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# New Scientist

WEEKLY 11 January 2020

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and enabled our evolution

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# Time to act

Australia's fires are a wake-up call. Let's reduce our reliance on fossil fuels

AT FIRST, Australia's leaders said the fires were normal. Prime Minister Scott Morrison called them "business as usual". The deputy prime minister, Michael McCormack, described those linking the fires to climate change as "inner city raving lunatics".

More recently, Morrison has made a point of acknowledging the link between reducing emissions and protecting environments against worsening bushfire seasons. But he has continued to insist that his government's current environmental policies are good ones.

In fact, the Liberal Australian government has long prevaricated on meaningful climate action. As treasurer in 2017, Morrison notoriously brought a lump of coal into the Australian House of Representatives to taunt those arguing for a transition away from fossil

fuels. Today, the country has no goal for net-zero emissions, and continues to be a leading global exporter of coal and gas.

The fires this season have already emitted an estimated 350 million tonnes of carbon dioxide into the atmosphere, roughly two-thirds of Australia's annual

**"If now isn't the time for Australia to get serious about climate change, when will be?"**

industrial emissions budget. Their catastrophic wider toll – loss of human life and wildlife, environmental ruin, destruction of property and long-term health effects of smoke inhalation – is only starting to be revealed (see page 6).

There has been generous support for the Australian Red Cross, state fire

services and the WIRES Wildlife Rescue charity. Prominent figures, including Russell Crowe, Nicole Kidman, Chris Hemsworth, Shane Warne and Ashleigh Barty, have pledged large donations. But meaningful change, to prevent similar and worse catastrophes in the future, can only be enacted by government.

In crisis, the country now faces a turning point. The Australian economy's reliance on fossil fuels must be weighed against the terrible cost of a continent that is becoming less habitable. If now isn't the time for Australia to get serious about climate change, when will be?

We have seen swift legislation in Australia before: in 1996, the nation quickly enacted gun control measures in response to a mass shooting. Can the nation's politicians show similar leadership again? ■

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ANDY WONG/AP/SHUTTERSTOCK

# Unknown illness hits China

Local authorities have ruled out SARS and bird flu as the cause of a disease that has affected 59 people, reports **Jessica Hamzelou**

AT LEAST 59 people in China have become ill with a mysterious pneumonia – seven of whom are in a serious condition. Chinese authorities still don't know what has caused the disease outbreak, but have ruled out SARS, MERS and bird flu.

"It seems that a new virus or bacteria might be the cause of the disease," says Shenglan Tang at Duke University in Durham, North Carolina.

The cases, reported to have occurred in Wuhan City, Hubei Province, are being investigated by Chinese health authorities. They say there is no evidence the infection can be passed between people. But it is too soon to definitively say that it won't spread this way, says Tang.

No deaths have yet been

recorded, but that doesn't mean the infection isn't dangerous, says Rosalind Eggo at the London School of Hygiene and Tropical Medicine. "It's hard to know how severe a disease is, especially a new infection, because you only see the cases that are severe enough to be detected," she says.

Several of those affected worked in a local market known for seafood. The market was closed on 1 January, according to a report in the *Wuhan Evening News*. All of the affected individuals became ill between 12 and 29 of December.

The symptoms include fever, and some people have had difficulty

## Airport staff check the temperatures of people arriving in Hong Kong

breathing. All are receiving medical treatment in isolation, and the people they have had contact with are being evaluated.

As of 5 January, the Wuhan Municipal Health Committee had ruled out influenza and adenovirus (which can cause colds, pneumonia and conjunctivitis), in addition to bird flu, MERS and SARS, which was responsible for 774 deaths in 2003.

The World Health Organization is "closely monitoring" the event, says spokesperson Fadéla Chaib. ■



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## Space

## Strange signal may be a tiny black hole

AN ODD set of gravitational waves has been sent across space by a mystery object. It could be the smallest black hole ever found or the largest neutron star.

Gravitational waves are ripples in space-time that are caused by the motion of massive objects. LIGO, a US-based detector, has spotted gravitational waves from many pairs of black holes colliding over the past few years, as well as one pair of neutron stars.

Now it has found a truly puzzling collision, LIGO team member Katerina Chatziioannou told a meeting of the American Astronomical Society in Hawaii on 6 January. A LIGO detector in Louisiana spotted signs of two objects colliding, but nobody is sure what one of the objects is.

In this smash-up, one of the objects was definitely a neutron star with a mass between 1.1 and 1.7 times that of the sun. While the other object is probably also a neutron star, months of analysis haven't been able to prove this, says LIGO team member Nelson Christensen.

Its mass could be as high as 2.5 times that of the sun, which means it could be massive enough to be a black hole. "We've never seen any neutron star with this large a mass," says Christensen. "The question is, is it really a neutron star? If it is, then we've detected a really strange heavy neutron star, but if it's a black hole, it's a really light black hole." ■

Leah Crane



## Wildfires

# Tragedy in Australia

We have known for over a decade that climate change would bring worse fires. Now those predictions have sadly come true, reports **Alice Klein**

OUTSIDE Batlow in New South Wales, the scorched remains of wildlife and livestock lie pressed against fences, where they tried in vain to escape the flames that ripped through the area on 4 January. Along with the other billion-or-so other animals that have already perished in Australia's worst wildfires on record, they will be buried in mass graves dug by the army.

Australians, myself included, are in a state of shock. At least 24 people have died, more than 2000 homes have been gutted, and 8 million hectares – an area the size of Scotland – have burned. For months now, the brown and red skies and smell of smoke have been a constant reminder of the tragedy unfolding around us.

The fires are being driven by record-breaking hot, dry conditions, which make vegetation more likely to catch fire when exposed to ignition sources like lightning strikes or discarded cigarettes. On 8 January, the Bureau of Meteorology announced that 2019 was both Australia's driest and warmest year on record. On 18 December, the country had its hottest ever single day, when the average maximum temperature reached 41.9°C.

Despite these extremes, the Australian government has acted almost as if nothing unusual is happening. In November, deputy prime minister Michael McCormack told ABC Radio that "we've had fires in Australia since time began". He dismissed the role of climate change in the current fires as the "ravings of some pure, enlightened and woke capital-city greenies".

But Sarah Perkins-Kirkpatrick at the University of New South Wales says there is no doubt that climate change is a driving factor. "We can



NEW YORK TIMES/REXUS/EVEVINE

certainly say it has contributed to the length and severity of this fire season," she says. In 2008, a report commissioned by the Australian government predicted that from about 2020, global warming would cause Australia's fire seasons to start earlier, end later and be more intense. "We knew this was going to happen," says Perkins-Kirkpatrick.

**"We can certainly say climate change is a driving factor. We knew this was going to happen"**

Two large-scale climate phenomena are also contributing to the conditions underpinning the fires, says Andrew Watkins at Australia's Bureau of Meteorology. The Indian Ocean Dipole (IOD) has pushed warm water away from Australia towards Africa, leading to drought. And the Southern Annular Mode (SAM) has driven hot, dry winds from Australia's desert interior towards its east coast and fanned fires in New

South Wales and Victoria – the south-eastern states that have been worst hit.

These two phenomena have coincided in Australia in the past, but never for this long in recorded history, says Watkins. Add in the extra 1°C of warming that Australia has experienced since 1910 and you get a dangerous mix, he says.

The fires started in September, a month earlier than Australia's official fire-danger season, which runs from October until the end of March. They have already burned through a greater area than the 2018 California wildfires and the 2019 Amazon fires combined, and torn through rainforests in northern New South Wales and southern Queensland that have historically been too wet to burn.

The sheer intensity of the fires has caused them to generate their own storm clouds, called pyrocumulonimbus, which can spit out lightning that starts more fires. Former New South Wales fire and rescue commissioner Greg

**Australia's fires have hit livestock as well as people and wild animals**

Mullins wrote in November that he had rarely seen fire-generated thunderstorms in his 47 years of fighting fires, but now they are occurring regularly.

It is also now common to see my fellow Sydneysiders wearing gas masks on the way to work. On 1 January, Canberra's air quality was the worst of any major city in the world.

The fires have taken a huge toll on Australia's unique wildlife. Chris Dickman at the University of Sydney estimates that 1.3 billion mammals, birds and reptiles have died in the fires. Flying animals like birds and bats and fast-moving animals like kangaroos may initially have been able to escape the flames, but probably died soon afterwards because of the difficulty of finding food, water and shelter in the blackened landscape, says Dickman.

"We also know that invasive species like cats and foxes quickly move in after a fire goes through and pick off small native animals, so it's really grim," he says.

Dickman has particularly grave fears for species like the eastern bristlebird, long-footed potoroo and silver-headed antechinus, which are already endangered and live almost exclusively in fire-affected areas. They may have been wiped out altogether, he says.

Australia's prime minister, Scott Morrison, has been heavily criticised for ignoring a meeting request from 23 former fire and emergency service leaders early last year. They wanted to warn him of the risk of a catastrophic looming fire season.

Morrison has also refused to ramp-up Australia's greenhouse emissions reduction targets,



## How close is Iran to building a nuclear weapon? The US assassination of an Iranian general is all the more worrying given a key arms deal hangs by a thread, says **Debora MacKenzie**

saying in a press conference on 2 January that the government needs to balance a “vibrant and viable economy” with a “vibrant and sustainable environment”. According to 2019 figures, 93 per cent of Australia’s energy comes from fossil fuels, compared with the 80 per cent average for countries in the Organisation for Economic Co-operation and Development. Without a big shift to renewable energy, the country is on track to miss its 2030 Paris climate deal target.

As *New Scientist* went to press, dozens of fires continued to burn in New South Wales and Victoria, but light rain and cooler conditions since 5 January had helped firefighters partially contain them. None were burning at emergency levels, but there were concerns that forecast warmer weather could soon cause conditions to deteriorate again.

“Typically, in southern Australia, the hottest weeks are at the end of January and in early February, so we haven’t even hit our hottest period yet,” says Watkins.

Shifts in the IOD and SAM climate patterns suggest that the hot, dry conditions should ease by March or April, says Watkins. We don’t know when they will return, but modelling suggests that climate change will make such IOD events more common, he says.

When the fires are finally extinguished, it will be a long road to recovery. For many Australians, it is clear that these fires aren’t business as usual. For me, that realisation came as ash rained down on the face of my infant son at a Sydney beach. On social media, on the radio, at the pub, people are finally talking about what we need to do about climate change. If that pressures the government into real action, it will be one small consolation. ■

THE risk of Iran getting nuclear weapons has risen this week, as tensions increase after the US assassination of a senior Iranian military official, Qassem Soleimani, on 3 January. His death is the latest example of President Donald Trump’s escalations against Iran, following the US withdrawal from a nuclear deal that Iran continues to unravel.

Iran announced on 5 January that it will no longer obey the limitations imposed on its nuclear activities by the Joint Comprehensive Plan of Action (JCPOA). This means the deal, which drastically reduced Iran’s likelihood of building a nuclear weapon, hangs by a thread – but it isn’t dead yet. Iran will continue to allow inspections by the International Atomic Energy Agency (IAEA), the world’s nuclear watchdog, and EU foreign ministers will hold a meeting on Friday attempting to save the deal.

Mounting tensions with the US may make the deal’s survival impossible, however. The world is heading for an unprecedented situation: a nation progressing towards nuclear weapons

### People march during the funeral of Qassem Soleimani



capability in full view of the IAEA.

The JCPOA was agreed in 2015 between Iran and the five permanent countries in the UN Security Council – the US, UK, Russia, China and France – plus Germany and the EU. It came after Iran was caught covertly enriching uranium in 2003, and punished with economic sanctions.

These sanctions were lifted when the JCPOA put limits on Iran’s nuclear activities backed by tough inspections. Trump withdrew the US from the deal in 2018, citing Iranian activities in areas such as missile development, and resumed sanctions. Iran says it will comply if sanctions are lifted. The remaining partners still back the deal. But trade with Iran risks US economic retaliation.

The IAEA says Iran remained in compliance with the JCPOA until May 2019, despite the renewed sanctions. But then it started abandoning the deal’s limits.

The JCPOA allowed Iran to make a total of 300 kilograms of uranium hexafluoride enriched to – but not beyond – 3.65 per cent uranium-235, enough to run its nuclear power reactor. In July, Iran exceeded both limits. In September, it installed more enrichment centrifuges than the JCPOA allows. In November,

it resumed using its off-limits enrichment plant at Fordow.

Its latest announcement that it is abandoning JCPOA limits on the number of active centrifuges seems timed as a retaliation for the death of Soleimani. But in December, prior to the assassination, the Arms Control Association (ACA), a think tank in Washington DC, had predicted that Iran would abandon another JCPOA measure on 5 January – Iran has taken steps every 60 days.

## 4

### Months Iran needs for first step to making one nuclear bomb

These are all steps towards creating weapons-grade uranium, which is enriched to over 90 per cent. The JCPOA restrictions meant Iran would need a year from abandoning the restrictions to make enough for a bomb. More enrichment and stockpiling shorten this “break-out time”.

“Enrichment beyond 20 per cent would not mean that Iran could build a nuclear bomb tomorrow, but it shortens our ability to react if they made a decision to do so,” says Corey Hinderstein of the US Nuclear Threat Initiative.

As things stand, the ACA calculates it would take Iran four months to make 1050 kilograms of low-enriched uranium, the first step to make one bomb. It would then need more time to further enrich it to weapons-grade, which takes less time with more enrichment centrifuges.

There is a much lower risk of proliferation today than in 2013, says the ACA. Back then, Iran had more than 7000 kilograms of low-enriched uranium and its break-out time was two to three months. This situation was ended by the JCPOA, but may return. ■



Astronomy

# Mystery space radio signal seems to have vanished

Leah Crane



SANDER MEERTJINS/GETTY IMAGES

STRANGE radio signals from space are still baffling astronomers with their odd behaviour. Fast radio bursts (FRBs) are blasts of radio waves that last just a few milliseconds, and some have been seen to repeat. They carry a lot of energy, but we don't know what causes them. Now one of the repeating signals may have gone unexpectedly silent.

