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WEEKLY September 12-18, 2020

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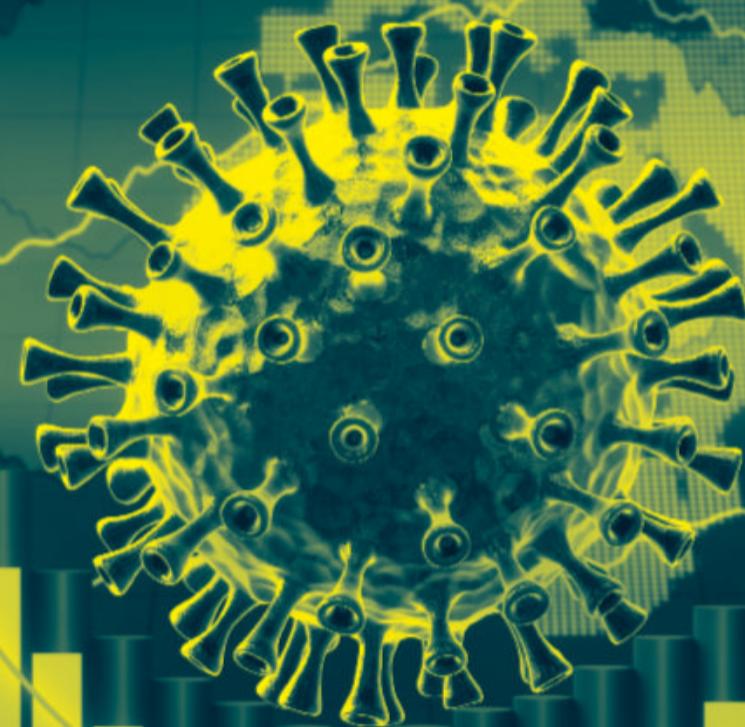


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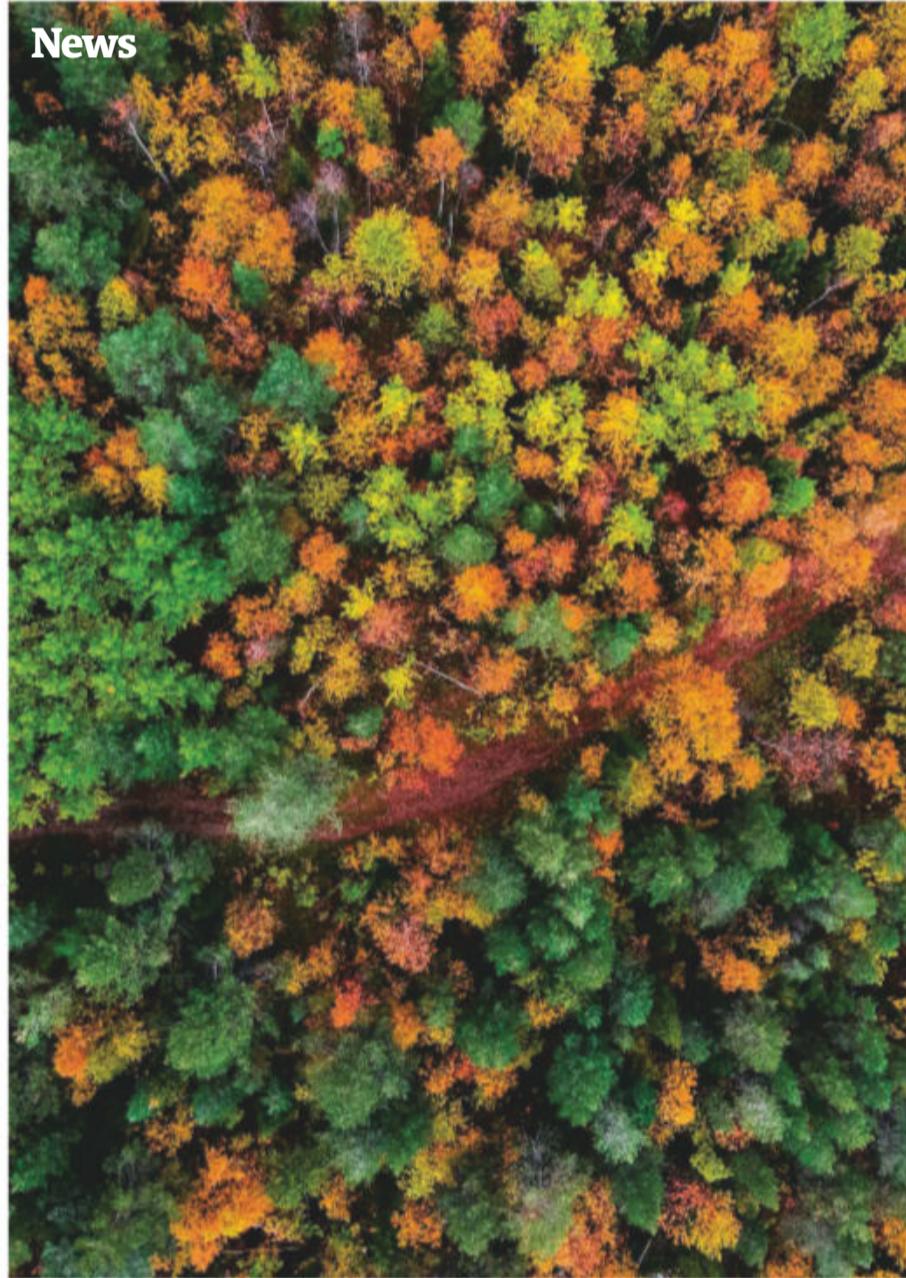
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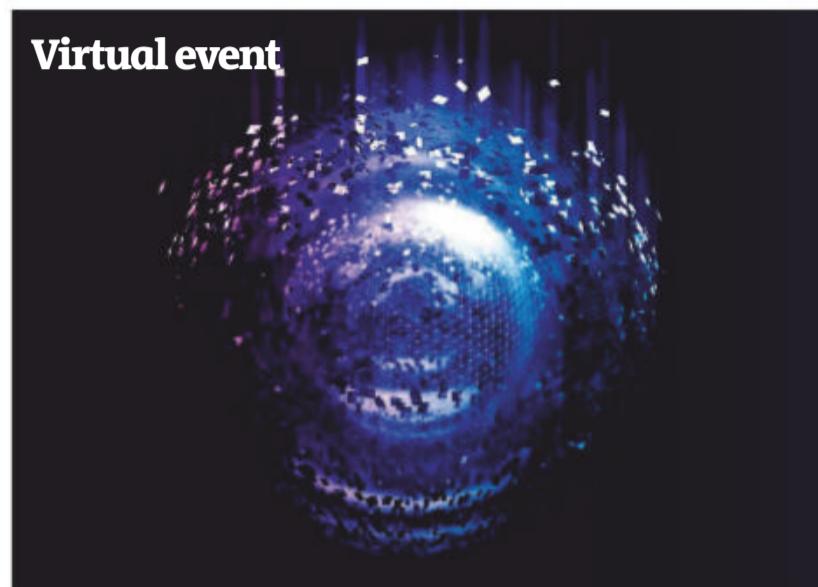
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Becoming reality How quantum computers could change the world



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Video

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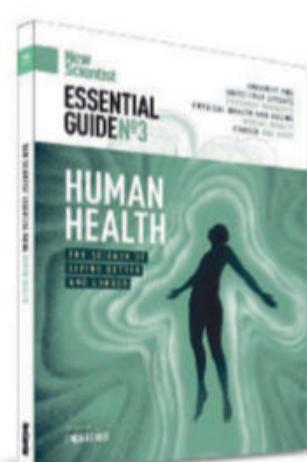
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Online

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The day's coronavirus coverage, including news and features, updated at 6pm BST/1pm EDT.

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Episode 31

Widening the search for alien life on habitable planets, why unconscious bias training might not work and the microbiome of cancer tumours

Episode 30

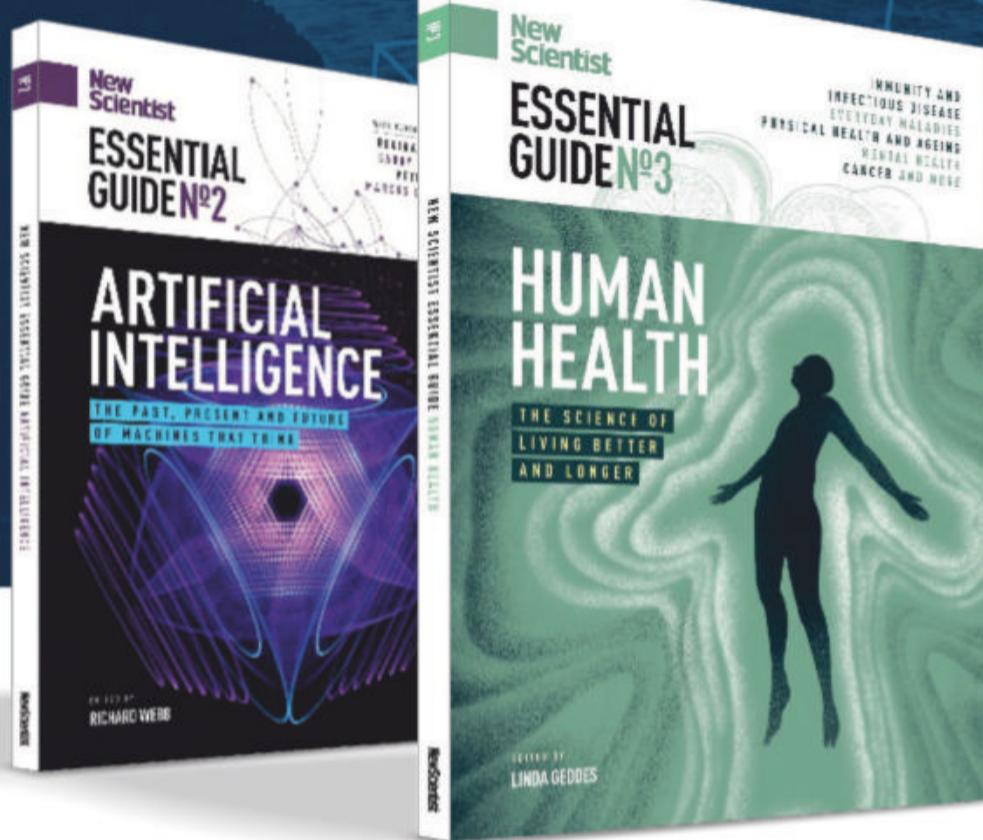
Redefining time, why mindfulness can cause problems and secrets of super-resilient tardigrades

Episode 29

Loneliness during lockdown, medical artificial intelligence beats doctors and who gets the coronavirus vaccine first

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Food for thought

To succeed, anti-obesity strategies must pay heed to new ideas on healthy eating

IT WAS a tempting offer enjoyed by millions of people: as many cut-price restaurant meals as you could eat every Monday to Wednesday for a month.

While the UK's recent "eat out to help out" scheme may have saved jobs and boosted the hospitality industry after the coronavirus lockdown, it is unlikely to have done much for the country's obesity crisis. The government's own figures show meals from restaurants are on average twice as calorific as the equivalent dish prepared at home.

For many years, the UK has laboured under the burden of having one of Europe's fattest populations. Earlier this year, prime minister Boris Johnson – who blamed his brush with severe covid-19 on being overweight – swallowed his opposition to "nanny state" schemes and announced a national obesity strategy.

It is likely to feature more calorie labelling, restrictions on junk food advertising and on BOGOF (buy-one, get-one-free) deals, along with nudge-style interventions to stop impulse purchases of calorific foods.

"In the UK we just get reheated scraps of earlier anti-obesity plans rather than following the latest science of nutrition"

None of these will do any harm, but as an anti-obesity strategy they fall well short of the latest science. As we report (see page 34), nutrition research is undergoing a much-needed revolution. It turns out that the way we respond to food varies so much from person to person that there is no such thing as a one-size-fits-all healthy diet.

That may explain why science has failed to tackle the obesity epidemic. Consider a recent test of the efficacy of low-fat versus low-carb diets for weight loss. The DIETFITS study put more than 600 overweight people on one of the diets for a year. At the end, the average weight loss was the same in both groups, about 5.5 kilograms, but there was huge individual variation, ranging from much larger losses to significant weight gain.

This fits the conclusion of cutting-edge nutrition research: that a customised diet based on an individual's metabolism and microbiome is required. Devising such diets isn't beyond us and should be at the forefront of anti-obesity strategies. The US has already committed to this. But in the UK, we get reheated scraps of earlier anti-obesity plans. Ironically, to tackle this issue, we must think bigger. ■

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Huge surge in UK cases

Almost 3000 new cases reported in a day as the number of infections in people younger than 40 rises sharply, reports **Donna Lu**

THE UK is experiencing a surge of new coronavirus cases, following in the footsteps of several other western European countries including Spain and France.

On Sunday, 2988 new cases were reported, the highest number of positive cases in a single day in the UK since 22 May, according to government figures.

The seven-day rolling average of new cases has increased to 1812 cases per day across the country, up from 1244 the week before and 1040 a fortnight ago.

The rise in cases may partly be due to increases in testing across the UK. Throughout August, more than 170,000 tests were processed daily, compared with about 70,000 daily tests at the beginning of May.

But UK health secretary Matt Hancock has warned that while greater numbers of people are being tested, "the proportion that tests positive is going up as well".

Public Health England has noted a broad increase across England rather than a spike in a single area, with most of the new cases coming from people being tested in the community, rather than in hospitals or care settings.

England's deputy chief medical officer Jonathan Van-Tam told reporters that people had "relaxed too much", over the summer.

Despite the increase in cases, the number of seriously ill people in hospital with covid-19 remains low, and only two deaths within 28 days of a positive test were recorded on Sunday. However, there may be a lag time of a few weeks before mortality figures catch up to new cases.

The majority of the new cases seem to be in younger people. While the rate of infection among

older people has fallen, the number of positive cases is rising sharply among those under the age of 40, who are less likely to have serious covid-19 resulting in hospitalisation or death.

The greatest rise has been in people aged between 17 and 21. Van Tam has warned that the UK risks following in the footsteps of other European Union countries, such as France and Spain, which began to see big increases in case numbers in August. Spain has now become the first western European country to have reported more than half a million cases of covid-19, and cases there continue to surge.

"Where case numbers rise initially in the younger parts of the population, they do in turn filter through and start to give elevated

Lockdown restrictions were eased in the UK during the summer

rates of disease and hospital admissions in the older age groups," he told the BBC.

"The fact that 17 to 21-year-olds are not becoming ill means they are lucky, but they also forget because the disease is not severe for them that they are potent spreaders," said Van Tam.

Government sources have reported concerns that the UK is six weeks behind France.

John Edmunds at the London School of Hygiene & Tropical Medicine, and a member of the government's SAGE advisory group, has warned that the R number, the number of people that each infected person goes on to infect, is already greater than 1 in England, and could be worsened by the reopening of schools and universities throughout September. An R number greater than 1 means that an epidemic is growing.

In the week since many pupils returned to classrooms, coronavirus outbreaks have been reported at dozens of schools in England and Wales. Across Liverpool, an estimated 200 pupils are self-isolating after positive covid-19 cases at five schools, and five teachers at a school in Suffolk have tested positive.

UK labs appear to be struggling to keep up with an increase in testing demand as cases rise, and home testing kits have been temporarily unavailable in some areas.

The government has prioritised testing capacity in high-risk areas, and some people with covid-19 symptoms have been asked to travel hundreds of kilometres across the country to get a test.

The head of NHS Test and Trace in England, Dido Harding, has apologised for the situation.

Officials have said that people with symptoms shouldn't have to travel more than 75 miles (120 kilometres) to get a test. Testing will be vital to keeping the spread of the virus under control in winter months (see page 8). ■

Daily coronavirus news round-up
Online every weekday at 6pm BST
newscientist.com/coronavirus-latest

Transmission

What winter holds for covid-19

Will the spread of the coronavirus accelerate in the northern hemisphere this winter? **Adam Vaughan** investigates

WITH hindsight, we may come to see late summer in the northern hemisphere as the calm before the storm. While many countries in the north have suppressed the spread of covid-19 for now, there is growing evidence warning us that winter could undo that progress.

Researchers are racing to pinpoint what role temperature and humidity may have in the spread and severity of the illness. They are exploring how SARS-CoV-2, the virus that causes covid-19, will interact with other

evidence, that this would just go away in hot weather. That could have led to complacency," says Rachel Lowe at the London School of Hygiene & Tropical Medicine. Trump's claim that the virus would be halted by summer appears to have been proven wrong. A study by Lowe's team found the virus spreading in different countries across the globe regardless of temperature.

Yet despite a flood of research into links between temperature, humidity and various other environmental factors on the transmission of the coronavirus and the severity of covid-19, the results are inconclusive so far. An analysis of 42 peer-reviewed papers and 80 preprints led by Albertus Smit at the University of the Western Cape, South Africa, found only five that could offer "credible insight" and deemed it too early to say if there is a link.

Similarly, Francois Cohen at the University of Oxford and his colleagues concluded in a paper in July that not enough testing is going on to provide the required data. Analysing weather means looking at day-to-day changes, but we have insufficient data on positive coronavirus cases on individual days. "The inference you can make is restricted," says Cohen.

If it is too soon to tease out a link, what are the plausible ways winter weather could affect respiratory viruses like influenza and SARS-CoV-2?

"There have been studies showing warmer temperatures and humid climates prohibit these kinds of viruses. That's why, in temperate regions, we tend to see them peaking in winter. But the mechanisms are not well understood," says Lowe.

Colder temperatures could directly affect the survival of the

"Some leaders assumed that this would go away in hot weather. That could have led to complacency"

seasonal respiratory viruses. And people are scouring data from winter in the southern hemisphere to see what the north might face.

These questions are a matter of life and death. In the UK alone, a reasonable worst-case scenario in the event of a resurgence of the coronavirus this winter estimates that there could be as many as 251,000 deaths in hospitals – although the total under the range of possibilities within this scenario is more likely to be less than half that. Whatever the outcome, UK scientific advisers expect cases to increase this winter.

The weather is the obvious change coming. To predict how this will influence the virus's spread, we need to disentangle the effects of weather from other confounding factors, such as how countries have responded, different demographics and variation in testing rates.

"Some of our motivation for studying this is, early in the pandemic, [US] President Trump and other global leaders were assuming, not backed up by



A worker shovels snow during the winter months in Tokyo, Japan

coronavirus itself. We know that flu viruses are more stable on surfaces in the cold, and lower temperatures are associated with increased shedding of flu virus by infected people. With winter sun delivering less virus-destroying ultraviolet light, the coronavirus may be able to survive on surfaces for longer. The winter peak in respiratory viruses might also be because colder weather hampers how our immune system functions – through a lack of vitamin D, for example. Or it could simply be about how we behave, crowding indoors in winter.

Indoor humidity, which is usually at its lowest in winter because of domestic heating, could affect things too. Gordan Lauc at the University of Zagreb in Croatia and his colleagues looked at 7000 people with covid-19

251,000

Maximum UK hospital deaths this winter in a worst-case scenario



in hospitals. They found that mortality fell with rising outdoor temperature – associated with higher indoor humidity as heating is turned down – after ruling out age and accounting for better care.

Lauc, a biologist and adviser to the Croatian government, says the dry indoor air common in winter dehydrates and weakens a mucosal barrier in our lungs that can stop viral infections. As humidity rose during the springtime, the barrier improved again, he says. “Of course, there are other factors. We cannot claim it is only weather, but I think the weather is a very important factor,” he says. There are caveats. For example, Lauc’s research didn’t account for comorbidities, such as obesity, which play a role in the severity of covid-19.

If SARS-CoV-2 behaves anything

like other seasonal viruses, then knowing exactly how cold it will be this winter will be important for planning, says Lowe. In the UK, for every 1°C drop in outside air temperature below 5°C, respiratory infections usually increase by 10 to 20 per cent and emergency hospital admissions rise about 1 per cent. Whether that holds true for the coronavirus remains to be seen.

Look south for clues

Meanwhile, research efforts are intensifying. The UN World Meteorological Organization held a virtual conference in August looking at the potential impact of the weather. At the event, secretary general Petteri Taalas referred to seasonal environmental factors, saying: “So far, I haven’t clear indications whether there is such a thing behind covid-19.”

On the face of it, though, there seems another way to predict what winter holds: just look at what happened in the southern winter. “Some of the experience in Brazil is not all that encouraging, but on the other hand, New Zealand and Australia are doing pretty well,” says Andrew Hayward at University College London.

Drawing parallels is hard, however, as both Australia and New Zealand had a much more effective initial response to the pandemic than places like the UK and US. Using the south’s winter as an analogue for the north’s is likely to be further complicated by potentially differing background levels of immunity to the coronavirus in populations and socio-economic factors.

“There are scientists in Australia who believe the winter conditions are exacerbating the risk in Melbourne,” says Lowe, referring to the recent spike of cases in

the state of Victoria. “I personally think it’s too early to say. I don’t think we have enough data.”

Perhaps the biggest issue this winter in the northern hemisphere will be how a virus new to humanity interacts with the existing ones that peak in the season: influenza, respiratory syncytial virus (RSV) and the four coronaviruses that already circulate widely and can cause the common cold (see “Could co-infection cause coronavirus to evolve?”, page 10). “Respiratory infections tend to transmit more easily in the winter. That applies to seasonal coronaviruses as well, which are the closest analogue we’ve got to SARS-CoV-2,” says Hayward.

Covid-19 first surged in the northern hemisphere at the end of the peak for respiratory viruses, resulting in countries entering lockdown. This winter promises the opposite. “By the time we hit the winter, maybe we’ve got back more to normal – with more crowded public transport, people using the shops, going into work more – and my concern is, if you add on the extra degree

Australia saw less flu in winter due to face masks and other measures



ASANKA BRENDON RATNAYAKE/AP/SHUTTERSTOCK

of transmissibility that winter brings, that could kick [the transmission rate] up to higher levels,” says Hayward.

An obvious problem is that other respiratory viruses cause symptoms, such as a dry cough and high temperature, that can also occur with covid-19. At the infection peak of a normal winter in the UK, there are around half

“Around half a million people have a cough or fever at the peak of a normal winter in the UK”

a million people with a cough or fever, says Hayward. Overlapping symptoms are likely to increase the workload for the testing-and-contact-tracing schemes governments are relying on to keep outbreaks in check.

Another concern is whether catching flu makes you more susceptible to having severe covid-19, and vice versa. That is why governments, including the UK’s, are expanding their annual flu vaccination programmes.

