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SEEKING SCIENCE

by STEM Action Teen Institution

A MONTHLY
STEM NEWSLETTER

AI RECYCLING

ZOMBIE INSECTS

ENZYMES & PROTEINS

and more...

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Zombie Insects: Cordyceps

Owen Chen

Recent shows like *The Last of Us* have created a fantasy world in which a fungus called cordyceps can infect humans and turn them into infected zombies. There is no zombie apocalypse occurring, but cordyceps is a very real fungus. So how does it work within nature in the real world?

Cordyceps is a type of fungus that belongs to the Ascomycota family. It has been used for centuries in traditional Chinese medicine to enhance physical performance, strengthen the immune system, and improve overall health. Cordyceps is commonly found at the heights of the Himalayas and is famous for its fascinating life cycle.

Cordyceps infects and ultimately kills insects by invading their bodies and consuming them from the inside. The fungus grows out of the insect's body, forming a long stalk that releases spores to infect other insects. Recently, scientists have discovered that cordyceps has several health benefits for humans, including boosting energy levels, improving respiratory function, and reducing inflammation.

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One of the main compounds found in cordyceps is adenosine, which has been shown to improve blood flow and oxygenation in the body, meaning it can enhance physical performance and reduce fatigue. Cordyceps also contains polysaccharides, which are carbohydrates that help stimulate the immune system. Studies have also shown that cordyceps can help reduce anxiety and depression and may even improve cognitive function and memory. Perhaps this fungus is not so bad for humans after all!

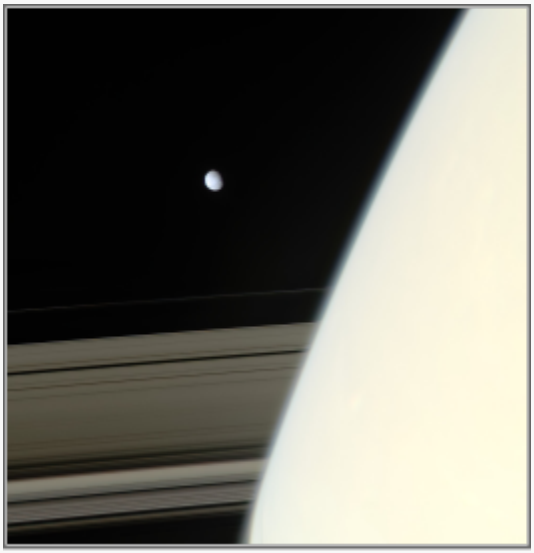
A Closer Look at Saturn's Rings

Edward Huang

Saturn, the sixth furthest planet from the Sun, is known for its beauty, especially with its ring system. While Saturn is not the only planet in the solar system with rings, its rings are the most prominent out of all of the planets. Saturn's rings have been thoroughly documented and researched by many scientists, so there is extensive knowledge of what Saturn's rings are made of.

Saturn's rings are made of water ice particles of varying sizes. The size of these ice particles can be anywhere from a few micrometers to many meters wide. Most of Saturn's ring matter is made of ice, but other impurities make up the other 0.01% of Saturn's rings in the form of dust and rocks.

Saturn's rings are not uniform, however, as there are thousands of small gaps, the ring system is composed of countless thin, concentric rings. Gaps within rings are made in a variety of ways. Some gaps are created due to the gravitational pull of one of Saturn's moons. The Cassini Division, which is the thickest and most visible gap, is caused by Saturn's moon Mimas, which orbits outside of the ring and pulls many of the ice particles closer to itself. The orbit of Mimas resonates with the orbit of Saturn's rings such that the gravitational pull of Mimas can split the ring into distinct inner and outer rings. Essentially, some parts of the ring orbit faster than others, and particles that happen to be near Mimas for

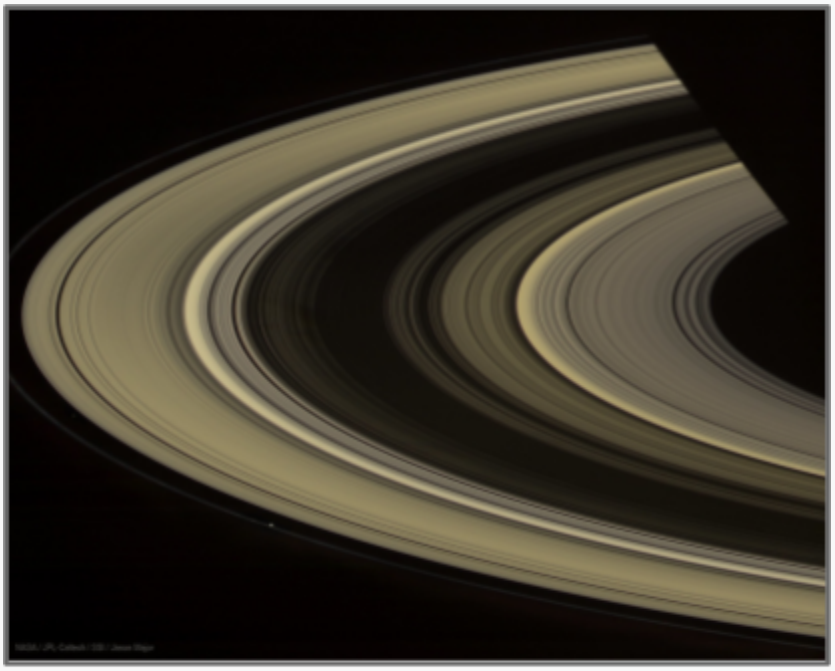


"Saturn and Mimas - November 30 2007" by Kevin Gill, licensed under CC BY 2.0. https://www.flickr.com/photos/kevinmgill/50323446488

a greater portion of time will be separated from particles that coincide with Mimas's orbit less.

Other divisions, such as the Encke Gap, are caused by a smaller moon orbiting within the ring itself. The Encke Gap is caused by one of Saturn's moons, Pan, which has a significant gravitational pull. As it orbits Saturn, a matter that is subject to Pan's gravitational pull will be moved inwards, towards Pan, leaving a trail of matter following Pan's orbit. The result is a large gap, with a thin, isolated, central ringlet that traces Pan's orbit.

Various combinations of gaps instead make Saturn's rings not one, but countless concentric rings. Large rings with easily visible distinctions are named D, C, B, A, and F, where their proximity from Saturn is in that order. The Cassini division is found in between the B and A rings, and the previously mentioned Encke Gap can be found within the A ring itself. These rings themselves are also not one single ring but instead composed of countless ringlets.