The first repeating FRB, called FRB 121102 or R1, was discovered in 2012 and later traced to its home, a dwarf galaxy about 3 billion light years away. The second, nicknamed R2, wasn't found until 2018.

Leon Oostrum at the Netherlands Institute for Radio Astronomy and his colleagues used the nation's Westerbork Synthesis Radio Telescope (WSRT) to watch R1 for 130 hours and R2 for 300 hours. They were looking for more bursts that might help characterise these FRBs better and find R2's host galaxy ([arxiv.org/abs/1912.12217](https://arxiv.org/abs/1912.12217)).

While they detected 30 bursts from R1, they didn't see any from R2. The simplest explanation for

this is that R2 isn't detectable in the wavelengths at which WSRT observes, which are different from those used by the telescope that discovered it. It would be as if this FRB emits reddish light, but WSRT can only see blue.

The other suggested explanation from Oostrum and his colleagues is that R2 could have stopped emitting bursts. However, it is more likely that the telescope can't detect the FRB's wavelengths or that any bursts it emitted while

**5**  
The number of fast radio bursts whose home galaxy is known

Oostrum and his colleagues were observing were just too dim to see, says Jason Hessels, who is also at the Netherlands Institute for Radio Astronomy but wasn't involved in this work. "Just because you don't see anything at this time with this telescope doesn't mean there's nothing to see," he says.

Regardless, it shows that R1 and R2 are very different from each other. "If the two were

The WSRT radio telescope can listen for fast radio bursts

similar, we should have seen that second repeater easily, and we didn't," says Oostrum. "They could be very different in how bright they are, how often they repeat, and basically any other parameters as well."

They could also be in very different galaxies, as evidenced by separate work led by Hessels. That traced a different repeating FRB called 180916.J0158+65 to its host galaxy, only the fifth time any FRB has been tracked back and only the second repeater to be pinned down in this way (*Nature*, [doi.org/dhwhf](https://doi.org/dhwhf)).

Its home galaxy is completely different from R1's. It has a spiral appearance more like that of our Milky Way rather than the irregularly shaped dwarf galaxy of R1. Its environment is also far less extreme, making some of the explanations for FRBs that came from analysis of R1 seem less likely.

"Either a successful theory has to explain that diversity or we have to start thinking seriously about there being multiple different types of sources for FRBs," says Hessels. If FRBs result from a variety of different types of events, that could explain why they all appear to be so different.

FRB 180916.J0158+65 is about six times closer to Earth than R1, so we will be able to observe it in more detail. And the next generation of huge telescopes should help explain what causes FRBs too. "The main goal in the end is to find out what these things are, but for now, the more information we have, the more questions we have," says Oostrum. ■

Pollution

# Air pollution may weaken our bones

Adam Vaughan

WE ALREADY know that dirty air is associated with problems in the lungs, heart, uterus and eyes and might affect mental health – and now weaker bones can be added to the list.

Researchers took readings of levels of PM2.5, a fine particulate form of pollution, at 23 sites outside Hyderabad in India. Then they worked with more than 3700 people in nearby villages to explore whether exposure to the air pollution was correlated with changes in the bone mineral content of their hips and spines, a measure of bone strength used to diagnose osteoporosis.

"What we see overall is a quite consistent pattern of lower bone mineral content with increasing levels of air pollution," says Cathryn Tonne at the Barcelona Institute for Global Health in Spain.

People in the area were exposed to average annual PM2.5 levels of 32.8 micrograms per cubic metre – three times higher than the safe limit recognised by the World Health Organization. After adjusting for other possible factors, including wealth, Tonne and her colleagues found that every extra 3 micrograms of PM2.5 per cubic metre was associated with an average reduction in bone mineral density for both men and women of 0.011 grams per square centimetre in the spine, and 0.004 g/cm<sup>2</sup> in the hip. Black carbon, a subset of PM2.5, was also associated with lower bone mass (*JAMA Network Open*, [doi.org/dhwd](https://doi.org/dhwd)).

More than half of the people in the study live in homes where food is cooked using solid biomass fuels, which release the pollutants. But no link to bone mass was found for those who used biomass as their main cooking fuel. This suggests it is the general exposure to air pollution in the ambient air that is responsible for the link. ■



## Medicine

# Fighting tumours from the inside

Special clumps of immune cells hint at a new way to target cancer

Clare Wilson

A NEW anatomical structure has been described inside tumours, and it could shed light on how our immune systems are sometimes able to destroy cancer.

The structures, dubbed immune outposts, are tiny clumps of immune tissue that form within tumours and seem to improve people's chances of surviving cancer. If we can encourage these to grow, it may lead to new treatments. Some existing medicines work by boosting the immune system's response to cancer, but they only lead to remission in a minority of people.

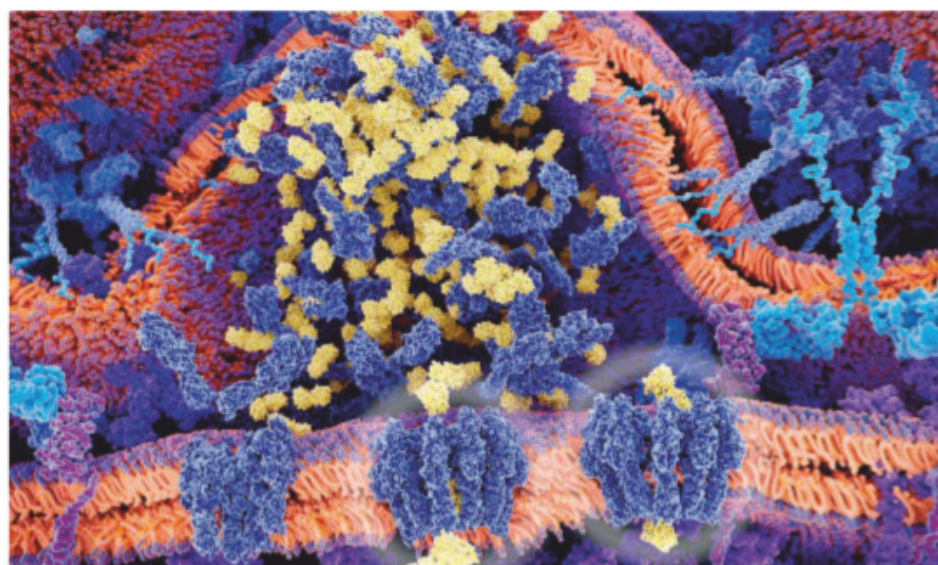
Haydn Kissick at Emory University School of Medicine in Atlanta, Georgia, and his colleagues looked at tumours removed from about 150 people with cancers of the kidney, bladder or prostate. The proportion of T-cells – immune cells that fight tumours – within the growths ranged from 0.002 per cent to more than 20 per cent of the total number of cells (*Nature*, doi.org/dhxxh).

The T-cells weren't randomly distributed within the tumours,

but were clustered in the outposts, which were about a tenth of a millimetre across and sited near tiny blood vessels going into the tumours.

Kissick likens these new anatomical structures to lymph nodes: small, bean-shaped nodules in places such as the neck and armpits where immune cells learn to fight anything harmful, such as bacteria or

**An illustration of immune proteins attacking cancer**



SCIENCE PHOTO LIBRARY

cancer cells, by recognising molecules on their surface. "These [outposts] are acting like a lymph node, but at the site where the fight is taking place. It's like a ground zero," he says.

As well as the fully developed T-cells, the outposts contained immature T-cells called stem-like cells that can multiply to produce a constant supply of new immune cells. "They keep pumping out the soldiers," says Kissick. "You need these things because T-cells are continually dying."

The outposts also held a second

kind of immune cell that picks up and displays cancer proteins on its surface, highlighting them to T-cells as something to attack.

"We knew there were [T-cells] in tumours, but this shows where the stem-like cells live," says Nicholas Restifo of US biotech firm Lyell Immunopharma. "All stem cells have niches where they are kept safe and sound. We had never pinned them anatomically."

The outposts hadn't managed to stop the tumours from growing – some were up to 10 centimetres across. But after people had their primary growth removed, those who had more outposts were less likely to have secondary tumours emerge elsewhere in their body.

This may have been because the T-cells had "learned" to recognise the cancer while they were in the outposts, says Kissick. "If you have these in your tumour, you seem to control the disease."

The team is now investigating whether some tumours produce chemicals that cause the outposts to break down. "If we can neutralise that, they can pop back up," says Kissick. ■

## Marine biology

# Hagfish tie complex knots in their bodies to help them eat

HAGFISH literally tie themselves in knots. They do this to escape a tricky situation as well as to help them eat and now we know which knots they use.

In many ways, hagfish are extraordinary. They are long, eel-like marine animals that carry far more blood relative to their body volume than any other fish, have four hearts – and only half a jaw.

It is partly because of this last

feature that it is so useful for hagfish to tie knots in their long bodies. When the animal ties a knot at its tail end and slips it along the body to the head, it forms a broad flat surface that its upper jaw can work against. Slipping a thick knot along its body can also help a hagfish pull its head out of a tight spot if it gets stuck during hunting or feeding.

But although we have known for decades that hagfish tie themselves in knots, it has been difficult to confirm what types of knot they tie. "Three-dimensional knots are difficult to visualise at the best

of times," says Theodore Uyeno at Valdosta State University in Georgia. "But when it's a squirmy self-manipulating knot that's thrashing about, it's impossible."

Uyeno and his colleagues came up with a solution. They anaesthetised a hagfish and gently inserted its head into a restraining device. When the hagfish woke, it slipped knots down its body to pull its head free. The researchers

**"Slipping a thick knot along its body can help a hagfish pull its head out of a tight spot when hunting"**

recorded the behaviour using high-speed cameras, and then analysed the knots. They repeated the procedure 100 times, capturing the knot-tying behaviour of three hagfish species.

It turned out that hagfish tie trefoil knots, where it has a single loop along its body, 45 per cent of the time, and slightly more complicated figure-eight knots 33 per cent of the time. Other knots were difficult to classify, but about 4 per cent of the time they tied a more complicated three-twist knot (*Journal of Zoology*, doi.org/dhwb). ■  
Colin Barras



## Security

# Phone number theft through SIM-jacking is on the rise in the UK

Adam Vaughan

SINCE April 2019, there have been more than 300 cases in the UK of attacks in which people try to fraudulently obtain codes that would let them gain control of someone's mobile phone number, the UK's data watchdog has revealed. The figures suggest the practice is getting more common.

The process of SIM-jacking, or SIM-swapping, involves an attacker contacting a person's mobile network operator and fraudulently obtaining a porting authorisation code (PAC) enabling them to switch the target's phone number to another phone on a different network.

UK-based food writer Jack Monroe recently had about £5000 stolen from her bank account after someone managed to hijack her mobile number.

Figures released under freedom of information rules to *New Scientist* by the UK Information Commissioner's Office (ICO) show that there were "over 300" reports of PAC fraud since the start of April 2019. The watchdog told privacy campaigners in November that there had been 399 cases in total since the start of April 2018, which

means most reports have been in the past nine months.

"SIM-swap fraud is devastating, as we saw with Jack Monroe. You mustn't just think in terms of financial harm, there's the anxiety and there's the distress," says data protection consultant Pat Walshe at Privacy Matters.

It isn't clear how many of the 300-plus cases of PAC fraud since April involve SIM-jacking. The ICO says it only identified 11 cases with

**Help-desk procedures defend against people hijacking your smartphone**

the term, but says the figure can't be taken as reliable because it may have missed variations on the phrase when searching its records.

SIM-jacking typically involves someone calling up a mobile network operator, armed with as much personal information about a target person as possible. In Monroe's case, for example, her date of birth was available on Wikipedia. The attacker then uses that information to attempt to pass security clearance with the operator in order to have them read out the PAC. That can then be used to port the number onto

another SIM, giving the attacker control of the number.

Attempts by *New Scientist* staff to mimic the process – by trying to obtain a PAC for their own number using just their name, mobile number and date of birth – were rebuffed. One network operator wouldn't give out the PAC without the caller reading out a code sent via text to the number to be ported. Another wouldn't allow the caller to proceed without a postal address.

However, some attempts clearly are succeeding, as Monroe's case demonstrates. The technique was also used to access the Twitter account of the social media company's founder, Jack Dorsey, last year.

Mobile numbers have increasingly become the main way for companies and governments to authenticate a person's identity, raising the stakes for losing control of the number.

Walshe, who spent 20 years in the mobile industry, says the sector isn't doing enough to tackle the issue. He says one solution is for networks to send a verification text to the original number. ■



VGA/ICGETTY IMAGES

## Medical technology

# Cooling body from within may help after heart attack

DOCTORS often cool down people who have had a cardiac arrest or stroke to reduce brain damage, usually with water-filled blankets. But doing this by circulating cold water in a tube down the throat to the stomach may be preferable.

In a pilot study testing the tube device in people who had a cardiac arrest, most doctors felt it was more convenient than blankets,

and patients reached the target temperature within about 2 hours.

The study didn't directly compare the new approach with the use of water blankets, but 2 hours is relatively fast, says Marvin Wayne at St Joseph Medical Center in Bellingham, Washington state.

It has been known for some time that cooling people by a few degrees can be beneficial in emergency medicine. It was thought that cooling to 32°C was necessary. Then in 2013, a trial showed it was just as beneficial to cool to 36°C. Although this is only about 1°C

below normal body temperature, people who have had brain injuries sometimes have a fever, and such cooling avoids this overheating.

The internal device, made by US firm Attune Medical, was used on 52 people in the new study to cool them to 32°C or 36°C depending on their doctor's preference. In 30 people, the target temperature was reached using the device alone.

