to a reproductive age. But even if every person on Earth has access to modern medicine, it won’t spell the end of human evolution. That’s because there are other aspects of evolution besides natural selection. Modern medicine makes genetic variation that would have been subject to natural selection subject to what’s called genetic drift instead. With genetic drift, genetic differences vary randomly within a population. On a genetic level, modern medicine might actually increase variety, because harmful mutations don’t kill people and thus aren’t eliminated. This variation doesn’t necessarily translate to observable, or phenotypic, differences among people, however. Researchers have also been investigating whether genetic adaptations to a specific environment could appear very quickly through epigenetic modification: changes not to genes themselves, but to whether and when certain genes are expressed. These changes can happen during a lifetime, and may even be passed to offspring— but so far researchers are conflicted over whether epigenetic modifications can really persist over many generations and lead to lasting changes in populations. There may also be other contributors to human evolution. Modern medicine and technology are very new, even compared to the quickest, most recent changes by natural selection— so only time can tell how our present will shape our future.

**P909 2020-09-11 'Jabberwocky' - One of literature's best bits of nonsense**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=909)

Today we have a frabjous treat for you. This poem is full of seemingly nonsensical words that somehow manage to make sense. Ready to see if you can follow along? Without further ado, we present: "Jabberwocky" by Lewis Carroll. ’Twas brillig, and the slithy toves Did gyre and gimble in the wabe: All mimsy were the borogoves, And the mome raths outgrabe. “Beware the Jabberwock, my son! The jaws that bite, the claws that catch! Beware the Jubjub bird, and shun The frumious Bandersnatch!” He took his vorpal sword in hand; Long time the manxome foe he sought— So rested he by the Tumtum tree And stood awhile in thought. And, as in uffish thought he stood, The Jabberwock, with eyes of flame, Came whiffling through the tulgey wood, And burbled as it came! One, two! One, two! And through and through The vorpal blade went snicker-snack! He left it dead, and with its head He went galumphing back. “And hast thou slain the Jabberwock? Come to my arms, my beamish boy! O frabjous day! Callooh! Callay!” He chortled in his joy. ’Twas brillig, and the slithy toves Did gyre and gimble in the wabe: All mimsy were the borogoves, And the mome raths outgrabe.

**P910 2020-09-14 Is life meaningless And other absurd questions -** **Nina Medvinskaya**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=910)

Albert Camus grew up surrounded by violence. His homeland of Algeria was mired in conflict between native Algerians and colonizing French Europeans. He lost his father in the First World War, and was deemed unfit to fight in the second. Battling tuberculosis in France and confronting the war's devastation as a resistance journalist, Camus grew despondent. He couldn’t fathom any meaning behind all this endless bloodshed and suffering. He asked: if the world was meaningless, could our individual lives still hold value? Many of Camus’ contemporaries were exploring similar questions under the banner of a new philosophy called existentialism. Existentialists believed people were born as blank slates, each responsible for creating their life’s meaning amidst a chaotic world. But Camus rejected their school of thought. He argued all people were born with a shared human nature that bonded them toward common goals. One such goal was to seek out meaning despite the world’s arbitrary cruelty. Camus viewed humanity’s desire for meaning and the universe’s silent indifference as two incompatible puzzle pieces, and considered trying to fit them together to be fundamentally absurd. This tension became the heart of Camus’ Philosophy of the Absurd, which argued that life is inherently futile. Exploring how to live without meaning became the guiding question behind Camus’ early work, which he called his “cycle of the absurd.” The star of this cycle, and Camus’ first published novel, offers a rather bleak response. "The Stranger" follows Meursault, an emotionally detached young man who doesn’t attribute much meaning to anything. He doesn’t cry at his mother’s funeral, he supports his neighbor’s scheme to humiliate a woman, he even commits a violent crime — but Meaursault feels no remorse. For him the world is pointless and moral judgment has no place in it. This attitude creates hostility between Meursault and the orderly society he inhabits, slowly increasing his alienation until the novel’s explosive climax. Unlike his spurned protagonist, Camus was celebrated for his honest philosophy. "The Stranger" catapulted him to fame, and Camus continued producing works that explored the value of life amidst absurdity many of which circled back to the same philosophical question: if life is truly meaningless, is committing suicide the only rational response? Camus’ answer was an emphatic “no.” There may not be any explanation for our unjust world, but choosing to live regardless is the deepest expression of our genuine freedom. Camus explains this in one of his most famous essays which centers on the Greek myth of Sisyphus. Sisyphus was a king who cheated the gods, and was condemned to endlessly roll a boulder up a hill. The cruelty of his punishment lies in its singular futility, but Camus argues all of humanity is in the same position. And only when we accept the meaninglessness of our lives can we face the absurd with our heads held high. As Camus says, when the king chooses to begin his relentless task once more, “One must imagine Sisyphus happy.” Camus’ contemporaries weren’t so accepting of futility. Many existentialists advocated for violent revolution to upend systems they believed were depriving people of agency and purpose. Camus responded with his second set of work: the cycle of revolt. In "The Rebel," he explored rebellion as a creative act, rather than a destructive one. Camus believed that inverting power dynamics only led to an endless cycle of violence. Instead, the way to avoid needless bloodshed is to establish a public understanding of our shared human nature. Ironically, it was this cycle of relatively peaceful ideas that triggered his fallout with many fellow writers and philosophers. Despite the controversy, Camus began work on his most lengthy and personal novel yet: an autobiographical work entitled "The First Man." The novel was intended to be the first piece in a hopeful new direction: the cycle of love. But in 1960, Camus suddenly died in a car accident that can only be described as meaningless and absurd. While the world never saw his cycle of love, his cycles of revolt and absurdity continue to resonate with readers today. His concept of absurdity has become a part of world literature, 20th century philosophy, and even pop culture. Today, Camus remains a trusted guide for moments of uncertainty; his ideas defiantly imbuing a senseless world with inspiration rather than defeat.

**P911 2020-09-16 The World Machine \_ Think Like A Coder, Ep 10**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=911)

As Ethic falls, she remembers. She remembers the world before they unearthed the crystal. She remembers the glee she felt when she built her first robot. But mostly she remembers the friends she’s made these last few days: courageous Adila and her resistance movement. Octavia’s sacrifice to keep the guards distracted. Lemma and her idealistic drive to cure everyone. And Hedge. Her creation, her responsibility, her failure… her betrayer. Hedge, who convinced her to collect the three nodes that she never actually needed. For Ethic remembers how to operate the World Machine. If only she could get a second chance at it. Adila has been in radio contact with Octavia, whom the robots captured and imprisoned in the same jail that held Ethic. Ethic explains that Hedge has manipulated them all, and will now try to break down the Bradbarrier and cover the entire world in a giant maze, unless they can stop him. But she has a plan: Ethic herself will go to the crystal at the center of the maze and use its powers to stop Hedge. Meanwhile, Adila and Lemma will do whatever they can to slow Hedge down. As Ethic weaves her way towards the innermost maze, her radio picks up a transmission. Octavia has freed hundreds of members of the resistance from stasis. Together, they’ve staged a jailbreak and overwhelmed the guards. The resistance has access to the World Machine, but they don’t know how to use it; they’ll need Ethic for that. All they have at their disposal are nearly limitless spools of wire. The strands are durable, but prisoners can break them deliberately if they need to. Ethic reaches the entrance to the inner most maze… and it’s sealed from within. She remembers a few things from when she flew over the maze days earlier. It centers on the crystal. There are many dead ends, but no paths that loop back on themselves. Ethic has one opportunity to radio the members of the resistance a simple set of instructions before they plunge into the labyrinth in search of the exit. What directions can she give them so they can quickly navigate the maze, open the door, and guide Ethic straight back to the crystal? Pause now to figure it out for yourself. Hint in 3 Hint in 2 Hint in 1 Here’s a hint: One of the challenges here is to find a way to indicate where dead ends are, so that the resistance members don’t keep going down them. Try simplifying the maze to something like this. Let’s say you’ve just hit this dead end, then came back to this intersection. What could you do to show the next person who gets here that they don’t need to explore that path? Pause now to figure it out yourself. Solution in 3 Solution in 2 Solution in 1 Most programming puzzles involve giving instructions to a single actor so that they can accomplish a goal. Instead, here we have a swarm of individuals, each of whom can follow basic instructions. That’s unusual in programming, but not unheard of; researchers are currently experimenting with swarms of small robots to do things like conduct search and rescue missions. The prisoners aren’t robots, but for Ethic’s purposes they’ll act like them. And by working together they can achieve their goal much more efficiently. Because you have a lot of prisoners, you’ll want them to cover a lot of ground. This matches up well to a maze-mapping technique called a depth-first search. It’s called that because it involves going as deeply down a path as possible before going back. In other words, if you had a maze like this, you’d want to explore all the way down one of these branches before returning to this intersection and trying another. Everyone needs a clear set of instructions for what they should do. Like — first, tie down the loose end of your wire by the crystal, so it leads back there. If you find the door, open it and hand your spool to Ethic. If you’re in a passageway, keep going until you hit a dead end or an intersection. But what happens at either of those places? If someone encounters a dead end, they should backtrack to the last intersection. But they also need to mark it, so no one wastes time and goes back there. The best tool for that is the wire— one option is to break both sections that lead down the dead end path, and tie the spool to the wire that leads back to the crystal. The broken wires tell everyone else who gets to this intersection “Don’t go this way.” They’ll also guarantee the final path will lead straight to the crystal, rather than visiting dead ends. Ok, so let’s say someone’s at an intersection. Now which way should they go? The first priority is to have everyone cover fresh ground to minimize doubling up. So if there’s no wire down a direction, go that way. If there are multiple choices, choose one at random. What if they’re in a sub-section like this, with 3 marked dead ends? The only thing to do is to go back where they came from. We now know that this whole section is one big dead end, so they should break and retie the wire when they get to the next intersection. But let’s say they get there, and find two options where someone’s exploring, but no one’s hit a dead end yet. They may as well choose at random and go help explore that path further, in case it’s the right direction for the exit. This isn’t the only way to solve this challenge, but in any correct method, someone will eventually find the way out. The moment of truth will be when Ethic takes their wire and follows it back, inward towards her goal. The great thing about this method is that Ethic’s path is straight and true. The maze doesn’t have loops, so there's only one path from door to crystal. And because everyone has been breaking and retying their wires, Ethic won’t go down any dead-end paths. Face to face with her creation, Ethic has a choice: she can destroy Hedge, or set things right. All of this destruction was her fault, not Hedge’s; it was her oversight that instructed him to build an infinitely large maze. His decisions were misguided, but everything he did, he did to follow his programming. Ethic accesses his core and fixes her error with a single number: the size the maze was supposed to reach. Ethic has prevented catastrophe and regained possession of the World Machine. Her work with Adila, Octavia, and Lemma has already started to help people and heal the world’s turmoil, but there’s much work to be done. With the forgetting food out of their systems, the people will become themselves again. They’ll regain their will to create and progress. They’ll be free to break down the walls they’ve built between each other. And they may come to approach their future with a little less greed and a little more... Ethic

**P912 2020-09-17 The problem with the U.S. bail system - Camilo Ramirez**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=912)