"Saturn's Rings" by Jason Major, licensed under CC BY-NC-SA 2.0
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Multiple theories exist as to how Saturn's rings formed in the first place. One theory is that during Saturn's formation, some leftover debris surrounding Saturn never became part of Saturn itself. This matter, perpetually stuck in an orbit around Saturn, eventually organized itself into rings via gravitational pull. Another theory is that rings were caused by a moon orbiting too close to Saturn, where the side closer to Saturn was pulled much more than the side facing away from Saturn. This "tidal force" essentially stretched the moon and ripped it apart, whose debris then became Saturn's rings. Another theory was that this moon instead collided with a comet, which correlates with the fact that most of Saturn's rings are made of ice.

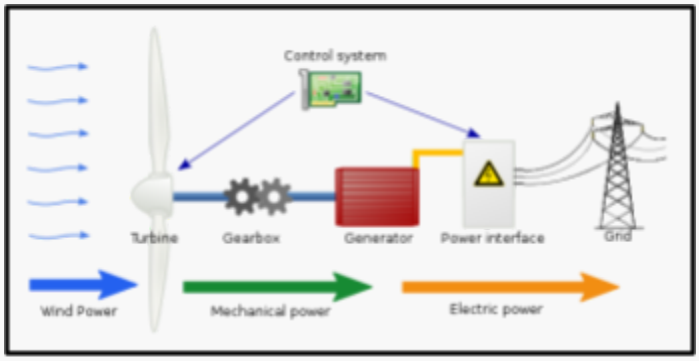
Wind Power: The Sustainable Solution for a Greener Future

Stephen Hung

Wind energy has become an increasingly popular solution to global warming, as people recognize the need for sustainable energy sources to reduce their dependence on fossil fuels. However, the establishment of wind farms requires a thorough consideration of multiple factors, including economic benefits and costs, as well as optimal locations that minimize negative impacts on local areas.

Economic considerations are crucial when it comes to transitioning to large-scale wind power. While wind energy is pricier than conventional sources like coal and petroleum, it offers greater cost-efficiency than other renewable energy alternatives, priced at a mere $97 per MWh. Additionally, wind farms offer significant economic benefits in the long run, such as new employment opportunities that can revive struggling local economies. The positive impact that wind energy has on the economy is a critical factor that cannot be ignored by agencies seeking to construct new wind farms.

Another important consideration is the strategic location of wind farms to mitigate their negative impacts on local communities. Research has shown that wind turbines can cause sleep interference, which can lead to harmful effects such as nausea, blurred vision, and difficulty reading and thinking. Wind turbines can also be a visual nuisance, disturbing the natural backdrop that residents are used to. In addition, the construction of wind turbines may have a detrimental effect on the natural habitat of local fauna. Therefore, agencies must prioritize maximizing energy output while minimizing noise pollution to prevent harmful effects on people's sleep, and also consider the impact on local habitats and the environment.



"Wind Turbine Schematic" By Jalonsom, CC BY-SA 3.0, https://commons.wikimedia.org/wiki/File:Wind_turbine_schematic.svg

To establish a wind farm successfully, it is essential to take into account the economic benefits and costs and identify ideal locations that minimize any adverse effects on the local communities and environment. Wind energy has the potential to revolutionize our energy systems and reduce our dependence on fossil fuels, making it a critical component in the fight against climate change. By investing in wind energy, people are not just making smart financial decisions, but are also investing in the health of the Earth and the well-being of local communities. Ultimately, taking these critical factors into consideration before establishing a wind farm will create a positive impact for all involved.

The Role of AI in Recycling

Cathie Zhu

The recycling industry is in a financial crisis as a result of policies such as the one China implemented in 2018 that limits the import of many materials intended for recycling and excludes the majority of recyclables coming from the United States as well as falling prices for sorted recyclables. It may also be disheartening to learn the reality of recycling in many regions of the United States and much of Europe. After recycling, the bin's contents will be transported to a facility for sorting recyclables. However, the majority of it will wind up in a landfill. The majority of the material will be sent off for processing and few will actually be used in new products.

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This is a huge problem, as only a small quantity of all recyclables makes it into the bins, with just 32 percent in the United States and 10 to 15 percent globally. The amount of waste from finite sources is staggering. To combat this, the recycling industry is required to improve. Solutions may be to use computer vision, machine learning, and robots to identify and sort recycled material, which can improve the accuracy of

automatic sorting machines, reduce the need for human intervention, and boost overall recovery rates.

Amp Robotics, a company based in Louisville, Colo., is developing hardware and software that relies on image analysis to sort recyclables with far higher accuracy and recovery rates than are typical for conventional systems. Other companies are similarly working to apply AI and robotics to recycling, including Bulk Handling Systems, Machinex, and Tomra. To date, the technology has been installed in hundreds of sorting facilities around the world. Expanding its use will prevent waste and help the environment by keeping recyclables out of landfills and making them easier to reprocess and reuse.

When recycling began in the 1960s, the task of sorting fell to the consumer, with newspapers in one bundle, cardboard in another, and glass and cans in their own separate bins. That turned out to be too much of a hassle for many people and limited the number of recyclable materials gathered. In the 1970s, many cities took away the multiple bins and replaced them with a single container, with sorting happening downstream. This “single stream” recycling boosted participation, and it is now the dominant form of recycling in developed countries.

Moving the task of sorting further downstream led to the building of sorting facilities. To do the actual sorting, recycling entrepreneurs adapted equipment from the mining and agriculture industries, filling in with human labor as necessary. These sorting systems had no computer intelligence, relying instead on the physical properties of materials to separate them. Glass, for example, can be broken into tiny pieces and then sifted and collected. Cardboard is rigid and light—it can glide over a series of mechanical cam-like disks, while other denser materials fall in between the disks. Ferrous metals can be magnetically separated from other materials; magnetism can also be induced in nonferrous items, like aluminum, using a large eddy current.

Given these considerations, recycling has established itself as a crucial component of trash reduction and environmental protection. However, many regions of

the globe currently lack sufficient recycling infrastructure, resulting in a significant amount of recyclable materials being dumped in landfills. The recycling industry can enhance accuracy, boost recovery rates, and reduce trash with the aid of AI and robotics. Leading businesses are pioneering the development of technology that can recognize and sort recyclables more precisely than conventional systems, including Amp Robotics, Bulk Handling Systems, Machinex, and Tomra. A world with less waste in landfills can be attained by investing in these new technologies.

The Traits That Shape Us

Anna Dai

Personality is a complex and multi-dimensional concept that consists of a wide range of traits and characteristics that shape who we are. These personality traits influence how we think, feel, and behave in various situations.