There is “no strong evidence” from the pandemic’s first wave that co-infection with another virus makes covid-19’s symptoms more severe, concluded research by Cariad Evans at Sheffield Teaching Hospital, UK, and her colleagues. But the same study notes that those with both influenza and covid-19 in England and Scotland did have higher odds of death than those without flu, after adjusting for age and sex.

Evans and her colleagues also say that other viral infections may possibly spur the transmission of the coronavirus by increasing how much it is shed.

There is one other big question about how different viruses interact this winter. Sema Nickbakhsh at the University

of Glasgow, UK, and her colleagues last year found that above-average flu years provide a short-lived protective effect at a population level that could explain why respiratory viruses fall in those years. Similarly, infections by rhinoviruses, some of which cause the common cold, were found to lower the chance of being infected by the 2009 strain of H1N1 swine flu. How this happens isn't fully understood and we don't know if this has any relevance for the coronavirus.

That fuzziness makes the coming winter hard to predict, says Nickbakhsh. Based on her previous work, she says: "My first hypothesis would be no interactions with flu, but potential for interactions with RSV." A harmful effect would be a problem as RSV is one of the world's biggest killers of children under the age of 5.

A dampener on flu

There may be some good news, though. For one, social distancing and face mask-wearing because of covid-19 could lead to fewer flu infections this winter. That appears to have happened in Hong Kong and Australia.

Restricted foreign travel and quarantines may help too. We don't have a good handle on where flu goes in the northern summer. It could carry on circulating at low levels or be reseeded from the south each season – or both of these may play a part. If reseeding from the south is a big factor, international air travel restrictions may further dampen the north's flu season.

Scientists are also exploring whether infection by the seasonal coronaviruses that winter brings might trigger

some cross-immunity to the new coronavirus through T-cells, the immune cells that help the body fight invading pathogens. For now, we don't know.

Testing will be key to working out some of these unknowns. Little simultaneous testing for influenza and the coronavirus was done in the UK at the end of last winter, partly because

"You don't have much time to make decisions when infections are increasing. It could be catastrophic"

the flu season was ending and because laboratories were overburdened. "Going forwards, we really need to be able to test for all of the pathogens," says Nickbakhsh.

The UK government's goal is to have capacity for half a million SARS-CoV-2 tests a day by October, up from about 350,000 now. But without a significant improvement in testing and tracing as UK schools and society reopen, there could be a second peak this December more than twice the size of the first, according to research by Jasmina Panovska-Griffiths at University College London and her team.

Winter is coming. How the northern hemisphere fares will hinge on whether nations prepare enough in advance and act fast enough when it arrives.

Monitoring for outbreaks and imposing local lockdowns is a good idea, but speed will be of the essence this winter, says Hayward. "You don't have much time to make these decisions if things are increasing. In a matter of a few weeks, it could increase to really catastrophic levels. If you wait to see big increases in hospital admissions, that might be too late." ■



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Virus evolution

Could co-infection cause coronavirus to evolve?

Graham Lawton

DOCTORS may be fretting about concurrent outbreaks of flu and covid-19 (see page 8) but some virologists are worrying about another scenario: a Frankenvirus.

SARS-CoV-2, the virus that causes covid-19, almost certainly originated from the hybridisation of two different coronaviruses. The details remain hazy, but the virus's genome sequence suggests that this mash-up occurred in a bat about a decade ago. The bat was simultaneously infected with two closely related coronaviruses, which merged into a new one.

Such recombination isn't unusual for coronaviruses. "If you look in the

family tree of coronavirus, there's recombination everywhere," says virologist Samuel Díaz-Muñoz at the University of California, Davis.

It occurs for two reasons. First, coronaviruses are tolerant to co-infection. Unlike many other viruses, they allow co-infection of the same cell by other viruses.

Second, the way coronaviruses replicate their genomes makes hybridisation not just possible but likely. They are RNA viruses, which usually have very high rates of mutation – the highest rate of any known biological entity – because the enzymes that copy their RNA don't have a proofreading function.

Coronavirus Essential Guide

All you need to know about coronavirus and covid-19

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Free flu shots on offer in New York during a protest over lives lost to covid-19

A high mutation rate can allow a virus to rapidly evolve resistance to the host's immune response.

Coronaviruses are the exception, because their replicate enzymes do proofread. SARS-CoV-2 has proved very resistant to mutation. According to Díaz-Muñoz, only six mutants have emerged thus far.

The variability in coronaviruses comes from something else: recombination. Their replicate enzymes frequently jump from one part of the RNA template to another. This makes them adept at remixing their own genomes to create variation, and also allows them to steal genetic material from other closely related coronaviruses. "It is one of the things that facilitates jumping from one species to another. I think there's no doubt that recombination in a bat was involved in the emergence of SARS-CoV-2," says Díaz-Muñoz. The fear is that it could now

happen again, inside a human.

Research by Huiguang Yi at the Southern University of Science and Technology in Shenzhen, China, implies that SARS-CoV-2 is recombining its genome inside human cells. He has analysed 84 published SARS-CoV-2 genome sequences from human cases and found some that could only have formed through recombination.

There are also many documented cases of co-infection with SARS-CoV-2 and other respiratory viruses including influenza, rhinovirus, respiratory syncytial virus and the seasonal coronaviruses that cause common colds.

This latter class are especially concerning, because they are quite closely related to SARS-CoV-2 and could potentially hybridise with it.

Coronavirus particles show up blue in this electron micrograph image

There are four of these seasonal coronaviruses in general circulation. There is also the original SARS virus, which caused an epidemic from 2002 to 2004. It is no longer in general circulation but virologists worry that it could make a comeback. Finally, there is the MERS coronavirus, which emerged in 2012 and still circulates at low levels. The fear is that a human co-infected with SARS-CoV-2 and a second coronavirus could be a crucible for the creation of a new virus, and even another pandemic.

A caveat is needed, however. In medical circles, co-infection means simultaneous infection of an individual host by two or more pathogens, not necessarily of the same cell within that host. We don't yet know whether cellular co-infection occurs with SARS-CoV-2, says Díaz-Muñoz. But from what is known about coronaviruses, it is likely that it does.

"We worry about flu, but we should be paying more attention to the seasonal coronaviruses," says Díaz-Muñoz. "They are flying under the radar. Looking at what is going to happen with seasonal corona is one of the most important questions right now."

It isn't known whether SARS-CoV-2 could recombine with a

common coronavirus, but we can't rule it out. "To effectively combine the genomic material of two viruses is more complicated if the viruses are very different," says Raúl Rabadán at Columbia University in New York. "If there is a co-infection between a common coronavirus and SARS-CoV-2 it is unlikely, although not impossible, that the potential recombinants will be viable."

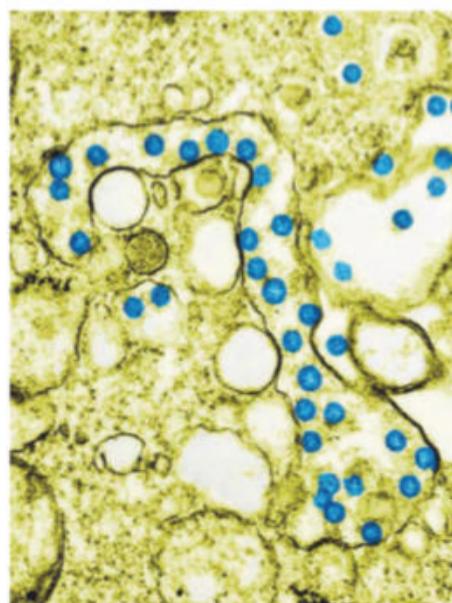
Yi told *New Scientist* that he isn't especially worried about a recombination event between

"We worry about flu, but we should be paying more attention to the seasonal coronaviruses"

SARS-CoV-2 and a cold-causing seasonal coronavirus, because their genomes aren't closely related enough. However, the SARS and MERS viruses, or as yet unknown closely related coronaviruses, are a different story. SARS is the most genetically similar and hence the most dangerous, he says.

That sounds worrying, but a hybrid virus wouldn't necessarily be worse than SARS-CoV-2, says Díaz-Muñoz. It could combine less virulent features of the two parent viruses, and become a mild respiratory virus like the common cold. "That may be evolutionarily advantageous to the virus. If people are no longer sheltering in place, it could spread more easily."

Even if a mash-up is unlikely, recombination in SARS-CoV-2 is still a huge concern, says Yi. It generates genetic variation that could make the virus more virulent, drug-resistant or better able to evade our immune system. It could also render diagnostics based on RNA assays useless. Doctors and disease control specialists should be concerned about these possibilities, he says. ■



CDC/SCIENCE PHOTO LIBRARY

Forensic science

Trees and shrubs might reveal the location of decomposing bodies

Ian Morse

PLANTS could help investigators find dead bodies. Botanists believe the sudden flush of nutrients into the soil from decomposition may affect nearby foliage. If scientists can understand those changes – for instance, on leaf colour – they may be able to identify where remains are buried simply by studying aerial images.

"If we're able to use the plants as sensors, at least first as indicators or crude indicators, we can identify whether a missing body may

"If we're able to use the plants as sensors, we can identify whether a missing body may be close by"

be close by," says Neal Stewart Jr at the University of Tennessee.

Teams looking for human remains often rely on aerial searches, but these are difficult if a cadaver is buried in a forest. Although pedestrian surveys or teams of trained dogs can help in these situations, such searches are impractical in huge forests or war zones.

Forensic anthropologists

at the University of Tennessee have been training members of the FBI for 20 years, including in rudimentary "forensic botany". Anecdotal evidence suggests that visual signals can appear in the leaves of trees and shrubs growing near a body. For instance, a body can affect the mix of plant species growing nearby and plant leaves may be visibly darker, indicative of higher nitrogen uptake.

Now, the plan is to explore those botanical effects more thoroughly at a "body farm" at the university, where researchers study the way cadavers decompose (*Trends in Plant Science*, doi.org/d7zc).

"We've actually built a whole plant imager that can analyse fluorescence signatures," says Stewart. "But the first steps are going to be very fine scale, looking at individual leaves and measuring how their reflectance or fluorescence changes over time when plants are near human remains."

The average person in the US contains roughly 2.6 kilograms of nitrogen, much of which is released and converted into



ammonium when their body decomposes. That may see nitrogen in the soil spike to levels up to 50 times higher than when a typical fertiliser is added. This can increase soil toxicity or alter leaf fluorescence or reflectance.

"That is why this study is exciting, as we can quantify exactly what is happening in the foliage with hyperspectral and chemical analyses even if we can't see a physical change," says team member Dawnie Steadman, also at the University of Tennessee.

Changes in leaf colour could warrant further investigation

Currently, the research is at an early stage. The team is focusing on plants growing at the body farm, which are predominantly Amur honeysuckles, an invasive plant found across much of the eastern US. The results may be translatable to different climatic zones and ecosystems, but the team is unsure how effects can be generalised between species. ■

Climate change

Flying is causing twice the warming effect it did in 2000

THE most comprehensive analysis so far of how much warming is caused by aeroplanes has found that the amount of warming caused by flying nearly doubled between 2000 and 2018.

"It is growing so rapidly," says David Lee at Manchester Metropolitan University in the UK.

The study only goes up to 2018, before the big decrease in flying due to the coronavirus pandemic,

but this decrease is just a blip, says Lee. "It's not going to make much difference in the long term."

Flying has complex effects on the climate. For instance, the soot from jet engines triggers the formation of contrails that, like clouds, can have both a warming effect by reflecting outgoing heat back down to Earth's surface and a cooling effect by reflecting sunlight back into space.

Lee and his colleagues used computer models to improve on previous estimates of the overall effect. These suggest that contrails cause less than half as much warming as previously thought.



Around 3.5 per cent of the global warming effect from human activities is caused by flying

of around 5 per cent (*Atmospheric Environment*, doi.org/d7x9).

This contribution of 3.5 per cent has remained relatively constant since 2000, but only because other sources of warming have also increased rapidly. Over this period, the warming effect from flying has nearly doubled due to the expansion of the aviation industry.

Using renewable energy to turn atmospheric CO₂ into synthetic kerosene could reduce emissions – but Lee doubts this will be adopted so long as it is cheaper to remove fossil fuels from the ground. ■

Michael Le Page

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Gene editing

CRISPR babies may still go ahead

Calls from an international report to limit human gene editing may go unheeded

Michael Le Page

RUSSIAN biologist Denis Rebrikov has told *New Scientist* that he still plans to use CRISPR gene editing to prevent children inheriting deafness, despite a major international report saying it isn't yet safe enough to try in people.

"We are still planning to correct the inherited hearing loss mutation in [the gene] *GJB2*, so that a hearing baby is born to a deaf couple," says Rebrikov, who is at Pirogov Medical University in Moscow.

Three children whose genomes were edited using CRISPR were born in China in 2018 and 2019. The unauthorised creation of those embryos caused global concern and spurred scientific institutes to set up the International Commission on the Clinical Use of Human Germline Genome Editing, a group of 18 doctors, biologists and ethicists tasked with drawing up guidelines for how to proceed in a responsible way.

The main conclusion of its report, published on 3 September, is that genome editing isn't ready to use on human embryos before implantation in the uterus. "The criteria for safe and effective heritable human gene editing have not yet been met," says Haoyi Wang at the Chinese Academy of Sciences, who is on the commission.

The reason is that existing methods can cause unintended genetic mutations and also may not correct the condition-causing mutation in every cell, an issue known as mosaicism. However, the technology is advancing so fast that it might be ready for use in just a few years, says Wang.

The CRISPR-Cas9 protein (blue) uses a guide RNA sequence (orange) to help it cut DNA (purple, centre) in the right place

These problems aren't a deal-breaker for using CRISPR to treat conditions such as cancer or sickle cell disease, as the potential benefits outweigh the risks, and the changes CRISPR makes in these cases aren't heritable. Many trials are already under way.



Denis Rebrikov wants to use CRISPR to prevent a mutation that causes deafness

However, there is widespread agreement that it isn't yet safe enough to use CRISPR to make heritable changes by editing human embryos – with Rebrikov being one of the few exceptions.

He told *New Scientist* last year that he plans to use CRISPR to correct a recessive mutation in the *GJB2* gene that causes deafness.

Almost all genetic conditions can be prevented by screening IVF embryos before implanting them, known as preimplantation genetic

diagnosis, or PGD. When both parents are deaf because of a *GJB2* mutation, however, all their children will be deaf too; PGD isn't an option.

When asked to comment on the commission's report, Rebrikov confirmed that he still plans to go ahead. He didn't mention the safety issue. It isn't clear if Rebrikov has any official approval for his plans. In October 2019, the Russian health ministry said it would be premature to gene-edit human embryos. But, as in many other countries, there are no laws explicitly banning it.

Even if CRISPR genome editing becomes safe and effective enough for altering human embryos, its use to prevent deafness would be controversial. "I would not be supportive of it being used first for deafness," says Sarah Norcross at the Progress Educational Trust, a UK charity to advance public understanding of science.

The commission's report recommends that if any countries decide CRISPR is safe enough to use for making heritable changes, it should be limited to a few

situations. First, those in which prospective parents have no option for having a genetically related child that doesn't inherit a condition. Second, those where PGD is unlikely to succeed – that is, in situations where less than 1 in 4 viable IVF embryos would be free of the condition. Even so, the report recommends that people should have attempted at least one cycle of PGD without success.

Rebrikov's plans do meet these criteria, but the report also says that heritable genome editing should initially be limited to serious conditions caused by a mutation in a single gene.

"My model is hereditary hearing loss, so, this can be limited to

3

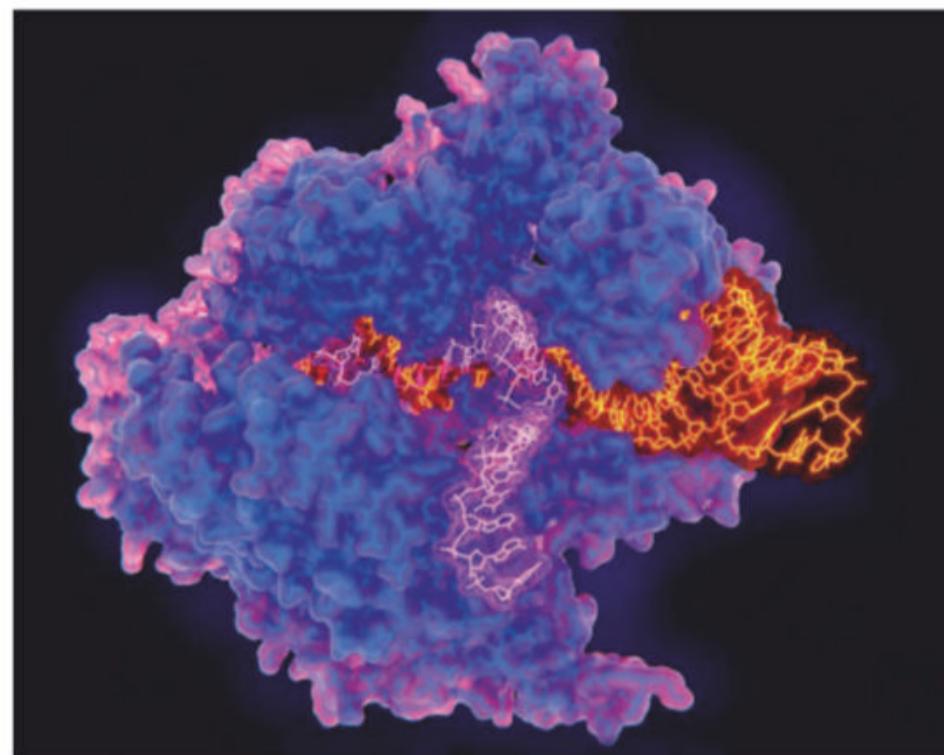
children with genomes altered by CRISPR have been born

serious single-gene diseases' I guess," says Rebrikov. However, the report defines a serious single-gene condition "as one that causes severe morbidity or premature death". Many would argue that this definition excludes deafness.

While Norcross doesn't support Rebrikov's stance, she and others are critical of the report's recommendations for initial uses. "It does seem rather narrow," she says. For instance, Norcross doesn't agree that people should have already tried PGD at least once. "PGD is not easy, and it's not necessarily available," she says. "The woman's age does not stop while all this is going on."

Nor does Norcross think the initial uses need to be limited to single-gene conditions. "It's not necessarily irresponsible to make two edits," she says.

Many conditions are caused by multiple mutations, and PGD is of little use for preventing these. ■



JAN GAERTNER/SCIENCE PHOTO LIBRARY

Nanoparticles turn windows into see-through solar panels

Donna Lu

WINDOWS can act as solar panels when a layer of nanoparticles is sandwiched between two glass panes. This could help us use solar energy in cities where space for solar panels may be limited.

"If we've done our job, no one will even know that they're there," says Hunter McDaniel at UbiQD, a materials manufacturing firm in the US. He and his colleagues have developed solar panels that are indistinguishable from glass.

Test installations involving panels that are 1 square metre in size are under way in buildings in the US and the Netherlands. The panels have a power conversion efficiency of 3.6 per cent, a measure of how much sunlight is converted into electricity. Opaque solar panels, in comparison, have efficiencies between 15 and 20 per cent.

These transparent panels are made from two layers of glass glued together with a polymer that contains nanoparticles known as quantum dots. With a core of copper indium sulphide and a shell of zinc sulphide, these quantum dots are tiny semiconductors that can manipulate light.

When the nanoparticles are excited by exposure to UV light, they release photons that travel along the transparent panel towards its edge. The perimeter is fitted with solar cells, which convert the photons into electrical current. The solar cell edging sits out of sight in the window frame (ACS Applied Energy Materials, doi.org/d8cz).

The panels are brownish in colour, but the team showed it could also produce panels of a grey or grey-blue colour by mixing in a blue dye. It is also possible to customise the transparency of the glass to make panels with a darker or lighter tint. The darker the tint, the greater the energy output, as more light is absorbed. "It's basically an almost linear relationship," says McDaniel.

Could Australia's clash with Facebook go global?

Internet giants are fighting a proposed law that could see them pay for news articles shared on their platforms, says **Donna Lu**

FACEBOOK has announced that it will ban users in Australia from sharing news content, in response to media regulation laws proposed by the Australian government.

The Australian Competition and Consumer Commission (ACCC), a government agency that regulates business practices, proposed a draft of new rules in late July that would enable Australian news organisations to ask for remuneration from companies such as Facebook and Google for news shared on their platforms.

Facebook has responded by announcing a ban on sharing news content. "Assuming this draft code becomes law, we will reluctantly stop allowing publishers and people in Australia from sharing local and international news on Facebook and Instagram," said Will Easton, managing director of Facebook Australia and New Zealand, in a statement.

It is the first regulatory legislation of its kind and may be a test case for potential global regulation to follow. "Facebook could well afford to pay for news in Australia, but they may not be able to afford to pay for news

"Facebook could well afford to pay for news in Australia, but may not be able to afford it globally"

globally," says James Meese at RMIT University in Melbourne.

The law is aimed at redressing what the Australian government sees as a "significant bargaining power imbalance between Australian news media businesses and Google and Facebook".

A decline in advertising revenue across the global news industry has been accelerated by covid-19, and more than 50 Australian news outlets have been shuttered since the pandemic began.



In a statement, the ACCC's Rod Sims criticised Facebook's threat of a news ban as "ill-timed and misconceived", while Australian treasurer Josh Frydenberg has said that the government "won't be bullied, no matter how big the international company is".

Google has also responded to the proposed legislation, saying in an open letter that it would lead to "dramatically worse" search and YouTube services.

If the legislation is passed, there is a significant risk that Facebook and Google will cease to provide news services in Australia, says Rob Nicholls at the University of New South Wales in Sydney.

Facebook's decision has troubling consequences for news media in Australia, a country in which 39 per cent of people use the platform as a source of general news – a figure that is even higher for younger audiences. Without trustworthy news on Facebook, misinformation may spread.

"It's a common play by platforms, when they're faced with regulation that they don't like, to basically withdraw their services from a particular

Australian news outlets have been hit by the pandemic

market," says Meese.

In 2014, Google withdrew its Google News service from Spain after legislation was introduced to make aggregators pay publishers for snippets of their content.

Negotiations between Google and news publishers are ongoing in France, which last year passed an EU copyright directive into law that mandates similar payments.

The UK and Canadian governments are eyeing proposals similar to the Australian law, which focuses on fair competition by forcing tech firms to share ad revenue with news outlets, unlike the European regulations, which are grounded in copyright laws.

Because of the symbiotic relationship between news media and online platforms, Google and Facebook may also lose out by withdrawing news services from Australia.

"The quasi-monopoly position that they're currently in could be threatened by their own exit," says Nicholls. ■

Space exploration

Secret Chinese spaceplane lands after two days

Jonathan O'Callaghan

CHINA seems to have launched an experimental spaceplane, which may be the precursor to a vehicle that can carry humans to and from space.