Since 2000, the annual number of people convicted of crimes in the United States has stayed steady, but the average number of people in jail each year has shot up. How can that be? The answer lies in the bail system— which isn’t doing what it was intended to do. The term "bail" refers to the release of people awaiting trial on condition that they return to court to face charges. Countries around the world use many variations of bail, and some don’t use it at all. The U.S. bail system relies primarily on what’s called cash bail, which was supposed to work like this: When a person was accused of a crime, the judge would set a reasonable price for bail. The accused would pay this fee in order to be released from jail until the court reached a verdict on the case. Once the case ended, whether found guilty or innocent, they’d get the bail money back if they made all their court appearances. The rationale behind this system is that under U.S. law, people are presumed innocent until proven guilty— so someone accused of a crime should not be imprisoned unless they’ve been convicted of a crime. But today, the bail system in the U.S. doesn’t honor the presumption of innocence. Instead, it subverts peoples’ rights and causes serious harm, particularly to people in low-income communities and communities of color. A key reason why is the cost of bail. In order for cash bail to work as intended, the price has to be affordable for the accused. The cost of bail wasn’t meant to reflect the likelihood of someone’s guilt— when bail is set, the court has not reviewed evidence. Under exceptional circumstances, such as charges of very serious crimes, judges could deny bail and jail the accused before their trial. Judges were supposed to exercise this power very rarely, and could come under scrutiny for using it too often. Setting unaffordably high bail became a second path to denying people pretrial release. Judges' personal discretion and prejudices played a huge role in who they chose to detain this way. Bail amounts climbed higher and higher, and more and more defendants couldn’t pay— so they stayed in jail. By the late 19th century, these circumstances led to the rise of commercial bail bond companies. They pay a defendant’s bail, in exchange for a hefty fee the company keeps. Today, the median bail is $10,000— a prohibitively high price for almost half of Americans, and as many as nine out of ten defendants. If the defendant can’t pay, they may apply for a loan from a commercial bail bond company. It’s completely up to the company to decide whose bail they’ll pay. They choose defendants they think will pay them back, turning a profit of about $2 billion each year. In fact, in the past 20 years, pretrial detention has been the main driver of jail growth in America. Every year, hundreds of thousands of people who can’t afford bail or secure a loan stay in jail until their case is resolved. This injustice disproportionately affects Americans who are Black and Latino, for whom judges often set higher bail than for white people accused of the same offenses. Unaffordable bail puts even innocent defendants in an impossible position. Some end up pleading guilty to crimes they did not commit. For minor offenses, the prosecution may offer a deal that credits time already spent in jail toward the accused’s sentence if they plead guilty. Often, the time they’ve already spent in jail is the total length of the sentence, and they can go home immediately— but they leave with a criminal record. Defending their innocence, meanwhile, can mean staying in jail indefinitely awaiting trial— and doesn’t guarantee an innocent verdict. Bail may not even be necessary in the first place. Washington, D.C. largely abolished cash bail in the 1990s. In 2017, the city released 94% of defendants without holding bail money, and 88% of them returned to all their court dates. The nonprofit organization, The Bail Project, provides free bail assistance to thousands of low-income people every year, removing the financial incentive that bail is designed to create. The result? People come back to 90% of their court dates without having any money on the line, and those who miss their court dates tended to because of circumstances like child care, work conflicts, or medical crises. Studies have also found that holding people in jail before trial, often because they cannot afford cash bail, actually increases the likelihood of rearrests and reoffending. The damage of incarcerating people before their trials extends to entire communities and can harm families for generations. People who are incarcerated can lose their livelihoods, homes, and access to essential services— all before they’ve been convicted of a crime. It’s also incredibly expensive: American taxpayers spend nearly $14 billion every year incarcerating people who are legally presumed innocent. This undermines the promise of equal justice under the law, regardless of race or wealth. The issues surrounding cash bail are symptomatic of societal problems, like structural racism and over-reliance on incarceration, that need to be addressed. In the meantime, reformers like The Bail Project are working to help people trapped by cash bail and to create a more just and humane pretrial system for the future.

**P913 2020-09-18 Performing brain surgery without a scalpel - Hyunsoo Joshua No**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=913)

Every year, tens of thousands of people world-wide have brain surgery without a single incision: there’s no scalpel, no operating table, and the patient loses no blood. Instead, this procedure takes place in a shielded room with a large machine that emits invisible beams of light at a precise target inside the brain. This treatment is called stereotactic radiosurgery, and those light beams are beams of radiation: their task is to destroy tumors by gradually scrubbing away malignant cells. For patients, the process begins with a CT-scan, a series of x-rays that produce a three-dimensional map of the head. This reveals the precise location, size, and shape of the tumor within. The CT-scans also help to calculate something called "Hounsfield Units," which show the densities of different tissues. This offers information about how radiation will propagate through the brain, to better optimize its effects. Doctors might also use magnetic resonance imaging, or MRI’s, that produce finer images of soft tissue, to assist in better outlining a tumor’s shape and location. Mapping its precise position and size is crucial because of the high doses of radiation needed to treat tumors. Radiosurgery depends on the use of multiple beams. Individually, each delivers a low dose of radiation. But, like several stage lights converging on the same point to create a bright and inescapable spotlight, when combined, the rays of radiation collectively produce enough power to destroy tumors. In addition to enabling doctors to target tumors in the brain while leaving the surrounding healthy tissue relatively unharmed, the use of multiple beams also gives doctors flexibility. They can optimize the best angles and routes through brain tissue to reach the target and adjust the intensity within each beam as necessary. This helps spare critical structures within the brain. But what exactly does this ingenious approach do to the tumors in question? When several beams of radiation intersect to strike a mass of cancerous cells, their combined force essentially shears the cells’ DNA, causing a breakdown in the cells’ structure. Over time, this process cascades into destroying the whole tumor. Indirectly, the rays also damage the area immediately surrounding the DNA, creating unstable particles called free radicals. This generates a hazardous microenvironment that’s inhospitable to the tumor, as well as some healthy cells in the immediate vicinity. The risk of harming non-cancerous tissue is reduced by keeping the radiation beam coverage as close to the exact shape of the tumor as possible. Once radiosurgery treatment has destroyed the tumor’s cells, the body’s natural cleaning mechanism kicks in. The immune system rapidly sweeps up the husks of dead cells to flush them out of the body, while other cells transform into scar tissue. Despite its innovations, radiosurgery isn’t always the primary choice for all brain cancer treatments. For starters, it’s typically reserved for smaller tumors. Radiation also has a cumulative effect, meaning that earlier doses can overlap with those delivered later on. So patients with recurrent tumors may have limitations with future radiosurgery treatments. But these disadvantages weigh up against some much larger benefits. For several types of brain tumors, radiosurgery can be as successful as traditional brain surgery at destroying cancerous cells. In tumors called meningiomas, recurrence is found to be equal, or lower, when the patient undergoes radiosurgery. And compared to traditional surgery— often a painful experience with a long recovery period— radiosurgery is generally pain-free, and often requires little to no recovery time. Brain tumors aren’t the only target for this type of treatment: its concepts have been put to use on tumors of the lungs, liver, and pancreas. Meanwhile, doctors are experimenting with using it to treat conditions such as Parkinson’s disease, epilepsy, and obsessive compulsive disorder. The pain of a cancer diagnosis can be devastating, but advancements in these non-invasive procedures are paving a pathway for a more gentle cure.

**P914 2020-09-22 The myth of the stolen eyeballs - Nathan D. Horowitz**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=914)

Deep in the Amazon rainforest in the river Nea’ocoyá, lived, according to Siekopai legend, a school of particularly big and tasty fish. When the rains came and the water rose, the fish appeared, swimming away as the waters fell again. The villagers along the river reveled in this occasional bounty— and wanted more. They followed them upriver deep into the jungle to a lagoon that thundered with the sound of flapping fish. The whole village set up camp by the lagoon, bringing barbasco, a poison they would put in the water to stun the fish. Meanwhile, their young shaman took a walk. He sensed he might not be completely alone. Then, he came to a monse tree humming so loudly he could hear it even above the thunder of the fish. With that, he was sure: spirits lived here. Back at camp, he warned his people these fish had an owner. He would find the owner. Until he returned, no one should fish. He went to the humming tree. Inside was a hollow as big as a house, full of busy weavers. Their chief invited him in, explaining that the juicy little siripia fruits were ripening, and they were weaving baskets to collect them. Though they looked and acted like people, the shaman knew they were juri, or air goblins, who could fly and control the winds. They taught him how to weave. Before the shaman left, the goblin chief whispered some cryptic instructions in his ear. Finally, he told him to tie a pineapple shoot outside a hollow log and sleep inside that night. Back at camp, the villagers were fishing with barbasco poison, cooking, and eating. Only the shaman’s little sister refrained. Then, everyone else fell into a deep sleep. The shaman and his sister yelled and shook them, but they wouldn’t wake. It was getting dark, so the shaman and his sister tied the pineapple sprout outside the hollow log and crawled inside. A strong wind rose— the mark of the air goblins. It broke branches and brought down trees. Caymans, boas and jaguars roared. The water began to rise. The fish flopped off the drying racks and swam away. The pineapple sprout turned into a dog. All night it barked, keeping the jungle creatures away from the fallen tree. When dawn broke, the flood receded. The fish were gone, and most of the people were, too: the jungle animals had devoured them. Only the shaman’s relatives survived. When his family turned toward him, the shaman realized what the goblins meant when they said the fruits were ripening: they weren’t really collecting siripia fruits at all, but human eyes. The shaman’s older sister called him over, trying to touch his face with her long, sharp nails. He backed away and, remembering the goblin chief’s instructions, threw palm seeds at her face. The seeds became eyes. But then she transformed into a white-lipped peccary and ran away— still alive, but no longer human. The shaman and his little sister’s whole community was gone. They went to live with another village, where he taught everyone to weave baskets, as the air goblins had taught him. But he couldn’t forget the last of the goblin chief’s words, which told him how to get revenge. He returned to the air goblins’ home carrying chili peppers wrapped in leaves. As the goblins watched through their peepholes, the shaman made a fire and put the chili peppers on it. The fire began to smoke the tree out. The goblins who had eaten people’s eyes died. Those who hadn’t were light enough to fly away. So the goblins, like the humans, paid a steep price. But they also lived to tell the tale, like the shaman. In Siekopai legend, where the spirit and human worlds meet, there are no clear victors, and even death is an opportunity for renewal.

**P915 2020-09-23 The surprising effects of pregnancy**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=915)

Muscles and joints shift and jostle. The heart’s pounding rhythm speeds up. Blood roars through arteries and veins. Over the course of a pregnancy, every organ in the body changes. Ignited by a range of hormones, these changes begin as soon as pregnancy begins. Just days after fertilization, the embryo implants in the lining of the uterus. Because its DNA doesn’t exactly match the mother’s, the immune system should theoretically recognize it as an invader, attack, and destroy it, like it would bacteria or other harmful microbes. That’s the challenge: the mother’s immune system needs to protect both her and the fetus, but can’t act as it usually does. What happens is not as simple as decreasing the immune response. Instead, it’s a complex interaction we’re just beginning to understand, involving many different types of immune cells— some of which seem to protect the fetus from attack by other immune cells. The body also creates an antibacterial plug made of mucus on the cervix, which keeps germs away and stays sealed until labor. As a pregnancy progresses, the uterus expands upward and outward with the growing fetus. To make room, hormones called progesterone and relaxin signal muscles to loosen. The muscles that propel food and waste through the digestive tract also loosen, which makes them sluggish, causing constipation as passage through the tract slows down. Loosened muscles at the top of the stomach might allow acid to escape into the esophagus and throat, causing heartburn and reflux. These changes can worsen morning sickness, which is caused in part by hormone HCG— and can also happen at other times of day. As the uterus grows, it pushes on the diaphragm, the muscle that expands and contracts the chest with each breath. This limits the diaphragm’s range. To compensate, the hormone progesterone acts as a respiratory stimulant, making the pregnant woman breathe faster so both she and the baby can both get enough oxygen with less lung capacity. This all may leave the pregnant woman feeling short of breath. Meanwhile, the kidneys make more erythropoietin, a hormone that increases red blood cell production. The kidneys also keep extra water and salt rather than filtering it out into urine to build up the volume of the blood. A pregnant woman’s blood volume increases by 50% or more. But it’s also a bit diluted, because it only has 25% more red blood cells. Usually, the body makes blood cells using iron from our food. But during pregnancy, the fetus is also building its own blood supply from nutrients in the mother’s food— leaving less iron and other nutrients for the mother. The heart has to work extra hard to pump all this blood through the body and placenta. A pregnant woman’s heart rate increases, but we don’t fully understand how blood pressure changes in a healthy pregnancy— an important area of research, because some of the most serious complications are related to the heart and blood pressure. The expanding uterus may press on veins— causing fluid buildup in the legs and feet. If it presses on a large vein called the inferior vena cava, it might interfere with blood returning to the heart, causing a dizzying drop in blood pressure after standing for too long. Some of these changes start to reverse even before birth. Shortly before delivery, the fetus drops down, decreasing the pressure on the diaphragm and allowing the pregnant woman to take deeper breaths. During labor and birth, much of the extra fluid in the body is lost when the water breaks. The uterus shrinks back down in the weeks after birth. Like the rest of the body, pregnancy affects the brain— but its effects here are some of the least understood. Recent studies show differences in brain scans after pregnancy and early parenting, and suggest that these changes are adaptive. That means they could help with parenting skills, such as an increased ability to read facial cues since babies can’t talk. The lack of information about pregnancy’s effects on the brain highlights a general truth: historically, almost all the research around pregnancy has focused on the fetus, rather than pregnant women. Experiences of pregnancy vary widely, both within the range of healthy pregnancies and due to complicating health conditions— new research will help us understand why, and develop effective treatments where necessary. In the meantime, every pregnancy is different, and it’s important to consult a doctor with any specific questions. Today, we’re turning an exciting corner, as more research is devoted to the astounding biology of pregnancy.