The Five-Factor Model (FFM) is one of the most accepted hierarchical organizations for understanding personality. It states that there are five broad dimensions of personality with each consisting of certain traits. These personalities are openness, conscientiousness, extraversion, agreeableness, and neuroticism. While everyone possesses a unique combination of these five traits, research has shown that they tend to be relatively stable throughout a person's life or different situation.

"File:Big Five 1.png" by Wikimedia Commons, licensed under CC BY-SA 4.0.
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Personality traits can affect a wide range of life outcomes, from career to health and well-being. For example, individuals who have a conscientious personality tend to have better job performance, high income, and career success because this personality is characterized by organization, responsibility, and dependability.

Personality can also impact physical health. Research has shown that those who score high in neuroticism tend to have poor health such as a greater risk of cardiovascular disease and mortality. Neuroticism is characterized by anxiety, moodiness, and emotional instability. However, individuals who lean more toward the agreeableness side tend to have better health, such as lower levels of inflammation and greater immune function. Agreeableness is characterized by kindness, empathy, and cooperation.

While personality is relatively stable, research has found that personality can change over time, particularly in response to major life events of significant personal growth. One example is a person who has experienced a traumatic event and that person may become more emotionally unstable or anxious. Those who experience personal growth may become more open and creative. Personality change is often a slow and gradual process. Some traits may be more difficult to change than others. It is important to know that personality should not be pursued due to societal expectations or others' perceptions of what a person should be. It should be viewed as a natural and ongoing process of discovering oneself and growing.

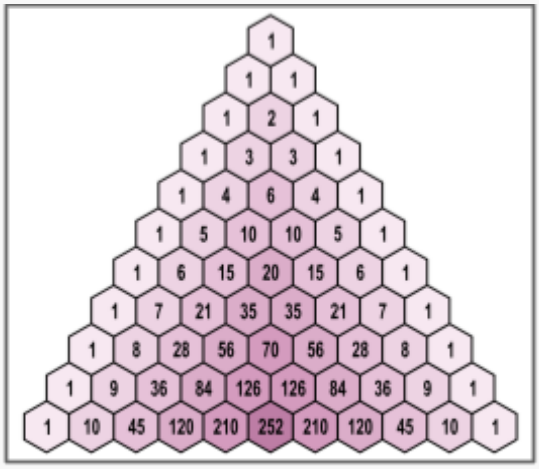
Counting Your Way to Success: The Power of Combinatorics

Brian Wang

While the materialistic world is trapped counting, the digital world has already advanced to the next level in a way people can't even fathom. Genetics that come from permutations, lotteries that choose winners from thousands of participants, or even password generators, use combinatorics to make it function behind the scenes, even when it seems simple on the surface. How was this problem solved, and how were they saved from a world of simple-mindedness?

Within a simple set of characters, thousands upon thousands of permutations, or possibilities, can result from those characters. A four-digit passcode has the possibility of each digit being from zero to nine in an old iPhone. The permutations are *n^r*, or *10^4*, where *n* is the possible number of digits and *r* is the number of digits. There are 10000 possible combinations in the old iPhone passcode lock! Lottery tickets generate like this. They produce digits from zero to millions for each person to buy and then create a random number to find the lottery winner.

In a more general math sense, another instance could be finding the number of combinations given the number of items, shown by *n*, and the number of items being chosen, represented by *r*. In the formula, *nCr*, we find the number of combinations by applying the formula: *n! / r!(n-r)!* which can be thought of as the possible number of varieties from a set of chosen numbers. The *!* symbol represents factorial, which is the mathematical operation of multiplying a number by all of the positive integers less than it. For example *4! = 4*3*2*1 = 24*. This nCr function, known as the *choose* function, has surprising connections with Pascal's Triangle.



"File:3-Pascal.png" by Wikimedia Commons, licensed under CC BY 3.0. https://commons.wikimedia.org/wiki/File:3-Pascal.png

The outer layer of the onion still holds layers upon layers, yet to be unraveled. While 10000 combinations may seem like a lot, a computer could generate that in only a few seconds up to a few minutes. Computers use this ability to produce mathematical optimization, a topic that combinatorics is known for. Devices could permutate or iterate through a discrete set of values to find the perfect optimization. A continuous optimization problem may have to be tested at different intervals of points until a heuristic answer is found.

The Complexities Behind Humor

Richard Wang

Remember that corny joke your teacher may have said that cracked a slight smile or maybe even a laugh on how corny it sounded? Humans have laughed for many centuries. In day to day conversations, there is likely laughter in it. Most of the time, this laughter is incited by a person's humor, the capacity to express and discern something that is funny. It acts as help in stressful or awkward situations. Humor is a very broad word though as there are a variety of types of humor that people have. This stimulus that creates laughter, comes with social and mental benefits as well.

Something somebody says may not be funny to you because people have different types of humor. Some common ones include self-deprecating humor. This involves the speaker putting themselves down to make others feel good and laugh. Another type of humor is deadpan humor where the speaker makes an absurd remark with a blunt and neutral reaction. Dark humor, this includes taboo topics which can be offensive to others but can also provoke a laugh. Satire another type of humor uses sarcasm and ironic comments to explain their point in a more interesting way. Wordplay humor, the humor that makes people groan at how corny it was. This includes dad jokes and puns that use words and their meanings in clever ways. The listed types of humors aren't the only types of humors as there are many others. However, the ones listed are common types of humor that is seen in our modern day.

These types of humor are encountered in human communication but there are many theories on why do people find these types of humors funny. Humor, this simple 5 letter word we constantly experience, yet it is a complex aspect of human life that is hard to explain why it evokes the responses it does. There is a solid theory though that we

laugh because humor works by throwing your expectations. The unexpecting remark we hear creates this positive response of laughter.