Early on 4 September, China launched a Long March 2F rocket from its Jiuquan Satellite Launch Center in the Gobi desert. While there was no official announcement prior to the launch, several observers noticed air traffic restrictions that indicated a launch was taking place.

The state-run Xinhua News Agency later confirmed the launch, saying that a “reusable experimental spacecraft” was on board that would “test reusable technologies during its flight, providing technological support for the peaceful use of space”.

On 6 September, Xinhua reported that the craft had landed after a two-day mission. “The successful flight marked the country’s important breakthrough in reusable spacecraft research and is expected to offer convenient and low-cost round trip transport,” it said.

Orbital data confirmed that the vehicle had been placed in an orbit up to 350 kilometres in altitude, a similar height to China’s previous crewed flights. Much about the launch remains shrouded in mystery, however, including the size of the vehicle and what it did while in orbit.

China is known to have been working on spaceplane technology for the past decade. It announced in 2017 that it aimed to fly such a vehicle by 2020. “There have been some clues that this mission might happen,” says Andrew Jones, a journalist who covers the Chinese space programme,



STR/AFP/VIA GETTY IMAGES

including modifications to the launch tower and a potential mission patch referencing the spacecraft. “But the actual timing was a surprise.”

Such a vehicle could take Chinese astronauts to and from orbit, possibly to a planned future Chinese space station. Jean Deville, a space analyst who tracks China’s activities, says a reusable crewed spaceplane could be part of China’s ambitious crewed space programme, which includes

“We don’t know if this is a scaled version to test certain technologies or a full-sized version”

its operational Shenzhou spacecraft and a new deep space vehicle.

“A spaceplane is an ideal technology for atmospheric re-entry due to less brutal accelerations for the human body,” she says.

Another possibility is that the vehicle is more similar to the secretive US X-37B spaceplane, a small uncrewed reusable craft built by Boeing,

A Long March 2F rocket like this one was used to launch a mystery craft

which has flown to space multiple times on missions lasting more than a year, performing unknown activities in orbit. “There [are] undeniable military uses for a spaceplane,” says Deville. “China has shown a strong interest in developing these technologies.”

Regardless of its true purpose, the launch is another signal of China’s growing capabilities. “If you look at what they’re doing in the commercial sector, promoting innovation and low-cost launch vehicles, this is part of a wider context of Chinese plans for space transportation,” says Jones. “But it’s hard to say how big this [spaceplane] is in China’s plans.”

Now, observers will be watching keenly to get more information about the vehicle. “We don’t know if this is a scaled version to test certain technologies or a full-sized version,” he says. “It’s so vague, so secretive. It’s very interesting, but it’s also quite frustrating.” ■

Physics

Ultracold atoms work together to shape and steer light

Karmela Padavic-Callaghan

EXTREMELY cold atoms can control the shape and direction of light when they work together, relying on a type of physics that was proposed more than 400 years ago but has only now been proved possible.

To shape light by manipulating both the electrical and magnetic interactions between it and atoms, previous research had to rely on specially designed metamaterials.

But Janne Ruostekoski and Kyle Ballantine at Lancaster University in the UK have shown this can be done with natural elements like ytterbium and strontium. They calculated that controlling the behaviour of atoms cooled to a billionth of a degree kelvin above absolute zero turns them into a powerful instrument for shaping light.

Under these conditions, the atoms move extremely slowly and can be manipulated through quantum mechanical effects that are negligible at higher temperatures.

The researchers then used lasers to excite the atoms and coax them into one shared motion. They found that when the atoms act collectively, they can shape and steer light through their electrical and magnetic interactions with it. This shared behaviour allows them to act like a collection of electric charges or atomic magnets that affect the light (arxiv.org/abs/2002.12930).

The work also connects to the ideas of 17th-century physicist Christiaan Huygens. Ruostekoski and Ballantine effectively found a way to build a so-called Huygens’ surface out of ultracold atoms. Each atom on this surface determines the shape of the emanating wave of light that passes through it, making it a tool for engineering light waves.

This work could help us study quantum information and potentially improve quantum memory devices by using the cooperative atom-light interaction. ■

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Addiction

Vaping may not help smokers quit

When it comes to helping people stop smoking, e-cigarettes don't seem that effective

Jessica Hamzelou

PEOPLE who use e-cigarettes to help them stop smoking are no more likely to be abstinent a year later than those who use alternative aids or nothing at all. These individuals are also more likely to remain dependent on nicotine.

That is what John Pierce at the University of California, San Diego, and his colleagues found when they assessed attempts to quit smoking by thousands of people in the US. But the findings don't necessarily mean that e-cigarettes won't help some people quit, argue researchers who weren't involved in the work.

More concerning are the flavourings used in some products, say researchers who find that new, undeclared chemicals form when vanilla flavouring, for example, mixes with solvents present in e-cigarette liquids.

Pierce and his colleagues assessed data collected as part of a study that has recruited around 49,000 people across the US. In one piece of research, the team looked at data from a subset of adults who were asked about their use of tobacco products. A year later, each person was asked if they had attempted to quit smoking, what methods they had used and whether they had been successful. The following year, they were asked whether they had remained abstinent for 12 months or more.

Of the 9021 people who initially said they smoked on a daily basis, 2770 had attempted to quit. Around 24 per cent used e-cigarettes as a cessation aid, while about 19 per cent used other methods, such as clinically approved drugs and other nicotine replacement therapies, like patches, sprays and lozenges. The remainder of the group didn't use any products.

The choice of product didn't seem to make a difference to how



REUTERS/BRENDAN McDERMID

A woman vaping in Times Square, New York, during the coronavirus outbreak

successful their attempt to quit was. Only around 10 per cent of people managed to stay abstinent from tobacco products for 12 or more months by the end of the period, regardless of whether they had used e-cigarettes, other products or nothing at all. About 82 per cent of those who had attempted to quit were still smoking by the end of the study period (*PLoS One*, doi.org/d7zn).

Looking at a separate subset of 2535 adults from the same 49,000-strong study group, the team found similar results. The participants were equally likely to quit smoking regardless of the method they used. But those who used e-cigarettes were more likely to still be using these products two years later, suggesting they were more likely to remain dependent on nicotine, says Pierce (*American Journal of Epidemiology*, doi.org/d7zp).

"When you look in the population, there's no benefit to using e-cigarettes to quit," says Pierce.

The findings contradict several other studies that suggest that e-cigarettes can help people give up smoking – although many studies do find that people who stop smoking do continue to use e-cigarettes for more than a year, says Jamie Brown at University College London.

"In these studies, e-cigarettes don't come out very well, but

"When you look in the population, there's no benefit to using e-cigarettes to quit"

neither does anything else," says Leonie Brose at King's College London. Counselling is an important factor, she says. People who want to give up smoking should ideally have support and be informed of how best to avoid situations in which they are likely to smoke, she says.

We don't yet know if long-term use of e-cigarettes will pose problems for health, says Pierce. "E-cigarettes are not harmless," he says.

It is now starting to look as if flavoured e-cigarette liquids could cause harm, says Sven-Eric Jordt at Duke University in Durham, North Carolina. About 90 per cent of these liquids are made up of solvents, while nicotine and flavourings can make up the rest. In the European Union, manufacturers are required to declare all of these ingredients.

But these ingredients can react together, forming new, undeclared chemicals. When Jordt and his colleagues applied these newly formed chemicals to cells taken from the human nose, they found that some appeared especially toxic, killing the cells. "These new compounds are more toxic than the flavours they are derived from," Jordt said at a press briefing for the European Respiratory Society annual meeting on 1 September.

Because the team hasn't yet studied the impact of these chemicals in people, it is too soon to say whether similar effects will be seen in those who vape, Jacob George at the University of Dundee, UK, said in a statement. "No one should claim e-cigarettes are completely safe. However... they contain far fewer harmful chemicals than the 8000 chemicals in traditional tobacco cigarettes, the chemical interactions between which we have not even been able to fully comprehend," he said.

E-cigarettes might still provide a useful quitting tool for some people, says Brose. They could encourage "additional quitters" who might not have attempted to give up smoking otherwise, she says. ■

Gravitational wave detectors find their biggest black hole yet

Leah Crane

ASTRONOMERS have spotted two large black holes smashing together to form an even bigger one with a mass 142 times that of the sun – the largest black hole detected using gravitational waves.

We have direct evidence for smaller and much larger black holes than these ones. Small black holes result from some dying stars and supermassive ones a million times as massive as the sun or more sit at the centres of galaxies. But the latest discovery, which was made at the Laser Interferometer Gravitational-wave Observatory (LIGO) and partner detector Virgo, is the first direct confirmation of an intermediate-mass black hole.

"At masses between 60 and 130 solar masses or so, it's impossible for a star to turn into a black hole, it just blows apart," says LIGO team member Nelson Christensen at the Observatory of Nice in France. "Astrophysicists theorised that we're not going to find any black holes in this gap [between smaller black holes formed by stars and supermassive ones] and we found at least one."

LIGO consists of a pair of enormous L-shaped detectors in the US, and Virgo is another

detector in Italy. When massive objects in space move, they create ripples in space-time called gravitational waves that stretch and squeeze everything in their path. The three detectors use that stretching and squeezing to determine what caused the ripples.

On 21 May 2019, all three detectors found gravitational waves from a pair of black holes that were about 65 and 85 times the mass of the sun, respectively, spiralling towards one another

An artist's impression of two black holes poised to collide

and merging. The result of this colossal collision was a single black hole 142 times the mass of the sun, with eight solar masses worth of energy radiating away in the form of gravitational waves.

Just like the product of this collision, the two black holes that merged might not have formed from stars, but could also be second-generation ones, formed by yet more pairs of smaller black holes, says Christensen (*Physical Review Letters*, doi.org/d7zb).

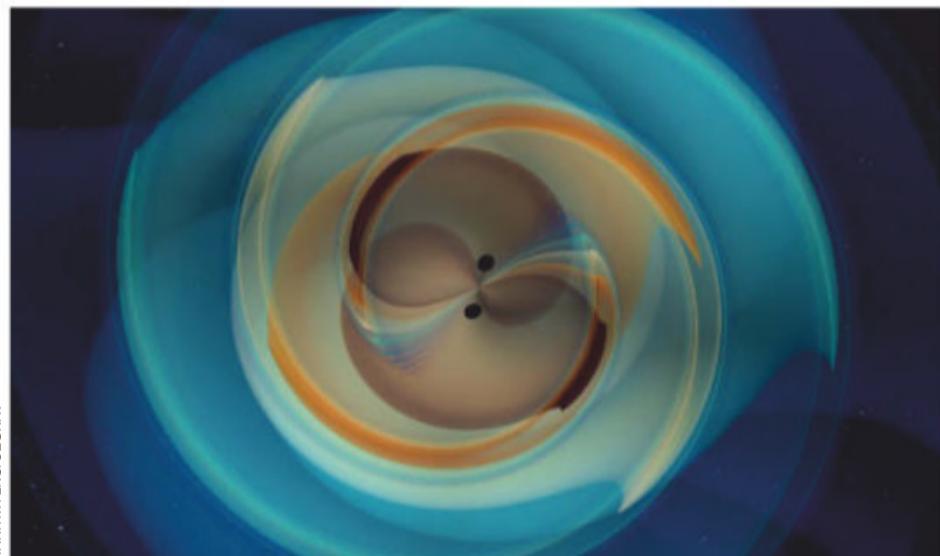
"There has been indirect evidence for intermediate mass black holes, but this is a real observation of an event

that's definitely above 100 solar masses," he says.

We might even have an idea of where this black hole is. Shortly after LIGO and Virgo picked up the merger, a sensitive astronomical camera in California, called the Zwicky Transient Facility (ZTF), spotted a burst of light in a galaxy close to where the gravitational wave measurements suggest the collision happened (arxiv.org/abs/2006.14122).

The flare was near the centre of the galaxy, where a dense disc of matter circles a supermassive black hole. Because this type of region is so crowded, we expect many objects, including black holes, to collide as they orbit the galaxy's centre, says Michael Coughlin at the University of Minnesota, who is part of the ZTF team. Then, as the black hole that results from the merger travels through the disc, it would crash through other matter and cause a burst of light.

"The association is a little suspect: the distances don't quite match," says Coughlin. "But this thing's gonna come around again, so it should cause another flare. That would be a smoking gun." ■



MARK MYERS/OZGRAV

Technology

A small patterned patch can hide a plane from drones

STICKING a small patch on a large object like a plane can hide it from artificial intelligence systems trained to spot objects in drone footage. The technology could help conceal military assets from drone surveillance, say Ajaya Adhikari and Richard den Hollander at the Netherlands Organisation for Applied Scientific Research.

They and their colleagues used an AI that generates a pattern to confuse a drone surveillance system called the YOLO object detector, which spots military objects in aerial images.

The researchers overlaid several patterns of different sizes on aerial photographs, and found that a certain pattern that looks a bit like colourful tie-dye prevented the object detector from spotting jet fighters in these images.

The most effective one was about 10 times smaller than the plane,

and it worked best when placed atop the aircraft in the image rather than beside it. This size patch reduced the accuracy of the YOLO detector from 94 to 38 per cent (arxiv.org/abs/2008.13671).

Sticking a patch like this onto an object in real life could conceal it from surveillance, say the researchers. "We believe this

"The most effective confusing pattern was about 10 times smaller than the plane"

technology will be applicable in other security domains where adversaries have an interest in concealing objects in images," say Adhikari and Hollander. For instance, similar technology developed last year conceals faces from surveillance cameras.

The researchers are also studying defences against such patches. "The detection of objects on the ground and the use of camouflage to prevent detection are in a continuous competition," they say. Layal Liverpool

Zoology



Naked mole rats may help treat deafness in humans

THE cause of poor hearing in naked mole rats has been revealed, possibly boosting the search for treatments for human deafness.

Sonja Pyott at the University of Groningen in the Netherlands and her team looked at mole rat species including *Heterocephalus glaber*, the naked mole rat (pictured left).

They first measured the animals' neural responses to various tones. This confirmed that they struggled to hear quiet sounds and could only perceive noise in a narrow frequency range, between 0.5 and 4 kilohertz. Humans, by contrast, can detect sound between 0.02 and 20 kHz.

The team then recorded the sound transmitted by the cochlea, a part of the inner ear that typically amplifies sound information. They realised that no such amplification occurred in the mole rats.

The researchers found the hair cell bundles in part of the ear were abnormal compared with those of other rodents. They were able to link the proteins involved in these bundles to human deafness, which makes the animals promising in work to find treatments for people.

Analysis of the evolutionary history of gene changes involved in causing these abnormal hair cell bundles in mole rats suggests the mutations weren't random, but positively selected for. This indicates that the mole rats evolved to have bad hearing (*Current Biology*, doi.org/d72n).

We still don't know why that might be the case. One idea is that the creatures lost some of their hearing ability because the sense isn't required underground.

Jason Arunn Murugesu

Climate change

Frigid sea heading for ice-free winters

WINTER sea ice extent in the Bering Sea is the lowest it has been for 5500 years and may soon be gone completely.

"We are essentially locked into a complete loss of winter sea ice in the Bering Sea," says Miriam Jones, who began the research while at the University of Alaska Fairbanks.

The sea borders the Arctic Ocean between Alaska and Russia. Its winter ice levels have been fairly stable in recent decades. However, in 2018, they plummeted to half the usual extent seen over the past 40 years, shocking researchers.

Jones and her team have been studying oxygen isotopes in peat from St Matthew Island in the middle of the Bering Sea. They found a very strong correlation between the sea's ice levels in winter and the ratio of oxygen isotopes in the peat over the past 40 years, the period for which sea

ice records exist. This is because the oxygen isotope ratio reflects the prevailing wind direction and the wind direction affects sea ice extent, says Jones.

Since the oldest peat in the cores is 5500 years old, the team was able to infer winter sea ice levels in the Bering Sea going back this far. The peat cores suggest that there has been a slow fall in winter ice over this time (*Science Advances*, doi.org/d73p). The long-term decline is due to the wobble in Earth's orbit, says Jones, which has resulted in the region getting a bit more sunshine during winters.

However, the cores also indicate a correlation between the Bering Sea's winter ice levels and carbon dioxide levels in the atmosphere, with changes in sea ice lagging several decades behind the CO₂ changes. The implication is that CO₂ levels are already high enough to cause the complete loss of all the winter ice within decades, with knock-on effects for the Arctic Ocean. Michael Le Page

Physics

How to float your boat upside down

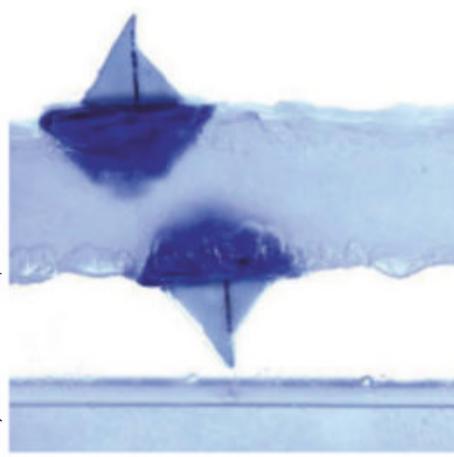
SHAKING a liquid fast enough allows it to levitate, and a toy boat can float on top of the levitating fluid – or upside down beneath it.

When a viscous fluid such as silicone oil is shaken up and down around 100 times a second, the resulting pressure waves can cause air bubbles in the fluid to pulsate, wobble and sink. If the bubbles are big enough, this can lead to a layer of air beneath the fluid.

When Emmanuel Fort at the Langevin Institute in Paris and his colleagues poured beads into one of these floating ponds, they discovered that rather than falling straight through the liquid and the air below it, some beads seemed to "float" at the bottom of the liquid.

They found that the shaking of the container stabilises the bottom of the liquid, vibrating any droplets that might start to form back into the bulk of the puddle (*Nature*, doi.org/d73k). This also creates a stable point for floating objects at the bottom of the liquid: the researchers floated toy boats on both the top and the bottom of this layer (pictured left).

Their container levitated about half a litre of silicone oil or glycerol, but Fort says a bigger shaker could, in theory, make much more liquid levitate. He says that levitating liquid and floating objects beneath it could be used for processes that involve sorting and transporting solids in fluids, like some kinds of mining. Leah Crane



BENJAMIN APFELLEF AL., NATURE



Really brief



Space

Global internet via satellite takes shape

SPACEX has launched its latest batch of Starlink internet satellites and released some early information about the satellite constellation's capabilities.

So far, SpaceX has launched 715 Starlink satellites, with plans to put nearly 12,000 in orbit and possibly expand to as many as 42,000. The goal of this orbital swarm is to provide internet access worldwide, particularly in areas where this has so far

been unreliable or non-existent.

During the webcast of the 3 September launch from Florida, SpaceX engineer Kate Tice said that the first phase of testing the satellites' capabilities has already begun. "We're checking how fast data travels from the satellites to our customers, and then back to the rest of the internet," she said. "Initial results have been good."

Those tests showed download speeds higher than 100 megabits per second. "Our download speed is fast enough to stream multiple HD movies at once and still have bandwidth to spare," says Tice.

SpaceX has claimed that Starlink will eventually hit gigabit speeds.

Meanwhile, the firm is starting to roll out new capabilities: Tice also announced that SpaceX has successfully tested inter-satellite links nicknamed "space lasers" that allow the satellites to quickly communicate with one another.

"With these space lasers, the Starlink satellites were able to transfer hundreds of gigabytes of data," said Tice. "Once these space lasers are fully deployed, Starlink will be one of the fastest options available to transfer data around the world." **LC**

Bitumen on roads pollutes the air

When roads covered in bitumen or asphalt are heated on a warm day, they release carbon-containing chemicals. These can then react in the atmosphere to create harmful particulates. We can expect more of this form of pollution as climate change ramps up (*Science Advances*, doi.org/d7xr).

Probability helps bees find food

Honeybees can calculate the probability of artificial flowers providing nectar, but use the information in an unusual way. They don't always visit the flower with the highest probability of nectar. Instead, if a flower has a two-thirds likelihood of paying off, the bees visit it two-thirds of the time (*Proceedings of the Royal Society B*, doi.org/d7x8).

How to spot a well-fed sea anemone

Animal body shape is typically controlled by genes, but sea anemones are an exception. The number of tentacles they grow is down to how much they eat. If people followed the same pattern, those with the richest diets would grow extra arms and legs (*Nature Communications*, doi.org/d7xs).

Environment



Blue jeans are polluting our blue planet

THEY may be a comfortable and convenient choice, but blue jeans could be harming the planet.

Microfibres of indigo denim have been discovered in water samples taken across Canada, from Toronto to the Arctic. The survey by Miriam Diamond at the University of Toronto and her team found that as many as one in four of all microfibres in the samples were blue denim.

Some of the microfibres were found at a depth of 1500 metres, so it seems they can withstand travelling long distances. The highest concentrations were found in shallow suburban lakes. While the survey was limited to Canada,

the team believes the results would be repeated elsewhere (*Environmental Science & Technology Letters*, doi.org/d722).

The researchers also found that around 50,000 microfibres detached from the surface of jeans every time they were cleaned. They didn't look at what happened when washing other materials.

While the researchers weren't sure of the effect of the microfibres on the environment, Samantha Athey at the University of Toronto points out the fabrics involved are chemically treated. Washing jeans less often could help reduce the pollution. **Chris Stokel-Walker**

Technology

Leap forward for quantum networks

A MORE secure internet could be around the corner thanks to the reported largest-ever quantum network of its kind.

Quantum systems are more secure than regular networks because they rely on quantum properties rather than computer code. But building a quantum network is tricky and costly.

Siddarth Joshi at the University of Bristol, UK, and his colleagues have developed a kind of quantum network using a method called multiplexing entanglement. Entanglement is a quantum property that sees two objects, such as a pair of photons, linked. This can be used to generate a secure encryption key.

Rather than connecting users one-to-one, which is costly for a large network, multiplexing splits photons from a single laser according to their wavelength. Each wavelength can hold a data stream, meaning the system could support between 50 and 100 users with existing hardware, says Joshi.

The team tested its system with eight users on existing optical fibres in Bristol. It says this makes its test system the world's largest entanglement-based network, in terms of number of users (*Science Advances*, doi.org/d73t). **CSW**

Signal Boost

Welcome to our Signal Boost project – a weekly page for charitable organisations to get their message out to a global audience, free of charge. Today, a message from **Ripple Africa**



Are you concerned about climate change and biodiversity? Could you help Ripple Africa make a real and lasting difference in one of the poorest countries in the world?