**P916 2020-09-24 What causes panic attacks, and how can you prevent them - Cindy J. Aa**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=916)

The body becomes its own corset. Past, present, and future exist as a single force. A swing without gravity soars to a terrifying height. The outlines of people and things dissolve. Countless poets and writers have tried to put words to the experience of a panic attack— a sensation so overwhelming, many people mistake it for a heart attack, stroke, or other life-threatening crisis. Though panic attacks don’t cause long-term physical harm, afterwards, the fear of another attack can limit someone’s daily life— and cause more panic attacks. Studies suggest that almost a third of us will experience at least one panic attack in our lives. And whether it’s your first, your hundredth, or you’re witnessing someone else go through one, no one wants to repeat the experience. Even learning about them can be uncomfortable, but it’s necessary— because the first step to preventing panic attacks is understanding them. At its core, a panic attack is an overreaction to the body’s normal physiological response to the perception of danger. This response starts with the amygdala, the brain region involved in processing fear. When the amygdala perceives danger, it stimulates the sympathetic nervous system, which triggers the release of adrenaline. Adrenaline prompts an increase in the heart and breathing rate to get blood and oxygen to the muscles of the arms and legs. This also sends oxygen to the brain, making it more alert and responsive. During a panic attack, this response is exaggerated well past what would be useful in a dangerous situation, causing a racing heart, heavy breathing, or hyperventilation. The changes to blood flow cause lightheadedness and numbness in the hands and feet. A panic attack usually peaks within 10 minutes. Then, the prefrontal cortex takes over from the amygdala and stimulates the parasympathetic nervous system. This triggers the release of a hormone called acetylcholine that decreases the heart rate and gradually winds down the panic attack. In a panic attack, the body’s perception of danger is enough to trigger the response we would have to a real threat— and then some. We don't know for sure why this happens, but sometimes cues in the environment that remind us of traumatic past experience can trigger a panic attack. Panic attacks can be part of anxiety disorders like PTSD, social anxiety disorder, OCD, and generalized anxiety disorder. Recurring panic attacks, frequent worry about new attacks, and behavioral changes to avoid panic attacks can lead to a diagnosis of a panic disorder. The two main treatments for panic disorder are antidepressant medication and cognitive behavioral therapy, or CBT. Both have about a 40% response rate— though someone who responds to one may not respond to the other. However, antidepressant medications carry some side effects, and 50% of people relapse when they stop taking them. CBT, meanwhile, is more lasting, with only a 20% relapse rate. The goal of CBT treatment for panic disorder is to help people learn and practice concrete tools to exert physical, and in turn mental, control over the sensations and thoughts associated with a panic attack. CBT begins with an explanation of the physiological causes of a panic attack, followed by breath and muscle exercises designed to help people consciously control breathing patterns. Next comes cognitive restructuring, which involves identifying and changing the thoughts that are common during attacks— such as believing you’ll stop breathing, have a heart attack, or die— and replacing them with more accurate thoughts. The next stage of treatment is exposure to the bodily sensations and situations that typically trigger a panic attack. The goal is to change the belief, through experience, that these sensations and situations are dangerous. Even after CBT, taking these steps isn’t easy in the grip of an attack. But with practice, these tools can both prevent and de-escalate attacks, and ultimately reduce the hold of panic on a person’s life. Outside formal therapy, many panickers find relief from the same beliefs CBT aims to instill: that fear can’t hurt you, but holding on to it will escalate panic. Even if you’ve never had a panic attack, understanding them will help you identify one in yourself or someone else— and recognizing them is the first step in preventing them.

**P917 2020-09-28 Can you solve the riddle and escape Hades - Dan Finkel**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=917)

Maybe the fates got clumsy. Maybe Poseidon had one of his angry days. However it happened, the underworld is overcrowded, and Zeus has ordered Hades to let some spirits out. Hades arranges all the souls of the dead in a line before Cerberus. When one of his three heads bites down on the soul in front of it, they’ll get returned to the land of the living. Anyone to the left must get out of line and stay in Hades forever. And everyone else shuffles forward, at which point Cerberus will feed again. Each of the dog’s heads has an equal chance of being the one to bite each time, and no two ever bite simultaneously. Unfortunately, Hades’ minions forgot to tell you what was happening, and by the time you show up there are only 99 souls left in line. Hades looks furious and drawing attention to yourself won’t end well. But suddenly, time freezes, and Hermes steps out of the shadows. He tells you he can instantly put you into the line, and no one will realize what happened. But he’ll only grant his grace to someone clever enough to take full advantage of it. Choose the best place in line and he’ll give you the spot. Choose wrong, and he’ll leave you to rot. Which spot should you pick? Pause the video to figure it out yourself. Answer in 3 Answer in 2 Answer in 1 It’s possible to calculate the exact probability of going free in all 100 spots. But there’s a much simpler path to the solution that requires surprisingly little calculation. Imagine being anywhere in line. Way up at the front, one of the three heads will pick someone at random, and you’ll move forward 1, 2, or 3 spaces. Since each is equally likely, your chance of survival from wherever you started is the average of the chances from each of the three spaces in front of you. And this is where you can find a huge shortcut. Averages must be on or between the extremes of what you’re averaging— they can never be higher than the highest value or lower than the lowest. So whatever your chances of survival are where you start, one of the three places in front of you is at least as good, and probably better. This observation is incredibly powerful. It means that wherever you are in line, it’d be wise to trade your place for one of the three spots in front of you. Let’s ignore which for now and think of them as a trio— this trio’s maximum value is better than this trio’s, and so on. Keep going and you’ll reach the front... These three spots must contain the extreme values— the best and worst probabilities— for the entire line. In other words, they’re all we need to consider. Place 1 is bad. Head one would save you, and the other two doom you forever. That’s just a 1 in 3 chance to escape. Place 2 is better: head two is great, head 3 is bad, and head 1 is ok in that it gives you another chance. But place 3 is best, because head 3 saves you while heads 1 and 2 both give you extra chances. If you did want to consider the exact probabilities, the odds of surviving in place 3 are 16 out of 27, or close to 60%. The spots later in line tend to be very close to having a 50% chance of survival. Why 50%? Because every time Cerberus sends one soul up to be reborn, he leaves 0, 1, or 2 souls in the underworld. That averages out to one person staying for each one who gets freed. But you can beat those odds handily with what you now know. Hermes has places to be, and so do you. He rewards your insight by sneaking you into the third spot. And from there it’ll be just a short wait to learn your ultimate fate.

**P918 2020-10-01 Who owns the 'wilderness' - Elyse Cox**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=918)

In 1903, the President of the United States took a three-day camping trip in California’s Yosemite Valley. President Theodore Roosevelt slept in a grove of towering Sequoia trees, camped in a snowstorm, and spent hours talking around the campfire with his host and guide, conservationist John Muir. Roosevelt famously loved the outdoors, but Muir had invited him there for more than just camping: Yosemite was in danger. Though Yosemite became protected land in 1864, the valley was still at risk for overdevelopment in 1903. It was at the heart of a decades-old struggle to set aside land for both preservation and public use— two goals that were much easier said than done. The battle over Yosemite began with the 1849 gold rush, when miners surged west, seeking gold in the Sierra Nevada foothills. In 1851, a state-sanctioned militia, drove the Ahwahneechee tribe from Yosemite Valley. Those who managed to return witnessed white settlers claiming the land, felling giant sequoias, and building hotels and saloons. In response, a small group of concerned Californians lobbied senator John Conness to protect the valley from private interests. In 1864, Congress passed Conness’ bill, granting the Yosemite Valley to the State of California, marking the first time the U.S. government brought land under public protection. But the management of that land remained an open question, one that would only become more complicated as more lands came under similar protection. Seven years later, geologist Ferdinand Hayden led an expedition to the Yellowstone Plateau, which many Native American tribes used for ceremonies, hunting, and trade. The expedition’s scientists and artists brought back news of spectacular geysers and hot springs, inspiring widespread support to bring Yellowstone under government protection— and restrict native people’s access to the land. However, unlike Yosemite, Yellowstone couldn’t be granted to a state— it was part of three U.S. territories that hadn’t become states yet. Instead, Congress brought Yellowstone under federal stewardship in 1872, creating the world’s first true National Park. During his presidency, Teddy Roosevelt was instrumental in expanding the lands under public protection. By 1916, there were fifteen national parks. But the problem of management remained unsolved, and maintenance of the park was handled haphazardly over multiple government departments. Straightforward tasks like building roads and hiring personnel required inefficient bureaucratic maneuvering. None of the departments had set rules for conduct in the park, so hunters killed park wildlife, cattle overgrazed fields, and visitors vandalized landmarks. The solution came from Canada, which had a highly effective centralized park service. In 1916, the United States established the National Park Service based on this model. To this day, the mission for the park service is comprised of two goals that sometimes conflict: to conserve the parks for the future and to allow the public to enjoy them. That’s a delicate balancing act: roads, trails, and other infrastructure make the parks accessible to visitors, but also alter the landscape, while visitors themselves can contribute to pollution, erosion, and damage of delicate ecosystems. The very history of preservation can also be at odds with this mission. Many parks were not, at the time of their founding, the uninhabited wilderness that’s become the standard for their preservation. Instead, many were homes or places of worship for native peoples, who lost access to these lands in the name of public use. Only recently has the National Park Service begun to reckon with this legacy and engage Native Americans in park management. Around the world, indigenous communities play crucial roles in land management and preservation. Today, there are thousands of national parks worldwide, and each must balance public use with historical and ecological preservation. Parks in New Zealand, Iceland, Australia, and South Africa have experienced severe erosion as visitor numbers have skyrocketed. Some, like Mu Ko Similan National Park in Thailand, have closed sections to tourists entirely to allow the ecosystem to recover. National Parks have preserved irreplaceable landscapes for future generations. They also force us to reckon with hard questions: what are our responsibilities to this planet, and to each other?

**P919 2020-10-03 The rise and fall of history’s first empire - Soraya Field Fiorio**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=919)

History’s first empire rose out of a hot, dry landscape, without rainfall to nourish crops, without trees or stones for building. In spite of all this, its inhabitants built the world’s first cities, with monumental architecture and large populations— and they built them entirely out of mud. Sumer occupied the southern part of modern Iraq in the region called Mesopotamia. Mesopotamia means “between two rivers”— the Tigris and the Euphrates. Around 5000 BCE, early Sumerians used irrigation channels, dams, and reservoirs to redirect river water and farm large areas of previously bone-dry land. Agricultural communities like this were slowly springing up around the world. But Sumerians were the first to take the next step. Using clay bricks made from river mud, they began to build multi-storied homes and temples. They invented the wheel— a potter’s wheel, for turning mud into household goods and tools. Those clay bricks gave rise to the world’s first cities, probably around 4500 BCE. At the top of the city’s social ladder were priests and priestesses, who were considered nobility, then merchants, craftspeople, farmers, and enslaved people. The Sumerian empire consisted of distinct city-states that operated like small nations. They were loosely linked by language and spiritual belief but lacked centralized control. The earliest cities were Uruk, Ur, and Eridu, and eventually there were a dozen cities. Each had a king who served a role somewhere between a priest and a ruler. Sometimes they fought against each other to conquer new territories. Each city was dedicated to a patron deity, considered the city’s founder. The largest and most important building in the city was this patron god’s home: the ziggurat, a temple designed as a stepped pyramid. Around 3200 BCE, Sumerians began to expand their reach. The potter’s wheel found a new home on chariots and wagons. They built boats out of reeds and date palm leaves, with linen sails that carried them vast distances by river and sea. To supplement scarce resources, they built a trade network with the rising kingdoms in Egypt, Anatolia, and Ethiopia, importing gold, silver, lapis lazuli, and cedar wood. Trade was the unlikely impetus for the invention of the world’s first writing system. It started as a system of accounting for Sumerian merchants conducting business with traders abroad. After a few hundred years, the early pictogram system called cuneiform turned into a script. The Sumerians drafted up the first written laws and created the first school system, designed to teach the craft of writing— and pioneered some less exciting innovations, like bureaucracy and taxes. In the schools, scribes studying from dawn to dusk, from childhood well into adulthood. They learned accounting, mathematics, and copied works of literature— hymns, myths, proverbs, animal fables, magic spells, and the first epics on clay tablets. Some of those tablets told the story of Gilgamesh, a king of the city of Uruk who was also the subject of mythical tales. But by the third millennium BCE, Sumer was no longer the only empire around, or even in Mesopotamia. Waves of nomadic tribes poured into the region from the north and east. Some newcomers looked up to the Sumerians, adopting their way of life and using the cuneiform script to express their own languages. In 2300 BCE, the Akkadian king Sargon conquered the Sumerian city-states. But Sargon respected Sumerian culture, and Akkadians and Sumerians existed side-by-side for centuries. Other invading groups focused only on looting and destruction. Even as Sumerian culture spread, a steady onslaught of invasions killed off the Sumerian people by 1750 BCE. Afterward, Sumer disappeared back into the desert dirt, not to be rediscovered until the 19th century. But Sumerian culture lived on for thousands of years— first through the Akkadians, then the Assyrians, then the Babylonians. The Babylonians passed Sumerian inventions and traditions through along Hebrew, Greek, and Roman cultures. Some persist today.