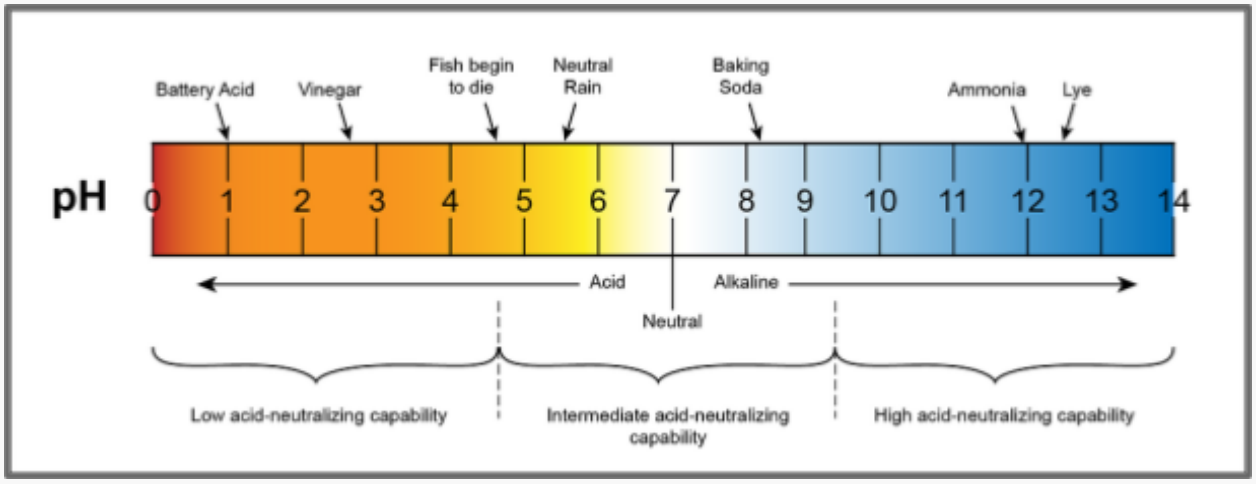
At the end of the day, humor is essential in creating and consolidating relationships. It acts as a coping tool that remedies stress. With this in mind, people do not always receive humorous comments like others. Some may feel offense, so one's humor can act as a double edged blade when it comes to relationships. As great as humor is to social life, other people's sensitivities to comments should be considered.

Acid-Base Reactions

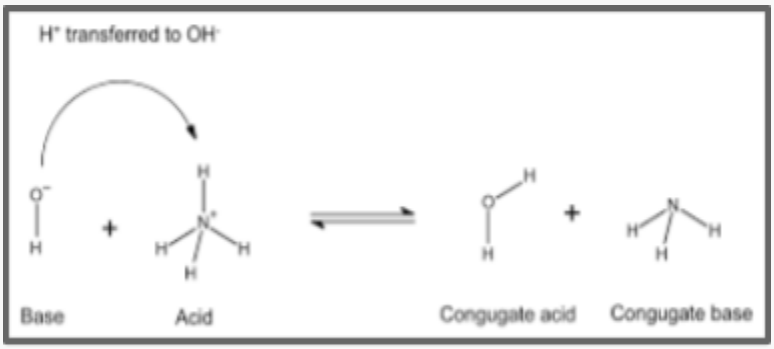
Kenny Wu

Acid-base reactions are basic concepts in chemistry and necessary for work in a range of scientific fields, from biochemistry to environmental studies. First thing first, a base is a material that receives a proton (H+), whereas an acid donates a proton (H+) to a chemical reaction. Salt and water are created in an acid-base reaction, which is when an acid and a base mix.

Furthermore, one prominent use of acid-base processes is the rule of pH in biological systems. The pH of a solution determines whether it is acidic or alkaline; a pH of 7 indicates neutrality; pH values below 7 indicate acidity; and pH values over 7 indicate alkalinity. The human body uses different ways to maintain a stable pH, including buffers, which are substances that can provide or receive protons to help.



In addition, acid-base reactions are also crucial to many industrial operations. For instance, acids are used to dissolve minerals, such as phosphorus, in the manufacturing of fertilizers, which can then be used as a nutrient for plants. Acid-base reactions are used in the petrochemical industry to refine crude oil, remove impurities, and produce gasoline and other products.



"Conjugate base reaction", by Wikimedia Commons, licensed under CC BY-SA 4.0 https://commons.wikimedia.org/wiki/File:Conjugate_base_reaction.svg

All in all, acid-base reactions are a key idea in chemistry with significant applications in a variety of areas. The study of biological systems, environmental science, the creation of novel materials, and industrial processes all depend on our ability to comprehend these responses. We can learn more about the chemical processes that underlie our environment and create fresh approaches to the problems we confront by researching acid-base reactions.

What are Enzymes?

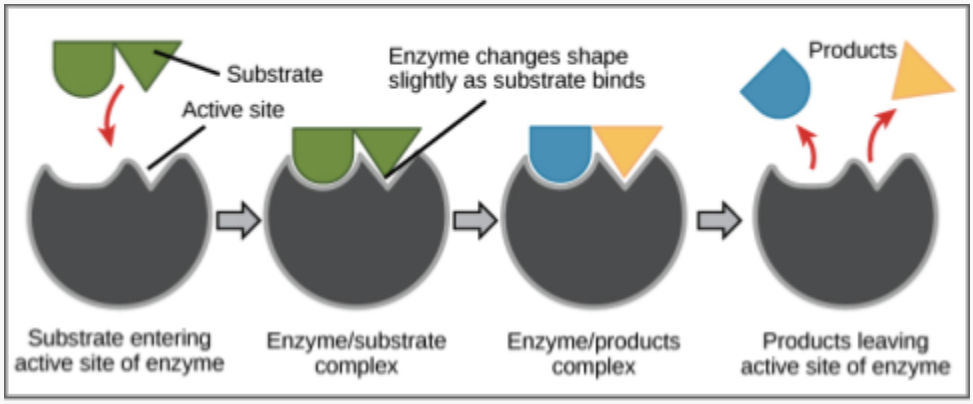
Eddie Zhang

Enzymes are proteins that help in sustaining the human body. Enzymes are catalysts, meaning they speed up the rate of chemical reactions by lowering the energy required to start a reaction (activation energy). To achieve this, they bind to specific molecules, called substrates, and convert them into new compounds.

The human body produces thousands of unique enzymes, each having its own function and structure. For example, digestive enzymes produced in the pancreas help break down the food we eat. Metabolic enzymes are involved in cellular respiration and other reactions cells need to acquire energy. Detoxification enzymes remove harmful substances from the human body.

Enzymes work together along a biochemical pathway, where the product of one reaction becomes the reactant (substrate) for the subsequent reaction. Every step along this path is catalyzed by a specific enzyme, and the overall reaction is regulated by many factors, including temperature, pH, and substrate concentration. Another way to regulate enzyme activities is through negative feedback, where the product of a process blocks an enzyme earlier in the same pathway from functioning, halting the process.

Enzymes all have unique three-dimensional structures that allow them to bind to specific substrates and catalyze their reactions. Substrates come in and bind at the active site of an enzyme, and the structure of the active site determines what reaction an enzyme will catalyze. The different structure of every enzyme in the body enables them to recognize and bind to their specific substrates, increasing the reaction's efficiency.