Ripple Africa is a UK registered charity working with communities in Malawi to help them manage their natural resources in a more sustainable way. We believe that by inspiring and empowering local people, we can help them secure a sustainable future and help the planet at the same time. However, in these difficult economic times, we are hoping that we can also inspire you to support our projects in Malawi:

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SUSTAINABLE FISHING Lake Malawi is the ninth largest and most biodiverse lake in the world. We are empowering people living along 300km of the shoreline to adopt sustainable fishing practices and help stocks of critically endangered fish species to recover. New bylaws ban the use of mosquito nets for fishing - which catch baby fish before they can grow and breed - and protect key breeding areas.

We need your help to enable us to keep these projects going and growing.

Want to help?

If you would like to make a donation or offset your carbon footprint by buying carbon credits, please visit our website at ripplefrica.org

The columnist

Chanda Prescod-Weinstein on escape via wormholes **p24**

Aperture

The flowing flight of a pair of whooper swans in China **p26**

Letters

Coronavirus affects our social norms in many ways **p28**

Culture

One man's fight to return beavers to England **p30**

Culture columnist

Jacob Aron tries chess with time-travelling pieces **p32**

Comment

The wrong questions

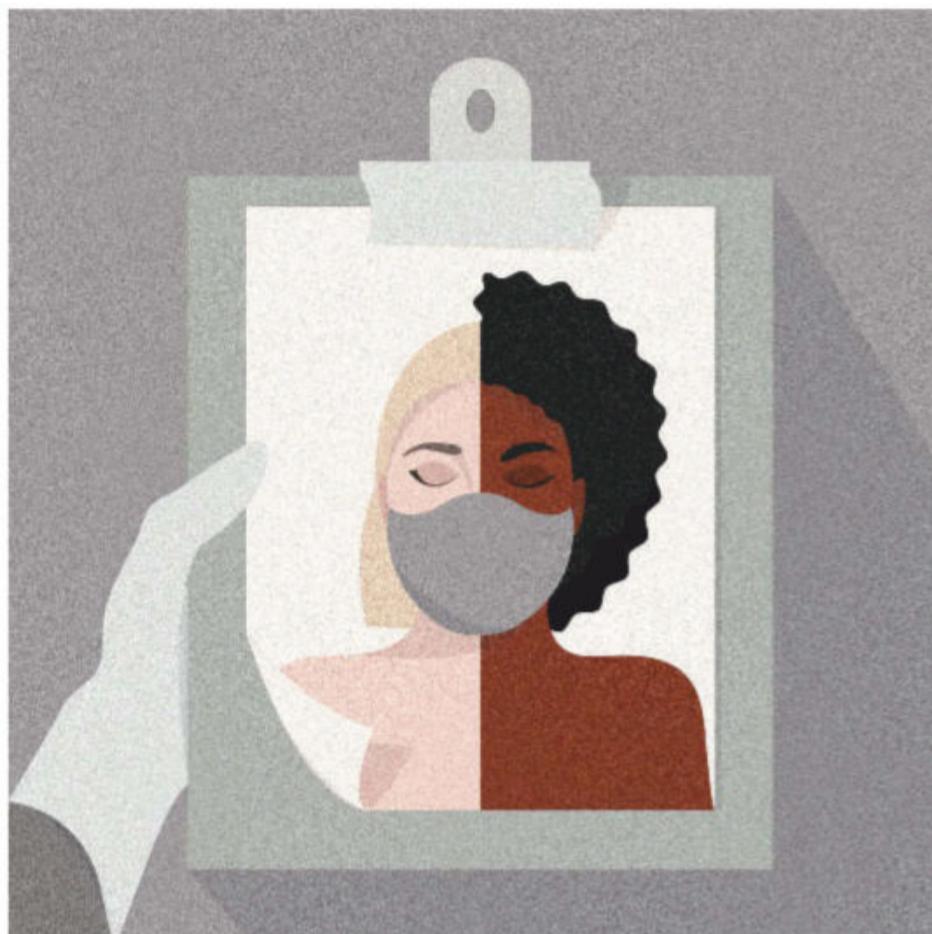
Covid-19 is affecting ethnic minorities more severely, but we will never understand why if we don't collect the right data, says **Alisha Dua**

THERE was the home health aide distraught at having potentially transmitted the coronavirus to her patients. The essential worker, just barely into his 40s, on a ventilator for six weeks. The beloved father's family whose agony was revealed in every phone call recorded in his medical record.

These are the stories of some of the people with covid-19 whose medical records I reviewed as a research volunteer in New York City. Combined with thousands of other people's anonymous data, such collections are critical for informing research, clinical care, government policies and funding allocations to tackle the pandemic. Participating in this process, it became clear that the system of healthcare data collection perpetuates systemic racism in medicine in the US and elsewhere.

It is well established that people of colour in the US are more likely to get covid-19 than white people. In the UK, the same is true for people from black, Asian and minority ethnic (BAME) backgrounds. But the way we are trying to understand these patterns is all wrong.

The statistics collected on covid-19 largely focus on biological factors, such as comorbidities: secondary conditions that may affect a disease's outcome. With covid-19, obesity has been linked to its severity, for example. Many comorbidities, obesity included, are also found at higher rates among people of colour in the



West. This has led many to highlight them as the sole explanation for covid-19 health disparities. This is an oversimplistic and harmful conclusion.

While we know that ethnic minority groups in the West have had higher infection rates, we will never fully understand why that is the case without looking at aspects of health that aren't down to biology. So-called social determinants, such as food security, housing and cultural practices, are not only important for explaining why health disparities exist, they are also vital for knowing how to address them.

Consider multigenerational households. When people with mild cases of covid-19 are told to isolate in their homes, the risk of spread rises with each extra member in the household. If they have older relatives living with them, the risk of a more severe case of covid-19 increases. In the West, people of colour are more likely than others to live in multigenerational family homes.

Early in the pandemic, we didn't collect data on this and many other social factors to determine if these households have an increased covid-19 burden. Such data would have helped reduce

the disease's spread for everyone, not just minority populations. Viruses don't care about the colour of your skin.

Published work on covid-19 illustrates the lack of data on social determinants. On pubmed.gov, a database of international biomedical literature, 676 articles mention "comorbidities" and "COVID-19" compared with just 52 for "social determinants of health" and "COVID-19".

Why is research on the social determinants of covid-19 so limited? Unfortunately, this is the status quo in clinical research.

From the start of their training, clinicians learn that biological factors are the most important for understanding, preventing and treating disease. Many medical schools in the US and Europe don't have a required curriculum on social determinants of health. In schools that do, it is common for the curriculum to be squeezed into a single class. The implication is that social determinants aren't a priority in medical care.

By failing to gather data on social determinants early in the pandemic, we lost the opportunity to reduce the spread of covid-19. We must now prioritise the collection of such data to ensure we operate equitable healthcare systems where minority communities aren't left behind. ■



Alisha Dua is a graduate research fellow in the Tri-Institutional MD-PhD Program in New York

Field notes from space-time

Wormholes to the rescue The chances that wormholes exist are slim, but this doesn't mean that they can't provide a useful escape, writes **Chanda Prescod-Weinstein**



Chanda Prescod-Weinstein is an assistant professor of physics and astronomy, and a core faculty member in women's studies at the University of New Hampshire. Her research in theoretical physics focuses on cosmology, neutron stars and particles beyond the standard model

Chanda's week

What I'm reading

In Defense of Looting: A riotous history of uncivil action by Vicky Osterweil is providing me with lots of food for thought.

What I'm watching

I am enjoying Lewis Hamilton's F1 victories, including his salutes to Wakanda and Black Lives Matter.

What I'm working on

A postgraduate introduction to cosmology.

This column appears monthly. Up next week: Graham Lawton

AFTER months of social isolation, Zoom birthday parties and loved ones falling ill with the coronavirus, many of us here in the US are feeling exhausted and fearful about both the present and the future.

This is especially true for those of us who are Black/Afro-descended. We have faced not only disproportionate death rates from covid-19, but persistent, public and violent harassment from state authorities and vigilantes, making many of us afraid for ourselves and our communities.

As I have struggled to stay focused in the midst of what seems like never-ending public grief, I have caught myself wondering: could a wormhole help us get out of this mess?

In the popular imagination, a wormhole is a rip in space-time that provides a shortened pathway between distant locations in the universe. The lore goes that if you enter a wormhole, you could end up on the other side of the galaxy.

The idea of wormholes was popularised around the time that freeways were becoming an increasingly important feature of life in the US. For us, I think wormholes have always seemed something like "the great cosmic highway". Of course, we know now that freeways are bad for the environment and were completely destructive to the communities that they broke up. What's more, traffic on such roads has been a painful misery nearly everywhere that I have lived.

Yet there is still something exciting about linking parts of space-time together in a way that – at least in theory – facilitates quick travel between distant locations, providing a means for escape that defies the universal speed limit,

the speed of light. A wormhole is conceptually more fun than a black hole because you can leave it. A black hole, on the other hand, is forever. Once you enter, you can't escape because there is a point of no return – the event horizon.

In reality, scientists are fairly certain that black holes exist. We have extensive circumstantial evidence in the form of the behaviour of particles near galactic centres, which are moving so energetically that the best explanation for what we see is the presence of a black hole in the middle of it all.

"The lore goes that if you enter a wormhole, you could end up on the other side of the galaxy"

Then, last year, the Event Horizon Telescope took an image that is most likely to be of the edge of a black hole. But while black holes almost certainly exist, wormholes aren't so likely.

The first wormholes – also known as Einstein-Rosen bridges, after Albert Einstein and Nathan Rosen – were understood as a mathematical solution to one of Einstein's equations, which connected black holes and a sort of hypothetical, mirror-image version of them called white holes.

Just as black holes can be entered but not exited, white holes can be exited but not entered. The idea that wormholes link black and white holes together is delightful, but it has the problem that the connections would be unstable.

Wormholes, if they are real, would collapse if anything traversed them at slower than the speed of light – that is to say,

if anything with mass did. Plus, just like black holes, it would be hard to get close to one.

There is hope for wormholes, however. Early research about them focused on models that only accounted for gravity in an empty space-time. Once we added quantum mechanics into the equation, scientists including Stephen Hawking hypothesised that wormholes may live longer.

An alternative fix would be to introduce an exotic form of matter that exists everywhere, but it would have to be something different from dark matter or dark energy, and there is no evidence for something like that.

Research on these topics continues, but I don't expect to be able to make use of a real wormhole any time soon, and I have little hope for observational evidence of one either.

That said, wormholes can still provide a useful escape. Regular readers of this column know that I am a big fan of *Star Trek*, and my favourite series in the franchise is *Star Trek: Deep Space 9* (DS9), which imagines the diplomatic, militaristic and spiritual possibilities of the Federation's management of a wormhole.

Early in the series, we learn that Commander Benjamin Sisko, the first Black lead of a *Star Trek* show, is known by and important to the Prophets, the space-time entities that live in the wormhole.

The story that unfolds over the next seven seasons sends a strong message: it is a Black person, in part through his relationship with the Prophets, who will help save the alpha quadrant from destruction. When I am feeling hopeless about our conditions on Earth, the story of DS9 and its wormhole provides a valuable escape – and an inspiring vision of the future. ■

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Fairy swans



Photographer **Shu Qing**/
Bird Photographer of the Year
www.birdpoty.co.uk

A PAIR of flying whooper swans glide above the water in seamless harmony in the city of Sanmenxia in Henan province, China.

The image is titled *Fairy Landing on Earth*, and it won Shu Qing the bronze prize in the Birds in Flight category of the 2020 Bird Photographer of the Year competition.

Qing followed the swans – which get their name from their characteristic “whooping” call – with a handheld camera, and used a slow shutter speed to blur their movements. This approach adds an artistic touch to the photo as the swans appear to blend into their surroundings in smooth, effortless strokes.

Each winter, whooper swans migrate from their breeding grounds in the higher latitudes of the northern hemisphere to parts of eastern Asia and Europe, including the UK. During their non-stop journey, which can span thousands of kilometres, they can reach altitudes as high as 8000 metres.

The species is a common sight in China, where tens of thousands of whooper swans winter across the country’s wetlands. ■

Gege Li

Editor's pick

The many ways this virus affects our social norms

15 August, p 32

From Bonita Ely, Sydney, New South Wales, Australia

Further to your look at social disruption amid the pandemic, two other factors affecting interaction are the inability to read facial expressions when everyone is wearing a mask and the need to distance yourself from people to a far greater extent than our cultural norms would dictate.

When speaking with strangers, they can't read your mood, so communication can be awkward, even rude. Similarly, dodging and weaving to keep a metre and a half away from people while outside feels as if you are shunning them.

Make covid-19 vaccines mandatory to go overseas?

Leader, 15 August

From Valerie Moyses, Bloxham, Oxfordshire, UK

A person's freedom to be unvaccinated doesn't outweigh my freedom not to be infected by the coronavirus. Even if it isn't made compulsory for everyone, international travellers should be obliged to be vaccinated.

Some of your readers may recall that in the 1950s and 60s there were many countries, including in Europe, that demanded a certificate of smallpox vaccination for foreign visitors. No certificate, no entry.

Such measures were accepted by travellers without protest. That helped to eradicate smallpox. We will need a similar international regulation on coronavirus vaccinations, unless we are to fight the virus from a severely weakened position.

From Steven King, Crewkerne, Somerset, UK
The World Health Organization has overlooked the most important group in need of vaccination: mothers. I won't dwell on the

tragic consequences for a dead mother's children, but ask the mainly male policy-makers to calculate the cost to the economy of the death of a primary carer. As someone over the age of 65, I would gladly give my vaccine to any mother anywhere.

Other uses of the vagus nerve weren't so great

15 August, p 21

From Bryn Glover, Kirkby Malzeard, North Yorkshire, UK

Your story on a device that stimulates the vagus nerve to aid language learning prompted a memory of the so-called Alderman's nerve, the auricular branch of the vagus. This seems to be the same part that is the focus of that device.

It is said that vagal stimulation of a sort was in use centuries ago by overindulgent aldermen at civic banquets. The application of a few drops of rose water to the earlobe was thought to trigger an increase in gut peristalsis, which would thus make room for more food.

Squatting may not be good for everyone

18 July, p 28

From Wolfgang Lankes, Nideggen, Germany

Despite the cardiovascular benefits of avoiding excessive use of chairs and sofas, we shouldn't assume that the benefits of squatting felt by the Hadza people will apply to people of European descent in the same way.

The higher prevalence among European-descended people of gene variants that lead to hypercoagulability of the blood, such as Factor V Leiden, combined with the compression of lower limb veins while squatting could have an adverse impact.



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We could do more to make forests lock away carbon

15 August, p 38

From Eric Kvaalen, Les Essarts-le-Roi, France

The trouble with using forests as carbon sinks is that rotting puts carbon dioxide back into the atmosphere. If we really want to reduce the carbon dioxide in the air, we should harvest wood from the forests and store it, either as wood, charcoal or some other carbon-containing substance.

Science may have issues, but that isn't one of them

22 August, p 36

From Ian Stewart, University of Warwick, Coventry, West Midlands, UK

In your interview with Stuart Ritchie on problems in science, you quote him as saying: "People who finish their PhDs now are expected to have some astonishingly high number of peer-reviewed publications, something like 19. A few years ago, you'd be expected to have five or six." That isn't the case.

"People who finish their PhDs" appears to refer to PhD students who have just completed a thesis. They have never been expected to have peer-reviewed publications, if only because it takes too long to get them published.

The editor writes:

Stuart Ritchie has clarified that his take on this applies only to some PhDs.

Life's beginnings may have been turbulent

8 August, p 34

From Martin Pitt, Leeds, UK

The latest ideas to explain the origin of cellular life may overlook

the effects of turbulence and shear in liquids. These are what make dispersions, akin to mayonnaise, that can encapsulate chemicals in a film of oily substance without the need for self-assembly.

Instead of cells arising from individual homogeneous chemical solutions on a small scale, for example in a pool, we should think of a disturbed situation – running water, rocks or ice falling into water, bubbles coming up, thermal convection – in which the composition is constantly varying, with films of oily material that perhaps arise sometimes.

This chaotic situation would produce trillions of permutations of chemicals that were more or less encapsulated, very occasionally producing something like a cell.

Another knotty problem could be solved

8 August, p 46

From Tom Roberts, Derby, UK

A useful piece of advice that I have imparted to friends and relatives is that if you want to stop a piece of string or a cord from randomly tangling itself into a knot, then fasten the two loose ends together. I have also joked that there is a formula describing an extension cord with both ends plugged together that can prove a knot would never form, but that it would take too long to write down.

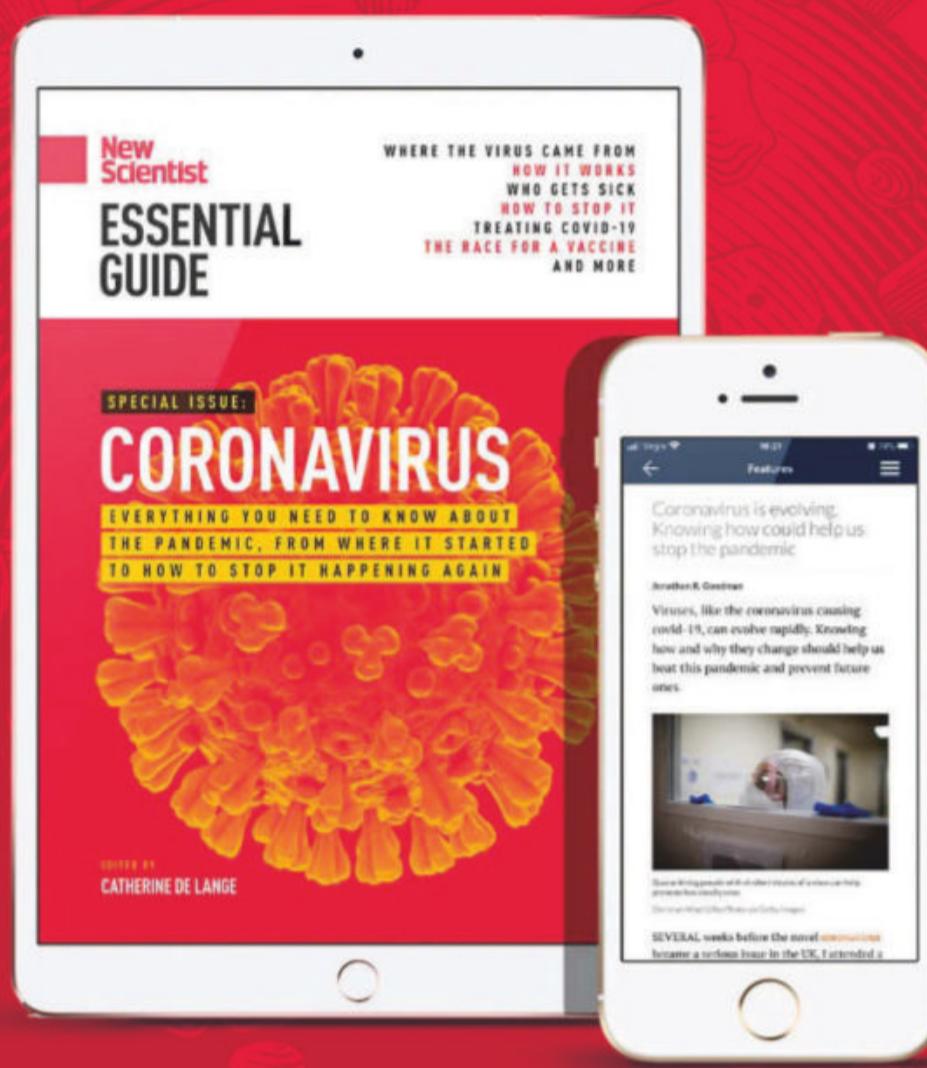
Having read your interview with Lisa Piccirillo on the Conway knot, it seems there may actually be such an equation. She says that a trivial knot can be untangled without unplugging it, whereas a hot mess knot can't. Can we also say that a trivial knot that has its ends plugged together can never form a hot mess knot, and prove it using a fourth dimension? ■

For the record

■ Our description of punched cards in early digital computers was the wrong way round. A hole was a 1 and solid card represented a 0 (25 July, p 36).

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Return of the beaver

One man's battle to reintroduce the beaver to England makes amusing but infuriating reading for all who appreciate the animals, finds **Graham Lawton**



Book

Bringing Back the Beaver: The story of one man's quest to rewild Britain's waterways

Derek Gow

Chelsea Green Publishing Company

LAST month, the UK government made a long-anticipated ruling on the future of a colony of beavers that has been living freely on the River Otter in Devon since at least 2014. Against expectations, it decided they could stay – the first time an extinct native mammal has been legally reintroduced into the wild in England. Scotland's government made a similar call in 2016, and in 2019 declared the beaver to be a protected species.

As Derek Gow says in his charmingly irascible little book *Bringing Back the Beaver*: “In England, Wales and Scotland, beavers are returning. Slowly.” Gow, a farmer-turned-zookeeper-turned-ecologist, has done as much as anyone to make it happen, though he makes it clear that it would have happened much more quickly were it not for the implacable hostility of a handful of powerful interest groups.

Gow cut his conservation teeth reintroducing endangered water voles, and he helped to establish the UK's first enclosed beaver trial at Ham Fen nature reserve, near Sandwich in Kent.

He has been fighting tirelessly to reintroduce beavers ever since, often against entrenched opposition. His “war” stories make up most of the book and they are a great, though maddening, read.

At every turn, he and his fellow

conservationists are stymied by puffed-off bureaucrats, ignorant politicians, grumpy farmers, greedy landowners and the hunting, shooting and fishing lobby. All of these Gow regards as fools – whom he doesn't suffer gladly. His portrayal of them is brutal, and the times when he outwits them are recounted with relish.

On one occasion, a “small man in a brown serge suit” left his briefcase in Gow's office. Gow promptly photocopied the contents and discovered that even though the UK's Department for Environment, Food and Rural Affairs (Defra) claimed to have legal authority over enclosed beaver trials, it did not. Needless to say, Gow squirrelled that information away and used it later to his considerable advantage,

deliciously wrong-footing Defra in the process.

Even so, progress was glacial. Compared with continental Europe, where beaver reintroductions have been under way since the 1960s, Britain has been slow to follow suit (as far as anyone knows, there have never been beavers on the island of Ireland). Attempts have been endlessly blighted by unscientific beliefs that beavers will destroy farmland, fell big trees, harm fish or spread disease.

Gow is a great and funny storyteller and acute observer of people. Admittedly, he has

“Nobody knows (or will admit) where the beavers on the River Otter came from”

a fantastic cast of characters to work with. The world of beaver reintroductions attracts more than its fair share of eccentrics, misfits and mischief-makers – in short, people very much like Gow who love nothing more than to stick a finger up at authority.