**P920 2020-10-08 Can we create the 'perfect' farm - Brent Loken**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=920)

Transcriber: TED Translators Admin Reviewer: Mirjana Čutura About 10,000 years ago, humans began to farm. This agricultural revolution was a turning point in our history that enabled people to settle, build and create. In short, agriculture enabled the existence of civilization. Today, approximately 40 percent of our planet is farmland. Spread all over the world, these agricultural lands are the pieces to a global puzzle we are all facing: in the future, how can we feed every member of a growing population a healthy diet? Meeting this goal will require nothing short of a second agricultural revolution. The first agricultural revolution was characterized by expansion and exploitation, feeding people at the expense of forests, wildlife and water and destabilizing the climate in the process. That's not an option the next time around. Agriculture depends on a stable climate with predictable seasons and weather patterns. This means we can't keep expanding our agricultural lands, because doing so will undermine the environmental conditions that make agriculture possible in the first place. Instead, the next agricultural revolution will have to increase the output of our existing farmland for the long term while protecting biodiversity, conserving water and reducing pollution and greenhouse gas emissions. So what will the future farms look like? This drone is part of a fleet that monitors the crops below. The farm may look haphazard but is a delicately engineered use of the land that intertwines crops and livestock with wild habitats. Conventional farming methods cleared large swathes of land and planted them with a single crop, eradicating wildlife and emitting huge amounts of greenhouse gases in the process. This approach aims to correct that damage. Meanwhile, moving among the crops, teams of field robots apply fertilizer in targeted doses. Inside the soil, hundreds of sensors gather data on nutrients and water levels. This information reduces unnecessary water use and tells farmers where they should apply more and less fertilizer instead of causing pollution by showering it across the whole farm. But the farms of the future won't be all sensors and robots. These technologies are designed to help us produce food in a way that works with the environment rather than against it, taking into account the nuances of local ecosystems. Lower-cost agricultural practices can also serve those same goals and are much more accessible to many farmers. In fact, many such practices are already in use today and stand to have an increasingly large impact as more farmers adopt them. In Costa Rica, farmers have intertwined farmland with tropical habitat so successfully that they have significantly contributed to doubling the country's forest cover. This provides food and habitat for wildlife as well as natural pollination and pest control from the birds and insects these farms attract, producing food while restoring the planet. In the United States, ranchers are raising cattle on grasslands composed of native species, generating a valuable protein source using production methods that store carbon and protect biodiversity. In Bangladesh, Cambodia and Nepal, new approaches to rice production may dramatically decrease greenhouse gas emissions in the future. Rice is a staple food for three billion people and the main source of livelihood for millions of households. More than 90 percent of rice is grown in flooded paddies, which use a lot of water and release 11 percent of annual methane emissions, which accounts for one to two percent of total annual greenhouse gas emissions globally. By experimenting with new strains of rice, irrigating less and adopting less labor-intensive ways of planting seeds, farmers in these countries have already increased their incomes and crop yields while cutting down on greenhouse gas emissions. In Zambia, numerous organizations are investing in locally specific methods to improve crop production, reduce forest loss and improve livelihoods for local farmers. These efforts are projected to increase crop yield by almost a quarter over the next few decades. If combined with methods to combat deforestation in the region, they could move the country toward a resilient, climate-focused agricultural sector. And in India, where up to 40 percent of post-harvest food is lost or wasted due to poor infrastructure, farmers have already started to implement solar-powered cold storage capsules that help thousands of rural farmers preserve their produce and become a viable part of the supply chain. It will take all of these methods, from the most high-tech to the lowest-cost, to revolutionize farming. High-tech interventions stand to amplify climate- and conservation-oriented approaches to farming, and large producers will need to invest in implementing these technologies. Meanwhile, we'll have to expand access to the lower-cost methods for smaller-scale farmers. This vision of future farming will also require a global shift toward more plant-based diets and huge reductions in food loss and waste, both of which will reduce pressure on the land and allow farmers to do more with what they have available. If we optimize food production, both on land and sea, we can feed humanity within the environmental limits of the earth, but there's a very small margin of error, and it will take unprecedented global cooperation and coordination of the agricultural lands we have today.

**P921 2020-10-09 Which type of milk is best for you - Jonathan J. O’Sullivan & Grace E**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=921)

If you go to the store in search of milk, there are a dizzying number of products to choose from. There’s dairy milk, but also plant-based products. To turn a plant into something resembling milk, it must be either soaked, drained, rinsed, and milled into a thick paste, or dried, and milled into flour. The plant paste or flour is then fortified with vitamins and minerals, flavoured, and diluted with water. The result is a barrage of options that share many of the qualities of animal milk. So which milk is actually best for you? Let’s dive into some of the most popular milks: dairy, almond, soy, or oat? A 250 ml glass of cow’s milk contains 8 grams of protein, 12 grams of carbohydrates, and 2 to 8 grams of fat depending on if it’s skim, reduced fat, or whole. That’s approximately 15% the daily protein an average adult needs, roughly 10% the carbohydrates and 2 to 15% the fat. Most plant-based milks have less carbohydrates than dairy milk. They also have less fat, but more of what’s often called “good fats.” Meanwhile, the healthy nutrients vitamin D and calcium found in dairy milk don’t occur naturally in most plant-based milks. Looking more closely at our plant-based milks, both almond and oat are low in protein compared to dairy. But while almond milk has the least nutrients of the four, oat milk is full of beta-glucans, a healthy type of fibre. It also has a lot of carbohydrates compared to other plant milks— sometimes as much as dairy milk. Soy milk, meanwhile, has as much protein as cow’s milk and is also a great source of potassium. Soybeans contain isoflavone, which people used to think might trigger hormonal imbalances by mimicking the function of estrogen. But ultimately, soy milk contains very small amounts of isoflavones, which have a much weaker effect on our bodies than estrogen. Depending on individual circumstances, one of these milks may be the clear winner: if you’re lactose intolerant, then the plant-based milks pull ahead, while if you’re allergic to nuts, almond milk is out. For people who don’t have access to a wide and varied diet, dairy milk can be the most efficient way to get these nutrients. But all else being equal, any one of these four milks is nutritious enough to be part of a balanced diet. That’s why for many people, the milk that’s best for you is actually the milk that’s best for the planet. So which uses the fewest resources and produces the least pollution? It takes almost 4 square kilometers to produce just one glass of cow’s milk, land use that drives deforestation and habitat destruction. Most of that is land the cows live on, and some is used to grow their feed. Many cows eat soy beans and oats. It takes much less land to grow the oats or soybeans for milk than it does to feed a dairy cow— only about a quarter square kilometer per glass. Almond milk has similar land use. But where that land is also matters— soybean farms are a major driver of deforestation, while oat and almond farms aren’t. Making milk uses water every step of the way, but it’s the farming stage where big differences emerge. Dairy milk uses the most water— about 120 liters per glass, mostly to water cows and grow their food. Almonds take second place, at more than 70 liters of water per glass. Most of that water is used to grow almond trees, which take years of watering before they start producing almonds. The trees must be watered consistently, or they die, while many other crops can be left fallow and still produce later. All told, soy and oats require less water to grow: only about 5 to 10 liters per glass of milk. Milk production generates some greenhouse gas emissions— about 0.1 to 0.2 kilograms per glass for the plant-based milks. But for dairy milk, the cows themselves also produce emissions by burping and farting out large quantities of the gas methane. Overall, each glass of dairy milk contributes over half a kilogram of greenhouse gas emissions. So while depending on your dietary needs, any one of these milks may be a good fit, in terms of the health of our planet there’s a strong case for choosing plant-based milks, particularly oat or soy milk.

**P922 2020-10-13 The hidden treasures of Timbuktu - Elizabeth Cox**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=922)

On the edge of the vast Sahara desert, citizens snuck out of the city of Timbuktu and took to the wilderness. They buried chests in the desert sand, hid them in caves, and sealed them in secret rooms. Inside these chests was a treasure more valuable than gold: the city’s ancient books. Founded around 1100 CE in what is now Mali, the city of Timbuktu started out as an unremarkable trading post. But its unique location soon changed that. Timbuktu marked the intersection of two essential trade routes, where caravans bringing salt across the Sahara met with traders bringing gold from the African interior. By the late 1300s, these trade routes made Timbuktu rich, and the city’s rulers, the kings of the Mali Empire, built monuments and academies that drew scholars from Egypt, Spain, and Morocco. The city’s prime location also made it a target for warlords and conquerors. As the Mali Empire declined, one of its domains, Songhai, began to gain power. In 1468, the Songhai king conquered Timbuktu, burning buildings and murdering scholars. But in time, intellectual life in the city flourished again. The reign of the second king of the Songhai Empire, Askia Mohammed Toure, marked the beginning of a golden age in Timbuktu. He reversed his predecessor’s regressive policies and encouraged learning. The Songhai rulers and most of Timbuktu’s population were Muslim, and the scholars of Timbuktu studied Islam alongside secular topics like mathematics and philosophy. In the libraries of Timbuktu, tracts of Greek philosophy stood alongside the writings of local historians, scientists, and poets. The city’s most prominent scholar, Ahmed Baba, challenged prevailing opinions on subjects ranging from smoking to slavery. Gold and salt trade had funded the city’s transformation into a center of learning. Now, the products of that intellectual culture became the most sought-after commodity. With paper from faraway Venice and vibrant ink from local plants and minerals, the scribes of Timbuktu produced texts in both Arabic and local languages. Written in calligraphy and decorated with intricate geometric designs, the books of Timbuktu were in demand among the wealthiest members of society. In 1591, the golden age came to an abrupt end when the Moroccan king captured Timbuktu. Moroccan forces imprisoned Ahmed Baba and other prominent scholars and confiscated their libraries. In the centuries that followed, the city weathered a succession of conquests. In the mid-1800s, Sufi Jihadists occupied Timbuktu and destroyed many non-religious manuscripts. 1894, French colonial forces seized control of the city, stealing even more manuscripts and sending them to Europe. French became the official language taught in schools, and new generations in Timbuktu couldn’t read the Arabic manuscripts that remained. Through it all, the literary tradition of Timbuktu didn’t die— it went underground. Some families built secret libraries in their homes, or buried the books in their gardens. Others stashed them in abandoned caves or holes in the desert. The priceless manuscripts of Timbuktu dispersed to villages throughout the surrounding area, where regular citizens guarded them for hundreds of years. As desertification and war impoverished the region, families held on to the ancient books even as they faced desperate poverty and near-starvation. Even today, the struggle to protect the books continues. From the 1980s to the early 2000s, Timbuktu scholar Abdel Kader Haidara painstakingly retrieved hidden manuscripts from all over northern Mali and brought them back to Timbuktu. But in 2012, civil war in Mali once again threatened the manuscripts, most of which were evacuated to nearby Bamako. Their future remains uncertain, as they face both human and environmental threats. These books represent our best— and often only— sources on the pre-colonial history of the region. Many of them have never been read by modern scholars, and still more remain lost or hidden in the desert. At stake in the efforts to protect them is the history they contain— and the efforts of countless generations to protect that history from being lost.