**"Cooling blankets get in the way and cover people up – a patient becomes somewhat invisible"**

In the rest, their doctors felt that blankets needed to be added as they weren't cooling fast enough ([medRxiv, doi.org/dhsh](https://doi.org/medRxiv/doi.org/dhsh)).

But if the new approach helps doctors avoid blankets at least sometimes, that is an advantage, says Wayne. "Blankets get in the way and cover people up – a patient becomes somewhat invisible."

John Andrzejowski at Sheffield Teaching Hospitals in the UK says a larger randomised trial is needed to check the device doesn't damage the lining of the oesophagus. ■

Clare Wilson



# UPCOMING EVENTS

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Let New Scientist help you cut through confusion as you join professor of cardiometabolic health Jason Gill and geneticist Giles Yeo for an evening exploring the facts behind the headlines about exercise and diet.

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We spend an astonishing one-third of our lives sleeping. Yet we know remarkably little about it. Discover the importance of sleep and rest on your health and wellbeing and find out how you might lead a more restful and balanced life.

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**Conway Hall, London**  
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## Up close with the Mars 2020 rover Our reporter visits the sterile room where NASA engineers are building a spacecraft that will search for signs of life on the Red Planet

Leah Crane

"WHAT you're doing today never happens," says NASA's David Seidel as the van rumbles along. We are headed to the Spacecraft Assembly Facility at NASA's Jet Propulsion Laboratory in California, where a group of journalists will be allowed to enter the clean room, a place members of the public are almost never allowed to go.

We are here to see the Mars 2020 rover, which is scheduled to launch to the Red Planet in July. But before we can get up close and personal with the rover, we have to get clean.

"There is some very sensitive equipment on the rover because we're trying to take pristine samples and seek past life on Mars, so we don't want to contaminate it, especially on the sampling system," says Mars 2020 engineer Michelle Colizzi.

To keep the rover from ferrying Earth microbes to Mars, it is being assembled in a specialised clean room called High Bay 1. The air in the room cycles through a filtration system about 70 times per hour to keep it free of any dust or other particles. The temperature and humidity are closely monitored, and everything is regularly wiped down with isopropyl alcohol.

Humans are chock-full of microbes and other particles, so



to go into the clean room I have to wear a full "bunny suit": head to toe sterile fabric with the sleeves and legs taped closed. Makeup and perfume aren't allowed. These restrictions are even more severe for engineers working on the most sensitive parts of the rover, who aren't allowed to shower before work for fear of soap residue.

Before entering the clean room, I pass through an air shower – an elevator-sized chamber covered in air nozzles that gently dislodged any stray particles. It's a refreshing reprieve from the stiflingly hot bunny suit. None of the NASA employees will admit to me that it gets smelly in here, but the suit

isn't very breathable, and with some employees not allowed to shower or use scented products, it's hard to imagine it wouldn't.

Finally, the rover. Mars 2020 is about the size of a car, with a camera-covered mast standing tall and imposing above the bunny-suited crowd. Once it arrives on Mars in February 2021, these cameras and a suite of other scientific instruments – including a small helicopter – will start to examine the planet and help us learn more about its climate and geology. They will also be looking for signs of past life.

The clean room is also home to the descent stage of the spacecraft, a sky crane (left) that will hover above the Martian surface and lower the rover to the ground, and part of the cruise stage, which will tuck away the rover and sky crane on the journey to Mars.

Mars 2020 will go through the same "7 minutes of terror" as the Curiosity rover did in 2012, as it slows from thousands of kilometres per hour to zero. "I'm probably most nervous

**The sky crane will lower the Mars 2020 rover to the Red Planet's surface**



**The Mars 2020 rover (above left). Leah Crane gives a thumbs up (right, bottom of picture)**

about the 7 minutes of terror," says engineer Chris Chatellier. "I was nervous watching the Mars Curiosity landing, and I didn't even work on that."

The part of the mission that most excites the scientists and engineers are the samples. The rover is equipped with a drill and a set of test tubes into which it will pack Martian dust as it drives around the surface.

The Mars 2020 mission won't be able to bring the samples back to Earth – that is up to another mission planned for 2026. The time between the missions will allow scientists to work on the more complex 2026 rover while the Mars 2020 rover is already on the Red Planet doing science.

When those samples eventually return to Earth, they could revolutionise our understanding of Mars. We know now that Mars once had the conditions necessary for life, and those test tubes of dust will help us figure out if those conditions were enough for life to actually arise there. ■





## Energy

# Sulphur could make phone batteries that last for days

Donna Lu

**A LITHIUM-SULPHUR battery with an ultra-high capacity could lead to cheaper electric cars and grid energy storage.**

**Mahdokht Shaibani at Monash University in Melbourne, Australia, and her colleagues have developed a battery with a capacity five times higher than that of the lithium-ion batteries that currently power electric cars and smartphones. The new battery maintains an efficiency of 99 per cent for more than 200 charging cycles, and a smartphone-sized version would be able to keep a phone charged for five days.**

**Researchers have long known the potential capabilities of lithium-sulphur batteries, but the capacity of a sulphur electrode is so big that it can break apart as it charges and discharges. That happens because the sulphur electrode expands and contracts as it cycles, with a volume change of about 78 per cent – eight times more than that of lithium-ion batteries.**

**To prevent the electrode from disintegrating, Shaibani and her team gave the sulphur particles more space to expand and contract. They used a polymer to create a series of bridges between particles,**

## 5 days

How long a lithium-sulphur battery could keep your phone charged

**rather than a dense network. This balances the battery's resistance to cracking with its ability to discharge a large amount of energy (Science Advances, doi.org/dhvr).**

**Shaibani says this lithium-sulphur battery would reduce the cost of batteries for electric cars and grid energy storage because sulphur is abundant and extremely cheap. The researchers will further test prototype batteries with a view to manufacturing them commercially in Australia. ■**

## Analysis UK politics

# Can 'weirdos' really help run the UK using science?

Adam Vaughan

DOMINIC CUMMINGS, a senior adviser to UK prime minister Boris Johnson, has said he wants the UK government to hire "weirdos and misfits with odd skills" to apply science to the civil service.

While primarily a quirky job ad, his blog post also offers a glimpse into how he sees scientific research transforming the government. As well as listing categories of people he would like to hire – including mathematicians and physicists – the blog post also focuses on the utility of data science, artificial intelligence and the "science of prediction".

But can his vision work? Can policy-making really be improved by building digital models of reality, or applying machine learning to government data, as Cummings appears keen on?

Jack Stilgoe at University College London says Cummings appears to be getting carried away in terms of how applicable science is for policy-making.

"Any civil servant would say: 'Yes, OK, I can see something in this, but we need to be careful', because there are all sorts of other things that need to be considered in policy-making," he says. "The idea there are just easy answers, or ways to easily reform policy-making, is naive."

Cummings lists research that should be read by "unusual mathematicians, physicists, computer scientists, data scientists" thinking of applying for a job.

Stilgoe notes that the papers, which include ones about forecasting future events using AI, are very recent, and that the claims in them still need testing.

Aaron Clauset at the University of Colorado Boulder, author of two

of the papers listed by Cummings, says he was surprised to see them in the post.

"I would say that our paper on scale-free networks is not directly relevant to government policy," he says. "I think Cummings is using our paper as an example of using careful statistical and computational analyses of large and diverse data sets to reassess ideas that may be accepted as conventional wisdom."

Another researcher cited by Cummings is Douglas Guilbeault at the University of Pennsylvania, for his paper looking at studies on which behaviours spread and why. Guilbeault tells *New Scientist* that the idea of such "complex contagions" can be useful for governments in areas such as public health, for example on policy to stop smoking.

Two papers on forecasting using machine learning were also highlighted. Spyros Makridakis at the University of Nicosia in Cyprus, one of the authors of the works, says these two papers are only vaguely related to civil service work, and their "connection to government is not clear to me".

Work by R.I. Sujith at the Indian Institute of Technology Madras is also listed by Cummings. Sujith says he agrees with Cummings's suggestion that his research on

the thermodynamics of sound waves could be applied to other fields. "We observe a lot of commonalities between transitions in our thermoacoustic systems and systems such as the economy, epidemics, climatic systems," he says.

**"The idea there are just easy answers, or ways to easily reform policy-making, is naive"**

One big focus for Cummings is using AI to inform how the civil service is run. David Curtis at University College London is sceptical. "It looks like he has bought all the hype about AI and is intending to attempt to apply it in places where it won't work at all," he says.

Matt Jukes at Notbinary, who has worked on digital government projects, said in a blog post that transforming the civil service may be harder than Cummings thinks, because so much government data is in spreadsheets and legacy systems. "It just fails to acknowledge just how messy the underlying data is."

Stilgoe says that while AI looks "really seductive", a bigger problem is making sense of its results.

Difficulty getting hold of usable data could also hold back Cummings's plan to build interactive digital models of real life, or "digital twins", as Jeni Tennison at the Open Data Institute dubs the idea. She also cautions about interpreting and unpicking the results of models, noting: "We need social scientists, not just computer scientists."

Since Cummings posted the ad, a spokesperson for the prime minister has said that he wouldn't be allowed to directly hire people, and civil servants will be appointed in the usual way. ■



DINENDRA HARIJALAMY STOCK PHOTO

**Dominic Cummings has long professed his admiration for physicists**



## Health

# Ban on the way for 'new car smell'

Chinese rules could limit potentially harmful chemicals that make the distinct odour

Adam Vaughan

AIR pollutants that generate "new car smell" have been found at levels up to 10 times regulatory limits inside some car models.

But new Chinese rules could put an end to the odour, which is generated by volatile organic compounds (VOCs), potentially harmful chemicals that are readily released as gases by the materials in dashboards, seat covers and other fittings.

China, Japan and South Korea regulate VOC levels, in part because many people in Asia have less of the enzyme that breaks down ethanol and one of the key VOCs released by car interiors, acetaldehyde. While the odour of a new vehicle is popular in the US and Europe, surveys in China have found that more than one-tenth of car buyers complained about it.

Difficulties in measuring VOCs have hampered tests inside cars, but new instruments allowed UK-based testing firm Emissions Analytics to check three models.

In a Hyundai i10, concentrations of methanol, a common solvent, rose from 18 micrograms per cubic metre ( $\mu\text{g}/\text{m}^3$ ) to  $935 \mu\text{g}/\text{m}^3$  during the test, a level that Emissions Analytics says may act as an

irritant. Acetaldehyde also jumped from 50 to  $550 \mu\text{g}/\text{m}^3$ , or 10 times the limit in China and Japan.

Spikes weren't as pronounced in unnamed Renault and Peugeot models, but ethanol went up more than expected, while acetaldehyde and methanol in the Peugeot also rose after 24 minutes of testing.

"Research is at an early stage and needs further investigation, but clearly the cabin contains a cocktail of health hazards," says Nick Molden at Emissions Analytics. The firm says VOCs may spike at the start of a car's life

because heating and ventilation systems in a vehicle act as a sink for the chemical compounds and release them when they are used. These systems were switched on during the tests.

Hyundai said all of its cars are "thoroughly tested" with regard to VOCs and interior air quality. Renault said it aims to manage VOC emissions "to minimise their impact on passenger health and

**China's latest rules for air quality inside vehicles may banish new car smell**

comfort". Groupe PSA, which owns Peugeot, said it has limits on VOCs. "The air in the passenger compartment is checked for VOCs before the vehicle goes on the market [to ensure international standards are met]," it said.

Alastair Lewis at the University of York in the UK says the VOCs measured for this test are found in most modern environments, from homes to offices. But they are worth our attention.

"Some people have very significant, genuinely debilitating sensitivities to certain VOCs even at low concentrations. Others actually rather like the smells and suffer no obvious acute effects," says Lewis.

The rise of car ownership in China and the country's influence in global car markets mean there might not be a new car smell for long. In June, China's environment ministry said it would introduce tighter controls on VOCs in cars, to take effect from 2020. Due to the size of China's car market, the new rules have the potential to act as de facto global regulations.

However, political wrangling in China means the rules may not take effect until later in 2021. ■



AIQING WANG/GETTY IMAGES

## Evolution

## Dolphin species could be splitting in two before our eyes

BOTTLENOSE dolphins in South America may be separating into two different species, thanks to varying habitats between two groups of the animal.

Along the coastlines of southern Brazil, Uruguay and Argentina in the South Atlantic Ocean, common bottlenose dolphins (*Tursiops truncatus*) that live near the shore

don't look like those that are further out to sea. They are longer, lighter and have a triangular dorsal fin, unlike the offshore dolphins' shorter bodies, darker skin and hooked dorsal fins.

The two kinds of common bottlenose dolphin also live differently from one another. Those near the coast form small groups in bays and estuaries and don't stray too far from home, while those offshore live in pods of hundreds and roam widely.

When Ana Costa at the University

of Glasgow in the UK and her team looked at the dolphins' skeletons, they found still more differences: the offshore dolphins had shorter and more plentiful vertebrae than the coastal variety.

Costa and her colleagues collected more than 250 tissue samples from common bottlenose dolphins of both groups off Brazil's

**"Bottlenose dolphins that live near the shore don't look like those that are further out to sea"**

coast and analysed the DNA. The results suggest the dolphins may be going down different evolutionary paths, separating into two species (*Journal of Evolutionary Biology*, doi.org/dhv8). The genetic analysis found differences in a small portion of the dolphins' genomes that experience fast rates of change over evolutionary time.

"All the findings so far are demonstrating that we are observing two dolphin groups in the process of speciation," says Costa. ■

Jake Buehler

# URGENT APPEAL: help Syrian refugee parents like Khitam to protect their children through the winter.



**Khitam lives with her children, husband Abdelsalam, and his elderly parents in a single, damp room of a half-built apartment block near Tripoli, Lebanon.**

There are holes in the walls and ceiling, and they share a toilet with other refugee families crammed into the building. Khitam and Abdelsalam are mentally and physically exhausted after years of struggling to survive, unable to earn a living and fighting a daily, relentless battle to feed their children.