"File:Enzyme-substrate complex.png" by Wikimedia Commons, licensed under CC BY 4.0.
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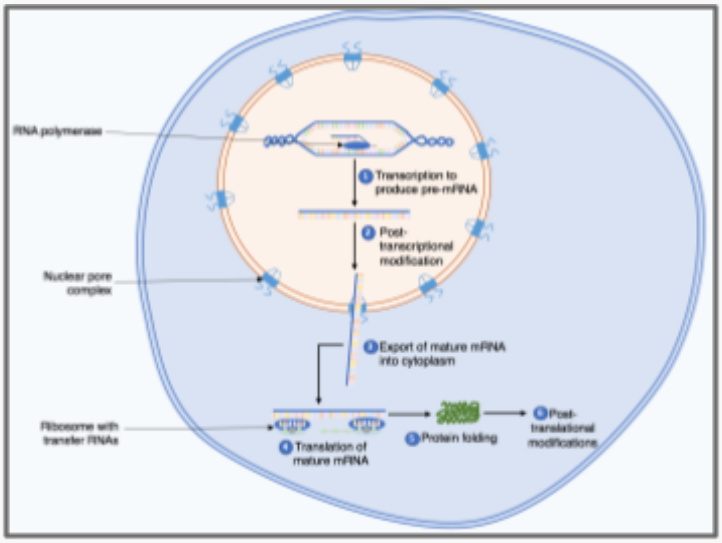
Overall, enzymes are important proteins that catalyze reactions within the human human body. Our bodies produce thousands of unique enzymes that are involved in many processes. Their activities are regulated by many factors, such as temperature, pH, and substrate concentration and they are crucial for human survival.

Protein Synthesis

Wilson Zhu

Protein synthesis is the process that cells use to make proteins based on the genetic information in their DNA. There are two stages of protein synthesis which are transcription and translation. In transcription, a single-stranded DNA template, in the 3' to 5' direction which is related to the carbon number on the pentose sugar which is located in a nucleotide, creates a complementary strand of RNA consisting of nucleotides in the 5' to 3' direction. For eukaryotic cells, eukaryotic cells are cells that have organized or specialized structures, the complementary RNA strand must undergo multiple stages to become a messenger RNA (mRNA). The mRNA goes from the nucleus and travels to a ribosome in the cytoplasm where it is used as instructions to build proteins.



"Summary of the protein biosynthesis process", by Kep17, licensed under CC BY-SA 4.0
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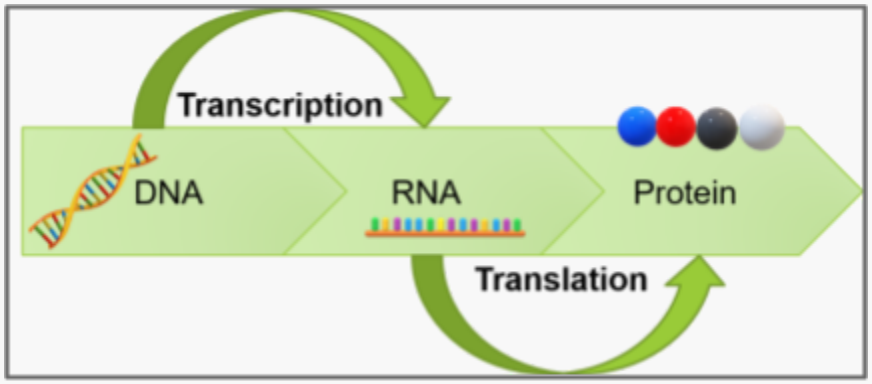
During translation, the cell reads instructions which are the codons of the mRNA, the codons are comprised of a sequence of three nucleotides that contain the nitrogenous bases: adenine, uracil, guanine, and cytosine. There are 61 codons for amino

acids and are used for the 20 amino acids found in protein. Transfer RNA (tRNA) connect mRNA codons to the amino acids they encode. Each tRNA has an anticodon that binds to a specific mRNA codon. The tRNA goes to the ribosomes, where proteins are created, to deliver amino acids. All of the amino acids are combined to create a larger protein molecule.

In brief, protein synthesis is a crucial process that allows cells to build proteins based on their genetic material. It contains the steps of transcription and translation. In these steps, genetic information from the DNA is transferred to mRNA which is then used as a template to create proteins with the tRNA.



"File:Transcription and Translation.png" by Wikimedia Commons, licensed under CC BY-SA 4.0
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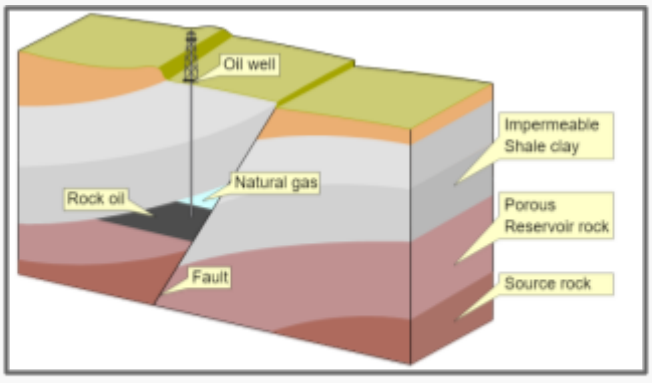
What Causes Earthquakes?

Owen Chen

Earthquakes are one of the most powerful natural disasters that can occur on our planet. These shaking events can cause widespread damage and destruction, and understanding what causes an earthquake is essential in helping us to prepare for and mitigate their effects.

The Earth's surface is made up of a series of massive tectonic plates that are constantly moving and shifting over time. These plates are composed of rock and are in motion due to the intense heat and pressure within the Earth's interior. When two plates collide or move past each other, the stress and pressure build up until it is released in the form of an earthquake.

The boundary between two tectonic plates is known as a fault, and it is along these fault lines that earthquakes occur. There are three main types of faults: normal faults, reverse faults, and strike-slip faults. Normal faults occur when the two plates move away from each other, causing the ground to drop or stretch. Reverse faults occur when the two plates move towards each other, causing the ground to rise or shorten. Strike-slip faults occur when the two plates move past each other horizontally.



"File:Fault line." by Wikimedia Commons, licensed under CC BY-SA 3.0.
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While the movement of tectonic plates is the main cause of earthquakes, there are other factors that can trigger seismic activity. For example, volcanic eruptions, landslides, and the collapse of underground caverns can cause earthquakes. Human activities such as fracking, mining, and building large dams can also cause earthquakes by altering the stress on the Earth's crust.

In conclusion, earthquakes are caused by the movement of tectonic plates along fault lines, and the sudden release of energy that occurs when the rocks along the fault rupture. Understanding the science behind earthquakes is essential in helping us to prepare for and mitigate their effects. By monitoring seismic activity, building earthquake-resistant structures, and developing emergency response plans, we can minimize the damage and loss of life caused by these powerful natural disasters.