**P923 2020-10-15 Could we harness the power of a black hole - Fabio Pacucci**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=923)

Imagine a distant future when humans reach beyond our pale blue dot, forge cities on planets thousands of light-years away, and maintain a galactic web of trade and transport. What would it take for our civilization to make that leap? There are many things to consider— how would we communicate? What might a galactic government look like? And one of the most fundamental of all: where would we get enough energy to power that civilization— its industry, its terraforming operations, and its starships? An astronomer named Nikolai Kardashev proposed a scale to quantify an evolving civilization’s increasing energy needs. In the first evolutionary stage, which we’re currently in, planet-based fuel sources like fossil fuels, solar panels and nuclear power plants are probably enough to settle other planets inside our own solar system, but not much beyond that. For a civilization on the third and final stage, expansion on a galactic scale would require about 100 billion times more energy than the full 385 yotta joules our sun releases every second. Barring a breakthrough in exotic physics, there’s only one energy source that could suffice: a supermassive black hole. It’s counterintuitive to think of black holes as energy sources, but that’s exactly what they are, thanks to their accretion disks: circular, flat structures formed by matter falling into the event horizon. Because of conservation of angular momentum, particles there don’t just plummet straight into the black hole. Instead, they slowly spiral. Due to the intense gravitational field of the black hole, these particles convert their potential energy to kinetic energy as they inch closer to the event horizon. Particle interactions allow for this kinetic energy to be radiated out into space at an astonishing matter-to-energy efficiency: 6% for non-rotating black holes, and up to 32% for rotating ones. This drastically outshines nuclear fission, currently the most efficient widely available mechanism to extract energy from mass. Fission converts just 0.08% of a Uranium atom into energy. The key to harnessing this power may lie in a structure devised by physicist Freeman Dyson, known as the Dyson sphere. In the 1960s, Dyson proposed that an advanced planetary civilization could engineer an artificial sphere around their main star, capturing all of its radiated energy to satisfy their needs. A similar, though vastly more complicated design could theoretically be applied to black holes. In order to produce energy, black holes need to be continuously fed— so we wouldn’t want to fully cover it with a sphere. Even if we did, the plasma jets that shoot from the poles of many supermassive black holes would blow any structure in their way to smithereens. So instead, we might design a sort of Dyson ring, made of massive, remotely controlled collectors. They’d swarm in an orbit around a black hole, perhaps on the plane of its accretion disk, but farther out. These devices could use mirror-like panels to transmit the collected energy to a powerplant, or a battery for storage. We’d need to ensure that these collectors are built at just the right radius: too close and they’d melt from the radiated energy. Too far, and they’d only collect a tiny fraction of the available energy and might be disrupted by stars orbiting the black hole. We would likely need several Earths worth of highly reflective material like hematite to construct the full system— plus a few more dismantled planets to make a legion of construction robots. Once built, the Dyson ring would be a technological masterpiece, powering a civilization spread across every arm of a galaxy. This all may seem like wild speculation. But even now, in our current energy crisis, we’re confronted by the limited resources of our planet. New ways of sustainable energy production will always be needed, especially as humanity works towards the survival and technological progress of our species. Perhaps there’s already a civilization out there that has conquered these astronomical giants. We may even be able to tell by seeing the light from their black hole periodically dim as pieces of the Dyson ring pass between us and them. Or maybe these superstructures are fated to remain in the realm of theory. Only time— and our scientific ingenuity— will tell.

**P924 2020-10-16 What if there were 1 trillion more trees - Jean-François Bastin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=924)

Standing at almost 84 meters tall, this is the largest known living tree on the planet. Nicknamed General Sherman, this giant sequoia has sequestered roughly 1,400 tons of atmospheric carbon over its estimated 2,500 years on earth. Very few trees can compete with this carbon impact, but today, humanity produces more than 1,400 tons of carbon every minute. To combat climate change, we need to steeply reduce fossil fuel emissions, and draw down excess CO2 to restore our atmosphere’s balance of greenhouse gases. But what can trees do to help in this fight? And how do they sequester carbon in the first place? Like all plants, trees consume atmospheric carbon through a chemical reaction called photosynthesis. This process uses energy from sunlight to convert water and carbon dioxide into oxygen and energy-storing carbohydrates. Plants then consume these carbohydrates in a reverse process called respiration, converting them to energy and releasing carbon back into the atmosphere. In trees, however, a large portion of that carbon isn’t released, and instead, is stored as newly formed wood tissue. During their lifetimes, trees act as carbon vaults, and they continue to draw down carbon for as long as they grow. However, when a tree dies and decays, some of its carbon will be released back into the air. A significant amount of CO2 is stored in the soil, where it can remain for thousands of years. But eventually, that carbon also seeps back into the atmosphere. So if trees are going to help fight a long-term problem like climate change, they need to survive to sequester their carbon for the longest period possible, while also reproducing quickly. Is there one type of tree we could plant that meets these criteria? Some fast growing, long-lived, super sequestering species we could scatter worldwide? Not that we know of. But even if such a tree existed, it wouldn’t be a good long-term solution. Forests are complex networks of living organisms, and there’s no one species that can thrive in every ecosystem. The most sustainable trees to plant are always native ones; species that already play a role in their local environment. Preliminary research shows that ecosystems with a naturally occurring diversity of trees have less competition for resources and better resist climate change. This means we can’t just plant trees to draw down carbon; we need to restore depleted ecosystems. There are numerous regions that have been clear cut or developed that are ripe for restoring. In 2019, a study led by Zurich’s Crowtherlab analyzed satellite imagery of the world’s existing tree cover. By combining it with climate and soil data and excluding areas necessary for human use, they determined Earth could support nearly one billion hectares of additional forest. That’s roughly 1.2 trillion trees. This staggering number surprised the scientific community, prompting additional research. Scientists now cite a more conservative but still remarkable figure. By their revised estimates, these restored ecosystems could capture anywhere from 100 to 200 billion tons of carbon, accounting for over one-sixth of humanity’s carbon emissions. More than half of the potential forest canopy for new restoration efforts can be found in just six countries. And the study can also provide insight into existing restoration projects, like The Bonn Challenge, which aims to restore 350 million hectares of forest by 2030. But this is where it gets complicated. Ecosystems are incredibly complex, and it’s unclear whether they’re best restored by human intervention. It’s possible the right thing to do for certain areas is to simply leave them alone. Additionally, some researchers worry that restoring forests on this scale may have unintended consequences, like producing natural bio-chemicals at a pace that could actually accelerate climate change. And even if we succeed in restoring these areas, future generations would need to protect them from the natural and economic forces that previously depleted them. Taken together, these challenges have damaged confidence in restoration projects worldwide. And the complexity of rebuilding ecosystems demonstrates how important it is to protect our existing forests. But hopefully, restoring some of these depleted regions will give us the data and conviction necessary to combat climate change on a larger scale. If we get it right, maybe these modern trees will have time to grow into carbon carrying titans.

**P925 2020-10-22 How do steroids affect your muscles— and the rest of your body - Anee**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=925)

They’ve caused global scandals. They’re banned in most athletic competitions. But are steroids actually bad for you? The term “steroids” refers to a broad category of molecules that share a similar molecular structure, but have many different functions. When people talk about steroids in the context of sports, they’re referring to a subset of steroids that resemble testosterone. Though elite athletes and bodybuilders began using these steroids in the 1950s, today, most steroid users are actually not competitive athletes, but people seeking a particular appearance. These steroids have two main effects: androgenic, or masculinizing, and anabolic, or growth-promoting. These effects mimic naturally-occurring testosterone, which drives the development and maintenance of male secondary sex characteristics and general growth in everyone. That means testosterone and the synthetic steroids based on it promote body and facial hair growth, enlargement of the vocal cords and deepening of the voice, increased muscle mass and strength, and increased stature and bone mass. Recreational steroid users are after the anabolic, growth promoting effects. To make muscles grow, steroids first promote protein synthesis— proteins are essential building blocks of all cells, tissues, and organs, including muscles. Steroids also block cortisol, a signaling molecule that drives the breakdown of substances including proteins. Finally, they may push the development of muscle, rather than fat, and boost our metabolism, shrinking fat deposits. These properties make steroids valuable for treating many illnesses and injuries. They can help people with wasting illnesses, like AIDS and certain cancers, maintain muscle mass and help burn victims recover lost muscle tissue. So if steroids are used as medicine, they must be safe to use recreationally, right? Well, it’s not that simple. To create the desired muscle growth, recreational steroid users must typically take doses orders of magnitude higher than those prescribed for a medical condition. Long term, high dose steroid usage can have both undesirable and outright harmful effects— some of them dependent on factors like age, sex, and underlying health conditions. We’re not sure what all the risk factors are, but we do know recreational steroid use is particularly risky for adolescents. During puberty, steroid use can prompt bones to mature before they’re done growing, causing growth defects. Adolescents are also most at risk for the harmful psychiatric effects of steroid use. The most common of these, increased impulsivity and increased aggression, are well-known as “roid rage.” Up to 60% of users experience these effects. But there are also less common, more damaging psychiatric side effects like mania and even psychosis. Steroid use can damage organs including the liver and kidneys, and cause cardiovascular problems like high blood pressure. While some or all of those effects may be reversible, steroid use can also cause liver cancer, especially in males. Though recreational users take steroids for their anabolic effects, they also experience androgenic effects— often undesired. That can mean increased body hair, enlargement of the clitoris, and permanent voice deepening in females. At the same time, excess testosterone-like steroids can cause feminization in males, because the body converts the excess into estrogen. This can lead to breast development and shrinking testicles. These effects are not uncommon— about a third of male steroid users experience them to some degree. Excess steroid use can also reduce fertility in males and females— by reducing the sperm in semen or by causing missed periods and conditions like polycystic ovary syndrome. All these effects may be reversible if steroid use stops— but they may not be. The specific steroid, the duration of use, and other factors could play a role in reversibility. Finally, there’s mounting evidence that users are susceptible to steroid dependence. They can develop tolerance and require increasingly large doses over time. This increases the risk of harmful effects, all of which are increasingly common at higher doses taken for longer durations. Still, there remains little definitive information on how common and how reversible almost any of the harms are at different levels of use. We don’t know enough, about either risk factors or exposure levels, to definitively say any recreational steroid use will be harm-free.

**P926 2020-10-26 Can you outsmart a troll (by thinking like one) - Claire Wardle**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=926)

Your town is holding a mayoral election and the stakes have never been higher: the outcome will decide the fate of a local movement to rely on 100% renewable energy. One mayoral nominee, Joanna B. Greene, is a champion of this movement, while the other, Stannis Quo, staunchly opposes it. He’s announced he’ll use whatever tactics are necessary to win the election. As the municipal cybersecurity expert, you’re on high alert. Election day is near and you suspect that Quo will begin pushing false information to swing the election in his favor. Your job is to inoculate the townspeople against false information before the election. One of the most effective ways to tackle disinformation is to encourage people to think about the strategies used by those who create and spread it. This might seem counter-intuitive— and potentially dangerous— but as long as you don’t create a “how-to manual,” active inoculation is an effective option. A study conducted in 2019 used an online game to train people to think like a disinformation producer. When the participants were next shown the disinformation, their perception of its reliability dropped significantly. But before you can teach your own townspeople, you need to figure it out for yourself. What strategies would you employ if you were Stannis Quo? In order to launch a successful disinformation campaign, you must use evocative, and convincing content that will spread quickly and create confusion. It’ll also help to take advantage of confirmation bias. People are intuitively more inclined to believe information that supports a worldview they already have. Many young voters in your town are in favor of transitioning to renewable energy and sympathize with Greene. Rather than trying to change their minds, Quo will likely focus on suppressing the youth vote. If you were him, how would you start? You might create fake user accounts to spread disinformation on popular social media platforms. You could even make one that impersonates a trusted figure. From these accounts, you can deliver highly shareable, engaging visual content, like memes relating to the imminent election. That’s how you would like to go about spreading disinformation, but what kind of disinformation would be effective in manipulating young Greene supporters? First, you could direct people to vote via text, a webpage, or an app, none of which are viable voting platforms in your town. The claim isn’t too far-fetched. An encrypted digital platform could actually seem safer to young people than the traditional ballot system. Perhaps you could also tell them that the voting day is one day after it actually is. You could then pair this approach with a more emotion-driven one. How about vilifying Greene and appealing to the young voters’ values? You want to share information that taps into people’s sense of civic duty and makes them feel that the election depends on their sharing it as widely as possible. Your fake accounts could circulate false accusations that Greene takes money from local, somehow corrupt renewable energy facilities; treats her staff poorly; or abuses stray kittens for fun. These inflammatory claims could lead people to question Greene’s integrity as a leader and even initiate further conspiracy theories. After you’ve introduced these disinformation campaigns, your fake users should keep repeating them so they stick in people’s minds. Finally, media coverage would further spread your claims and give them perceived legitimacy. You could message a few local journalists asking whether these rumors are true and express your concerns. By the time an article comes out debunking the rumors, people’s experiences of the truth will have become so warped that convincing them otherwise will be difficult. A disinformation campaign like this would pit citizens against one another and exploit their values and fears. You can't personally protect each individual from disinformation, but you can equip them with the insights you have— and encourage them to pass these tools further along. After all, community organizing is what elections often call for.