Right now, they are terrified by the prospect of another winter in their cold, uninsulated single room. Another winter where they will feel every blast of icy wind. Another winter where every time their children cough or sneeze they will fear they have contracted a lethal respiratory condition like pneumonia or tuberculosis.

UNHCR, the UN Refugee Agency, needs your support

to help parents protect their children this winter.

**Please will you give £75 to provide a refugee family like Khitam's with a Winter Survival Kit to protect against the freezing weather?**

The kit

contains essentials such as a heating stove, thermal blankets, warm clothes and a tarpaulin for insulation. It could mean survival for a family like Khitam's.

Two winters ago, as a result of their exposed and unsanitary living conditions, Khitam and all of her children became ill. Baby Bilal had a high temperature and diarrhoea. Her sons Khaled (3, pictured) and Abdul Rahman (8) had chest infections and their sister Fatimah (4) contracted worms. Khitam herself



*"Living here, in these conditions, I cannot keep my children healthy."*

developed painful growths on her throat and lost her voice. Without access to a free healthcare system like we have in the UK, Khitam became overwhelmed with worry about how to pay for the treatment and medicines her children needed.

**"I felt helpless. My children were coughing and crying and there was nothing I could do."**

Khitam believes that

without assistance from UNHCR "my children would be dead".

Across Lebanon and Jordan, seven of the last eight winters have brought heavy snowfall and temperatures regularly drop below 0°C.

Right now, with the conflict continuing in Syria, 1.7 million refugees in Lebanon and Jordan remain unable to return home. They are living, like Khitam's family, in derelict buildings,

or in makeshift shelters made of little more than wood and plastic sheeting. With temperatures falling, the lives of the most vulnerable – young children, pregnant women and the elderly – are at grave risk.

**With a gift of £75 you can provide a Winter Survival Kit containing a stove, blankets, warm clothes and a tarpaulin to help a family insulate and heat their home. Please give today – you could save the lives of children like Khitam's.**

**100mph.**  
Wind speed during Storm Norma, Lebanon, January 2019.

**Give £75**  
to provide a Syrian refugee family with a Winter Survival Kit

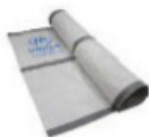
Visit [unhcr.org/wintersupport](http://unhcr.org/wintersupport) or call 0800 029 3883

**With £75, you can give a Winter Survival Kit containing:**



**STOVE**

For heating and cooking. An absolute essential.



**TARPAULIN**

For insulation. Keeps the cold out and the warmth in.



**BLANKET**

Families left their homes with nothing. A simple blanket could save a life.



**WARM CLOTHES**

Hats, gloves and scarves keep families warm, indoors and out.

**Yes, I will help Syrian refugee families survive the winter**



Please accept my gift of: ☐ £75 ☐ £150 ☐ £225 My own choice of £

Please post urgently to: **Freepost UNHCR**. You do not need a stamp.

NSCPAW119B

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Card no.     -     -

Valid from   -   Expiry date   -   Issue no.

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Environment

## China getting to grips with problem of water pollution

CHINA has made huge strides in cleaning up its rivers and lakes over recent decades.

While major waterways such as the Yangtze river still suffer from pollution, a big study has found that government policies since 2001 have significantly improved average inland water quality.

Between 2003 and 2017, the annual mean chemical oxygen demand, a measure of the level of pollutants in water, fell by 65 per cent. Levels of ammonia, which can run off from farmland, dropped more sharply, by 77 per cent. Dissolved oxygen, which shows how much oxygen is available to river life, rose by 14 per cent.

The study, led by Ma Ting at the Institute of Geographic Sciences and Natural Resources Research in Beijing, also looked at discharges

of pollution from factories, farms and other sources over the period. It found that reductions almost entirely explained the advances in water quality. "Our results confirm the effectiveness of massive environmental efforts, notwithstanding rapid urbanisation and economic growth," says Ma.

Independent Chinese experts say the findings support official reports by China's environment ministry, and that the state's pollution policies appear to be working.

Still, difficulties remain. While pollution from industry and urban homes is down, discharges from rural homes have received less attention and rising pollution from livestock farming poses an "increasing challenge", say the authors (*Science Advances*, doi.org/dhvv). **Adam Vaughan**



TEHENG KOON/GETTY IMAGES

Infections

## Intravenous vaccine may help defeat TB

GIVING our only vaccine against tuberculosis via veins rather than the skin might drastically increase its potency and prove crucial to efforts to eradicate the disease.

TB is the leading cause of death from infection, killing 1.5 million people globally each year. But the BCG vaccine, given at birth or early in life, isn't very effective against infections via the lungs as we age.

Robert Seder at the National Institute of Allergy and Infectious Diseases in Maryland and his colleagues found this could be because of the way the vaccine is given. The standard approach is to inject it into the skin. But in monkeys, it turns out to be more effective when delivered via a vein.

Nine out of 10 monkeys that had the vaccine intravenously were protected from the disease when exposed to it six months later. Just two out of 10 monkeys that

received the vaccine into the skin were protected. Monkeys given the vaccine via veins also showed much higher levels of T-cells in the lungs, a key part of the immune system's protection against TB (*Nature*, doi.org/dhr7).

The reason for the difference seems to be that giving the vaccine via the skin generates T-cells locally there, and only some of these circulate to the lungs where they can combat a TB infection. The intravenous route sees the vaccine go to lymph nodes around the body, and the spleen and the lungs, where it generates T-cells at the site of infection.

Tests in humans could be around 18 months off, says Seder. There are still issues to iron out: for instance, it might be hard to organise a mass inoculation programme that delivers a vaccine directly to veins. There are safety considerations too. "It's potentially a game changer if we show we can administer it safely," says Seder. **AV**

Ancient humans

## The real Paleo diet included lots of carbs

CHARRED fragments found in 170,000-year-old ashes in a cave in southern Africa are the earliest roasted root vegetables yet found. The finding suggests the real "Paleo diet" included lots of roasted vegetables rich in carbohydrates, similar to modern potatoes.

In 2016, Lyn Wadley at the University of the Witwatersrand in South Africa and her team found dozens of bits of charcoal in an ash

layer in the Border cave in South Africa, the remnants of ancient fires lit by early humans.

By studying the charred remains of modern plants under a microscope, the team was able to identify the charcoal as being the rhizomes – or buried stems – of a plant from the genus *Hypoxis* (*Science*, doi.org/dhr4).

The rhizomes of *Hypoxis* plants can be as rich in carbohydrates as potatoes, although they taste more like a yam, says Wadley. They are still eaten today, though they have become rare as a result of over-exploitation.

The abundance of the rhizome fragments suggests that roasted root vegetables were a common part of the diet, contrary to the popular notion that early humans ate a lot of meat. Most versions of the modern Paleo diet, supposedly based on what our ancestors ate, advise people to avoid potatoes as well as grains. "I'm afraid the Paleo diet is really a misnomer," says Wadley. **Michael Le Page**

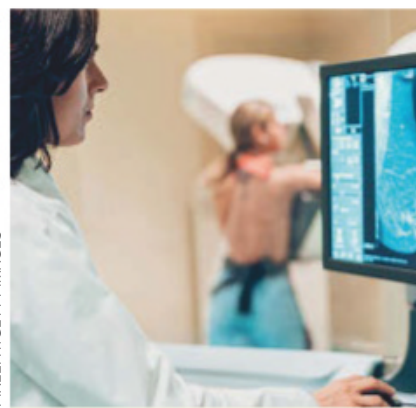


OLHA AFANASIEVA/AMY STOCK PHOTO





## Really brief



PIXELT/GETTY IMAGES

### Google AI better at breast cancer check

An AI trained on 91,000 mammograms taken from women in the UK and US is better than a radiologist at spotting signs of breast cancer. The team at Google Health tasked the AI with analysing 28,000 other mammograms and found it resulted in fewer errors than a doctor (*Nature*, [doi.org/dhrz](https://doi.org/dhrz)).

### 'Golden rice' gets the go-ahead

The Philippines has become the first country in which diets are seriously deficient in vitamin A to approve "golden rice" as safe for humans and animals to eat. According to a government report, the rice, which is genetically modified to boost vitamin A, is as safe as conventional varieties.

### UK electric power goes green

Last year was the first in which low-carbon sources of electricity eclipsed those based on fossil fuels burned in the UK. Wind, solar, nuclear power and imports supplied 48.5 per cent of electricity, while 43 per cent came from UK coal and gas power plants. In 1990, three-quarters of power in the UK came from fossil fuels.

## Palaeontology

### Tiny tyrannosaur just teeny *T. rexes*

SKELETONS held up as evidence that *Tyrannosaurus rex* shared its environment with a tiny lookalike species may just be young *T. rexes*.

Two sets of bones, one nearly complete, were discovered in rocks of the Hell Creek Formation, which spans Montana, Wyoming and North and South Dakota.

The more complete specimen is nicknamed Jane, and the other Petey. Along with one other small skull found in 1942, they have been

used to argue for a new species of dinosaur called *Nanotyrannus*, which was like a *T. rex* but smaller.

As researchers performed more detailed analysis of the specimens, it seemed increasingly likely they were just young *T. rexes*, but there was still some dispute. The newest analysis by Holly Woodward at Oklahoma State University and her team may settle the matter.

All modern vertebrates have a period every year when bone growth briefly pauses. We don't know exactly why this happens, but it leaves a circle in every bone like tree rings that shows when the

growth stopped, says Woodward.

Woodward and her team counted the rings in Jane and Petey's leg bones. They found that Jane was probably around 13 years old and Petey about 15 when they died (*Science Advances*, [doi.org/dhr8](https://doi.org/dhr8)).

Other fossils, such as Sue, one of the largest and most complete *T. rex* skeletons found, have shown that these animals lived to around 30. That makes Jane and Petey adolescents. Because they are so young, the authors say there is no need to invoke a new species to explain their size. **Leah Crane**

## Zoology



COURTESY LAUREN SUMNER-ROONEY

### Eyeless brittlestars may 'see' thanks to colour-shifting skin

MARINE animals called brittlestars may see without eyes by changing the hue of their bodies.

We already knew that brittlestars have photoreceptors on their bodies but not exactly how they worked. To learn more, Lauren Sumner-Rooney at the University of Oxford and her team looked at two related species of brittlestar: *Ophiocoma wendtii*, which can turn towards light, and *Ophiocoma pumila*, which can't.

They wanted to see whether the animals could "see" contrast in a scene, rather than just differentiate between light and dark. To test this, they used a tank in which the light level on the floor was fixed but

some bits of the wall were darker.

They found that *O. wendtii* was able to seek out darker bits of tank wall, but *O. pumila* couldn't. Sumner-Rooney says this skill may make it easier to hide in complex environments.

*O. wendtii*'s ability to "see" may be down to its colour-changing skin. The team suggests that in light, the animal's pigment-containing cells constrict its photoreceptors. This means that it can only receive light from one direction, giving it more detailed information about contrast in its surroundings (*Current Biology*, [doi.org/dhr3](https://doi.org/dhr3)). **Jason Arunn Murugesu**

## Dermatology

### Key to allergic rash may have been found

A PROTEIN in skin may explain why cosmetic products cause rashes – and it could help us prevent such allergic reactions.

Annemieke de Jong at Columbia University, New York, and her colleagues wanted to work out why substances in perfumes, toothpaste and skin creams can trigger problems. Through a series of tests, they discovered that many allergens in them were able to bind to a molecule in skin called CD1a. This molecule then activates immune system T-cells, which in turn cause an allergic reaction (*Science Immunology*, [doi.org/dhvw](https://doi.org/dhvw)).

But the binding to the skin protein is reversible, suggesting allergic reactions could be stopped. "If you could find a way to outcompete these allergens binding to CD1a, there would be no allergic reaction," says de Jong. The research was done in a dish, so the next step is to look for a similar response in human skin.

Sara Brown at the University of Dundee, UK, says if these findings lead to a treatment, "it would be a great help to many patients whose skin allergies can currently only be prevented by avoiding what they have become allergic to or by using steroids". **JAM**



## Climate change

# Flying scared

The aviation industry is finally waking up to its reputation as a major climate villain. But is it too late, asks **Adam Vaughan**

IT IS a bad time to be working in aviation. The past year has seen Greta Thunberg travel the world while shunning planes, climate protesters occupying airports and the *Flygskam* (flight shame) movement on the rise.

The aviation industry has been under pressure to cut its climate change impact for some time, but the pressure is growing. At a meeting near Geneva airport in Switzerland last month, the International Air Transport Association (IATA) warned that, without faster action on emissions, the industry faces a shift in public attitudes and countries unilaterally imposing environmental taxes.

France has already put a modest “eco-tax” on outward-bound flights beginning this month, and Sweden imposed one last April. Even the UK, the third biggest departure country in terms of aviation carbon dioxide emissions, saw frequent flyer taxes proposed in the recent general election battle. Environment pressures don’t yet pose an existential threat to the industry, but it is anxious.

The problem isn’t so much current aviation emissions, even though at between 2 and 3 per cent of the global figure they account for more emissions than the whole of Germany. The real issue is the rate of growth. China and India’s flight numbers are increasing 10 per cent a year. Global aviation CO<sub>2</sub> emissions have climbed 27 per cent in the past five years, to 936 million tonnes in 2019 (see chart, right).

There are signs that Greta and *Flygskam* are having an impact. Emissions from flights in Sweden – a proxy for flight numbers – fell in the first half of 2019. Alexandre de Juniac, CEO of the IATA, rejects the idea that *Flygskam* is solely to blame, arguing that it isn’t



JINGYING ZHAO/GETTY IMAGES

## Global flight numbers continue to climb, as do carbon emissions

possible to tease out its effects from those of Sweden’s aviation tax and weak economic growth.