One such colourful character is the Belgian activist Olivier Rubbers. He got so fed up with the way his country's government constantly thwarted the reintroduction of beavers that he went to Bavaria, bought 100 beavers from a farm, drove back to Belgium and simply released them into the wild. He fought a five-year legal battle, outmanoeuvred the authorities and escaped with a nominal fine.

Incidentally, nobody knows (or will admit) where the River Otter beavers came from. The official version is that they escaped from a local wildlife centre. But with rogues like Rubbers around, you can't help wondering.

As a nature writer, Gow is less compelling. I just wanted him to keep doing what he does best, which is skewering his foes and sometimes also his friends with his barbed wit. But one description of a beaver-engineered landscape struck me as beautiful: it was, he wrote, “a complex wet, woody Venice”.

I am fortunate enough to have visited two enclosed beaver trials, one in Devon (not the River Otter) and the other in North Yorkshire, where I saw one of the resident beavers. Gow's description of the landscape they create is spot on; it is unlike any other you will see in the nature-denuded British countryside.

We need more beaver reintroductions, and thanks in no small part to the bull-headed and tireless work of Gow, it looks like we are finally going to get them. ■



GUY EDWARDS/NATUREPL.COM

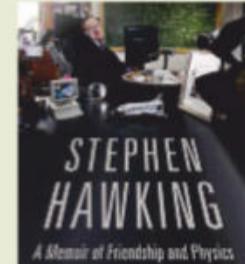
Reintroducing the beaver has been glacially slow in English waters

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Reversing time

Christopher Nolan's new film twists time in a fun way, but it is head-spinningly hard to grasp, says **Francesca Steele**



Film

Tenet

Christopher Nolan

In cinemas

BULLETS racing towards guns, not from them; dust explosions deflating back down into the solid earth. This, *Tenet*'s writer and director Christopher Nolan assures us, is time inversion. It is absolutely not time travel.

Nolan has been peculiarly insistent that *Tenet*, which is visually thrilling, superbly acted and emotionally empty, isn't about time travel, but about inversion of the time stream, causing material to run backwards instead of forwards.

The thing is, *Tenet* is actually very much about time travel. Yes, there are backwards bullets and inverted fight scenes so inventively choreographed that they are impossible to describe, but people do also go back in time to try to ward off some kind of third world war.

If that isn't time travel, then what is? Saying that it isn't seems to be Nolan's way of telling us that this isn't some kitsch flick for *Back to the Future* fans, but a serious film grounded in theoretical physics. Reminiscent of the time dilation of Nolan's 2014 grand space odyssey *Interstellar*, *Tenet*'s inversion concept draws on the idea that time reversal is technically possible.

For the first hour or so, this doesn't matter much, because until the midpoint *Tenet* is basically just a Bond film on steroids. John David Washington plays a secret agent named simply "The Protagonist", who bungee-jumps off apartments in Mumbai, orchestrates a 747 crash and attends exposition-heavy ballistics meetings with a physics whizz played by Clémence Poésy.

Poésy explains about those backwards bullets and the "detritus



MELINDA SUE GORDON

Robert Pattinson (left) and John David Washington in *Tenet*

of a coming war" that she keeps finding and has presumably been sent back from the future, before helpfully reassuring her confused audience, "Don't try to understand it. Feel it." She doesn't really look like she understands it all either.

The Protagonist joins forces with louche British spy Neil, played by Robert Pattinson, and together they set about disrupting the inevitably malign ambitions of Kenneth Branagh's heavily accented Russian arms dealer, doing something with plutonium and absolutely not time travelling. They do go back to a previous moment in time through an inversion turnstile to help the arms dealer's abused wife Kat, played by Elizabeth Debicki. But that definitely isn't time travel, just inverting time so that they are in the past. Totally different.

Tenet's biggest issue isn't actually that its "temporal pincer" plot (a temporal pincer is a... no, never mind) is a little heavy on the

exposition and yet still head-spinningly difficult to understand. All that feels somewhat displaced by the rush of the car chases, the pounding score, the yachts and the stunning sets. As a blockbuster to reopen cinemas, *Tenet* is great fun.

The problem is that it has no real heart. Nolan often bends time to his will, but usually with a narrative anchored in love. In *Inception*, Leonardo DiCaprio's character's longing for his wife underscores the dreamworld compression of time; in *Interstellar*, Matthew McConaughey's brief absence in space as his daughter ages decades in Earth years moves us beyond the spectacle and the science.

In *Tenet*, however, the emotional development seems secondary. The stakes, despite the coming apocalypse, never feel that high.

Tenet is slick, solid big screen entertainment, but it will not, as its characters ask repeatedly of each other, cause anyone to look at the world in a new way. ■

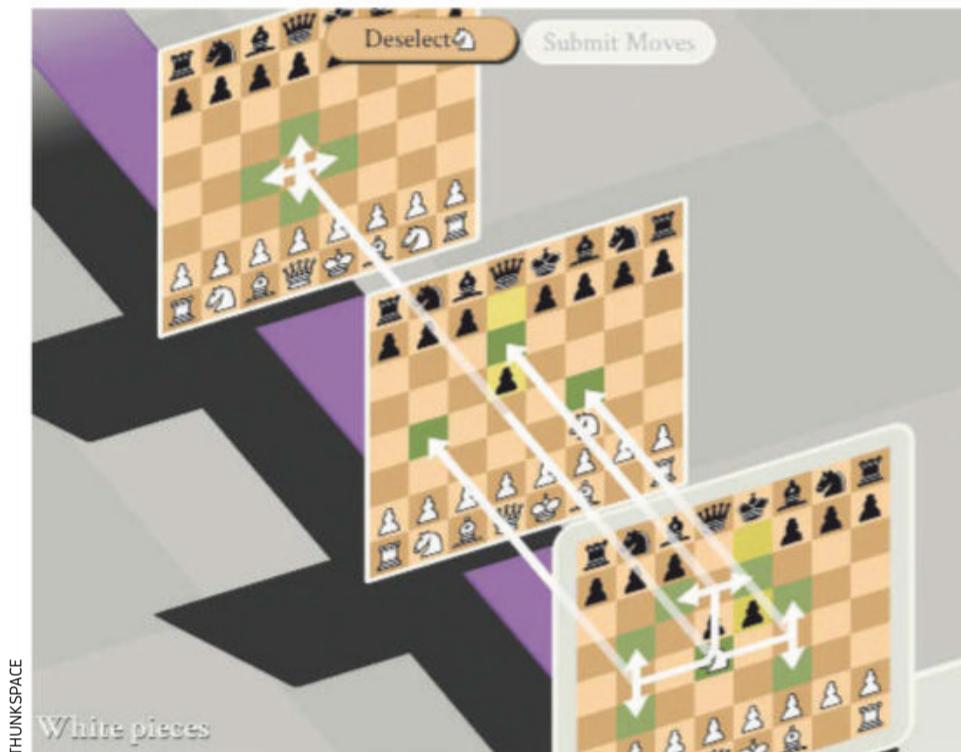
Francesca Steele is a freelance writer based in London

The games column

Totally confusing, but in a good way Playing a version of chess in which pieces can travel back in time isn't for the faint-hearted – try keeping track of all the possible threats facing every king that ever existed, says **Jacob Aron**



Jacob Aron is New Scientist's deputy news editor. He has been playing video games for 25 years, but still isn't very good at them. Follow him on Twitter @jjaron



Game

5D Chess With Multiverse Time Travel
Thunkspace
PC

Jacob also recommends...

Game
Microsoft Flight Simulator
Asobo Studio
PC

The latest version of the venerable flight-sim franchise offers up the entire world in amazing detail, thanks to satellite maps and AI-generated terrain. You can literally fly over your own house, though the most fun is to be had from seeing where the AI has made mistakes, such as rendering Buckingham Palace as a drab office building.

THERE is a phrase that has entered the political lexicon recently. When a politician does something that looks really incompetent, wannabe analysts will fall over backwards to explain why this is part of a dastardly plan that mere mortals can't comprehend. "X is playing 5D chess!" they exclaim.

If so, that explains a lot about the state of the world because 5D chess is brain-meltingly hard. I have been playing *5D Chess With Multiverse Time Travel* and I am totally confused.

Let's start with the basics. A regular chess board is a two-dimensional surface on which pieces are allowed to move forwards and backwards, left and right and diagonally. Technically, chess also has a third dimension, height, but this has no bearing on the game, unless you are playing the variant seen on *Star Trek*.

Now things get complicated. In *5D Chess*, pieces can travel back in time. This movement is broadly governed by the normal rules of chess. For example, pawns are only able to travel to a square immediately in front of them,

and one turn back in time, while queens can travel in any direction, as long as the number of turns and the number of squares they move is equal (think of this as being "diagonal" in time and space).

OK, now things get really, really complicated. When you send a piece back in time, you can't change the past because that

"Since pieces can move in five dimensions, it is possible to put the king in check in the past, or in another universe"

would create a paradox. Instead, time travel spawns a new universe running in parallel to the existing one, your own baby multiverse. What's more, pieces can jump between universes, giving you the fifth dimension of movement.

Keeping all this straight is made surprisingly easy by the game's clean interface, which lays each turn out on its own board. As time advances each turn, new boards spring up to the right, while multiverse boards are

Seeing all the possible moves isn't the same as anticipating threats

placed above and below the main timeline. Clicking on a piece will show you where in the multiverse you can move it so you don't have to remember all the rules.

Actually playing the game, either against a human or an artificial intelligence, is another matter. Since pieces can move in five dimensions (well, four in practice), it is possible to put the king in check deep in the past, or in another universe. That requires you to constantly monitor all possible threats to every king that ever existed, which is too much for my brain to cope with.

I have experimented with a few strategies, none of them optimal, I am sure. First, I tried collecting kings from across the multiverse onto one board, figuring strength in numbers would make it easier to protect them, yet it actually meant the AI could use a knight from another universe to constantly put them in check. In another game, I tried to create an army of queens, but left my forces on the other boards so depleted they were easily overwhelmed.

I am keen to keep playing, however, as *5D Chess* can generate incredible moments. In one game, the AI had two kings on one board, and I was manoeuvring to put both in check at once, which would give me victory, as only one piece can move each turn. But before I could, the AI jumped one king just a single turn back in time, scuppering my careful plans. As I regrouped and grew closer to a checkmate, the AI jumped a bishop to almost the start of the timeline, trapping my king – and winning.

It was no Deep Blue versus Garry Kasparov, but I felt thoroughly trounced. ■

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FOR about a decade, geneticist Tim Spector of King's College London ate the same thing every day: a tuna and sweetcorn sandwich on brown bread, followed by a banana. He thought it was a healthy choice, until he turned the microscope on himself and discovered that it was about the worst possible thing he could eat. He was having huge post-lunch surges of sugar and fat in his bloodstream, both of which are known risk factors for diabetes, heart disease and obesity.

But just because tuna sandwiches are bad for Spector doesn't mean they are bad for everyone. Far from it: for some people, they are super healthy. The same is true of almost any food, even things like ice cream and white bread that have long been considered universally bad news.

Recent research by Spector and others has revealed that our response to food is highly individualised and that, consequently, there is no such thing as a healthy diet that works for everybody. In fact, people respond to food in such idiosyncratic ways that everybody needs a personalised nutrition plan. Now he and others, including the US National Institutes of Health, are seeking to deliver such plans in a healthy eating revolution that is being called "precision nutrition".

The findings could also explain why

ANDREA DE SANTIS

decades of one-size-fits-all dietary advice has failed to halt the global epidemic of obesity and diabetes and why nutrition science has consistently failed to produce a straight answer to its most pressing question: what constitutes a healthy diet?

The idea of diet as a major determinant of health goes back to at least the ancient world, with Hippocrates' famous (but probably apocryphal) dictum "let food be your medicine". Scientific attempts to define a healthy diet date back to the 1890s, when nutrition pioneer Wilbur Atwater at Wesleyan University in Connecticut published the first ever dietary guidelines. He recommended variety, moderation and the avoidance of too much fat, sugar and starch. That advice has largely stood the test of time, along with its underlying assumption that there is such a thing as a healthy diet. But now, 125 years of nutritional orthodoxy is being chewed up.

The first taster of a new paradigm came, as so often happens, from scientists outside the field trying to answer a different question.

In 2014, a team at the Weizmann Institute of Science in Israel began probing the effects of artificial sweeteners. Immunologist Eran Elinav and mathematician Eran Segal were specifically interested in whether sweeteners were actually worsening the epidemics of obesity and diabetes that these substances

were supposed to be helping to cure. So they and their colleagues fed saccharin to healthy human subjects and watched what happened.

One measurement they took was glycaemic response: whether consuming sweeteners caused subjects' blood sugar to rise. This is a normal reaction to eating, but if glucose rises and falls too quickly, or "spikes", it is a marker of poor metabolic health. "People who have regular glucose spikes are more likely to develop diabetes and put on weight than people who don't," says Spector.

Sugar rush

What they saw took them by surprise. In some people, glucose spiked dramatically, some had no spike at all and others were somewhere in the middle. "We saw highly personalised responses," says Elinav. That wasn't supposed to happen for two reasons. First, artificial sweeteners contain no calories so shouldn't cause a spike at all – though why they do is a different story. Second, glycaemic responses aren't supposed to vary much from person to person. There is scope for some individual variation, but people given the same foods are expected to have broadly similar spikes. This is the concept behind the glycaemic index (GI), a measure of how quickly a given foodstuff is converted into glucose and diffuses into the bloodstream.

The unexpected result sent Elinav and Segal back to the original studies on the glycaemic response. "We realised that all of them utilised a very small number of volunteers, maybe 10, who were given identical foods and then had their blood sugar measured," says Elinav. "The average response was turned into the GI for that food. We couldn't find anything on individual responses to foods."

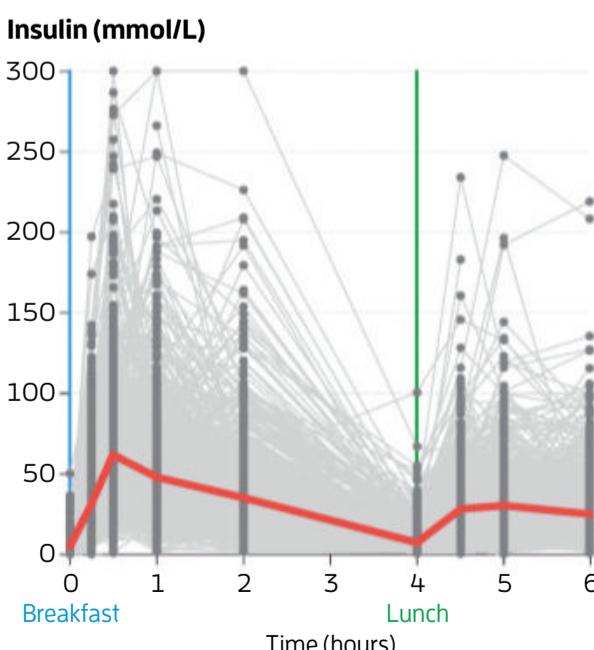
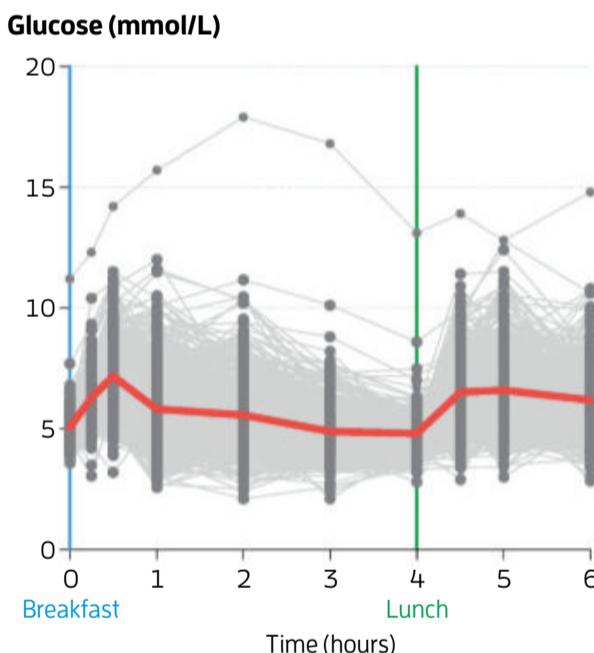
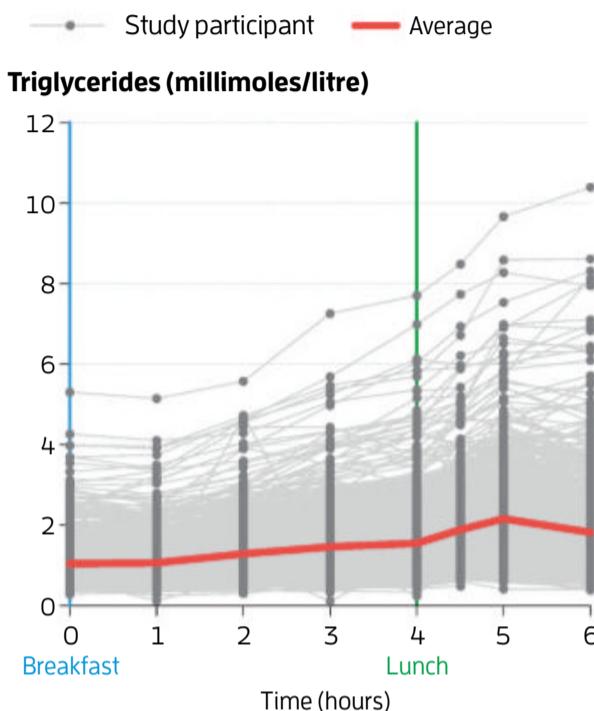
So they set out to do that work, and found enormous variation in glycaemic responses to the same foods. In one experiment, they and their colleagues compared industrially produced white bread with artisan wholegrain sourdough, which Elinav describes as "the best bread ever made in Tel Aviv". Based on GI, they expected the white loaf to always generate a bigger glucose spike, but that turned out not to be the case. For some people, mass-produced white bread was healthier than wholegrain sourdough. "We were stunned," says Elinav. "You give people a slice of white bread, some people don't spike at all and others spike to diabetic levels, though on average, they spike to

Precision nutrition

We all respond to food in very different ways, so there's no such thing as a healthy diet that works for everyone, says **Graham Lawton**

Same meal, different response

Eating the same meal produces highly variable responses in different people, even identical twins. In the PREDICT-1 study, 1002 healthy people ate a standardised breakfast and lunch, and the levels of glucose, insulin and fatty acids called triglycerides in their blood were monitored.



SOURCE: DOI.ORG/GG2NW2



**Food that is healthy
for you can be very
unhealthy for
someone else**

exactly the glycaemic index of white bread. And this is true for almost any food."

This was a seminal moment, says Elinav. "It told us something very interesting, but also disturbing: that this paradigm of the one-size-fits-all diet is inherently flawed. If your glycaemic response to a given food is opposite to mine, then the same food cannot be good for both of us. We realised that rather than scoring the foods, maybe we should be scoring the individuals who eat the foods."

This finding tallies with that of another study on 800 volunteers lead by Elinav and Segal, which is now widely regarded as the foundational paper in precision nutrition. They gathered information on each participant's age, gender, lifestyle and medical history. They measured their body mass index and waist-to-hip ratio and took stool samples to reveal people's microbiomes. Then they monitored the volunteers' blood glucose for a week while getting them to exhaustively log what they ate and when, plus their sleep and activity patterns. In total, the researchers recorded glycaemic responses to more than 52,000 meals. As hinted at by their earlier studies, these were hugely individualised, even after eating identical meals.

When they analysed all the data using a



“Even identical twins reacted differently after eating the same meal”

yet unpublished – is the first to look at the long-term effects of a personalised low-GI diet over the course of a year.

Other research teams have been doing similar experiments and making similarly surprising discoveries. Spector’s group recently published the results of what he says is “the most intensive nutrition intervention study that’s been done”. PREDICT-1 – the Personalized Responses to Dietary Composition Trial – recruited 1002 healthy people and fed them identical meals for two weeks while keeping track of their lifestyles and measuring their metabolic responses.

Intensive intervention

As well as the glycaemic response, it measured a class of fat called triglycerides, which can also spike in the bloodstream after eating. Again, the study found highly individual responses to identical meals (see “Same meal, different response”, page 36). “Some people had hardly any rise, in others it dropped back fast, in others it was going up and up for hours,” says Spector. But triglyceride spikes weren’t correlated with glucose spikes. “Everyone reacts differently to identical foods,” says Spector.

Triglycerides are a risk factor for chronic

diseases, too. “If you’ve got all these fats circulating in your blood for long periods of time, it increases inflammation and you get metabolic problems, diabetes, heart disease and obesity.”

Spector and his team also measured hundreds of baseline variables in the volunteers, including their age, sex, height, weight, body composition, blood pressure, fasting metabolite levels, circadian rhythms, genome sequence, microbiome and normal diet. During the study, the researchers recorded when the participants ate, slept and exercised, and what they ate on top of the standardised meals.

After crunching the data with their own machine-learning tool, they found that an aggregate of those measurements could quite accurately predict an individual’s metabolic responses to any given meal. For glycaemic responses, it was 77 per cent accurate, and for triglycerides 47 per cent. That is far from perfect, but is still progress from merely recommending a universal healthy diet. “We’ve already moved away from this idea that there’s one standard good diet for everybody,” says Spector.

Separate research led by scientists at Imperial College London arrived at a similar conclusion via another route. They fed people identical diets and analysed thousands of metabolites in their urine. “We find that people respond differently to diet, but we demonstrated it a different way, looking at the metabolic response,” says Isabel Garcia-Perez. She and her colleagues are developing a urine test for different “metabotypes” that could be used to personalise people’s diets.

One big surprise, says Spector, is how little genetics influences responses to food. Among his 1002 subjects were 86 pairs of identical twins and even they showed widely different responses to the same meal. “That told us straight away that genes don’t play a major part,” he says. How we respond to a fatty meal has virtually no genetic component and only about 30 per cent of our glucose response relates to our genes. Other factors such as gut microbes and circadian rhythms are more important, says Spector.

This all holds out the prospect of being able to design personalised diets based on a few simple tests. In the future, maybe you could visit your doctor, donate some blood, stool or urine, take a few tests and go home with a precision diet plan tailored to your individual needs.

“We can already do that to some extent,” ➤

machine-learning tool, they found that one of the strongest predictors of an individual’s glycaemic response to any given meal was their biometric data, especially microbiome composition. This suggested it should be possible to design a low-GI diet for any individual based on a few measurements.