**P927 2020-11-05 How do investors choose stocks - Richard Coffin**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=927)

Every day, billions of stocks are traded on the New York Stock Exchange alone. But with over 43,000 companies listed on stock exchanges around the world, how do investors decide which stocks to buy? To answer this question, it’s important to first understand what stocks are, and what individuals and institutions hope to achieve by investing in them. Stocks are partial shares of ownership in a company. So by buying a stock, investors buy a share in the company’s success— or failure— as measured by the company’s profits. A stock’s price is determined by the number of buyers and sellers trading it; if there are more buyers than sellers, the price will increase, and vice versa. The market price of a share therefore represents what buyers and sellers believe the stock, and by association the company, is worth. So the price can change dramatically based on whether investors think the company has a high potential for increasing profitability— even if it isn’t profitable yet. Investors aim to make money by purchasing stocks whose value will increase over time. Some investors aim simply to grow their money at a faster rate than inflation diminishes its value. Others have a goal of “beating the market,” which means growing their money at a faster rate than the cumulative performance of all companies’ stocks. This idea of “beating the market” is a source of debate among investors— in fact, investors break into two main groups over it. Active investors believe it is possible to beat the market by strategically selecting specific stocks and timing their trades, while passive investors believe it isn’t usually possible to beat the market, and don’t subscribe to stock picking. The phrase “beating the market” usually refers to earning a return on an investment that exceeds the Standard & Poor 500 index. The S&P 500 is a measure of the average performance of 500 of the largest companies in the United States, weighted by company valuation, meaning that companies with a higher market value have a larger effect on the S&P— again, market value corresponds to what investors believe a company is worth rather than actual profits. The S&P doesn’t directly represent the market as a whole— many small and mid-range stocks can fluctuate according to different patterns. Still, it’s a pretty good proxy for the overall market. It’s often said that “the stock market behaves like a voting machine in the short term, and a weighing machine in the long term”— meaning short term fluctuations in stock prices reflect public opinion, but over the longer term, they do tend to actually reflect companies’ profits. Active investors aim to exploit the short term, “voting machine” aspect of the market. They believe the market contains inefficiencies: that stock prices at any given point in time may overvalue some companies, undervalue others, or fail to reflect developments that will impact the market. Active investors hope to exploit these inefficiencies by buying stocks they think are priced low. To identify undervalued stocks, they may investigate a company’s business operations, analyze its financial statements, observe price trends, or use algorithms. Passive investors, by contrast, put their faith in the long term “weighing machine” aspect of the market. They believe that even though markets may exhibit inefficiencies at any given point, over time those inefficiencies balance out— so if they buy a selection of stocks that represents a cross-section of the market, over time it will grow. This is usually accomplished through index funds, collections of stocks that represent the broader market. The S&P 500 index is one of many indexes. The overall goal is the same for all index funds: to hold stocks for the long term and ignore short-term market fluctuations. Ultimately, active and passive investing aren’t mutually exclusive— many investment strategies have elements of each, for example, choosing stocks actively but holding them for the long term as passive investing advises. Investing is far from an exact science: if there was one foolproof method, everyone would be doing it.

**P928 2020-11-05 How fast is the speed of thought - Seena Mathew**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=928)

Your mortal enemy has captured you and hooked you up to a bizarre experiment. He’s extended your nervous system with one very long neuron to a target about 70 meters away. At some point, he’s going to fire an arrow. If you can then think a thought to the target before the arrow hits it, he’ll let you go. So who wins that race? In order to answer, we have to examine the hardware of thought: neurons. The human brain has about 86 billion of these cells. They transmit signals down their axons by way of electrical impulses, or action potentials. One neuron can then pass that signal to the next at a synapse by way of chemical neurotransmitters. The signal is received by the next neuron’s dendrites, propagated down its axon, and passed further along. So, the key factors that determine how quickly you think include how long it takes to generate an initial action potential; propagate it down the length of the axon; and transport it through the synapse. We must also factor in the number of neurons involved and the distance the signal has to travel. Let’s see what this looks like in a simple pathway— your knee-jerk reflex. A strike to your patellar tendon triggers an electrical impulse that travels up a sensory neuron to your spine. There the signal branches, and for the sake of simplicity, we’ll consider the segment that jumps into a motor neuron to journey back down your leg. The total length of the neurons in that pathway is about 1 meter in someone who is 5 foot 5 inches, and on average it takes 15 to 30 milliseconds from strike to kick. Speed is distance divided by time, so this signal travels somewhere between 120 to 240 kilometers per hour. The initial action potential accounts for 1 to 5 milliseconds and synaptic transmissions only take .1 to .5 milliseconds, so the bulk of that time is spent within the axons. This is consistent with research findings that the average individual neuron sends signals at around 180 kilometers per hour. But speeds can be boosted with myelination and increased axon diameter. Myelin is a fatty sheath that insulates an axon, preventing electrical currents from leaking out. Meanwhile, axons with larger diameters offer less internal resistance. These compounded factors can raise the speed of an action potential as high as 432 kilometers per hour. There’s plenty of variation: some people think faster than others, and your own speed of thought changes throughout your lifetime. In particular, as you reach old age, the myelin sheath covering your axons wears down, and other neuronal structures degrade. Back to the dastardly experiment. Arrows shot from recurve bows fly, on average, around 240 kilometers per hour. Which means that given a sufficiently long, myelinated or large-diameter neuron, your thoughts actually could win the race. But… there’s a wrinkle. The arrow and thought don’t leave the gate at the same time; first the arrow fires, then once you perceive it, your signal can start down its path. Processing images or music, participating in inner speech, and recalling memories all require complicated neural pathways that are nowhere close to the linearity of the knee-jerk reflex. The speed at which these thoughts occur is mostly consistent, with variations based on myelination and axon diameter. But the duration of a thought will vary significantly depending on its routes, pitstops, and destination. In this case, when you perceive a threatening stimulus, you’ll invoke a fear startle response. Similar to the knee-jerk response, a startle can be involuntary and quite fast. If the string twangs loud enough, you might react in less than 65 milliseconds. More likely though, your startle reaction will be based on sight. Our eyes can process an image as quickly as 13 milliseconds, but computation of what you’re seeing and determining the danger it poses can take as long as 180 to 200 milliseconds. In that time the arrow will have gained a head start of about 13 meters. The target is far enough away that you’ve got just enough of a chance to catch up, if you can quickly, and quite literally, think your way out.

**P929 2020-11-05 Why do you get a fever when you're sick - Christian Moro**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=929)

In 1917, doctors proposed an outlandish treatment for syphilis, the incurable bacterial infection that had ravaged Europe for centuries. Step 1: Infect patients suffering from the later stages of syphilis with the parasite that causes malaria, the deadly but curable mosquito-borne disease. Step 2: Hope that malarial fevers clear the syphilis. And step 3: Administer quinine to curb the malaria. If all went according to plan, their patient would be left alive and free of both diseases. This killed some 15% of patients, but for those who survived, it seemed to work. It actually became the standard treatment for syphilis until penicillin was widely used decades later. And its driving force was fever. There are many mysteries around fever, but what we do know is that all mammals, some birds and even a few invertebrate and plant species feel fever’s heat. It has persisted for over 600 million years of evolution. But it has a significant cost. For every 1 degree Celsius of temperature increase in the human body, there’s a 12.5 percent increase in energy required, the equivalent of about 20 minutes of jogging for some. So, why and how does your body produce a fever? Your core temperature is maintained via thermoregulation, a set of processes that usually keep you around 37 degrees Celsius. These mechanisms are controlled by the brain’s hypothalamus, which detects minute temperature shifts and sends signals throughout the body accordingly. If you’re too hot, the hypothalamus produces signals that activate your sweat glands or make your blood vessels dilate, moving blood closer to the skin’s surface— all of which releases heat and cools you off. And if you’re too cold, your blood vessels will constrict and you may start to shiver, which generates heat. Your body will disrupt its usual temperature equilibrium to induce a fever, which sets in above 38 degrees Celsius. Meanwhile, it has mechanisms in place to prevent it from exceeding 41 degrees Celsius, when organ damage could occur. Immune cells that are fighting an infection can induce a fever by triggering a biochemical cascade that ultimately instructs your hypothalamus to increase your baseline temperature. Your body then gets to work to meet its new “set point” using the mechanisms it would to generate heat when cold. Until it reaches this new temperature, you’ll feel comparatively cool, which is why you might experience chills. But why does your body do this? While the jury's still out on how higher temperatures directly affect pathogens, it seems that fever's main effect is in rapidly inducing a whole-body immune response. Upon exposure to raised internal temperatures, some of your cells release heat shock proteins, or HSPs, a family of molecules produced in response to stressful conditions. These proteins aid lymphocytes, one of several kinds of white blood cells that fight pathogens, to travel more rapidly to infection sites. HSPs do this by enhancing the “stickiness” of lymphocytes, enabling them to adhere to and squeeze through blood vessel walls so they can reach the areas where infection is raging. In the case of viral infections, HSPs help tell nearby cells to dampen their protein production, which limits their ability to replicate. This stunts the virus’s spread because they depend on their host’s replicative machinery to reproduce. It also protects surrounding cells from damage since some viruses spread by rupturing their host cells, which can lead to large-scale destruction, the build-up of detritus, and potentially even organ damage. The ability of HSPs to protect host cells and enhance immune activity can limit the pathogen’s path of destruction inside of the body. But for all we know about fever’s role in immune activation, some clinical trials have shown that fever suppressor drugs don’t worsen symptoms or recovery rates. This is why there’s no definitive rule on whether to suppress a fever or let it ride. Doctors decide on a case-by-case basis. The fever’s duration and intensity, as well as their patient’s immune status, comfort level, and age will all play a role in their choice of treatments. And if they do let a fever ride, they’ll likely prescribe rest and plenty of fluids to prevent dehydration while the body wages its heated battle.

**P930 2020-11-10 Why is pneumonia so dangerous - Eve Gaus and Vanessa Ruiz**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=930)

Every time you breathe in, air travels down the trachea, through a series of channels called bronchi, and finally reaches little clusters of air sacs called alveoli. There are some 600 million alveoli in the lungs, adding up to a surface area of roughly 75 square meters— the size of a tennis court. These tiny sacs, only one cell thick, facilitate a crucial exchange: allowing oxygen from the air we breathe into the bloodstream and clearing out carbon dioxide. Pneumonia wreaks havoc on this exchange. Pneumonia is an infection of the alveoli that causes them to fill with fluid. There are many different kinds of pathogens that can cause pneumonia. The most common ones are viruses or bacteria. These microscopic invaders enter the body via droplets either in the air we breathe, or when we touch our eyes, noses, or mouths after touching a contaminated surface. Then, they face the respiratory tract’s first line defense: the mucociliary escalator. The mucociliary escalator consists of mucus that traps invaders and tiny hairs called cilia that carry the mucus toward the mouth, where it can be coughed out. But some of these invaders may get past the mucociliary escalator into the lungs, where they meet the alveoli. Because alveoli serve as critical exchange points between the blood and air from the outside world, they have their own specialized types of white blood cells, or macrophages, which defend against foreign organisms by enveloping and eating them. When pathogens enter the lungs, the macrophages work to destroy them. The immune system releases additional white blood cells in the alveoli to help. As these immune cells fight the pathogens, they generate inflammation— and fluid as a by-product of the inflammation. When this fluid builds up, it makes gas exchange inside the alveoli much more difficult. As the level of carbon dioxide in the bloodstream begins to rise, the body breathes more quickly to try to clear it out and get more oxygen in. This rapid breathing is one of the most common symptoms of pneumonia. The body also tries to force the fluid out of the alveoli through coughing. Determining the cause of pneumonia can be difficult, but once it is established, doctors can prescribe antibiotics, which may include either antibacterial or antiviral treatments. Treatment with antibiotics helps the body get the infection under control. As the pathogen is cleared out, the body gradually expels or absorbs fluid and dead cells. The worst symptoms typically fade out in about a week, though full recovery may take as long as a month. Otherwise healthy adults can often manage pneumonia at home. But for some groups, pneumonia can be a lot more severe, requiring hospitalization and oxygen, artificial ventilation, or other supportive measures while the body fights the infection. Smoking damages the cilia, making them less able to clear even the normal amount of mucus and secretions, let alone the increased volume associated with pneumonia. Genetic and autoimmune disorders can make someone more susceptible to pathogens that can cause pneumonia. Young children and the elderly also have impaired clearance and weaker immune systems. And if someone has viral pneumonia, their risk of bacterial respiratory infection is higher. Many of the deaths from pneumonia are due to lack of access to healthcare. But sometimes, even with appropriate care, the body enters a sustained fight against the infection it can’t maintain, activating inflammatory pathways throughout the body, not just in the lungs. This is actually a protective mechanism, but after too long in this state organs start shutting down, causing shock and sometimes death. So how can we prevent pneumonia? Eating well and getting enough sleep and exercise helps your body fight off infections. Vaccines can protect against common pneumonia-causing pathogens, while washing your hands regularly helps prevent the spread of these pathogens— and protect those most vulnerable to severe pneumonia.