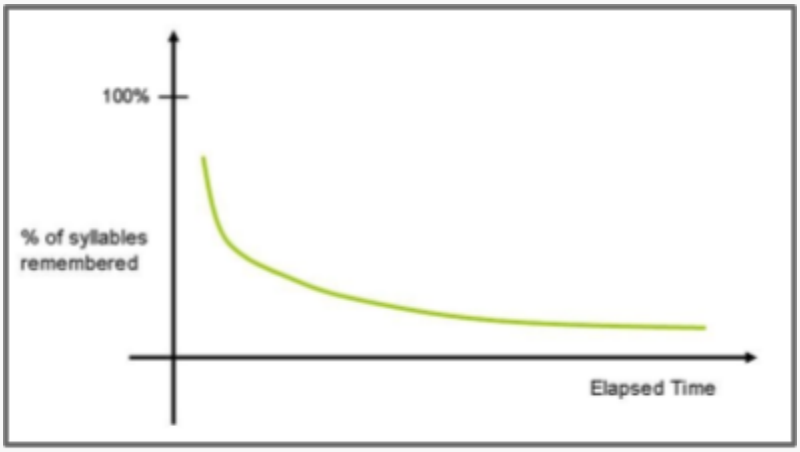
The Science of Memory

Eason Fan

Have you ever walked into a room forgetting what you were going to do, or forgot the answer to a test question? We have surely all experienced this before. These are examples of the amazingly complicated systems of memory working in your brain.

Our memory is made up of several different processes, encoding, storage and retrieval. Encoding is the process in which the data is handled. There are 4 methods of encoding: visual (the appearance), acoustic (the sound), semantic (the meaning), and tactile (how something feels). The information stored may be different to the original. Storage is how, where, and the amount of data that is stored. There are 2 types of memories, short-term and long-term. Short term memory usually lasts 15 to 30 seconds and only holds a couple of items at once. The only way to keep it is through practice. On the other hand, long term memory lasts forever and is limited in capacity. Retrieval refers to the process of retrieving the information stored. Short term memory is accessed in the order it was stored (i.e. an array of items), while long term memory is situation dependent (i.e. when you watch and suddenly remember something related to the topic) .

In a research called “Ebbinghaus Forgetting Curve”, showed that loss of memory depended on the time, memory skills, and the experiences that the people had. By knowing how memory works we can get better at memorizing. Memory skills can be improved, by using a variety of techniques.



"Ebbinghaus Forgetting Curve," By Jooja, CC BY-SA 3.0 https://commons.wikimedia.org/wiki/File:Ebbinghaus_Forgetting_Curve.jpg

The first technique is referred to as "The Testing Effect". Research shows that frequent testing of the knowledge you learned can improve one's long term memory of the information. For example, after learning a chapter on evolutions on frogs, you can test them. By practicing retrieving information, they are more likely to remember the information long term.

Another technique for memorization is referred to as "interleaving" and "blocking". Interleaving is when inter-study and a couple of different chapters. For example, you are not only studying chapter 1 but you study chapters 1, 2, and 3 together. Blocking is when you pick a specific chapter to study and nothing else. Use "interleaving" as it was shown to be more efficient in most cases. It's clear that there are many different ways of improving memory retention.

These techniques include practice testing and interleaving. By understanding how memory works you can work and use these techniques. However, remember that memory is not perfect and forgetting is natural. Next time, don't be frustrated when you forget an answer to a question.

Black Hole Catastrophe

Denise Lee

What are black holes? A black hole is an area in space where the gravitational pull is so strong that light and matter get sucked up. Black holes are invisible because no light is able to escape from them. Now, what happens when two massive black holes collide with each other?

Astronomers used NASA's Chandra X-ray Observatory to spot two pairs of gigantic black holes, each in a different dwarf galaxy, racing toward each other, dragging an enormous train of gas and stars, and they're set for two separate collisions. The first pair was spotted in the galaxy cluster, Abell 133, located 760 million light-years from Earth, and the other was seen in the Abell 1758S galaxy cluster, roughly 3.2 billion light-years away. They are set to collide and merge to form even larger galaxies. According to Space.com, *Double Trouble! Two pairs of giant black holes spotted on a collision course*, published by Robert Lea,

> “The findings could have important implications for our understanding of how these cosmic titans and the galaxies they inhabit grew in the early universe. The scientists examined the colliding black hole pairings using NASA's Chandra X-ray Observatory and found that as the dwarf galaxies are racing toward each other, they are pulling in gas that is ‘feeding’ their inhabitant black holes causing them to grow even before the merger.”

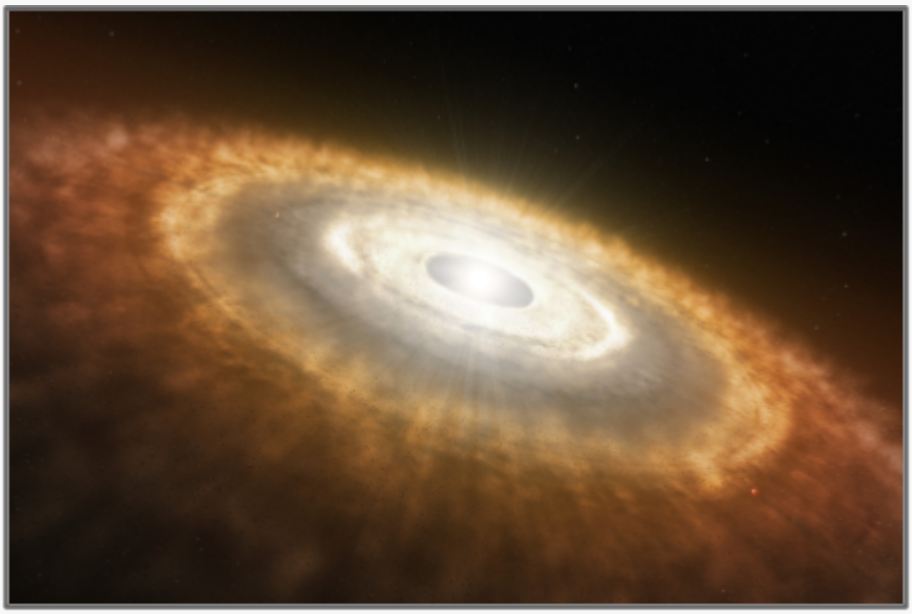
Studying the black holes as they approach each other could help astronomers understand how black holes and galaxies grew at the beginning of time. Many stars, comets, asteroids, or other matter are already being sucked into the black holes, causing them to grow even larger before they crash.

This black hole catastrophe may teach us more about the mysteries of space and what happens when two black holes crash into each other.