As proof of that pudding, the team then recruited 26 more volunteers, this time people with prediabetes, ran them through the volley of tests and designed personalised diets. Everyone got a good diet and a bad diet, each of which they ate for a week while being monitored. As hoped, the good diet significantly improved their glucose responses and the bad one made them worse. Yet, unlike the diets that are routinely recommended for people with prediabetes, a number of the good diets contained some pretty unorthodox health foods. “Some people could consume beer or chocolate or ice cream as part of their good diet, but not tomatoes,” says Elinav.

Since that research, the Weizmann researchers have kept on adding data and have kept on being amazed. “We’ve now done more than 50,000 individuals and in every one you encounter surprises,” says Elinav. “For some people, some very bad foods are actually very good.” Their latest research – as

says Spector. "Initially, they're going to be slightly simplistic. But we can already know whether you are someone who should be having more good fats in your diet, whether it's safe to have carbs." His group and the Israeli one are rolling out commercial products that promise to deliver personalised nutrition advice via smartphone apps under the brand names Zoe and The Personalized Nutrition Project. You could also try your own approach (see "Make it personal", below).

How effective the apps will be is still up in the air, says Bernadette Moore at the University of Leeds, UK. Sleep, exercise and the timing of meals also matter, which makes the designing of personalised nutrition plans a complex challenge. The apps will come across the same problems as traditional dietary advice too – people often fail to follow it. But the research holds great promise, she says. The 2015 Israeli study was groundbreaking and had huge implications. "It's a really exciting study and a really exciting space," she says.

Yiannis Mavrommatis, who heads the Nutrition and Genetics Research group at St Mary's University in London, agrees. "The project is a milestone in nutrition science," he says. "One of the most impactful findings is confirmation that one-size-fits-all diets will not work for everyone. Personalised nutrition is the natural outcome."

Big funders are also getting behind this new field. In May, the US National Institutes of Health announced that precision nutrition would be a research priority over the next 10 years, with a goal to "fundamentally



"One-size-fits-all diets will not work for everyone"

One day a few simple tests could let you know what foods are best for your health

transform nutrition science."

One transformation it may deliver is rehabilitation of the flagging reputation of this science. The highly individualised response to foods may be why it so often fails to get its story straight, says Sarah Berry at King's College London. "A lot of people criticise nutritional science. They say we don't know what we're talking about because recommendations are always changing. Actually, that's because food is so complicated and individuals are as complicated."

But she warns about taking the new knowledge to extremes. Even though we are moving away from recommending a generic diet, that isn't a licence to disregard all the old advice. "We're not going against the broad, accepted healthy eating guidelines," she says. "We should still all be eating a diverse diet with fibre-rich foods, fruit, veg, nuts and pulses, an appropriate amount of fat and limited processed food. But within this broad spectrum, there is huge potential to personalise to make it even more healthy. It concerns me that some people might say, 'Oh, maybe that means I can eat chocolate all day and I don't need to eat fruit.'"

"There are still some high-level paradigms that hold," agrees Elinav. "Calories still matter. Even if ice cream is one of your better foods, if you eat 10 kilos a day, you would still get fat." ■

Make it personal

If you don't want to use an app and can't wait for personalised nutrition to be made available to the masses, there are some things you can do now.

About 10 per cent of people can feel themselves having sugar highs and lows, says Tim Spector at King's College London, so if certain foods give you a sugar rush then a crash, avoid them.

Eran Elinav, who is at the

Weizmann Institute of Science in Israel, recommends using a skin-prick glucose sensor. "Try a food or meal and measure blood-sugar level afterwards: you'll get some idea what elements of your diet spike your blood sugar."

That may be especially useful information for people who want to lose weight, says Sarah Berry, also at King's College London. "High peaks and

big dips in blood sugar are related to hunger," she says.

"People who are bigger dippers get hungrier, consume more calories at their subsequent meal and consume more calories over the following 24 hours. Over a long period of time, that will impact weight. So we can look at personalising food to prevent that dip, which would then impact hunger, energy intake and weight."



Graham Lawton is a staff writer at New Scientist



Beyond ancient DNA

Proteins extracted from the fossils of strange, archaic humans could fill the gaps in our evolutionary story, finds **Colin Barras**

IT WAS an astonishing discovery: a chamber deep underground, packed full of ancient human remains. The excavators who uncovered the fossils at South Africa's Rising Star cave in 2013 described the experience as "breathtaking" and "emotional". Then they took a proper look at the bones, and exhilaration gave way to bewilderment. This new species of ancient human, which the researchers called *Homo naledi*, had such an odd combination of primitive and modern features that it was impossible to know how it was related to other ancient humans and, ultimately, to us.

About 20 years ago, it looked like the human evolutionary tree was coming into ➤

focus. Then palaeontologists started finding ancient humans, like *H. naledi*, that are so strange, it is as if they had walked off the pages of a Tolkien fantasy. We can't expect ancient DNA to help resolve their place in the human family tree because most of these misfit cousins were found in places too warm for genetic material to survive. The trail seemed to have gone cold.

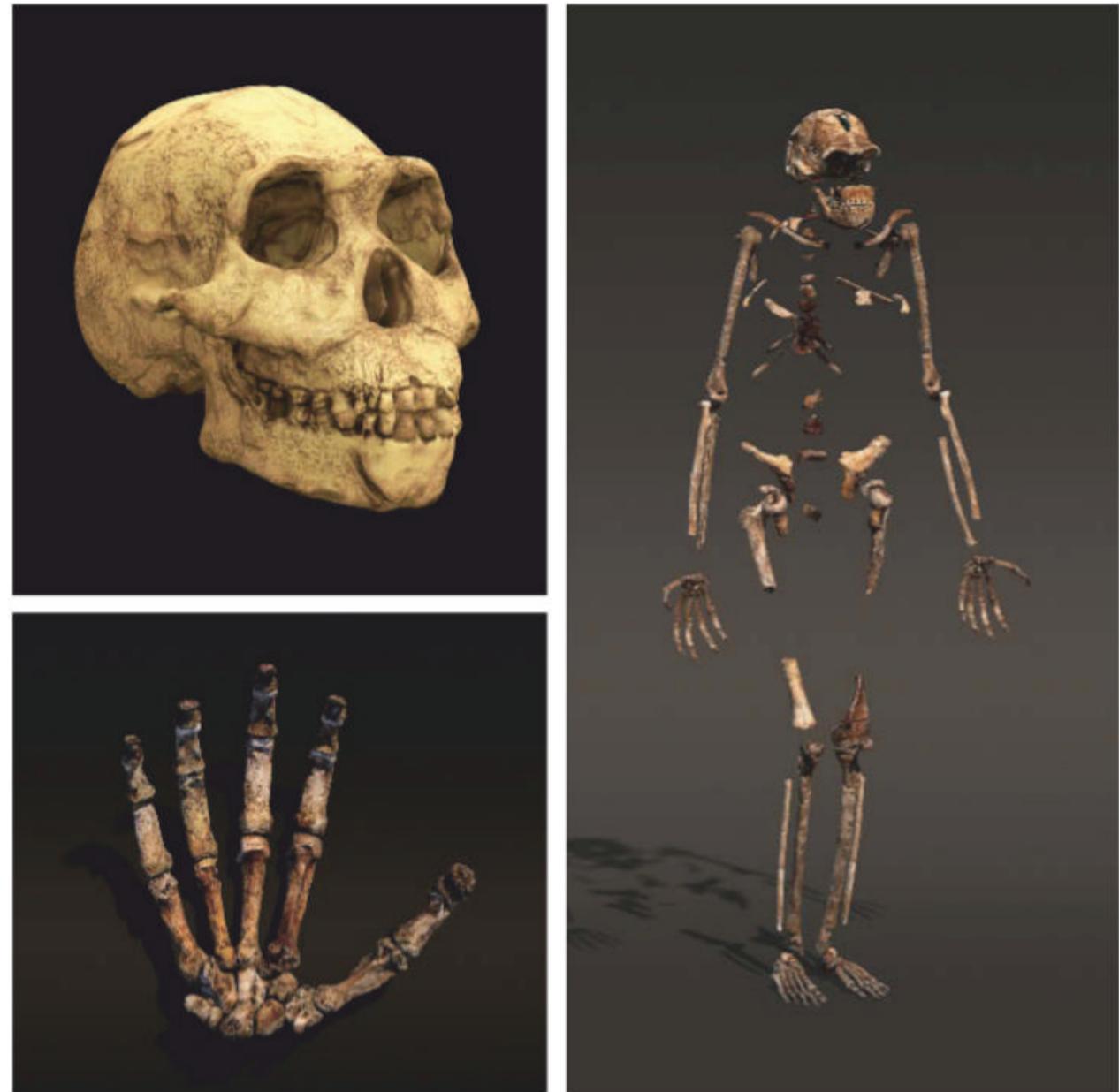
In the past few years, however, we have learned to read the signals in other organic molecules that tend to survive longer than DNA and persist even in warm environments. Researchers have already analysed samples of proteins extracted from ancient bones and teeth to reveal relationships between ancient mammals. Now, some think they could reveal how archaic humans like *H. naledi* evolved and interacted. "I'm confident that it will be possible to put some of these very unusual hominins on the [family] tree," says Matthew Collins at the University of Copenhagen in Denmark.

Human hybrids

It is no exaggeration to say ancient DNA has transformed our understanding of human evolution. It confirmed that our ancestors interbred with Neanderthals between about 100,000 and 50,000 years ago. It revealed the existence of a distinct group of Stone Age humans we had never recognised before – the Denisovans of east Asia – and showed that our ancestors interbred with them too, between about 50,000 and 15,000 years ago. More recently, ancient DNA studies have even begun to find evidence that Denisovans once interbred with a far more ancient group of humans, perhaps a species called *Homo erectus* that appeared almost 2 million years ago and vanished about 100,000 years ago.

In other words, ancient DNA has revealed that the Stone Age world was populated by many distinct human groups that, despite their genetic differences, were more than willing to interact and interbreed when their paths crossed.

Ancient genes can't tell us everything, though. All of the revelations came from



***Homo naledi* lived in Africa some 250,000 years ago. The fossils we have found don't contain DNA, which doesn't survive well in warm conditions. But if researchers can extract proteins from the bones, we might finally figure out how this mysterious ancient human is related to us**

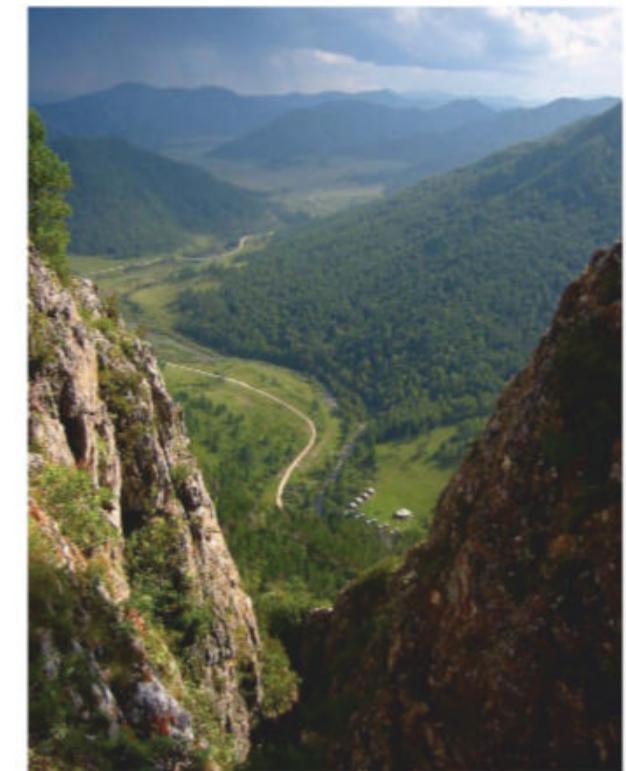
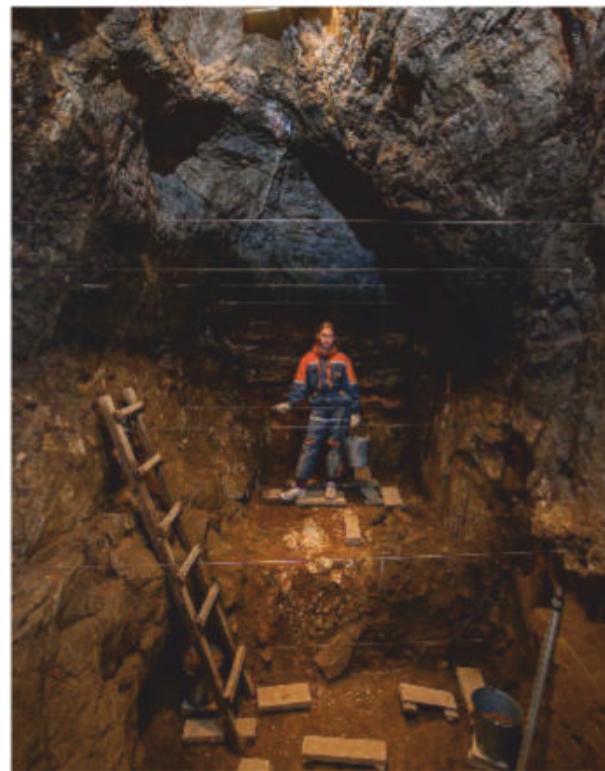
analysis of DNA from living people and samples from a handful of ancient humans who lived in cooler parts of Eurasia within the past 50,000 years. We could learn a lot more by analysing even older genetic material, but DNA tends to fall apart over such time spans. That means we are missing vital genetic information from most of human evolutionary history, which arguably began around the time that *H. erectus* evolved and began spreading across Africa and Eurasia. Furthermore, DNA is completely silent on our earlier, more ape-like hominin ancestors that lived in Africa between about 7 million and 2 million years ago.

This is where proteins can help. Large and complex molecules, they are built from smaller components, amino acids, that occur in sequences according to instructions encoded in genes, so they contain the same sort of information as DNA. We have known for 65 years that proteins, or at least bits of them, might survive in the fossil record. The problem was that studying them was always too fiddly and difficult.

Things changed at the beginning of the 21st century with the development of new techniques. They involved adding electrically charged ions to the ancient and fragile protein fragments, which means the molecules can be run through a machine called a mass spectrometer to quickly identify their amino acid sequence. Ancient protein research took a huge leap forward. “Anyone can do this,” says Collins.

And they have every reason to. Analysing fragments of protein in this way can offer insights into ancient human behaviour, including what sort of foods people ate and even clues about their sex lives (see “Extracting insights into ancient lives”, page 43). Extract larger chunks of ancient protein, however, and you might be able to work out where our strange cousins belong in the hominin family tree.

Biologists build evolutionary trees by examining similarities and differences between species, whether in terms of their physical appearance or their molecular make-up. By and large, the more similarities



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two species share, the more likely they are to be closely related. Proteins are suitable for this sort of evolutionary analysis because animals typically produce equivalent versions of the same proteins – collagen, keratin, haemoglobin and so on – and because the sequence of amino acids within these proteins can differ slightly between species. This means that if you extract large chunks of particular proteins from extinct hominins and read their amino acid sequences, you can use that to work out how they relate to one another, and to living humans.

There are some caveats. Although the human body contains tens of thousands of distinct proteins, surprisingly few of these are found in the tissues that readily become fossilised. Teeth are a good example. Tooth enamel preserves ancient proteins very well, but even in a living human it contains just 10 or so different proteins, says Frido Welker, also at the University of Copenhagen. Each protein is generally 50 to 2000 amino acids

Denisova cave in Siberia, where archaeologists discovered an entirely new group of humans

long, so even if all the proteins found in enamel – the “enamel proteome” – are recovered from a fossil tooth, there might be a combined sequence of about 20,000 amino acids at most. For comparison, a complete ancient human genome contains a genetic sequence billions of base pairs long. The question then is: do ancient proteomes contain enough information to build a reliable evolutionary tree?

Recent work suggests they do. Over the past five years, this approach has been used to construct evolutionary trees for various ancient mammals. A 2019 analysis of sloths, for instance, looked so different to conventional evolutionary trees for this group of animals that it was viewed suspiciously by some people in the field. But in a second study, geneticists independently analysed sloth relations using a tried-and-trusted DNA analysis and it gave essentially the same result as the protein study.

The field of palaeoproteomics, as it is known, has now moved into the realm of primates. Last year, Welker and Enrico Cappellini, also at the University of Copenhagen, led an analysis of an ancient enamel proteome taken from the largest of extinct apes, *Gigantopithecus*. The information it contained suggested that the ancient primate, which lived in South-East Asia until about 300,000 years ago, was

“We are missing vital genetic information from most of human evolutionary history”

related to living orangutans – an idea that matched expectations.

What made the result particularly intriguing was that the *Gigantopithecus* tooth the researchers sampled is 1.9 million years old and came from a subtropical cave in southern China. That is exactly the sort of place in which *H. erectus* and enigmatic species like *H. naledi* have lived over the past 1.9 million years. The implication is that the fossils they left behind might contain enough protein to work out where they fit in the hominin evolutionary tree. “The *Gigantopithecus* study definitely pushed the boundaries of what we know about protein preservation,” says Jessica Hendy at the University of York, UK.

By the time the *Gigantopithecus* paper came out, the researchers had already moved on from apes to hominins. A few months earlier, Welker and his team had published work describing the dentine proteome from a 160,000-year-old hominin jaw. The fossil, they concluded, may have belonged to a Denisovan. It was a conclusion with profound implications, because the jawbone had been found 3280 metres above sea level on the Tibetan plain. Perhaps, they suggested, Denisovans adapted to life at such altitudes.

Earlier this year, Welker and Cappellini notched up another success. Their team reconstructed an enamel proteome from a tooth that was potentially 950,000 years old and that belonged to another poorly understood early human, *Homo antecessor*, that once lived in Spain. The information within the proteome firmed up the idea that *H. antecessor* was closely related to the common ancestor our species shared with Neanderthals and Denisovans. It was spectacular proof that ancient proteins really can shine a light on the murkier early chapters of our evolutionary history.

Now thoughts are turning to the contentious hominins that walked Earth more recently, particularly the Indonesian “hobbit” (*Homo floresiensis*), discovered in 2003, and *H. naledi*. Both were alive when our species, *Homo sapiens*, evolved about 300,000 years ago, but both show a truly

“We still have no idea where *Homo naledi* sits on the human evolutionary tree”

bizarre mix of features. *H. floresiensis* had a chimpanzee-sized brain inside a miniature *H. erectus*-like skull, while its shoulders, wrists and feet are reminiscent of the ape-like hominins, including the famous Lucy, that lived in Africa more than 2 million years ago. *H. naledi*, meanwhile, had a brain only marginally larger than a chimpanzee’s, hands that looked a little like Lucy’s and feet very similar to those of living humans.

We still have no idea where either *H. floresiensis* or *H. naledi* sits on the human evolutionary tree. We don’t even know whether they really are humans that ultimately descended from a species like *H. erectus*, or whether they group with the ape-like hominins.

Fresh clues

Both scenarios are plausible – and proteins should help us figure out which is right, says Welker. This is because the amino acid sequences within proteins change at a relatively constant rate, like a clock. It isn’t a very accurate clock, he says, but by comparing the ancient protein sequences with similar sequences from living people, it should be possible to determine whether *H. naledi* and *H. floresiensis* branched off our family tree a few hundred thousand years ago – making them human – or more than 2 million years ago, when the Lucy-like hominins had their heyday.

Collins says he is involved in ongoing discussions about putting an *H. naledi* specimen under the drill to extract proteins. There is no official word on when – or if – the work will go ahead. However, Lee Berger at the University of the Witwatersrand, South Africa, who leads the *H. naledi* research, says he was due to take fossil samples to Europe several months ago, only for the coronavirus pandemic to thwart the plans.

Within a few years, then, proteins might help some of our more inscrutable relatives find a place in the human family tree. Whether or not the scientists who study hominin fossils will accept the evidence from protein analysis is another matter.



Clockwise from top left:
Homo neanderthalensis,
Homo antecessor, *Homo erectus* and *Homo sapiens*

Extracting insights into ancient lives

As we get better at reading the information they contain, ancient protein fragments are telling us about how our ancient ancestors behaved. For instance, Neanderthals who lived in southern France during the Stone Age typically hunted reindeer. But earlier this year, an ancient protein analysis by Naomi Martisius at the University of California, Davis, and her colleagues revealed that the ancient humans chose to make their bone tools from the ribs of aurochs and bison, although these animals were less common.

Studying ancient proteins can also throw new light on recent human evolution. Earlier this year, Shevan Wilkin at the Max Planck Institute for the Science of Human History in Germany and her colleagues examined food proteins trapped in ancient dental plaque. They concluded that people on the eastern Eurasian steppe began consuming dairy produce at least 5000 years ago. This means there is an equally long history of dairy consumption in Europe and on the Eurasian steppe. And yet, while many Europeans now carry a genetic adaptation that makes digesting milk easier for adults, few people on the Eurasian steppe do. “These two regions seem to take these different trajectories when it comes



to evolutionary selection for dairy consumption, and it's so interesting to ask why,” says Jessica Hendy at the University of York, UK, a co-leader of the study. It is a question she is now eager to answer.

Ancient proteins can even guide us to a better understanding of prehistoric sex lives. One of the biggest science stories of 2018 was the discovery that a 90,000-year-old bone fragment belonged to a teenage girl – nicknamed Denny – who had a Neanderthal mother and Denisovan father. Although it was DNA analysis that revealed Denny’s remarkable parentage, geneticists might not have chosen to study the bone fragment if not for the fact that ancient proteins had already shown it belonged to an ancient human.

Researchers can use mass spectrometers to analyse ancient proteins

“I’m confident that the new data would be taken very seriously by most,” says William Jungers at Stony Brook University, New York, but he adds that it probably wouldn’t be seen to override all of the evidence gleaned from the shape of the fossil bones themselves.

That’s probably a good thing as molecular information isn’t infallible, says John Hawks at the University of Wisconsin-Madison. For instance, he recalls that when geneticists first looked at segments of Neanderthal DNA in the late 1990s, they concluded that our species didn’t interbreed with Neanderthals, which we now know is incorrect.

But although some caution is required, ancient proteins are almost certain to be one of the next big things in human evolutionary studies. Assuming the work on *H. naledi* goes ahead successfully, there is potential to recover proteins from far older fossils. Already, Welker and his colleagues have extracted them from a 1.9-million-year-old *H. erectus* tooth. They were too degraded to be useful, although Welker says that might be because the tooth in question was damaged, meaning some of the proteins it originally contained might have leached out.

Collins says it could even be possible to extract proteins from the ape-like hominins that came before humans, and use the information to work out how some of them relate to each other and to us. That might seem far-fetched – but in 2016, Collins was involved in a study that successfully extracted proteins from ostrich eggshell fragments collected at Laetoli, a 3.8-million-year-old site in Tanzania world famous for preserved footprints left by a Lucy-like hominin.