However, figures from the Netherlands show the same trend, and recent numbers reveal that flights between German cities were down 12 per cent in November compared with a year before, while rail trips were up.

Faced with these headwinds, aviation is turning to technology and carbon offsetting (see “No silver bullet”, right) to clean up its act – and ward off more regulation.

The industry thinks biofuels will be a big part of the answer. The IATA prefers the term sustainable aviation fuel: biofuels that don’t compete with food production. Such fuels can cut emissions by 70 or 80 per cent when raw versus fossil fuel-based kerosene,

with which they are blended.

Some of these fuels are made from waste animal fat and used cooking oil but others contain controversial materials, such as palm oil, which is linked to deforestation. Henrik Erämetsä at Neste, which makes biofuel for European and US airlines, says they don’t use palm oil because customers don’t want it. But

**“Without faster action on emissions, the aviation industry faces a shift in public attitude”**

attitudes differ globally. The chief executive of AirAsia recently said the airline is a “big supporter for palm oil”.

Even if greener fuels can avoid environmental side effects, they still face two big problems. The first is scale. About 220,000 flights have used the fuels since 2008, which sounds like a lot until you

consider that there were 39 million flights in 2019. Biofuel accounts for just 0.01 per cent of all aviation fuel used today. The IATA says the share could rise to 2 per cent by 2025, but only if governments provide incentives.

Price is the other hurdle. Biofuels typically cost three times the price of fossil fuels. Asked when greener alternatives will reach price parity with kerosene-based jet fuel, Erämetsä is blunt. “The short answer is never. We just have to appreciate the fact the renewable fuels are more expensive.”

What about embracing electrification instead, as car manufacturers are rapidly doing? The only electric planes in development today are a long way from commercial jumbo jets. Models such as the Alice by Israeli start-up Eviation will carry nine passengers. Rolls Royce hopes its ACCEL model will set the speed record for an all-electric plane in

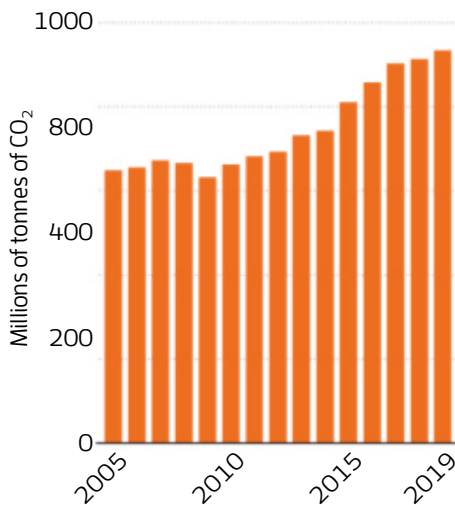
the first half of the year; it has a single seat. The firm is one of a group working to certify an electrified version of a nine-seater Britten-Norman plane by 2022.

The reason companies are starting small is simple: weight. The kerosene jet fuel powering the gas turbine engines on today's planes is much more energy dense than batteries, says Duncan Walker at Loughborough University, UK. Kerosene holds around 42 megajoules per kilogram compared with at most 1 megajoule per kilogram for a lithium-ion battery. And unlike batteries, as fuel is burned during the flight, the weight decreases, boosting efficiency.

Electrifying small planes will do little to reduce aviation's CO<sub>2</sub> emissions, says Walker, but he thinks they are a legitimate stepping stone for testing the technology. Richard Goodhead at Rolls Royce sees promise in electrification at all scales, but says it will be difficult. "The bigger the

## Up, up and away

Global aviation emissions rose again in 2019



SOURCE: IATA

aircraft is, and the longer it flies, the more challenging it is to use a purely electric solution," he says.

A key test for electrified planes will take place in 2021, when Airbus hopes to fly the E-Fan X, a plane the size of a regional airliner, with one of the engines swapped out for an electric motor, albeit powered by a gas turbine in the

plane's fuselage. It will allow the firm to test voltages much higher than normal in planes, to keep electricity losses to a minimum. The low pressure and high altitude environment of a plane mean high voltages pose technical challenges, including higher temperatures and electric discharge.

With today's technology, a pure electric plane would have no space for passengers, says Sandra Bour Schaeffer at Airbus, because the batteries would take up the entire structure. But she says the firm will have a fully "decarbonised plane" ready by about 2035, which could involve other technologies, potentially even hydrogen.

Realistically, hybrid electric and fully electric planes are about 40 years away, says Walker. This is partly because the safety-focused production cycles of the big plane makers mean it takes some 20 years for the likes of Airbus and Boeing to produce a new model.

There are other ways aviation can cut emissions. But they are either incremental – more efficient engines, better management of air traffic and ways to cut fuel during take-off – or unlikely to happen for reasons of cost, such as advanced planes that look radically different from today's fixed wing designs.

The industry may want to get less heat for its climate change impact but the technology just isn't mature enough to fix its footprint any time soon. Quick, deep cuts in carbon emissions only look likely to come from people following Greta's example and the industry accepting slower growth. During three and half hours of debate in Geneva, that idea was never aired. ■

Adam Vaughan's travel to Geneva and accommodation were paid for by the IATA

## Working hypothesis

Sorting the week's supernovae from the absolute zeros



### ▲ Aliens

**Helen Sharman, the UK's first astronaut, says aliens may be on Earth right now, unseen. If so, hello! Sorry about the mess.**

### ▲ Puffins

**Itchy feathers have driven puffins to tool use. The birds have been spotted scratching with sticks in Wales and Iceland.**

### ▲ Ethical veganism

**A UK tribunal has ruled that ethical veganism – a lifestyle avoiding all forms of animal exploitation – is a legally protected philosophical belief.**

### ▼ Paddlefish

**One of the world's largest freshwater fish species, the Chinese paddlefish, has been declared extinct. The last known sighting was in 2003.**

### ▼ AI fridges

**At CES, the annual gathering of gadgets no one would possibly want to buy, Samsung and LG have unveiled AI fridges that tell you what is inside. Food, probably.**



TOP: AF ARCHIVE/ALAMY STOCK PHOTO; BOTTOM: SAMSUNG

## No silver bullet

Starting this month, airlines will have to offset any growth in their carbon emissions, although not their existing, sizeable emissions. It is part of a 2016 deal brokered by the UN. The industry says airlines will fund reforestation and clean energy projects worth about \$40 billion over the next decade.

Kai Landwehr at Swiss offsetting group MyClimate says carbon offsetting isn't a silver bullet for the aviation industry. "But it is a proven and impactful and measurable system. It buys us time before we are ready to decarbonise."

Some airlines are also choosing to offset passengers' flights for

them. British Airways has started offsetting all domestic flights this year. Easyjet recently began offsetting all its flights.

Landwehr calls Easyjet's move bold, saying its cheap offsets, which cost just £3 per tonne of carbon dioxide, may not guarantee the money goes to new projects, which is crucial for real offsetting.

"We have a rigorous process to select the schemes we buy credits from," says an Easyjet spokesperson. "These accreditors check projects to ensure the carbon reductions they are claiming would not have happened without the offsets."



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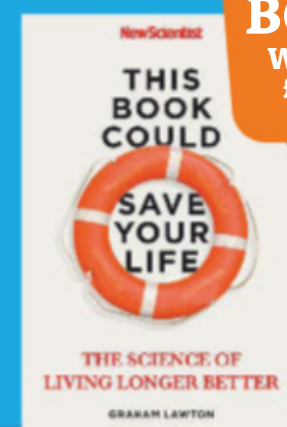


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Putting microplastics in their proper proportion **p26**

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Beautiful close-ups of big cats aim to raise awareness **p28**

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Busting myths at London's Vagina Museum **p30**

## Culture columnist

Sally Adee on a new crop of time-travel fiction **p32**

## Comment

# Make deniers your friends

Our experience talking to flat-Earthers shows science must embrace its critics, argue **David Westmoreland** and **Connor McCormick**

**T**HERE are about 3 million people in the US who believe our planet is flat. Buoyed by social media and increased publicity due to the Netflix documentary *Behind the Curve*, their numbers are growing. You should meet them. If you do, they are likely to ask: "How confident are you that the Earth is round? How do you know?" What would you say?

We have a better idea than most. For the past year, we have met regularly with our local flat-Earth group. We gather in a cafe around a flat table, marked by a sign of yellow Lego bricks shouting "FLAT EARTH" on a green background. Passers-by throw furtive glances at the sign, then at us.

The meetings are intriguing. The flat-Earthers aren't joking. They honestly believe that Earth is flat and stationary, that satellites don't orbit and that Antarctica isn't a real continent, but a ring of ice encircling the planet like salt on a margarita glass.

It isn't that they are ignorant about science – certainly not compared with the average citizen. The Pew Research Center recently reported that people in the US scored an average of 6.7 out of 11 on a multiple-choice science quiz. We gave it to 20 of our flat-Earther friends. Their average score was 10.

But they do question everything about mainstream science. Flat-Earthing is like buying internet service. It comes with optional extras: denial of gravity, anti-vaccination allegiance, rejection of



Albert Einstein's relativity. People bundle, picking and choosing the package they like best.

Some of this is commendable. A questioning attitude is, after all, a distinctive mark of rationality and central to the empirical process. Flat-Earth activists stand out among science deniers in setting up instruments, taking measurements and sharing results. We have collaborated with them to try to determine whether a lake's surface follows a round planet's predicted curve, and how much shadows lengthen at higher latitudes on the winter solstice, with as-yet inconclusive results.

True, these "experiments" may be poorly designed. But flat-Earthers care about truth, even if their conclusions differ from our own.

Our interactions have mellowed our attitudes. The meetings are a blast. We leave each one with questions that we would have never thought to ask, and thinking of new ways to defend our scientific beliefs. We haven't converted anyone yet, but we have convinced them to retire some of their weaker arguments.

Social psychologists talk about "cultural cognition", the inherent human distrust of information from outside our social groups.

In a world where information sources are overwhelmingly social, we all risk building belief echo chambers. Belief in a flat Earth is just one instance of this.

Of course, it is a fairly inconsequential one, compared with the harms of anti-vaccination beliefs, say. But those of us who want to respond to science deniers have a choice. We can ignore and ridicule them, or we can engage them on the common ground that we are all seeking truth.

Our General Theory of Anti-Conspiracy is this: "Science can't be your enemy if scientists are your friend." Too frequently, science is seen as an impersonal imposition on belief, rather than a way to resolve disagreement with people you care about.

So this is our suggestion. Search online for your local "flat Earth" or "vaccine alternatives" group and spend an evening with people you have only seen demonised and debunked on YouTube – not as an antagonist, but as a friend. When they ask why you're there, tell the truth: "I don't believe in what you believe, but I'm open to being wrong and I want to hear what you have to say." Try it. It might just begin to change some minds. ■



David Westmoreland is a biologist at the US Air Force Academy and Connor McCormick a software engineer at Lot Spot in Colorado Springs



## No planet B

**A pivotal year for the environment** Three crucial events in 2020 will set the direction and scope of long-term global action on climate change and biodiversity, writes **Graham Lawton**



Graham Lawton is a staff writer at *New Scientist* and author of *This Book Could Save Your Life*. You can follow him @grahamlawton

### Graham's week

#### What I'm reading

*Not a lot because I'm hooked on two great true crime podcasts instead: Season 2 of In The Dark, about a man who has been tried for the same murders six times, and The Dropout, the jaw-dropping story of the rise and fall of biotech company Theranos.*

#### What I'm watching

*Steven Moffat and Mark Gatiss's stylish adaptation of Dracula on the BBC.*

#### What I'm working on

*I am busy promoting New Scientist's latest book, This Book Could Save Your Life – rising up the Amazon charts.*

This column appears monthly. Up next week: Annalee Newitz

**W**ELCOME to 2020, the year that began with Australia in flames and its leaders in denial, and could end with the whole world facing the same predicament.

To say that this is a pivotal year for the environment is no exaggeration. To borrow a sporting analogy, it is crunch time, with three knife-edge fixtures that will establish the direction and scope of global action for years to come – and with it, maybe the habitability of the planet.

The first big one is the biodiversity convention in Kunming, China, in October, where the UN and heads of government will set new targets for protection of the natural world. That will be quickly followed by climate talks in Glasgow, UK, in November, where world leaders (probably minus the US) will reconvene to finalise their commitments. Sandwiched between them is the most important US general election since, well, the last one.

It is always tempting to hype up forthcoming fixtures as “vital” or “last-gasp”. But the importance of these three can be in no doubt. If they go the wrong way, our last best shot at turning things around will have been lost, and the future will look bleak. In the event that they go well, maybe we will look back on 2020 as the year the penny finally dropped.

So what is at stake? Let's start in Kunming. This really is a vital one because the current global system for biodiversity conservation, called the Aichi targets, expires this year and is up for renegotiation. Those ambitious targets set out to halt the loss of biodiversity within a decade and make progress towards reversing it, as per the UN's goal of living in harmony with nature by 2050.

Unsurprisingly, they haven't been going well.

An assessment published halfway through the 10-year programme warned that countries were failing miserably and that the targets were already slipping out of reach. It fell on deaf ears: it is now inevitable that most of the targets will be missed. According to a paper published in *Science* last month, of the 54 components of the targets, only five can report good progress, while 21 have seen poor progress or gone backwards.

Even the bright spots carry a health warning. Yes, 15 per cent of land and fresh water and

### “The US elections could mean business as usual under a re-elected and re-energised Donald Trump”

7.5 per cent of the ocean are now protected – not far off the respective targets of 17 and 10 per cent – but they are often poorly managed and still leave too many important biodiversity hotspots unprotected.

All of which make Kunming away a really tough fixture – yet a winnable one. The host nation, China, is setting it up as a global test of its “ecological civilisation” vision for transformative change across all sectors of society. What emerges from the meeting will tell us a lot about who is in the ascendancy, especially whether China really can take global leadership on the environment.