The Formation Process of Planets

Riley Lee

The Big Bang theory is how most people believe Earth was born, but how were other planets formed? Due to gravity, some molecules of dust will be denser than others which will cause them to form into clouds. As the density of these clouds increases, atoms begin to collide more and form larger molecules, including water that forms on the grains of dust and covers the grains with ice. Stars begin to form when parts of the cloud reach a certain density and heat up enough to start fusing hydrogen atoms together. A small fraction of the icy grains of dust and gas will evolve into a star. The rest of the gas and dust form a disk circling around the spinning, newborn star. Astronomers call that disk, a proto-planetary disk.



"File:Artist's Impression of a Baby Star Still Surrounded by a Protoplanetary Disc.jpg" by Wikimedia Commons, licensed under CC BY 4.0 https://commons.wikimedia.org/wiki/File:Artist%E2%80%99s_Impression_of_a_Baby_Star_Still_Surrounded_by_a_Protoplanetary_Disc.jpg

Scientists believe that planets, including the ones in our solar system, start off as molecules of dust, slowly emerging from a proto-planetary disk. Gravity and other forces cause the small grains of dust and gas to merge together. Over time, dust particles combine to form pebbles, which evolve into bigger rocks. After billions of years, those molecules of dust have evolved into planets. Planets usually have enough mass so that their immense gravity will shape itself to be round and spherical. The colder area of the proto-planetary disk, where tiny fragments of ice with dust, will evolve into dirty snowballs that can amass into giant planetary cores. Those colder regions also allow gas molecules to slow down enough to be drawn onto a planet, which is how gas giants are created. In the warmer parts of the disk, closer to the star, rocky planets begin to form.

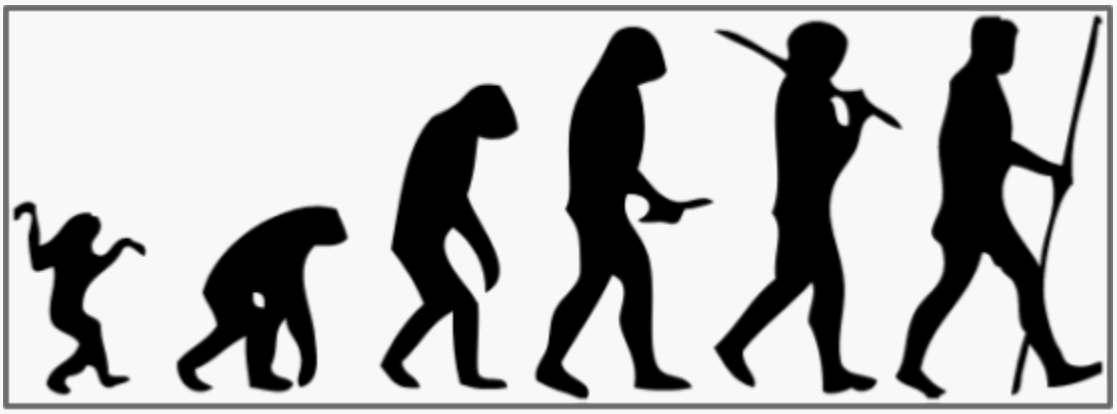
The cycle of how planets are formed repeats over and over as many billions of years go by. Our solar system is a product of billions of years of particles colliding, forming clumps and rocks, and eventually creating the planets and the Sun we see today.

Survival of the Fittest

Cody Duan

In 1859, Charles Darwin published a book, “On the Origin of Species,” that proposed his idea of the theory of evolution, or natural selection. Natural selection is the passing of advantageous traits from generation to generation. The adapted traits are better suited to the environment.

The reveal of Darwin’s theory of evolution shocked Britain’s religious establishment. A common belief was that God created all living things, so naturally, Darwin’s theory was not very popular. Gradually, natural selection was proven and accepted through direct observation.



“File:Human evolution scheme.svg” by Wikimedia Commons, licensed under CC BY-SA 3.0
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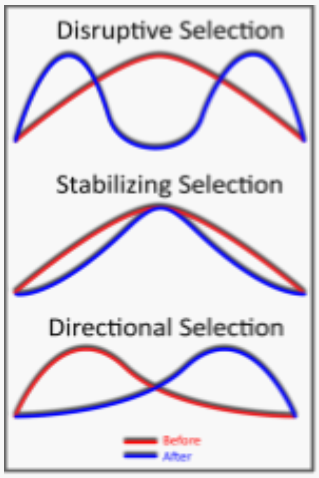
Natural selection categorizes into three categories: directional selection, stabilizing selection, and disruptive selection. These can be visualized as a graph representing a particular trait, with both extremes on the sides.



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Directional selection occurs when a trait in one of the extremes is favorable for survival, thus shifting the overall population toward that extreme. Stabilizing selection occurs when the intermediate (middle) trait is favored. Disruptive selection occurs when both extreme traits are favored. By using birds as an example, directional selection is the increase of larger birds to fend off a predator that primarily feeds on smaller birds. In birds, stabilizing selection can mean an increase in the number of birds with average-sized beak, which allows for a more vast amount of food for the bird. Disruptive selection in birds can mean the beak shape. One side is a sharp beak, and the other shows a blunt beak. The adaptation of a sharp beak lets the bird eat more insects, while a blunt beak shows that a bird will eat more nuts and fruit. Disruptive selection leads to a diverse variation in a species.

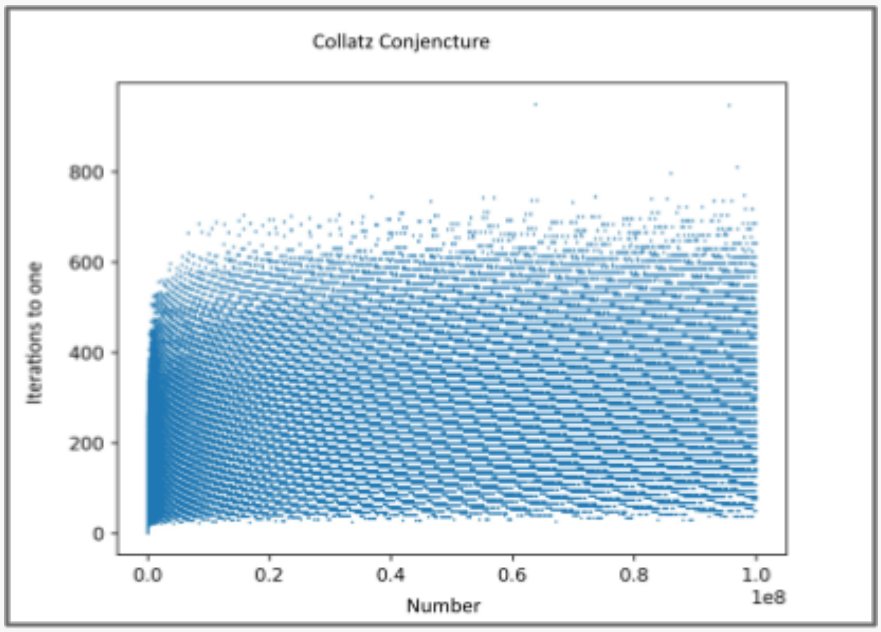
Natural selection is a pivotal factor in the driving force of evolution. It can lead to significant changes over a species' lifetime and can lead to a genetically different creature. The theory of evolution is everlasting as it shapes the animals we see today.