“We have such an interesting family tree with some curious critters in there,” says Collins. “But I’m pretty sure the protein work will be able to put some of them on the right evolutionary branch.” ■

LEWIS HOUGHTON/SCIENCE PHOTO LIBRARY



Colin Barras is a New Scientist consultant based in Ann Arbor, Michigan

Blue sky thinking

Entrepreneur **Anousheh Ansari** was the first Muslim woman in space and paid her own way to get there. She tells Chelsea Whyte how the experience shaped her world view



IN 2006, Anousheh Ansari made history in several ways. Joining an international crew of astronauts aboard a Soyuz spacecraft, she became the first Iranian and the first Muslim woman in space, as well as the first self-funded woman to fly to the International Space Station, where she spent nine days conducting science experiments. Prior to blasting off from our planet, Ansari and her family sponsored the first X Prize competition, which offered a \$10 million reward to the first non-governmental organisation to launch a reusable crewed spacecraft into space twice in two weeks.

Ansari is now the CEO of the X Prize Foundation, which offers large sums of money as incentives to find solutions for huge global issues. There have been X Prizes offered for engineering efficient vehicles, cleaning up oil spills, landing a rover on the moon, improving adult literacy and designing sensors to monitor health. Now, the X Prize Foundation is turning towards the biggest threats we face today: the loss of biodiversity due to climate change and the creation of treatments and vaccines for covid-19. *New Scientist* spoke to Ansari about how her experiences in space helped give her the collaborative outlook we need to tackle these challenges together.

ROCI MONTOYA

Chelsea Whyte: You are best known for being one of the first people to self-fund a trip to space. Were you always interested in space?

Anousheh Ansari: I was fascinated with space and stars. As a young child, when I looked at the night skies, I was just very curious to see what's out there. I always believed there were aliens out there and other worlds, and I wanted to go explore them and visit them.

Do you still go out and look at the night sky? I used some of my limited walks while sheltering in place to look at the stars and say hi to the moon, just to sort of escape what's going on here on Earth.

I love that you said you say hi to the moon, because I do that too. When I was living on the space station for a short, brief moment, I felt at home. When I was growing up, I watched *Star Trek* and all the sci-fi movies. I imagined myself one day being one of those explorers and going to far, far galaxies and meeting new species.

How did you make your dream of going to space happen?

It was a long journey. Normally, you would try to study something that would give you a better chance of getting accepted into the astronaut corps. For me, it was different. I'm an immigrant. I grew up in Iran and came to

the US when I was about 16 years old. I didn't speak English and I didn't think that my chances of getting into NASA were very high. I wasn't even a US citizen, and it was after the 1979 hostage crisis, so the political situation wasn't great.

Not having money, my mom was very practical and encouraged me to think about finding a job that would support us and the family. I chose my second area of interest, which was engineering. I became an electrical engineer and computer science major and built a career, which eventually led me to start my own company with my husband. Building that company gave me the financial capability to find a commercial path to space. Then I became the sponsor of the first ever X Prize, and that was sort of the launching pad.

Why was it important to encourage non-governmental organisations to develop crewed spacecraft?

I think we have about 550 people who have flown to space. Knowing that we have 7 billion people on this planet, that's a very small number – and only about 10 per cent of them are women. So we need to create more opportunities for people to be able to experience space, and we can't just do them through the government space agencies. ➤

Do you think most people would benefit from a trip to space?

Experiencing space is transformational. It's undeniable. When you have this incredible moment of looking at our planet from the vantage point of being in space, it's like a moment of truth. You can really see with your own eyes that we are all inhabitants of one planet. We all have one home and that home is Earth. This notion that we're separate and we're different and we have these borders that we see on maps – it completely washes away.

Also, one thing that becomes apparent very quickly is that you look around and you see the vast darkness of space. The only thing that is beautiful and shining and full of life is our home planet, Earth, right in front of you. You feel this connection to it, even though you are completely separate from it.

Your childhood was marked by political upheaval. Did that heighten the experience of seeing a world without borders?

Coming from the Middle East, I know how much war and conflict plagues the whole region. When you look at just that one area from up there, you can't even see it. It isn't even a pinprick. It's just amazing how much hate and war and negative energy goes into fighting over a small area of land. It just feels senseless. When I was up there, I felt like: "Would people fight over the same things if they were able to see what I'm seeing right now?"

That question always stayed with me. I always tell people that if there were a way we could have the G20 or the United Nations General Assembly held in space, perhaps we would have better global policies.

That's quite an idea.

We would need a bigger space station, but yeah, why not?

Is there anything you don't miss from your trip to space?

The trip is uncomfortable. It took two days. The flight to orbit is short, but it takes days to get into the right orbit and dock. Now it's a bit quicker, but that's probably the only thing I

"The only thing that is beautiful and shining and full of life is our home planet"

would avoid. If I could just be beamed up to space, I would choose that option versus riding a rocket.

That sounds like science fiction, or at least technology that is many, many years down the road. Does looking ahead in that way come naturally to you?

To me, science fiction can easily become science reality. If it doesn't break the laws of physics, it's possible. That's why I came to X Prize, because we try to look into the future and pull that future forward. What I've learned being a tech entrepreneur is that sometimes we underestimate how quickly things can change – just look at what's happening in the world with covid-19 and how quickly people have adapted and changed their behaviour, which is one of the hardest things to change.

We're in a unique point in history where the world has pressed the pause button and we have a chance to think. We're told that things have to change and we can decide how we change them. It's forcing everyone to do things that were hard before, and because of that opportunity, we need to think about what future we want to build.

What is the X Prize Foundation doing specifically to address the challenges of the covid-19 pandemic?

We have a call to action to all the entrepreneurs in the areas where we work,

whether it's environment or energy or education, and they are now working with our pandemic alliance to find solutions to build resilient communities.

We reached out to researchers, scientists, entrepreneurs, companies and non-profit institutions. We now have 194 universities and organisations from around the globe that have joined forces. They meet on a weekly basis to discuss what research is happening right now, whether it's towards treatments or vaccine development. They are also discussing the use of telemedicine, and identifying areas where there is a need to accelerate a technology or a piece is missing. That's where X Prize can help, through launching challenges that try to address those gaps and bring attention to them.

What are these gaps?

Most of them are around data. Right now, everyone is willing to share their data and their research, which has made it possible for us to create a collaboration and see how we can push things forwards together. That means developing treatments or vaccines or tests for early detection, things that will allow us, perhaps, to be safe and go out and be able to live semi-normal lives.

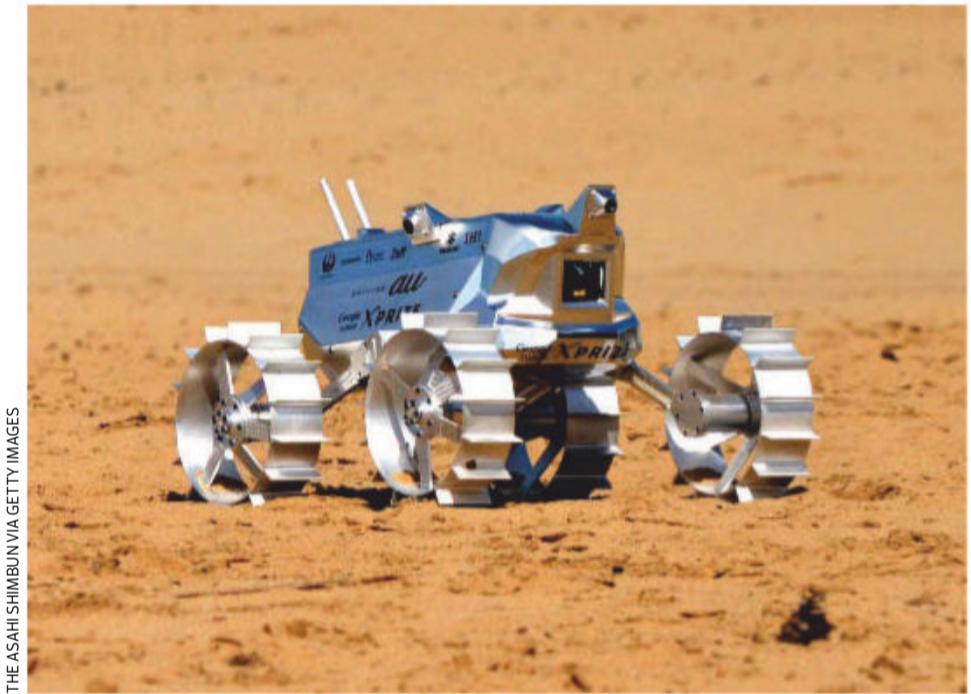
We're also looking at distribution and supply-chain issues. For example, once we have a vaccine, how can we make sure that it can be administered quickly around the globe at an affordable cost?

What other X Prize challenges are coming up?

We have an active prize called the ANA Avatar X Prize. The aim is to allow someone to experience a place from afar, to basically transport all their senses as if they are there. It's a combination of augmented reality, virtual reality, robotics and haptics. So you can feel like you're in a location when you may actually be sitting in your room wearing a suit and gloves and just imagining you're on Mars or the moon or just down the street.

Could I use that technology to remotely hug my mom during the pandemic?

Yes, you could visit your loved one. When



Clockwise from top left:
Earth from space;
a red-crested turaco
in the rainforests of
Angola; testing an
X-Prize winning
device for mapping
the ocean floor; a
prototype automated
lunar rover

we started this a few years ago, we weren't thinking of the pandemic, we were thinking of situations where there may be a disaster and, without endangering someone's life, you can have rescue missions or doctors performing tasks remotely. But in this new world we're living in right now, it may have new uses. I would love to go visit my mom and I can't because she's far away. I may

scare her because the avatars aren't looking so nice right now, but that can be fixed.

Oh no. You will need to add an extra prize to make it look like a person. Is there anything else coming up?

We also announced our rainforest X Prize late last year. Our rainforests are a very important part of our ecosystem, and the biodiversity embedded in the rainforests is an incredible part of our world. It's important that we preserve it. At X Prize, we believe that once you know the value of something, you'll preserve it even more. Through this prize, we're trying to better understand the value of the biodiversity in our rainforests so we will protect it. And as we know, the way we're treating our environment – especially our rainforests and how we're encroaching on them – is actually a root cause of the increasing rate of the pandemics that we have seen.

These days, we are all hyper-focused on the coronavirus pandemic, so keeping your attention on climate change and the loss of biodiversity must be hard right now. It is difficult, but with the pandemic putting our world on pause, we've seen more of the blue skies and birds singing and our waterways have more biodiversity in them. That demonstrates to anyone who has any doubt that we can change behaviour and reverse some negative impacts. It's obviously a difficult choice. I'm not suggesting that we stay at home to preserve nature, but I think it shows we can find ways to live more harmoniously with our environment. ■



Chelsea Whyte is a New Scientist news editor based in Portland, Oregon

Essential Guide Extract

The coronavirus pandemic has reminded us of the importance of healthy immune systems to help us ward off infection. In two extracts from the new *New Scientist Essential Guide: Human Health*, we examine ways of optimising our immune response. Overleaf we examine claims made of some dietary supplements, but first we investigate a troubling question: has an obsession with killing off all bacteria using heavy-duty cleaning agents actually made us more susceptible to certain conditions?

HATE housework. You make the beds, wash the dishes and then six months later you have to start all over again". Adherents of this Joan Rivers quote got a fillip back in 1989, when David Strachan, then an epidemiologist at the London School of Hygiene and Tropical Medicine, proposed his hygiene hypothesis. He suggested that modern lifestyles, with their lack of unhygienic exposure, mean we catch fewer infections in early childhood, and that this predisposes us to developing allergies.

Some of the evidence is fascinating. Children who grow up on farms seem to be healthier, as are children whose parents wash dishes by hand rather than using a dishwasher, and those who have a dog. Meanwhile, a 2014 paper found that children are less likely to develop precursors to asthma if, during their first year, they're exposed to particles from cats, mice and cockroaches.

Many of us have embraced the idea of a link between a little bit of dirt and good health. There's just one problem: things probably aren't that simple. In recent years, thousands of studies have linked changes in the microorganisms living inside our bodies to everything from allergies and asthma to obesity, depression, and Alzheimer's disease. This emerging understanding of what's known as our microbiome suggests that, rather than there being a clear distinction between "clean" and "dirty", we have a complicated relationship with bacteria. Being exposed to some kinds is good for us, to others not. And figuring out which is which isn't easy.

One thing is becoming clear, however: it's diversity that counts. A 2015 study of nearly 400 infants in Germany hinted as much, when researchers found no direct link between their chances of developing asthma or allergies and their caregivers' personal and home cleanliness. What did make the difference was their exposure to bacteria. Several studies show that healthier people tend to host a wider range of microbes. Western lifestyles may have adverse effects on this

diversity, which was found to be 40 per cent lower than that detected in an isolated, traditional hunter-gatherer society. And a 2013 study found that infants whose parents picked their dropped dummy up off the street, sucked it clean, and then handed it back to their child, were less likely to develop asthma or eczema. The organisms in their saliva were also different from the ones inhabiting infants whose parents would never do such a thing, prompting the researchers to suggest that the protective effect is down to the transfer of beneficial microbes from parent to child.

There is now also evidence for why living on a farm is so good at reducing allergies – the bacterial components in farm dust suppress inflammatory immune responses. This seems to indicate that the hygiene hypothesis is in need of revision. Possibly it is not so much infections as exposure to a wide variety of bacteria that benefits our immune systems.

When we are exposed to these beneficial microbes is also crucial. The most important time seems to be early childhood. According to current thinking, the cut-off may be as early as three. So, if you're the parent of a very young child, it is probably very important to take them outdoors and let them play on the ground.

By the time we are adults, our microbiome may be largely set, so any suggestions that shirking the chores – or your personal hygiene – could improve your health, is spurious, and potentially even harmful.

For example, there are about 17 million cases of food poisoning a year in the UK, caused by microbes including *Norovirus* and *Campylobacter*. Many cases are picked up in restaurants, but a study of 18 European countries suggests that nearly a third of food-borne outbreaks occur inside our own homes.

Filth has consequences. About 50 per cent of chickens in the UK carry *Campylobacter*, the country's most common cause of food poisoning, and the bacteria can easily transfer from the raw meat to your hands or a chopping board. Seen in this light,



HAVE
WE
BECOME
TOO
CLEAN?

anything that encourages people to cut back on habits like handwashing is dangerous.

But while being too slovenly stands a good chance of giving us diarrhoea, in certain respects it seems we don't need to be too clean. In particular, you might want to cut back on antibacterial handwashes and laundry detergents. Not only might some of these have less benefit than advertised, but there is some evidence they might contribute to bacteria becoming resistant to antibacterials and even antibiotics. There's also growing concern about indoor pollution connected with overzealous use of certain household products.

How do we find the sweet spot between being too dirty and too clean? "Targeted hygiene" could be the answer. Although this strategy has been around since the 1950s, it was largely limited to hospitals and industries such as catering, pharmaceuticals, and cosmetics. Increasingly though, hygiene experts believe it should become an everyday feature of people's lives.

Rather than striving for a sterile home or office, targeted hygiene means focusing only on removing harmful bacteria, from important surfaces, at critical times. Most of the cleaning should focus on doorknobs, light switches and the bathroom – anything we touch a lot. It's also crucial to thoroughly clean everything you use while cooking. That includes all surfaces, chopping boards and utensils that come into contact with raw meat, as well as unwashed dirty vegetables, whose bacteria can give you food poisoning just as raw chicken can. The most important advice is to wash your hands, after cooking, before eating and after using the toilet.

But beyond that? Well, Joan Rivers fans can take heart: cleaning the walls, floors or the furniture really can wait six months. If you're not allergic to dust mites, vacuuming is entirely optional. And you can forget about making the bed – especially if you're allergic to dust mites. Mites need a humid atmosphere to survive, so leaving the covers open in the morning might help to kill the beasts.

Beyond these basics, it seems there is one big thing we can do to improve our health beyond worrying too much about the state of our homes: spend more time outdoors. Preliminary findings hint that spending more time doing social sports and other outdoor activities can help restore a healthily diverse microbiome. The best advice is quite pleasingly wholesome and old-fashioned. Use cleaning products sparingly, in the places that matter, open the windows after you've finished, and then go out for a nice long walk in the fresh air. ■

IMMUNE BOOSTERS

Beyond cleaning regimes, there are some things that can boost our immune system's performance we have more control over. Some dietary supplements can help – although they're probably not the best medicine

NUMEROUS dietary supplements are sold for their supposed immune-boosting powers. Many of these health claims are spurious, stemming from tests in petri dishes, rather than from randomised, controlled trials in people – the gold-standard for any scientifically proven effect. But it's not all marketing guff.

Of commonly sold supplements, zinc probably comes out best, with evidence that it can both prevent colds and shorten their duration if started within 24 hours of the symptoms first appearing. It is thought to work by stopping the cold virus from replicating, or preventing it from gaining entry to cells lining the airways. Even so, overdosing on zinc will suppress your immune system, so care is needed.

Vitamin E has also been shown to enhance immune function in human and animal studies. Dayong Wu at Tufts University in Boston and his colleagues tested vitamin E in older people – giving half of the 670 residents of a nursing home a small daily dose of vitamin E and the other half a placebo – and found significant differences in the rate of upper respiratory infections. A bigger clinical trial is in the pipeline, but the evidence is already strong enough that Wu recommends people over 65 routinely take 200 international units (IUs) of vitamin E. Moderation is again key, as vitamin E can be toxic in high doses.

Vitamin D, meanwhile, appears to do something

similar for the innate arm of the immune system, especially among people living at latitudes where there isn't enough winter sunlight for their skin to synthesise the molecule. A 2017 review of the evidence for taking vitamin D supplements concluded that it helps prevent upper respiratory tract infections. About 1000 to 2000 IUs should be safe and beneficial, says Wu, but people shouldn't go higher than that because, once more, big doses actually suppress T-cell function.

But maybe popping pills isn't the best approach. Exercise is a proven immune-boosting strategy. It keeps the thymus youthful, the heart-shaped patch of lymphatic tissue, located beneath your breastbone, where new T-cells mature before being released on active duty. T-cells are pivotal in the adaptive immune response, the more targeted part of the system.

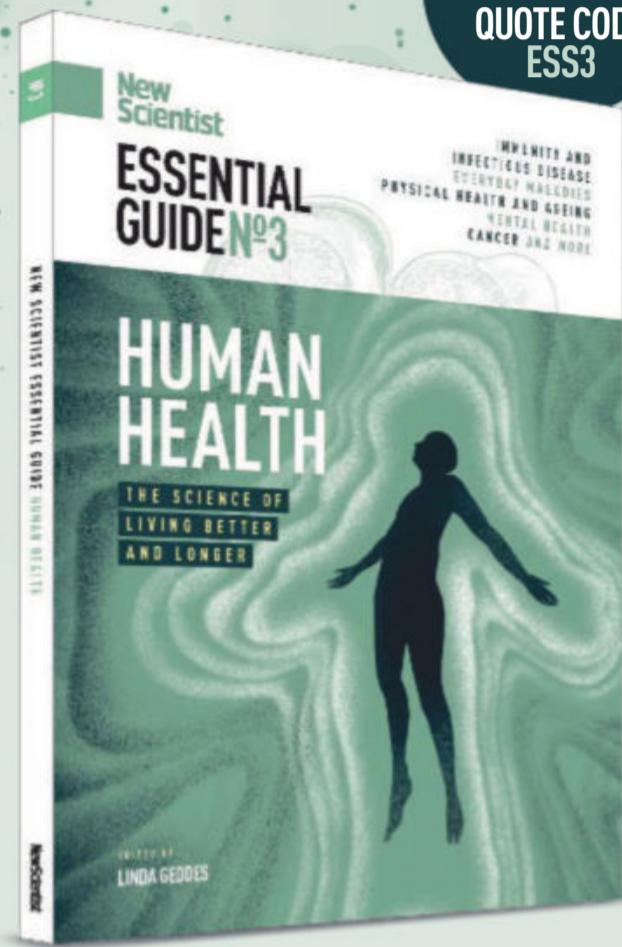
The thymus degenerates with age, and our T-cell count with it, with consequences for our ability to fend off new pathogens. However, when Janet Lord at the University of Birmingham, UK, and her colleagues took blood samples from 125 amateur cyclists aged between 55 and 79, many of whom had been regularly riding long distances for decades, they found that their T-cell counts were similar to those of much younger people and their thymuses were youthful.

Exercise is also good for our neutrophils, a crucial first line of defence against bacterial invaders. When bacteria are detected, neutrophils squeeze out of the blood vessel and barrel towards their target, engulfing them like Pac-Man, spraying them with deadly chemicals, or disgorging their DNA and throwing it around the invaders like a net.

The ability of neutrophils to tunnel through tissues and find their target becomes increasingly erratic as we age. Older neutrophils can still detect invaders, but often blunder haphazardly through tissue or charge off in the wrong direction. Not only does this reduce the speed and efficiency of the immune response, it can also result in friendly fire – a leading cause of the generalised low-grade inflammation that creeps throughout our bodies as we age.

In a separate study, Lord and her colleagues measured exercise levels and neutrophil migration in 211 older adults, and found that those doing 10,000 steps a day on average had neutrophils as good as those of young adults. Neutrophils don't kill viruses, so they won't prevent you from catching diseases like covid-19 or influenza, but they will shore up your defences against bacteria – including helping to protect against secondary infections, such as bacterial pneumonia. ■

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- **Applied Ocean Physics & Engineering**
- **Biology**
- **Geology & Geophysics**
- **Marine Chemistry & Geochemistry**
- **Physical Oceanography**

A joint **USGS/WHOI** award will be given to a postdoc whose research is in an area of common interest between USGS and WHOI Scientific Staff. The individual will interact with both USGS and WHOI based advisors on their research.

The **Center for Marine and Environmental Radioactivity (CMER)** will award a fellowship for research on natural and human-made radioactive substances in the environment including the study of their sources and fate or use as tracers of ocean processes.

The **National Ocean Sciences Accelerator Mass Spectrometry Facility (NOSAMS)** will award a fellowship in the development and implementation of new techniques in marine science radiocarbon studies.

The **Ocean Bottom Seismic Instrument Center (OBSIC)** will award a postdoctoral fellowship for research on the earth's internal structure and earthquake processes using seafloor seismic measurements.

The **Ocean Twilight Zone (OTZ)** project will award a fellowship for research on twilight zone (100-1000 m) ecosystems and processes, including biomass, biodiversity, life histories and behavior, trophic interactions, links to the global carbon cycle, and ways to engage scientists with stakeholders.