**P931 2020-11-13 Can you solve the Alice in Wonderland riddle - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=931)

After many adventures in Wonderland, Alice has once again found herself in the court of the temperamental Queen of Hearts. She’s about to pass through the garden undetected, when she overhears the king and queen arguing. “It’s quite simple,” says the queen. “64 is the same as 65, and that’s that.” Without thinking, Alice interjects. “Nonsense,” she says. “If 64 were the same as 65, then it would be 65 and not 64 at all.” “What? How dare you!” the queen huffs. “I’ll prove it right now, and then it’s off with your head!” Before she can protest, Alice is dragged toward a field with two chessboard patterns— an 8 by 8 square and a 5 by 13 rectangle. As the queen claps her hands, four odd-looking soldiers approach and lie down next to each other, covering the first chessboard. Alice sees that two of them are trapezoids with non-diagonal sides measuring 5x5x3, while the other two are long triangles with non-diagonal sides measuring 8x3. “See, this is 64.” The queen claps her hands again. The card soldiers get up, rearrange themselves, and lie down atop the second chessboard. “And that is 65." Alice gasps. She’s certain the soldiers didn’t change size or shape moving from one board to the other. But it’s a mathematical certainty that the queen must be cheating somehow. Can Alice wrap her head around what’s wrong— before she loses it? Pause the video to figure it out yourself. Answer in 3. Answer in 2 Answer in 1 Just as things aren’t looking too good for Alice, she remembers her geometry, and looks again at the trapezoid and triangle soldier lying next to each other. They look like they cover exactly half of the rectangle, their edges forming one long line running from corner to corner. If that’s true, then the slopes of their diagonal sides should be the same. But when she calculates these slopes using the tried and true formula "rise over run," a most curious thing happens. The trapezoid soldier’s diagonal side goes up 2 and over 5, giving it a slope of two fifths, or 0.4. The triangle soldier’s diagonal, however, goes up 3 and over 8, making its slope three eights, or 0.375. They’re not the same at all! Before the queen’s guards can stop her, Alice drinks a bit of her shrinking potion to go in for a closer look. Sure enough, there’s a miniscule gap between the triangles and trapezoids, forming a parallelogram that stretches the entire length of the board and accounts for the missing square. There’s something even more curious about these numbers: they’re all part of the Fibonacci series, where each number is the sum of the two preceding ones. Fibonacci numbers have two properties that factor in here: first, squaring a Fibonacci number gives you a value that’s one more or one less than the product of the Fibonacci numbers on either side of it. In other words, 8 squared is one less than 5 times 13, while 5 squared is one more than 3 times 8. And second, the ratio between successive Fibonacci numbers is quite similar. So similar, in fact, that it eventually converges on the golden ratio. That’s what allows devious royals to construct slopes that look deceptively similar. In fact, the Queen of Hearts could cobble together an analogous conundrum out of any four consecutive Fibonacci numbers. The higher they go, the more it seems like the impossible is true. But in the words of Lewis Carroll— author of Alice in Wonderland and an accomplished mathematician who studied this very puzzle— one can’t believe impossible things.

**P932 2020-11-13 Which bag should you use - Luka Seamus Wright and Imogen Ellen Napper**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=932)

You’ve filled up your cart and made it to the front of the grocery line when you’re confronted with yet another choice: what kind of bag should you use? If you’ve seen the images of plastic bags strewn across the ocean, it might seem obvious that plastic is bad for the environment. Surely a paper bag or a cotton tote would be the better option. But is that really true? Each of these three materials has a unique environmental impact that’s determined by its carbon footprint, its potential to be reused and recycled, and its degradability. So, to get the full story on these grocery bags we need to look at how they’re made, how they’re used, and where they ultimately go. Let’s start with plastic. The typical thin and flimsy plastic bag is made of high-density polyethylene, commonly known as HDPE. Producing this material requires extracting petroleum from the ground and applying extreme heat. The resulting polymer resin is then transported alongside additional ingredients like titanium oxide and chalk to a bag manufacturing plant. Here, coal powered machines melt the materials down and spin them into sheets of plastic, which are then folded into bags. By the time a bag reaches its final destination, it’s contributed an estimated 1.6 kg of carbon dioxide to the atmosphere. That’s the same amount of carbon a car produces, driving a little over 6 kilometers. But the alternatives actually possess a much larger carbon footprint. Paper is made from wood pulp, and when you account for the carbon cost of removing trees from their ecosystems, a single paper bag can be responsible for about 5.5 kg of carbon dioxide. Meanwhile, growing cotton is an extremely energy and water intensive process. The production of a single cotton tote emits an estimated 272 kg of carbon dioxide. When we compare carbon footprints, plastic bags are the clear winner. But environmental impact is also determined by how the bag is used. Reusing or recycling these bags significantly offsets their environmental toll by reducing demand for new production. To quantify that offset, we can divide the bag’s carbon footprint by the number of times it’s reused. For example, if a typical paper bag is reused three times, it has a lower net impact than a single-use plastic bag. The carbon footprint of a cotton tote can similarly be lowered, if it’s reused 131 times. Of these three options, durable cloth totes are most likely to be reused. Evidence shows paper bags are quickly discarded due to their tendency to tear. This issue plagues HDPE plastic bags as well. But even when they’re made to avoid tearing, their widespread availability makes it easy to treat them as single-use items. Fortunately, researchers estimate that 40% of HDPE bags are reused at least once for throwing out waste. Recycling these bags also offsets their carbon footprint, but it’s not universally possible for each material. Many countries lack the infrastructure to efficiently recycle plastic bags. Cotton totes are perhaps even more difficult to breakdown and process, but since they’re often reused for long periods, they’re still least likely to end up in landfills. Whenever these bags aren’t recycled, the third factor in calculating environmental impact comes into play: degradability. Since HDPE bags are heat-resistant and insoluble, they stick around long after we’re done with them. Partially broken down plastic can circulate in ecosystems for centuries. Cotton on the other hand degrades substantially in a matter of months, and paper bags break down completely in just 90 days. So, which bag should you use? It turns out the most environmentally friendly bags have features of several materials we've discussed. They’re durable and reusable, like cotton, but made of plastic, which has a lower carbon footprint than cotton or paper. These sturdy shopping bags consist of polyester, vinyl and other tough plastics, and are already used worldwide. Most importantly, they should last a lifetime— making them the best option for the planet, and your groceries.

**P933 2020-11-20 The myth of Loki and the deadly mistletoe - Iseult Gillespie**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=933)

Baldur— son of All Father Odin and Queen Frigg, husband of Nanna the Peaceful, and God of truth and light— was the gentlest and most beloved being in all of Asgard. In his great hall of Breidablik, Baldur’s soothing presence eased his subject’s woes. But lately, he was plagued by troubles of his own. Every night, Baldur had gruesome visions foretelling his own imminent death. Determined to protect her son from these grim prophecies, Queen Frigg travelled across the nine realms, begging all living things not to harm Baldur. Her grace moved each being she encountered. Every animal and element, every plague and plant, every blade and bug gladly gave their word. Frigg returned to Breidablik, and threw a great feast to celebrate. Wine flowed freely, and soon the gods took turns testing Baldur’s immunity. Lurking in the corner, Loki rolled his eyes. The trickster god had never cared for Baldur the Bright, and found his new gift profoundly irritating. Surely there was a flaw in Frigg’s plan. Taking the form of an old woman, Loki crept to Frigg’s side and feigned confusion. Why were the gods attacking sweet Baldur, whom they all loved so dearly? Frigg told her of the oaths, but the old woman pressed on. Surely you didn’t receive a vow from everything, she asked. Frigg shrugged. The only being she hadn’t visited was mistletoe. After all, what god could fear a trifling weed? At this, Loki dashed outside to find a sprig of mistletoe. When he returned, the festivities had grown even rowdier. But not every god was enjoying the party. Baldur’s brother Hodur, who was blind and weapon-less, sat dejected. Seeing his opportunity, the trickster slyly offered Hodur a chance to participate. Loki armed him with mistletoe, guided his aim towards his brother, and told Hodur to hurl with all his might. The mistletoe pierced Baldur’s chest with deadly force. The god’s light quickly flickered out, and despair swept over the crowd. Within moments, the impact of Baldur’s death could be felt across the nine realms. But from the weeping masses, Hermod the Brave stepped forward. The warrior god believed that with the help of Odin’s mighty steed, there was no plane he could not reach. He would travel to halls of Hel herself, and bring Baldur home. The god rode for nine days and nine nights, past halls of corpses and over paths paved with bone. When he finally reached the Queen of the Underworld, Hermod begged her to return Baldur to his family. Hel considered taking pity, but she wanted to know the extent of the gods’ mourning. She agreed to relinquish Baldur’s soul— if Hermod could prove that every living thing wept at Baldur’s death. Hermod shot back to the land of the living. He met with every creature that Frigg visited earlier— all of which cried for Baldur and begged for his return. Meanwhile, Loki watched Hermod’s mission with disdain. He would not let his work be so easily undone, but if he interfered too boldly it might reveal his hand in Baldur’s murder. Disguising himself as a ferocious giant, he hid himself at Hermod’s final stop. When the warrior came, the howling wind and craggy rocks each declared their love for Baldur. But the giant within spewed only contempt for the deceased. No matter how much Hermod begged, she would not shed a single tear. With his last hope dashed, the god began to mourn Baldur a second time. But an echo from the cave rang out above his sobs. Loki’s twisted cackle was well-known to every Asgardian, and Hermod realized he’d been tricked. As he leapt to accost the trickster, Loki took the form of a salmon and wriggled into the waterfall. His escape was guaranteed, until Thor arrived at the scene. Dragging Loki back to the cave, the gods bound him with a poisonous serpent. Here, Loki would remain chained until the end of days— the serpent dripping venom on his brow as punishment for dousing Asgard’s brightest light.