Which brings us to the Glasgow climate negotiations. These are slightly less crunchy than the biodiversity talks, but are still the most important fixture since Paris 2015, when negotiators won an unexpected victory by agreeing

to hold warming to well below 2°C. Since then, however, the game has reverted to type. We are still on track for at least 3°C of warming and the most recent talks, in Madrid last month, achieved little but a return to loggerheads and can-kicking.

Can we expect any better this year? Much hangs on whether the US's expected withdrawal from the Paris deal – due to be confirmed just before Glasgow – precipitates its renegotiation, a collapse of the entire system or renewed determination to get it done without the US. On those issues, expert opinion is divided.

A day before the withdrawal, there is another huge fixture: the US election, which will decide not only the next president but also who controls Congress. There are many unknowns between now and then – not least who will be on the presidential ballot – but one possible result is that the Democrats win the White House and retain the House of Representatives. That could fire the starting pistol for the Green New Deal, a gigantic infrastructure project designed to turn the US economy into a powerhouse of sustainable prosperity and a model for how to transform the world. Or it could be business as usual under a re-elected, re-energised and unimpeachable Donald Trump.

How these three crucial fixtures pan out is still anyone's guess. Mine is that we end 2020 in an even worse state than we started it: lofty new commitments but no real action on biodiversity, still no meaningful climate agreement and the New Green Deal dead in the water. But maybe I'm being deliberately pessimistic. As any sports fan will tell you ahead of a crunch, it's the hope that kills you. ■

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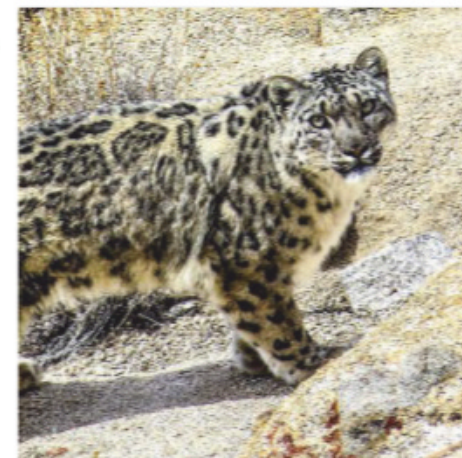


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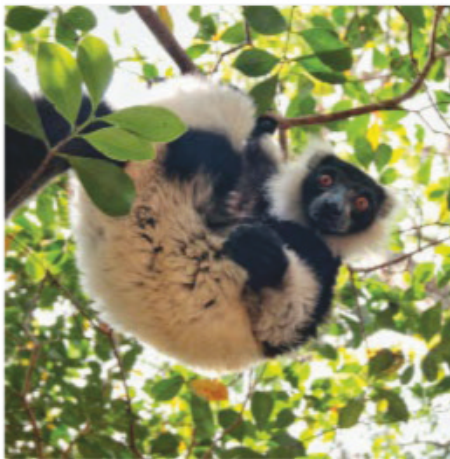
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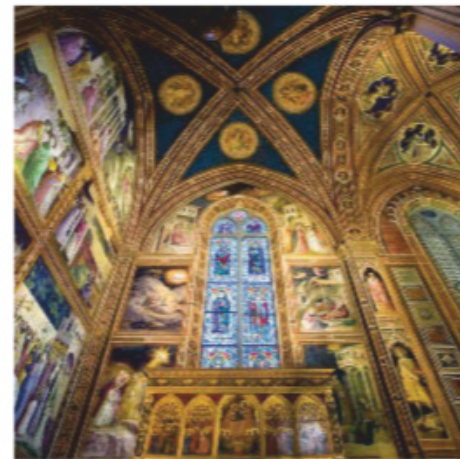
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## Editor's pick

### When I couldn't think without language

Letters, 7 December 2019

From Lyn Antill,

Church Stretton, Shropshire, UK

**Max Starkey says he is bilingual and thinks in concepts and images, rather than either language. My experience is different.**

When I came round in hospital after a stroke, I was relieved to be able to understand what had happened and what was said to me, and also to be able to consider what might come next. I busily made plans for my recuperation and tried hard to convince my husband that I still had my wits about me. Unfortunately, I couldn't string together the words to explain this, despite knowing they were on the tip of my tongue.

Over the next few days, I came to a realisation. Although my thoughts were clear and even insightful, without access to a mental running commentary I couldn't organise them into a narrative. They remained vivid, but individual, scenarios in my working memory, with the usual limitation on how many "items" can be held in this system at any one time.

Every time I tried to follow a line of thought, I realised after a few steps that I had forgotten where I started. This made me very aware of the importance of language in enabling us to manipulate our thoughts, as well as in communicating them to others.

### Putting microplastics in proper proportion

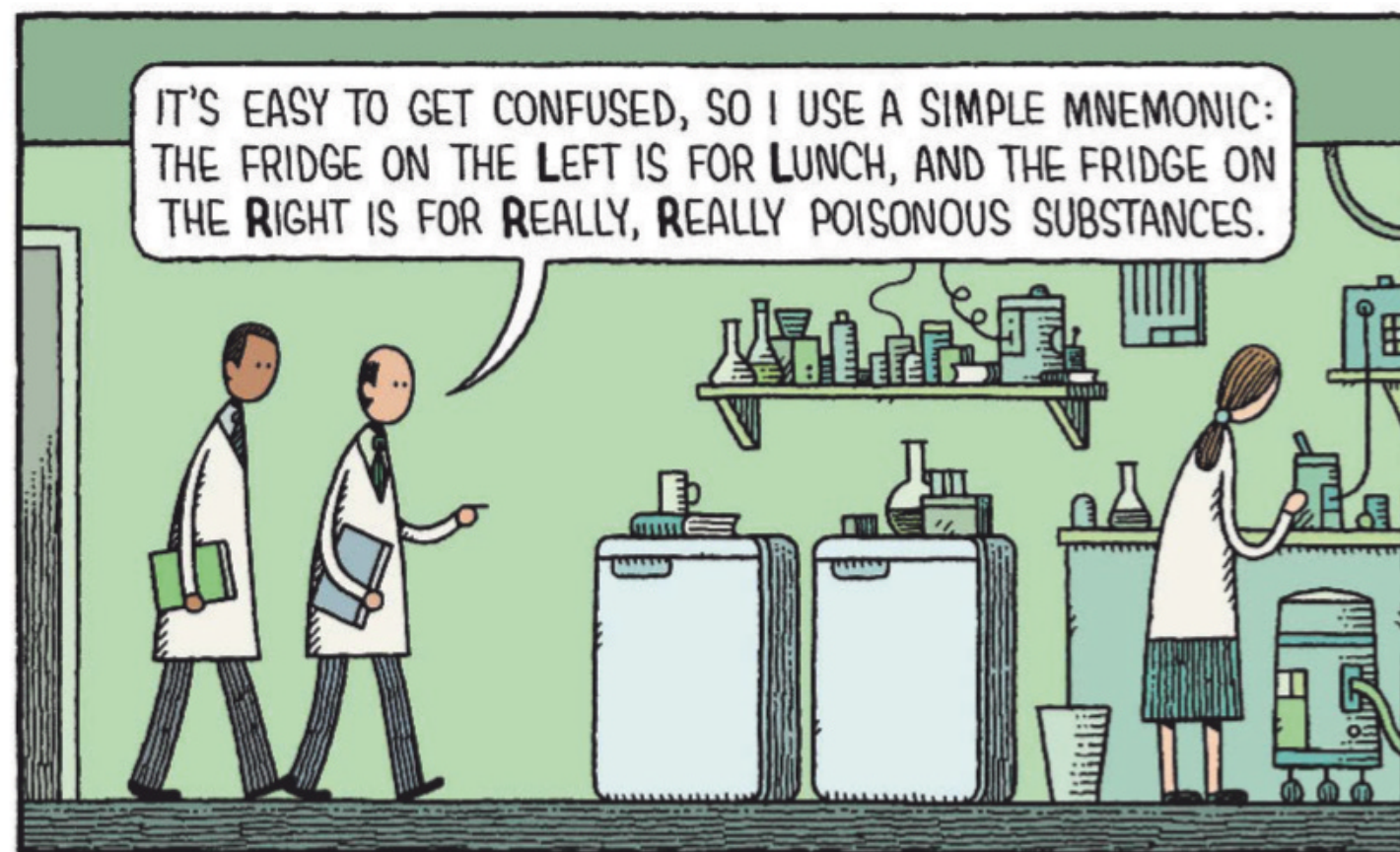
7 December 2019, p 38

From Martin Bide,

Hope Valley, Rhode Island, US

Textile fibres are a significant source of microplastic pollution, as Graham Lawton points out. Beyond the many unknowns and confusions outlined in the article, textiles provide one more.

Humans have lived with textile fibres for millennia, and we are all familiar with the dust and lint



TOM GAULD for NEW SCIENTIST

that accumulate in our homes. Exposure to such particles shouldn't come as a surprise.

Around a quarter of the fibres we use today are cotton, and a lot of the microfibre materials that appear in the environment are cellulosic, such as natural cotton and manufactured rayon.

One study found that about 80 per cent of microfibres in ocean sediment are cellulosic ([doi.org/gfk57x](https://doi.org/gfk57x)). Surely these materials, too, are ingested and are capable of releasing dyes and chemicals used in their manufacture? Or are we giving "natural" materials a pass?

From Peter Urben,

Kenilworth, Warwickshire, UK

Lawton mentions plastic particles smaller than a nanometre. As atomic diameters are about a tenth of a nanometre, a sub-nanometre lump should surely be a small molecule, not a polymer.

### A complete solution to plastic pollution

14 December 2019, p 28

From Hugh Boyd, Glasgow, UK

You write that, as yet, plastic removed by Mr Trash Wheel

from rivers flowing into Baltimore harbour can't be separated into reusables, so it is incinerated to generate electricity. Recycling is fine, but it only postpones the day when the plastic starts to break down into smaller and smaller pieces. Incineration completes the life cycle of plastic from ancient sunshine energy to energy for present-day use, getting rid of the incinerated plastic completely. There are social problems, but these can be overcome by, for example, building incinerators far from housing.

### The dynamics of a brewery in a gastrointestinal tract

26 October 2019, p 14

From Roger Lord,

Brisbane, Australia

I read with interest the case of a man who was intoxicated due to a gastrointestinal tract (GIT) infection with brewer's yeast (*Saccharomyces cerevisiae*). The condition is thought to have arisen after prolonged antibiotic use, which would have decreased GIT bacterial flora and allowed an opportunistic infection with yeast.

What surprised me was that the

yeast continued to be a problem long after the antibiotic treatment had stopped. Yeast is a eukaryotic organism and I imagined that its cell division couldn't keep pace with that of prokaryotic GIT flora such as *E. coli*. Under anaerobic conditions, brewer's yeast has a doubling time of 90 minutes. The doubling time of *E. coli* is around 20 minutes under laboratory conditions, but has been estimated at 12 to 24 hours in the GIT, much slower than yeast. The apparent rarity of this type of infection suggests that the biochemical characteristics of the yeast strain are significant.

### How we nearly invented the internet in the UK

26 October 2019, p 34

From Roger Scantlebury,

Esher, Surrey, and

Peter Wilkinson, London, UK

You mention the fundamental technology of packet switching being developed in the early 1960s by independent groups of researchers in the UK and the US. Paul Baran's team at the US RAND Corporation came up with the idea of independently routed "message

blocks”, while researching ideas for networks that could survive attack for the US Department of Defense. At the UK’s National Physical Laboratory (NPL), Donald Davies’s work was motivated by the increasing availability of powerful computers and the need to facilitate remote access. We were members of a small team at the NPL that worked on a proposal for a 12-node national network.

Davies first published his ideas in 1965. One of us, Roger Scantlebury, outlined the proposal at a conference in Gatlinburg, Tennessee, in 1967. Another paper presented there summarised the US plans for ARPANET, without defining its intended communications technology.

After discussions at the conference, packet switching was adopted for ARPANET, which debuted in October 1969. A preliminary version of the UK’s first packet-switched network came into operation in January 1970 as a local network at the NPL.

In the UK, despite support from the IT industry, the government wouldn’t fund a wide-area network. The Post Office, which then had a monopoly on communications infrastructure, believed speech traffic would always dominate data traffic and refused to sanction use of its trunk network.

## All definitions of what constitutes life are false

16 November 2019, p 42

*From Michael Vandeman, San Ramon, California, US*  
Donna Lu reports on a search for unprecedented forms of life. But how can we tell what is alive?

In Canada, there are frogs that freeze in winter and thaw out in spring. During dormancy, are they alive or dead? If living, they don’t conform to any current definition of life. If dead, they shouldn’t be able to revivify in spring. While frozen, they do nothing.

Or consider seeds that were dormant for thousands of years and then sprouted when cultivated. If they had done

anything while dormant, they would have exhausted their store of energy and been unable to germinate. My conclusion is that it is impossible to distinguish life from non-life.

## Power lines, big berries, birds and nutrients

Letters, 23 November 2019

*From Emma Lamerton, Roche, Cornwall, UK*

The many hypotheses as to why berries found under power lines may be larger and juicier than those elsewhere are fascinating. Looking out of the window at birds on a wire makes me wonder about waste products from birds falling under the cables, adding fertiliser and perhaps making the berries less appealing to animals.

*From Anna Timmins, Perth, Western Australia*

Bird excrement contains nitrogen, potassium and phosphorus – all essential macronutrients for fruit production, as gardeners know.

*From Hazel Beneke, Bribie Island, Queensland, Australia*

While at school in the middle of last century, I remember learning that for deficient soils, power lines were a source of copper, which stimulated crop growth.

## Near-death experiences and burials are a mystery

23 November 2019, p 40

*From Steve Taylor, Leeds, UK*  
You suggest that near-death experiences (NDEs) may be caused by lack of oxygen to the brain. But this usually produces chaotic, hallucinatory experiences, confusion and memory loss.