Recipients of awards are selected competitively, with primary emphasis placed on research promise. Scholarships are awarded for 18-month appointments with a stipend of \$62,250 per year, a health and welfare allowance and a modest research budget. Recipients are encouraged to pursue their own research interest in association with resident Scientific and Senior Technical Staff. Communication with potential WHOI advisors prior to submitting an application is encouraged. Completed applications must be received by October 15, 2020 for the 2021/2022 appointments. Awards will be announced in December. Recipients of awards can initiate their study and research period at the Institution any time after January 1, 2021 and before December 1, 2021.

Further information about the Scholarships and application forms as well as links to the individual Departments and their research themes may be obtained through the Academic Programs section of the WHOI web pages at:

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The back pages Puzzles

Puzzle

Can you weigh four hippos using some dodgy scales? **p54**

Cartoons

Life through the lens of Tom Gauld and Twisteddoodles **p54**

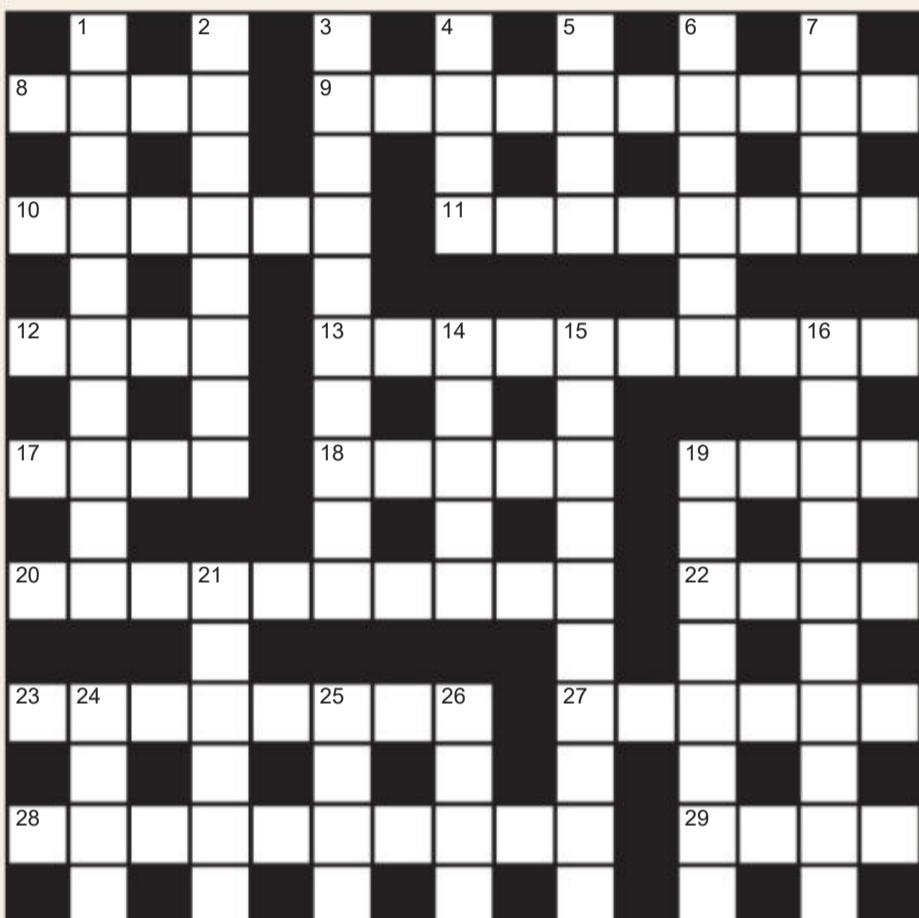
Feedback

Grunts of discontent for Elon's cyber-pig: the week in weird **p55**

The last word

Is there a way to set a real benchmark for sea level? **p56**

Quick crossword #66 Set by Richard Smyth



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

- 8** Unpaired; unattached (4)
- 9** The use of mechanical labour (10)
- 10** Mucus-producing (6)
- 11** CH₃OH (8)
- 12** Line joining two vertices (4)
- 13** CH₃CH(OH)COOH (6,4)
- 17** Fronded plant that reproduces via spores (4)
- 18** Robert ___, botanist who observed random motion of particles suspended in water (5)
- 19** Niels Bohr or Tycho Brahe, perhaps (4)
- 20** Strong-billed bird that might be green or great spotted (10)
- 22** Sac within bodily tissue (4)
- 23** LAN networking technology (8)
- 27** The human mind (6)
- 28** Faster than Mach 1 (10)
- 29** Geek; enthusiast (4)

DOWN

- 1** Location closest to a large detonation (6,4)
- 2** Gull-winged automobile that was manufactured in the early 1980s (8)
- 3** Lipophilic (3-7)
- 4** Science, technology, engineering and mathematics (4)
- 5** Secrete; send out (4)
- 6** Layers (6)
- 7** Primate genus (4)
- 14** Chronometer (5)
- 15** 1987 science-fiction adventure film (10)
- 16** Part of Earth's upper atmosphere (10)
- 19** Decomposing (8)
- 21** Rudolf ___, inventor of a compression-ignition engine (6)
- 24** Veracious; accurate (4)
- 25** US space-exploration agency (4)
- 26** Precisely adjust a machine or musical instrument (4)

Quick quiz #68

- 1** Diversity in what feature of Galapagos island finches was considered by Charles Darwin to be prime evidence for his theory of evolution by natural selection?
- 2** Psilocybin is a mind-altering drug most notoriously found where?
- 3** What is the signature feature of an ekpyrotic universe?
- 4** Weak electrical forces between atoms and molecules that aren't considered to be chemical bonds are often named after which Dutch theoretical physicist?
- 5** What is the difference between autosomal-dominant and autosomal-recessive genetic diseases?

Answers on page 54

Cryptic Crossword #39

Answers

ACROSS **7** Solace, **8** Dollar, **9** Stem, **10** Angstrom, **11** Scarlet, **13** Adore, **15** Baron, **17** Despots, **20** Atom bomb, **21** Type, **23** Paella, **24** Ice Age

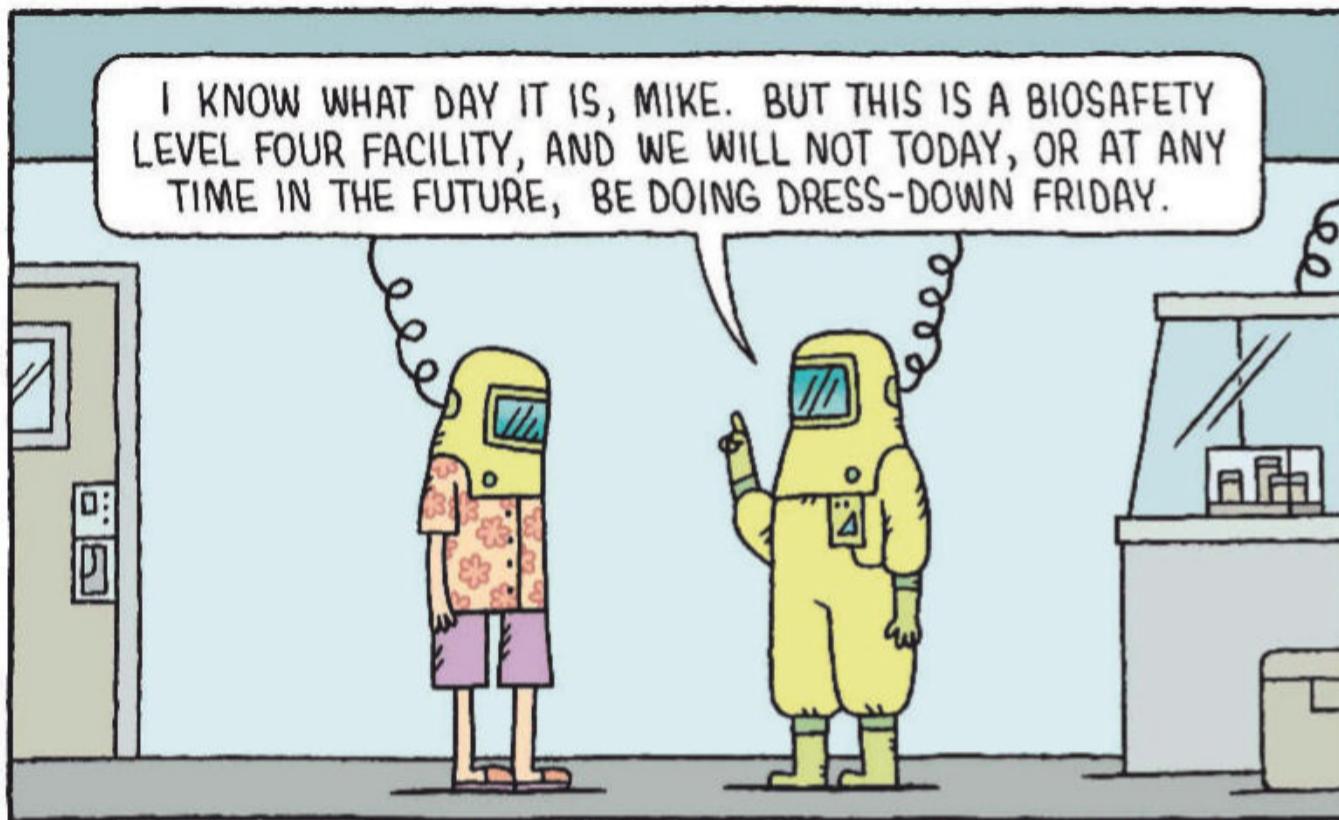
DOWN **1** Moat, **2** Yammer, **3** Legatee, **4** Adage, **5** Slated, **6** Tabouret, **12** Claptrap, **14** Leibniz, **16** Ormolu, **18** Petrel, **19** Topaz, **22** Page



Our crosswords are now solvable online
newscientist.com/crosswords

The back pages

Tom Gauld
for *New Scientist*



Twisteddoodles
for *New Scientist*

STORM NAME FACTS

- 1) TO CHOOSE NAMES, METEOROLOGISTS MAKE A BIG LIST OF THEIR ENEMIES AND EXES THEN ARRANGE THEM ALPHABETICALLY.
- 2) IF A STORM CAUSES A LOT OF DAMAGE, ITS NAME IS RETIRED E.G. STORM EMMA IN 2018
- 3) IN 2019, KEITH TRIED TO GET "STORM ENEMMA" APPROVED BECAUSE HE STILL HASN'T GOTTEN OVER THAT BREAK-UP. HE WAS UNSUCCESSFUL

@twisteddoodles

Quick quiz #68 *Answers*

- 1 Their beaks
- 2 In "magic" mushrooms
- 3 It is cyclical – expanding, contracting and being constantly reborn
- 4 Johannes Diderik van der Waals
- 5 In autosomal-dominant conditions, you need only inherit a mutated gene from one parent; in autosomal-recessive conditions you need to inherit a mutated gene from both parents

Puzzle
set by *Zoe Mensch*

#76 Four hippos

The rangers at the Savannah Wilderness Experience are on a mission to weigh the four adult hippos in the park. Their scales can bear a weight of up to 4 tonnes, but are unreliable with anything below 2 tonnes, and all the hippos weigh less than that, so the rangers have had the smart idea of weighing the hippos in pairs.

The first five weighings are: 2.23, 2.35, 2.48, 2.72 and 2.85 tonnes.

The rangers now guide the two heaviest hippos onto the scales, but as the weighing is about to take place, the lightest hippo sneaks on as well and the scales break.

How much does the lightest hippo weigh?

Answer next week

#75 Seventh time lucky?

Solution

The code is 4321. Septa has four correct digits in six goes. No digit appears in a column more than twice, so she has either got three of the digits correct twice or two digits correct twice and two once. The digits that appear twice are: 7 in the first column; 3 in the second column; 2 in the third column; 8 in the fourth column. The only pair of these that doesn't coincide is x 3 2 x. One of the digits 4 8 8 2 is correct. Since 2 can't be repeated, it must be 4, and from 1191, the last digit must be 1.

RoboHog

The world's science journalists were on tenterhooks in August, as billionaire tech entrepreneur Elon Musk dropped intriguing hints on Twitter about a forthcoming demo of Neuralink, his sci-fi brain-computer interface.

Musk has a wide internet fanbase thanks to his pioneering work in futuristic fields, such as space rocketry and self-driving cars – but he does have form for overpromising on what he can deliver.

According to Musk, the coin-sized device will eventually let people control gadgets with their minds and download their memories. The display on 28 August would, he said, show neurons firing in real time. Or, in other words, "the matrix in the matrix".

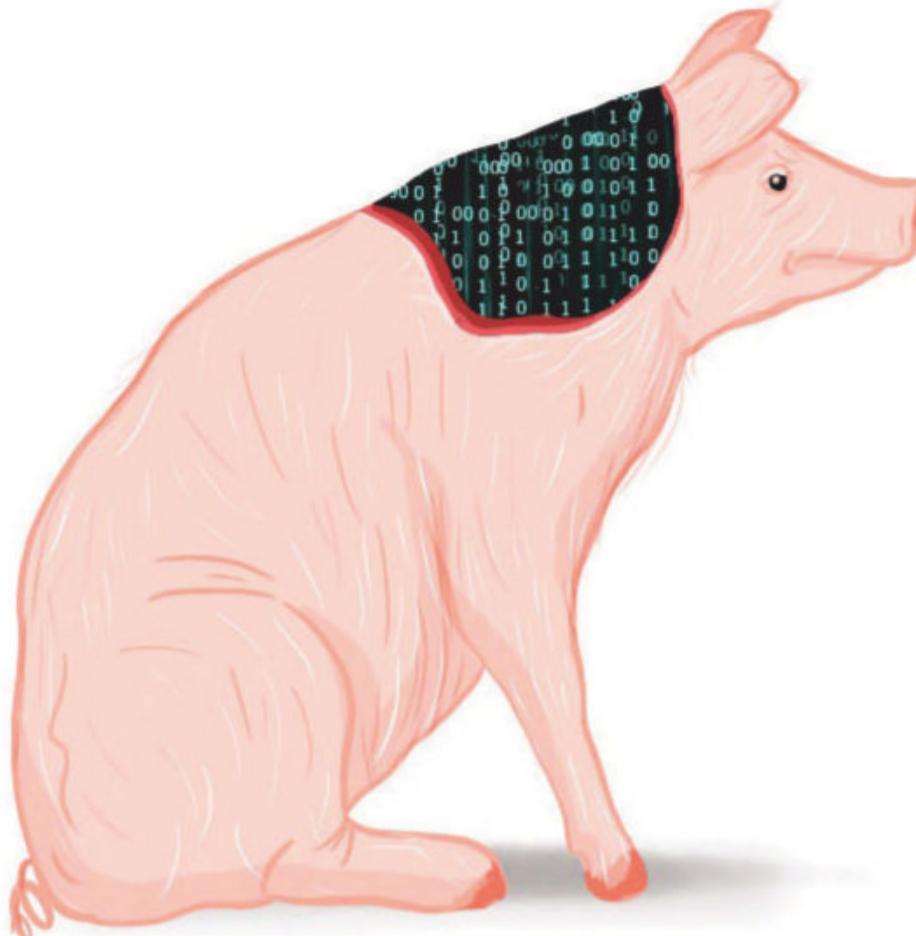
As *The Matrix* depicts a future in which wires jacked into our necks can simulate a virtual world indistinguishable from reality, Feedback was atremble with anticipation.

Sadly, the presentation didn't quite live up to the heights of the Keanu Reeves blockbuster. Out trotted three little pigs, one of whom, Gertrude, had the Neuralink implanted in the region of the brain that receives input from the snout. When her nose was booped, the sensory signals were transmitted to a monitor and speaker.

The audience whooped and clapped, but it is by no means the first time that researchers have recorded from the brains of live animals, nor even the first time they have done so wirelessly.

Neuroscientists that have been doing this stuff for years took on an aggrieved tone on Twitter, reminiscent of older siblings when a new baby gets attention for basic feats like smiling. "The device is way off downloading memories," sniffed one. "We'll definitely be living on Mars b4 that happens."

At least the press had a good name for Gertrude's half-pig-half-machine nature: she is now, officially, a Cypork.



Got a story for Feedback?

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New Scientist, 25 Bedford Street, London WC2E 9ES

Consideration of items sent in the post will be delayed

Hokey saga

We return to the debate over the world's many versions of the *Hokey Cokey*. For those who missed last week's shock news, UK neuroscientist Sophie Scott discovered that the US incarnation of that music hall classic is referred to as the *Hokey Pokey*, and unaccountably omits the best part: the chorus with its life-endangering mass collision.

We were left wondering – along with the whole of philological Twitter – what could explain the English-speaking world's divergence of names for essentially the same song. But after speaking with Scott herself, Feedback has learned that the *Hokey Cokey* has also crossed linguistic borders into non-English-speaking countries and has only improved with

translation. In Denmark, for instance, it is known as the *Boogie Woogie*, while in Finland it is the *Hoogie Googie*.

Then came a plot twist. Scott divulged that the *Hokey Cokey* is not, in fact, the first incarnation of this song. The original ancestor of all modern *Hokey Cokeys* – the ur-*Hokey Cokey*, if you will – seems to be a Scottish folk dance known as the *Hinkum-Booby*. Mind. Blown.

Mask slips

People who refuse to wear face coverings are sociopaths – at least according to recent newspaper headlines. These are based on a study that found that people who break lockdown guidelines on face coverings, social distancing and so on are more likely to score highly in the so-called dark triad

of personality traits: narcissism, Machiavellianism and psychopathy.

Although the findings might seem to explain those recent altercations in shops that people love to film and share online, Feedback has a policy of scepticism towards any research conveniently finding that people with frowned-upon opinions have undesirable personality traits. What's more, there are a couple of problems with the study. Firstly, it ignores people who are genuinely unable to wear face coverings. And if we only consider people who can wear masks but choose not to, the finding seems tautological.

A propensity to rule-breaking is associated with all three of the cited personality traits. So what the study seems to have found is that people who break rules are more likely to be people who break rules.

Heads or fails

Speaking of research with unsurprising conclusions, a study has emerged on an important question in today's era of fake news and conspiracy theories: can politicians be trusted? The answer turns out to be "Not much", according to researchers who came up with a cunning ruse to test their honesty en masse.

The team sent 816 elected mayors a survey and said that participants could receive the results if they had obtained heads on a coin flip – something that they were trusted to do in real life, unsupervised. Astoundingly, 68 per cent of the mayors reported that they had successfully landed on heads. For those who don't have their thinking caps on, the actual figure should have been close to 50 per cent.

Either something has gone fundamentally awry with the laws of statistics, or, as technology journalist Chris Stokel-Walker pointed out, politicians can't even be trusted to tell the truth about the toss of a coin. ■

Written by Clare Wilson

Rising tide

How are sea levels measured over time?

Chris Daniel

Colwyn Bay, Conwy, UK

Sea level has only been measured accurately since the early 1800s, when the US first began to systematically survey its coastline. This was originally done with a simple measuring stick to gauge the height of the water relative to a benchmark on land.

The stick was often used in a stilling well, a tube with a small hole placed below the water's surface that dampens movement caused by waves. This surprisingly accurate system remained unchanged in principle – apart from the introduction of automated recording – until microwave radar scanners arrived in the 1960s. These are mounted on coastal structures, such as bridges or breakwaters.

The drawback of these systems is that they only measure sea level relative to the land at that location. Land height may also change due to tectonic activity or movements associated with the end of the last glacial period.

In recent decades, corrections based on statistical models of ground movement have been used. Nowadays, though, GPS detects changes in the height of the land to offset against nearby sea level measurements.

It was only in the 1990s that satellites began to measure global sea level independently of the land. One current example is the European and NASA Jason-3 satellite, which scans the whole planet (except the poles) every 10 days and uses this information to calculate the mean sea level. A similar joint mission called Sentinel-6 will begin in late 2020.

Satellites have been tracking the annual rise in sea level associated with global warming. From 1993 to 2018, it averaged 3.2 millimetres per year, but in the last five years of that period, it increased by 4.8 millimetres per year.



BENCE MATE/NATUREPL

This week's new questions

Birdily functions Are there any species of bird that hiccup? If so, why would they do this? *Freya Smith, Mosgiel, New Zealand*

Patchy cabbage Why do cabbages exist? What is the point of having a tight bundle of leaves that don't attract pollinators and shield each other from the sun? Does its structure affect its ability to photosynthesise? *Tim Stevenson, Great Missenden, Buckinghamshire, UK*

Mike Follows

Sutton Coldfield, West Midlands, UK

Sea level used to be measured through stilling wells dotted around the world, but is now gauged using satellite altimetry. A radar pulse from a satellite is bounced off Earth's surface, and the time it takes the echo to return to the satellite is then used to infer the distance to the sea surface.

Satellite altimetry provides global coverage and eliminates the problem of the land rising or falling locally. Some land masses that were overlain by ice during the most recent glaciation, making them sink, are still rising to their former height in a process called post-glacial or isostatic rebound.

When the population of a coastal city consumes water from the aquifers that the city is built on, the land can subside, giving the illusion of sea level rise. Places where this has occurred include Bangkok, Dhaka and Tokyo.

Bangkok is sinking at a rate of up to 2 centimetres per year.

Dhaka, too, is still sinking and the frequency of floods has increased. Tokyo subsided by about 2 metres over several decades, but the rate was greatly reduced when regulations restricting the extraction of groundwater were introduced in the 1960s.

Cover up

When you wash a duvet cover, why does other washing end up in it? (continued)

Lorna Cox

Cambridge, UK

The question about duvet covers in the wash was answered in the Last Word some decades ago. One answer given at the time was that any decorative printing on the fabric could cause a differential stiffness of the outside and inside surfaces, promoting inversion

Is it possible for birds to hiccup, and if so, why would they?

in the washing machine. This inversion would then result in items finding their way inside the cover, especially if the machine had been overloaded.

Since reading that answer, I have always washed duvet covers inside out and this has solved the problem. In my experience, it hasn't been necessary to close the poppers or other fastenings. Occasionally, something may end up inside, but very rarely. Life is too precious to be spent doing and undoing poppers and the cover will dry faster on a washing line if the two sides are free.

James Fradley

Wimborne, Dorset, UK

Perhaps the things inside the duvet cover are experiencing something akin to thermophoresis, the movement of particles in a temperature gradient. As items are thrown about in a washing machine, smaller articles of clothing like socks are likely to have higher velocities than larger ones, such as shirts.

You might suppose that if a sock goes into the duvet cover, the odds are good that it will zoom back out again. But when it comes to a larger item, the chances may not be so good, as friction could play more of a role. On the other hand, by the same logic, it is harder for a shirt to get stuck in a duvet cover than a sock.

Have any studies been done to estimate if there is a size discrepancy at the end of the wash between what is in the duvet cover and what isn't?

John van Someren

London, UK

Because it is a lobster pot made of cotton. ■

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