**P934 2020-12-01 The world’s largest organism - Alex Rosenthal**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=934)

This is Goliath, the krill. Don’t get too attached. Today this 1 centimeter crustacean will share the same fate as 40 million of his closest friends: a life sentence in the belly of the largest blue whale in the world. Let’s call her Leviatha. Leviatha weighs something like 150 metric tons, and she’s the largest animal in the world. But she’s not even close to being the largest organism by weight, which is estimated to equal about 40 Leviatha’s. So where is this behemoth? Here, in Utah. Sorry, that’s too close. Here. This is Pando, whose name means “I spread out.” Pando, a quaking aspen, has roughly 47,000 genetically identical clone trunks. Those all grow from one enormous root system, which is why scientists consider Pando a single organism. Pando is the clear winner of world’s largest organism by weight— an incredible 6 million kilograms. So how did Pando get to be so huge? Pando is not an unusual aspen from a genetic standpoint. Rather, Pando’s size boils down to three main factors: its age, its location, and aspens’ remarkable evolutionary adaptation of self-cloning. So first, Pando is incredibly expansive because it’s incredibly old. How old exactly? No one knows. Dendrochronologist estimates range from 80,000 to 1 million years. The problem is, there’s no simple way to gauge Pando’s age. Counting the rings of a single trunk will only account for up to 200 years or so, as Pando is in a constant cycle of growth, death, and renewal. On average, each individual tree lives 130 years, before falling and being replaced by new ones. Second: location. During the last ice age, which ended about 12,000 years ago, glaciers covered much of the North American climate friendly to aspens. So if there were other comparably sized clonal colonies, they may have perished then. Meanwhile, Pando’s corner of Utah remained glacier-free. The soil there is rich in nutrients that Pando continuously replenishes; as it drops leaves and trunks, the nutrients return to nourish new generations of clones. Which brings us to the third cause of Pando’s size: cloning. Aspens are capable of both sexual reproduction— which produces a new organism— and asexual reproduction— which creates a clone. They tend to reproduce sexually when conditions are unfavorable and the best strategy for survival is to move elsewhere. Trees aren’t particularly mobile, but their seeds are. Like the rest of us, sexual reproduction is how Pando came into the world in the first place all those tens or hundreds of thousands of years ago. The wind or a pollinator carried pollen from the flower of one of its parents to the other, where a sperm cell fertilized an egg. That flower produced fruit, which split open, releasing hundreds of tiny, light seeds. The wind carried one to a wet spot of land in what is now Utah, where it took root and germinated into Pando’s first stem. A couple of years later, Pando grew mature enough to reproduce asexually. Asexual reproduction, or cloning, tends to happen when the environment is favorable to growth. Aspens have long roots that burrow through the soil. These can sprout shoots that grow up into new trunks. And while Pando grew and spread out, so did our ancestors. As Hunter-gatherers who made cave paintings, survived an ice age, found their way to North America, built civilizations in Egypt and Mesopotamia, fought wars, domesticated animals, fought wars, formed nations, built machines, and invented the internet, and always newer ways to fight wars. Pando has survived many millennia of changing climates and encroaching ice. But it may not survive us. New stems are growing to maturity much more slowly than they need to in order to replace the trunks that fall. Scientists have identified two main reasons for this. The first is that we’ve deprived Pando of fire. When a fire clears a patch of forest, Aspen roots survive, and send shoots bursting up out of the ground by the tens of thousands. And secondly, grazers like herds of cattle and mule deer— whose natural predators we’ve hunted to the point of local elimination— are eating Pando’s fresh growth. If we lose the world’s largest organism, we’ll lose a scientific treasure trove. Because Pando’s trunks are genetically identical, they can serve as a controlled setting for studies on everything from the tree microbiome to the influence of climate on tree growth rates. The good news is, we have a chance to save Pando, by reducing livestock grazing in the area and further protecting the vulnerable young saplings. And the time to act is today. Because as with so many other marvels of our natural world, once they’re gone it will be a very, very long time before they return.

**P935 2020-12-03 Building the world's largest (and most controversial) power plant - A**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=935)

In 2018, a single power plant produced more energy than the world’s largest coal-powered and gas-powered plants combined. And rather than using finite fossil fuels, this massively powerful plant relied on a time-tested source of renewable energy: running water. Stretching over 2.3 kilometers, China’s Three Gorges Dam isn’t just the world’s largest hydroelectric plant. It’s capable of producing more energy than any other power plant on Earth. So what allows Three Gorges to generate all this power? And how do hydroelectric plants work in the first place? A hydroelectric dam is essentially a massive gate, which redirects a river’s natural flow through a large pipe called a penstock. Rushing water flows through the penstock and turns the blades of a turbine, which is attached to a generator in an adjacent power station. The turning of the blades spins coils of wire inside a magnetic field, producing a steady supply of electricity. Because the penstocks can be sealed at any time, a dam can hold back excess water during stormy seasons, and save it for dry ones. This allows hydroelectric dams to produce power regardless of the weather, while simultaneously preventing floods further downstream. These benefits have long appealed to China’s Hubei Province. Located near the basin of the Yangtze River, this region is prone to deadly floods during rainy seasons when the Yangtze’s flow is strongest. Plans to build a dam that would transform this volatile waterway into a stable source of power circulated throughout the 20th century. When construction finally began in 1994 the plans were epic. The dam would contain 32 turbines— 12 more than the previous record holder, South America’s Itaipu Dam. The turbines would supply energy to two separate power stations, each connecting to a series of cables spanning hundreds of kilometers. Electricity from Three Gorges would reach power grids as far away as Shanghai. However, the human costs of this ambition were steep. To create the dam’s reservoir, workers needed to flood over 600 square kilometers of land upstream. This area included 13 cities, hundreds of villages, and over 1,000 historical and archaeological sites. The construction displaced roughly 1.4 million people, and the government’s relocation programs were widely considered insufficient. Many argued against this controversial construction, but others estimated that the lives saved by the dam’s flood protection would outweigh the trauma of displacement. Furthermore, raising the water level upstream would improve the river’s navigability, increase shipping capacity, and transform the region into a collection of prosperous port towns. When the project was completed in 2012, China became the world’s largest producer of electricity. In 2018, the dam generated 101.6 billion kilowatt-hours. That’s enough electricity to power nearly 2% of China for one year; or to power New York City for almost two years. This is a truly astonishing amount of energy. And yet, two years earlier, another dam less than half the size actually generated more electricity. Despite Three Gorges record-setting scale, the Itaipu Dam still produced more power. To understand why Itaipu can outperform Three Gorges, we need to look at the two factors that determine a dam’s energy output. The first is the number of turbines. Three Gorges has the world’s highest installed turbine capacity, meaning it’s theoretically capable of producing over 50% more power than Itaipu. But the second factor is the force and frequency of water moving through those turbines. Three Gorges spans several deep, narrow ravines surging with powerful water. However, the Yangtze’s seasonal changes keep the dam from reaching its theoretical maximum output. The Itaipu Dam, on the other hand, is located atop what was previously the planet’s largest waterfall by volume. Although the dam’s construction destroyed this natural wonder, the constant flow of water allows Itaipu to consistently generate more power each year. This dam rivalry is far from over, and other projects like the Inga Falls Dam in the Democratic Republic of Congo are also vying for the title of most powerful power plant. But whatever the future holds, governments will need to ensure that a power plant’s environmental and human impact are as sustainable as the energy it produces.

**P936 2020-12-04 Can you solve the monster duel riddle - Alex Gendler**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=936)

You’ve come a long way to compete in the great Diskymon league and prove yourself a Diskymon master. Now that you’ve made it to the finals, you’re up against some tough competition. As you enter the arena, the referee explains the rules. There are three Diskydisks you can use. Disk A will always summon a level 3 Burgersaur. Disk B summons a Churrozard that has a 56% chance of being level 2, a 22% chance of being level 4, and a 22% chance of being level 6. Disk C will summon a level 5 Wartortilla 49% of the time, and a level 1 Wartortilla 51% of the time. All Diskymon fully heal between battles, and the higher level Diskymon always wins, no matter what type it is. In round one, you’ll face a single opponent and get to choose your disk before she picks from the remaining two. Which one gives you the best chance of winning? Pause here to figure it out yourself Answer in 3 Answer in 2 Answer in 1 Before you start calculating probabilities, take a look at the disks themselves. Disks B and C each have a more than 50% chance of summoning a level 2 or a level 1 Diskymon, respectively. This means that disk A’s guaranteed level 3 Burgersaur will always have better than even odds of winning. If you choose B or C, your opponent could pick A and gain an advantage over you. And C fares worst of all, being more than 50% likely to lose to any opponent. So you choose A, hoping for the best, and sure enough, your level 3 Burgersaur triumphs over the level 2 Churrozard. Now it’s time for round two, and while you’ve prepared for trouble, you didn’t anticipate they’d make it double. You get to choose any one of the three disks again, but this time, you’ll be in a battle royale against two opponents, each using one of the other disks. Whoever summons the highest level Diskymon wins. Should you stick with A, or switch? Pause now to figure it out yourself Answer in 3 Answer in 2 Answer in 1 For many Diskymon trainers, it seems intuitive that if A is the best at beating B or C, it should also be the best at beating B and C. Strangely enough, that couldn’t be further from the truth. Let’s calculate the odds. For A to win, B has to summon a level 2 Diskymon, and C has to summon a level 1. Those are independent events, so their odds are 56% times 51%, or 29%. For disk B, a level 2 Churrozard would automatically lose to the Burgersaur. But you’d have two ways to win. The 22% chance of summoning a level 6 would give you an outright win, while a level 4 could still win if C summons a level 1. Adding up those mutually exclusive possibilities gives you odds of about 33%. Finally, C will win with a level 5 Wartortilla as long as B doesn’t summon its level 6, giving C a 38% chance overall. So while disk A’s middling consistency was an advantage in a single matchup, multiple fights increase the odds that one of the other disks will summon something better. And although C was the worst first-round option, its decent chance of summoning a strong level 5 gives it an advantage when facing two opponents simultaneously. This sort of counterintuitive result is why misleading statistics are a favored tool of unscrupulous politicians and nefarious Diskymon trainers alike. Fortunately, your Wartortilla comes out level 5 and makes short work of its foes. You’re about to celebrate when your rivals capture the referee and announce a surprise third round. You’ll have to repeat each of the previous matches in succession, with all the same rules except for one: you must keep the same disk throughout. Which should you choose to give yourself the best chance at becoming that which no one ever was?

**P996 2021-05-10 What’s in the air you breathe - Amy Hrdina and Jesse Kroll**

[播放链接](https://www.bilibili.com/video/BV1Gf4y1y7wc?p=996)

Take a deep breath. In that single intake of air, your lungs swelled with roughly 25 sextillion molecules, ranging from compounds produced days ago, to those formed billions of years in the past. In fact, many of the molecules you’re breathing were likely exhaled by members of ancient civilizations and innumerable humans since. But what exactly are we all breathing? Roughly 78% of Earth’s atmosphere is composed of nitrogen generated by volcanic activity deep beneath the planet’s crust. The next major ingredient is oxygen, accounting for 21% of Earth’s air. While oxygen molecules have been around as long as Earth’s oceans, oxygen gas didn’t appear until ocean dwelling microorganisms evolved to produce it. Finally, .93% of our air is argon, a molecule formed from the radioactive decay of potassium in Earth’s atmosphere, crust, and core. Together, all these dry gases make up 99.93% of each breath you take. Depending on when and where you are, the air may also contain some water vapor. But even more variable is that remaining .07%, which contains a world of possibilities. This small slice of air is composed of numerous small particles including pollen, fungal spores, and liquid droplets, alongside trace gases like methane and carbon dioxide. The specific cocktail of natural and man-made compounds changes dramatically from place to place. But no matter where you are, .07% of every breath you take likely contains man-made pollutants— potentially including toxic compounds that can cause lung disease, cancer, and even DNA damage. There’s a wide variety of known pollutants but they all fall into two categories. The first are primary pollutants. These toxic compounds are directly emitted from a man-made or naturally occurring source. However, they don't always come from the places you'd expect. Some large factories mostly generate water vapor, with only small quantities of pollutants mixed in. Conversely, burning wood or dung can create polycyclic aromatic hydrocarbons; dangerous compounds that have been linked to several types of cancer, as well as long-term DNA damage. In all cases, pollutants interact with regional weather patterns and topography, which can keep compounds local or spread them kilometers away. When these molecules travel through the air, a transformation occurs. Natural compounds called oxidants, formed by oxygen and sunlight, break down the pollutants. Sometimes, these reactions make pollutants more easily washed out by rain. But in other cases, they result in even more toxic secondary pollutants. For example, when factories burn coal, they release high concentrations of sulfur oxides. These molecules oxidize to form sulfates, which condense with water vapor in the air to form a blanket of fine particles that impair visibility and cause severe lung damage. This so-called sulfurous smog was well-known in 20th century London and continues to plague cities like Beijing. Since the advent of cars, another secondary pollutant has taken center stage. Exhaust from fossil fuel-burning vehicles releases nitrogen oxides and hydrocarbons which react to form ozone. And while some ozone in the upper atmosphere helps shield us from ultraviolet rays, on the ground, this gas can form alongside secondary particles and create photochemical smog. This brown fog can be found covering densely packed cities, making seeing difficult and breathing hazardous. It also contributes to climate change by trapping heat in the atmosphere. In recent decades, industrial activity has contributed to a huge spike in various trace gas emissions, fundamentally changing the air we all breathe. Many places have already responded with countermeasures. Most cars produced since the 1980′s are equipped with catalytic converters that reduce the emission of carbon monoxide and nitrogen oxides. And today, places like Beijing are battling smog by electrifying their energy infrastructure and limiting automobile emissions altogether. But while moving away from fossil fuels is essential, there's no universal remedy for air pollution. Different regions need to respond with unique regulations that account for their local pollutants. Because no matter where you live, we all share the same air.