NDEs are unlike this. They are serene, structured and well-integrated. It has been suggested they may be caused by psychedelic

chemicals released by the body, such as ketamine analogues or dimethyltryptamine. But there is little similarity between the experiences these produce and NDEs, and no evidence that they are released when a person is near death. NDEs remain a mystery, perhaps suggesting the view that consciousness is directly produced by the brain may be too simplistic.

*From Helmut Krueger, Munich, Germany*

Archaeological evidence for afterlife beliefs goes back at least 12,000 years, when bodies started to be buried with useful stuff to take to the other side, says Graham Lawton. But there are other reasons to bury such items.

Those left behind may gain a feeling of closure by burying their loved one with things they cherished. Doing so may prevent the hurt they would feel on seeing someone else using those items.

## Life with little sleep can be a mixed blessing

26 October 2019, p 18

*From Robert Chard, Wadeford, Somerset, UK*

I was interested in your article about those who need very little sleep. I am one such person and, at age 77, I would like to meet others. Some of my relatives and ancestors have or had the same ability.

In relationships, like attracts like. “Never sleepers” tend to have energy and stamina that others can find difficult to cope with. A “normal” child surrounded by those who need little sleep can feel very left out.

Among half a dozen of my relatives who need little sleep, I have observed shared traits of enthusiasm for endurance sports, ambidextrousness, some dyslexia, poor performance at school, high intelligence and an inability to

sing in tune. I hope this is of interest. I would be pleased to assist any researchers who contact me through *New Scientist*.

## More mammals that experience menopause

9 November 2019, p 16

*From Henryk Urbanski, Beaverton, Oregon, US*

Humans aren’t the only land mammals to undergo menopause. Adult female rhesus macaque monkeys (*Macaca mulatta*) have menstrual cycles of approximately 28 days. Those that live long enough experience menopause at some point between 24 and 29 years of age.

## Carbon-dioxide-eating bacteria are no free lunch

7 December 2019, p 19

*From Andrew Forrest, Epping, Essex, UK*

Gege Li reports work to modify bacteria so they consume carbon dioxide instead of sugars. This clearly requires energy: that would have to come from the sun or from chemical energy, and supplying the latter generally involves producing CO<sub>2</sub>. I would hope to see a more critical scientific assessment of the potential of such technology to remove CO<sub>2</sub> from the atmosphere. ■

## For the record

■ Brass is an alloy of copper and zinc, and bronze of copper and tin (14 December 2019, p 10).

■ A white dwarf star is made of atoms, and doesn’t collapse further because that would require their electrons to occupy the same energy levels, contrary to the rules of quantum physics (14 December 2019, p 15).

■ Cavitation consists of low-pressure bubbles forming in a fluid and then imploding (14 December 2019, p 16).

■ The flakes shedding from Jupiter’s Great Red Spot have an area of 100,000 km<sup>2</sup> (30 November 2019, p 11).



## Want to get in touch?

Send letters to *New Scientist*, 25 Bedford Street, London WC2E 9ES or [letters@newscientist.com](mailto:letters@newscientist.com); see terms at [newscientist.com/letters](http://newscientist.com/letters)





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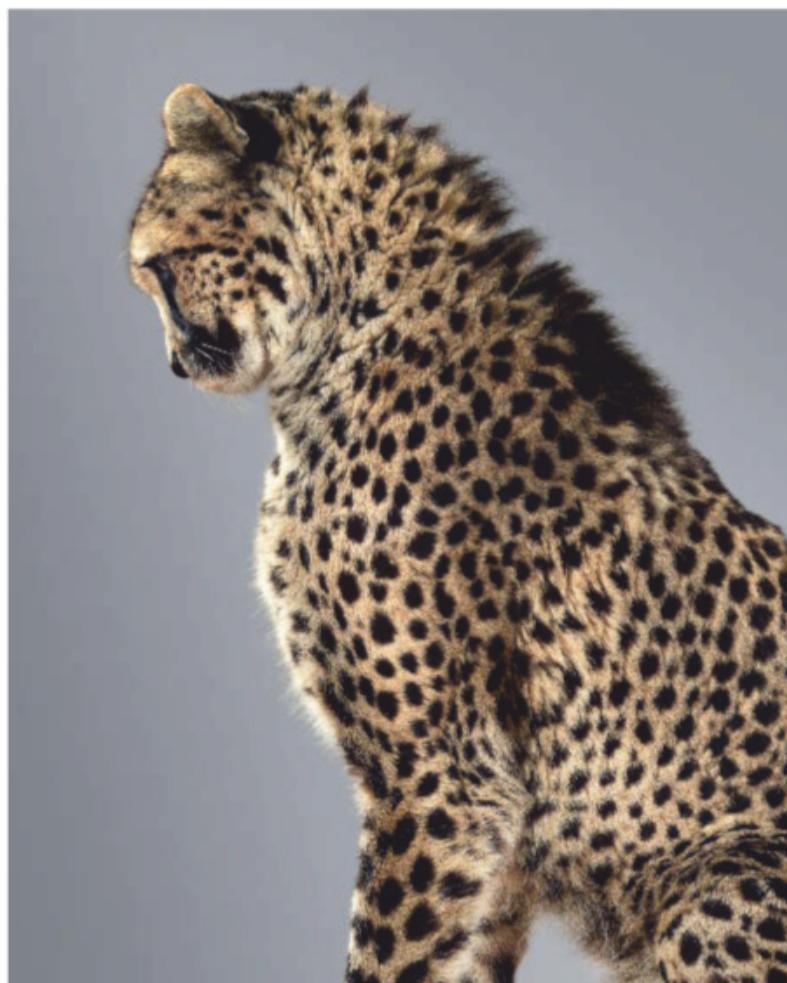


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## The real catwalk



### Photographer Perou

BEST known for his fashion photography and portraits of musician Marilyn Manson, Perou is used to capturing the wilder side of life. But these models are particularly fierce.

“I set up a photo studio to photograph these magnificent animals, much the same way I would photograph a rock star or a fashion model,” he says of his year-long stint at The Big Cat Sanctuary in Smarden, UK. He created a special room for the cats, in which they could come and go as they pleased.

Popping antihistamines to ease his cat allergy, Perou spent many hours feeding the animals, getting them accustomed to him. After six months, he feared he wouldn't get any decent pictures. But the process of adapting to each cat's personality began to pay off, and he was eventually able to take striking shots.

The jaguar (*Panthera onca*) on the far left is Maya. Despite her fearsome teeth, she is said to be affectionate. Moving clockwise, shy-looking Xizi is actually confident for an Amur leopard (*Panthera pardus orientalis*). Keene the cheetah (*Acinonyx jubatus*) ended up strangely interested in being photographed. Narnia is a rare white Bengal tiger (*Panthera tigris tigris*), which lack orange pigment because they have two copies of a recessive gene. Narnia needed a lot of time to become at ease in front of the lens.

Perou's project aims to highlight the plight of the cats, many of which are under threat in the wild. The portraits are on display at London Bridge station until mid-January and are currently being auctioned online. ■

Chris Simms



# V for Vagina

In 2020, surely we don't still need to learn about vaginas?

A new exhibition may make you reconsider, says **Clare Wilson**



## Exhibition

**Muff Busters:  
Vagina myths and  
how to fight them**  
Vagina Museum,  
Camden Market, London  
Until 29 March

A GIANT, red, glittery tampon is the first thing you see as you walk into the Vagina Museum, a small gallery that recently opened in London and claims to be the first of its kind. The point of this exhibition, Muff Busters: Vagina myths and how to fight them, is to educate visitors about human anatomy, as well as tackling taboos and giving people confidence to talk to doctors about their bodies.

When I first heard about the project, it sounded pretty old hat. Do we really still need this kind of consciousness-raising in the UK in 2020, where, until last year, the prime minister was a woman?

But when I visited the museum, it made me think again. A display of images celebrating the normal diversity of gynaecological anatomy may seem like a cliché, until you recall that, in recent years, there has been a fivefold rise in the number of labial reduction surgeries by the National Health Service in the UK. According to a recent report by gynaecologists, this is partially due to unrealistic representations in pornography. The problem seems to be that people don't know what typical genitals look like.

Other exhibits aim to bust myths. Contrary to popular belief, the hymen isn't a reliable indicator that a person has had sex. As a small area of mucosal skin around the edges of the vagina, the hymen may bleed a little when someone first has penetrative sex, but it usually doesn't. It is so naturally



ANGUS YOUNG

variable that one individual may have regular sex and still retain some visible hymen tissue, while another may never have had sex and yet have no hymen at all.

Nevertheless, this scrap of flesh has long been used to control the lives of girls and women the world over – and still is in some families. In November, US rapper TI said he took his daughter on yearly trips to a doctor to have her virginity

**“Contrary to popular belief, the hymen isn't a reliable indicator that a person has had sex”**

“checked”, something that is medically impossible and that critics called abusive.

Former advice columnist and social psychologist Petra Boynton says she had letters every week from distressed women being similarly policed by their partner or relatives, who often have no idea of the range in the hymen's appearance. One charity, the Swedish Association

for Sexuality Education, argues it should be renamed the vaginal corona, to help dispel the myth that it is a sheet that ruptures on penetration.

Even if a woman's virginity isn't being questioned, she may hear messages that her genitals are offensive in some other way. One exhibit displays various douches, sprays, lotions and potions marketed for cleansing or perfuming the vagina.

All are unnecessary, as vaginas are self-cleaning: they get rid of dead skin cells and bacteria by releasing a clear or white fluid, something that may cause disquiet but is really a sign that everything is in working order. In fact, such products can disrupt this efficient self-maintenance by changing the vagina's pH balance, thereby making infections more likely.

It would be nice to think the misguided idea that vaginas are inherently troublesome organs needing constant care is in decline. But this seems unlikely, judging by the success of Gwyneth Paltrow's lifestyle brand Goop,

**A glittery tampon takes pride of place at this myth-busting exhibition**

with its promotion of vaginal steaming and jade eggs.

The Vagina Museum is an initiative from crowdfunded activists, rather than doctors, and it shows. Some of its content strays from biology into ideology – tricky when it includes topics over which feminists clash, such as sex work or the removal of pubic hair.

And I can't help wondering if lecturing someone for using the “wrong” terms for their body – such as saying vagina for the external parts of their genitals, when the right term is vulva – is really the best way to boost their confidence. Isn't educating people about sexual health more important than policing their language?

Still, the fact that this exhibition, located in trendy Camden Market, has a different atmosphere to the capital's more traditional science museums may help it attract a wider audience. ■



# Around the mulberry tree

Unshackling the mulberry from its deep links with silk reveals an extraordinary species, finds **Adrian Barnett**



## Mulberry

Peter Coles

Reaktion Books

IN THE right hands, book series can be very satisfying. Reaktion Books has developed several over recent years. One of these is a delightful series called Botanical that aims to integrate the social, biological and historical contexts of a plant, tree or flower. It has provided excellent treatments of the yew, snowdrop, oak and primrose among some two dozen more. *Chrysanthemum* and *Berries* will appear later this year.

Right now though, in *Mulberry* by Peter Coles, we have a splendid account of one of the world's most celebrated trees, one that shows the events, people, historical twists and turns, and biological peculiarities that moulded today's species. Given the mulberry's long association with silk – silkworms will only eat the leaves of the white mulberry – Coles has a huge amount of material to draw on. A less able author might have pitched things too broadly, providing a shallow skim across the history of silk production, or gone to the other extreme, stuffing the book with stats on 18th-century embroidered silk ribbons.

Instead, Coles satisfies a number of audiences. For the historically minded, there are the origins of silk cultivation in India and China, and the various attempts – successful and otherwise – to introduce silkworms and their food plant to northern Europe. Those with an economic focus will like the analysis of how European governments tried penalties, persuasion and payouts to get landowners to plant mulberries (importing silk was

expensive), while discussions of the members of the genus *Morus* should please those with a botanical bent.

There is plenty of local history too, from the obviously well-travelled Coles. We learn how large parts of central Paris once sported mulberries, about the effect of the Lebanese silk industry on local agriculture, and the rise of the Cheney Bros silk empire in Connecticut. For UK readers, there is an invitation to spot ancient mulberry trees across London and the south-east, the remnants of royal attempts to breed silkworms.

Then there are wonderful oddities. Coles cites a master builder of wooden carousels as a source of information about the care of silk moth eggs in Greece, and explains how the Chinese grew mulberry trees on the banks between fish ponds, using fish faeces as fertiliser and tree leaves as fish food. And he tells us about the bloody symbolism of the black mulberry's juice-rich berries: from the legend of Pyramus and Thisbe in Ovid's Latin narrative poem *Metamorphoses* to the Hebrew work *1 Maccabees*, the berries are central in legends from Spain to Samarkand and beyond.

Not content with this, Coles explores the role of mulberry trees in everything from musical instruments, such as the Afghan *rubab*, to the production of the oldest banknotes and the uniquely lustred wood *shimakuwa*. One of the world's most expensive, it is derived from densely grained wood from mulberries found only on a small group of Japanese islands.

While mulberry fruits are used in foods and medicines, the leaves, with their powerful toxins inimical to all insects except the silk moth, are now the focus of serious pharmaceutical interest.

All this, and gorgeous mulberry-inspired art, is stitched together with elegant prose, quirky observations and a love of history's strangeness.

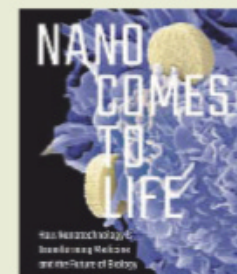
By the end, Coles has made an excellent case for the tree: "We often think of the oak or yew as ancient landmark trees, but perhaps the time has come for the humble mulberry, unshackled from its 5000 years of bondage to the silkworm, to take its place alongside them." ■

Adrian Barnett is a rainforest ecologist at the National Institute of Amazonian Research in Manaus, Brazil



The role of the mulberry tree in China is celebrated in this traditional picture

## Don't miss



## Listen

### Nano Comes to Life

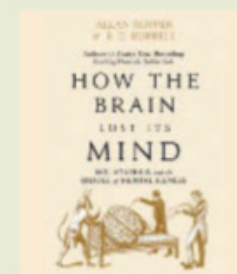
at London's Royal Institution at 7 pm on 13 January, when physicist and author Sonia Contera explains how nanotechnology will transform our health and extend our longevity.