The Collatz Conjecture

Aidan Hong

Functions are fairly simple. You input a number, apply the formula based on the given rule, and receive an output. Some functions take it a step further, where evaluating the value of a function given an input requires the evaluation of that same function with a different input. Of all recursive equations, there is one particular recursive function that stumps mathematicians all around the globe. Enter the Collatz Conjecture, also known as the 3n + 1 problem, the simple equation that mathematicians can't solve.

The Collatz Conjecture is fairly simple. Given an even number, divide the number by 2. If you have an odd number, multiply the number by 3 and add 1. Repeat this process over and over again, and for some reason, no matter what input you start off with, you will eventually reach the number 1. No matter what number you input, sooner or later, you'll get 1 as your answer.



"Collatz Conjecture", by Porl pigeon Wikimedia Commons, licensed under CC BY-SA 4.0
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However, many mathematicians are still trying to prove it true or false. So far, values as large as 2 to the 68th power have been checked, and all return a value of 1. However, some argue that some numbers may never end if they were plugged into the function. Thus, they argue that this proves the conjecture wrong.

The Collatz Conjecture is a recursive function that utilizes two equations: n/2 when n is even and 3n+1 when n is odd. Despite the premise seeming very simple and easy to solve, mathematicians have been stumped by this problems for years. Even with the rise of supercomputers, mathematicians have come nowhere close to solving this conjecture. Until it becomes solved, the conjecture proves to be one of the biggest mysteries of math.

Asteroids

Donia Cao

Asteroids are fascinating objects in our Solar System, occupying a region between Mars and Jupiter known as the Asteroid Belt. This region extends from 2.2 AU up to 3.2 AU–one astronomical unit (AU) is equivalent to 150 million km, or the distance from the Earth to the Sun. The most noteworthy asteroids include Ceres, Vesta, and Pallas; together they contribute 7% of the total mass of the Asteroid Belt. In this article, we'll provide an overview of asteroid types and their defining characteristics.

Asteroids are remnants from the formation of our Solar System, which is estimated to be around 4.6 billion years ago. Generally classified as minor planets, asteroids orbit around the Sun without possessing an atmosphere and can range in size from microscopic objects to larger objects, which are classified as planetoids. The majority of asteroids share a similar orbit centered on the Sun–located in the asteroid belt between Mars and Jupiter. Planetoids, on the other hand, constitute those asteroids exhibiting qualities similar to traditional planetary bodies but failing to meet all criteria that define them as such.

"Dwarf Planet Ceres" by NASA Goddard Space Flight Center, licensed under CC by 2.0, https://www.flickr.com/photos/gsfc/49921245716

Asteroids are relatively small objects and do not have sufficient gravitational pull to maintain an atmosphere. Collisions among asteroids are relatively frequent. When asteroids collide, it can result in a variety of outcomes. Some may cause an asteroid to spin faster or slower. A collision can also blast a giant asteroid into smaller fragments. After the collision, those bits will usually move slower than their mutual escape velocity. Over several hours, gravity will reassemble all but the fastest pieces into a rubble pile.

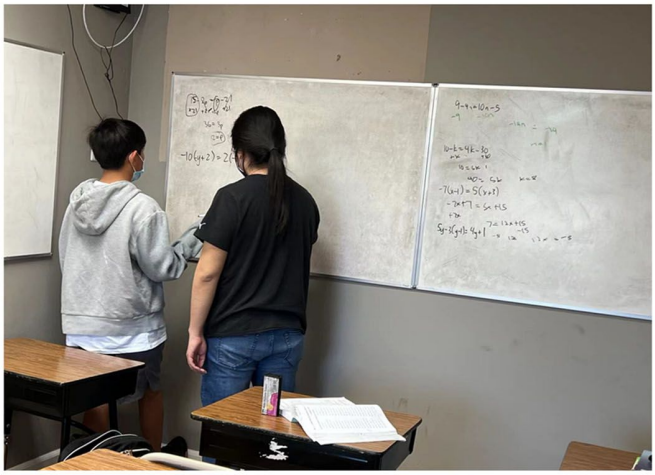
The asteroid belt is made up of three distinct types of asteroids: C, S, and M. The various types are determined by where the asteroids originated from in relation to the Sun. As the varying distances from the Sun affected the composition of the different asteroids, they all have their own unique characteristics.

C-type asteroids, often referred to as carbonaceous chondrite asteroids, are characterized by their compositions, which includes silicates and clays, and often appear dark in color. Much of their original composition is preserved since they tend to exist further away from the heat of the sun. These rocks can typically be found in the outer part of the asteroid belt and are the most common type out of the three.

S-type asteroids, sometimes called “stony” asteroids, are made up primarily of silicates and nickel-iron. S-types are abundant in the inner asteroid belt, accounting for around one-fifth of all known asteroids.

M-type asteroids, also known as Metallic asteroids, are of great scientific interest. They contain iron and nickel and were likely heated when they were first formed since there is evidence of radioactive decay of unstable elements present. This process causes the metals to sink to the core. These asteroids can typically be found in the middle region of the asteroid belt.

Studying the variety of asteroids present in our solar system can provide insight into their origins and development. An examination of their characteristics, features, and compositions will yield valuable information that may shed light on early solar system progression. As such, asteroids give us a unique opportunity to explore the history of our solar system.



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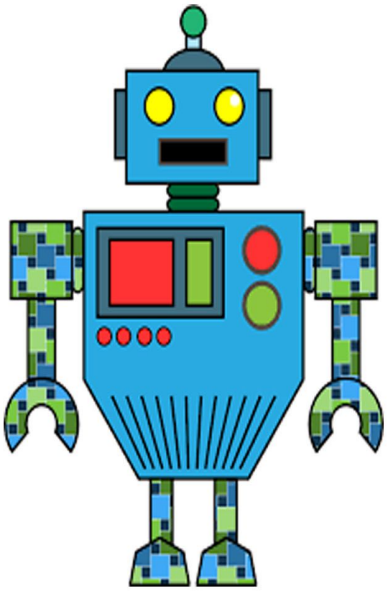

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