## Visit

### The Lost Girl

from 13 January at Bush House Arcade in London, is an immersive, film-based installation by Kate McMillan, set in a future virtually abandoned by humanity. You can even explore the washed-up debris shown in the film.



## Read

### How the Brain Lost Its Mind

(Atlantic Books) by neurologist Allan Ropper and writer Brian Burrell explains how teasing apart two maladies, syphilis and hysteria, generated insights that underpin today's ideas about mental health.

THE PRINT COLLECTOR/ALAMY STOCK PHOTO

KATE MCMILLAN/ARCADE AT BUSH HOUSE



## The science fiction column

**Five minutes to midnight** A new crop of time-travel fiction has abandoned the genre's old paradoxes in favour of seriously messing around with timelines and asking how much of the world we're really responsible for, says **Sally Adee**



Sally Adee is a technology and science writer based in London. Follow her on Twitter @sally\_adee



JÜRGEN FÄLCHLE/ALAMY STOCK PHOTO

**Recent science fiction plays with the idea that time has no undo button**

between 90s California and the 1893 World's Fair in Chicago with shouty, urgent, "young adult" characters, though this accessibility doesn't make the book any less resonant. With a clever twist, Newitz kills off the classic time-travel paradox about one's inability to kill one's own grandfather: people can kill anyone they like, but as a consequence they become stranded in their new timeline, solitary, haunted guardians of the memories their edits erased.

The time structure that Gibson brings to *Agency* is the most thoughtful of these books, involving a clever, computational riff on the Copenhagen interpretation of quantum mechanics. We learn that one of the time branches thrown up by a malevolent continua enthusiast took place in 2017, and that this timeline is heading for nuclear war unless the police of 2130 can weave it back into the main trunk.

Why go to so much trouble to save people who are far removed from the here and now? The police will gain nothing tangible by intervening in the affairs of other timelines: their own world's past is unchangeable so none of its misfortunes can be reversed. What they have, instead, is the ability to enlarge their idea of who they are responsible for. Rainey, one of the characters from 2130 working to save the 2017 timeline from Armageddon, at one point needs to take a sick day because of timeline empathy sickness.

Gibson's novel comes the closest to showing us how we might think about the future we ourselves are editing, even now. The clue's in the title: *Agency*. ■



### Book

#### Agency

William Gibson

Viking

UK release, 23 January

### Sally also recommends...

### Book

#### This Is How You Lose the Time War

Amal El-Mohtar and

Max Gladstone

Simon & Schuster

Two agents from opposing factions in a time war fall in love over and across millennia.

### Film

#### Timecrimes

Directed by

Nacho Vigalondo

2007

This Spanish masterpiece, about a man trapped in a time battle with his other selves, rejuvenated the time-travel genre.

OVER the past couple of years, a meme has emerged according to which we inhabit "the worst timeline". Buried in this social media snark is the fear that time is actually running out for us on this planet, whether we're drowning under rising seas, fleeing fiery no-go zones or succumbing to the exotic pandemics we're told are learning to surf the advance of climate change.

Literary science fiction's rediscovery of time travel started with William Gibson's *The Peripheral* in 2014: a devastated future just beginning to get a tenuous grip on civilised life discovers a mysterious server that can branch new timelines off the main trunk. "Continua enthusiasts" use these timelines for games or sport, while a cop intervenes to rescue the branched timelines from the worst mistakes of the main one.

Over the past year, *The Peripheral* was joined by Annalee Newitz's *The Future of Another Timeline* and *This Is How You Lose the Time War* by Amal El-Mohtar and Max Gladstone. Now Gibson

has written a sequel to *The Peripheral* titled simply *Agency*. All offer ways for us to bootstrap ourselves out of a bad reality.

These new time-travel books make short work of the genre's earlier preoccupation with paradoxes. They rely on more-or-less rigorous science to build more interesting narrative structures, and spin intriguing ways by which we might twist time to our service.

**"One time branch from 2017 is heading for nuclear war unless it can be woven back into the main trunk"**

In *This Is How You Lose the Time War*, these twists are literal: time is a braid whose strands can be carefully and subtly rewoven to bring about profound change far down the line. But the only people capable of comprehending these labyrinthine relationships are warriors from a future so deep that they – and their priorities – are barely human.

Newitz, by contrast, zips





*What is consciousness?*

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# MYSTERIES OF THE HUMAN BRAIN

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# Easy ways to a better you

Self-improvement needn't be difficult. You can get a lot of benefit by simply tweaking the everyday things you do without thinking. Whether it is breathing, sitting, relaxing, eating, walking or defecating, there is often a way to do it better.

## BREATHING

IT MAY be the most natural thing in the world, but breathing is surprisingly easy to get wrong – and that matters more than you might think.

Most of the time, the right way to breathe is through your nose. The pointy thing stuck to your face is exquisitely designed to trap dust and other foreign bodies in its hairs and snot. Beyond your visible nose lies the nasal cavity, a cavernous space the size of a gaping mouth. This is lined with folded membranes designed to warm or cool the air to body temperature, add moisture and trap pathogens in yet more mucus. Your sinuses – air-filled spaces that connect to the nasal cavity – swirl the air around more and add nitric oxide, which kills bacteria and viruses and relaxes the blood vessels in the respiratory tract, allowing more oxygen to pass into the blood.

The upshot of all this is that nose breathing adds 50 per cent more air resistance than breathing through the mouth. That gives your heart and lungs a workout and increases the vacuum in your lungs, which allows you to draw in up to 20 per cent more oxygen than breathing by mouth.

As if that wasn't enough, nasal breathing boosts brain function too. Young mouth-breathing rats were slower to complete a maze than nose

breathers and, when they reached adulthood, they had fewer neurons in the hippocampus, a part of the brain important for learning and memory. Studies in people reveal that we also do better on memory tests when we breathe through our noses.

The explanation is that the nasal cavity has a direct line to the emotional and memory processing centres of the brain, via sensory neurons that connect to the brain's olfactory bulb. As well as carrying messages about scent, these neurons sense air moving in and out of the nasal cavity and lock brainwaves to the same rhythm. Synchronised brainwaves then spread beyond the scent-processing brain areas into regions responsible for memory, emotion and cognition.

### Nil by mouth

Many of us are missing out on these benefits. According to some estimates, more than 50 per cent of children and 61 per cent of adults breathe through their mouths too often. As a result, we also risk bad breath, poor sleep, learning difficulties, tooth decay and even malformation of the jaw.

If you suspect you are an accidental mouth breather, you could set an alarm to remind yourself to check how you are

breathing throughout the day. You can buy strips to tape your mouth shut at night. However, the evidence that this works is confined to one small study, which found that it reduced snoring and sleepiness in people with mild obstructive sleep apnoea.

As for how fast to breathe, if it is calm you seek, slow it down to about six breaths per minute. This triggers a reflex that widens blood vessels and reduces heart rate. Concentrating on a long, slow exhalation also stimulates the vagus nerve, which is in charge of the rest-and-digest response, the opposite of fight or flight. Breathing more slowly still might even lull you into an altered state of consciousness. At three breaths per minute, theta brainwaves increase, together with a zoned-out state that looks like slow-wave sleep, a deep state of slumber.

Whatever the rate, nose breathing is the way to go. And you might want to hum a little tune too. Humming sets up swirls of air in the sinuses, which boost production of nitric oxide 15-fold, with all its immune and cardiovascular benefits. The only time that nose breathing falls short is when you need to fill your lungs quickly. In an emergency, a gasp of air through the mouth works wonders. Just try not to make a habit of it. **Caroline Williams**

SERGO MEMBRILLAS





## SITTING

When it comes to sitting properly, we all know the drill – even if we don't follow it to the letter. No slouching or crossed legs, buttocks touching the back of the chair and feet on the ground. But even if you are doing it right, sitting for long periods is shockingly bad for you. It has been described as the new smoking, linked to heart disease, diabetes and even cancer. There is no doubt we should all try to do less of it. But perhaps we could also do it better.

Chances are you view sitting as synonymous with chairs. This is a peculiarly Western perspective. A classic survey, published in 1953, described 100 different sitting postures adopted by 480 cultures around the world. Among the most common were sitting cross-legged, kneeling and the deep squat, with feet flat on the ground and buttocks resting on or just above it. Even in Western cultures, these are preferred sitting positions among young children. But Westerners tend to enforce chair use from an early age, strapping toddlers into buggies and insisting children sit on seats in school.

One big problem with this passion for chairs is that they make sitting so, well, sedentary. Consider the Hadza, a hunter-gatherer people in Tanzania. They spend around 9 hours a day sitting. However, they squat and sit on the ground in various positions, and activity monitors reveal that this entails significant levels of muscle activity. The supportive nature of chairs, with their high backs and armrests, remove this effort – perhaps the reason that people love them.

Another problem with chairs is the toll they take on the spine. When standing, our backs naturally have an S-shaped curve. However, when sitting, many people curve their spine into a C shape, compressing the disks between their vertebrae and putting them at risk of back injuries.

“Normal chairs tend to flatten the lower part of the back, which puts more pressure on it,” says Josette Bettany-Saltikov at Teesside University, UK.

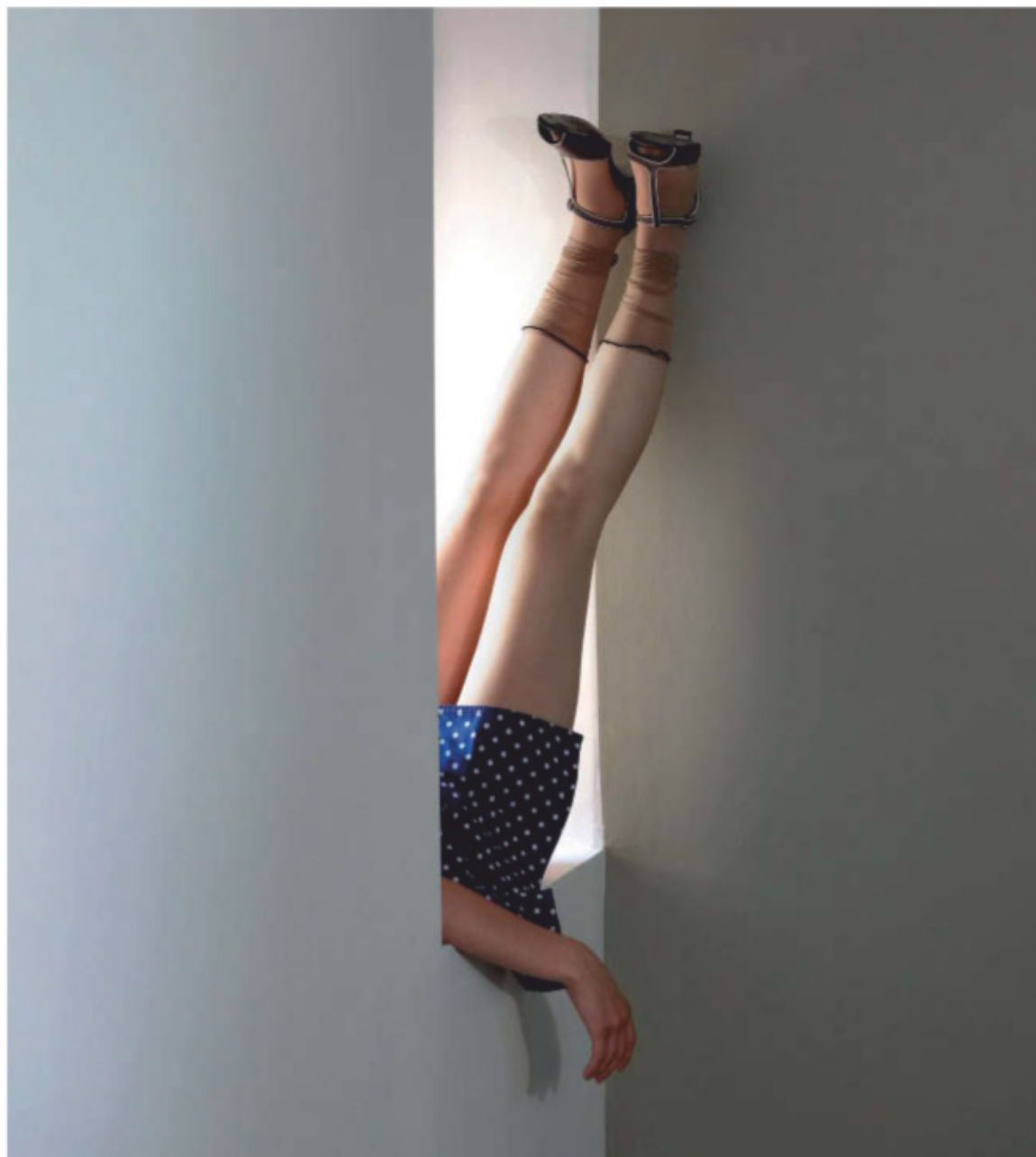
So what's the best way to sit? Bettany-Saltikov has found that kneeling or using a stool with a saddle seat can help

keep the spine in a better position – as does squatting. We might also take inspiration from traditional cultures like the Hadza. “Use a variety of postures and preferably not just still postures but some which allow movement,” says physiotherapist Leon Straker at Curtin University, Australia.

More radically, Straker believes that we should be rethinking what it means to do a desk job. “We will need to design workplaces that enable people to be productive while being lightly active, like with under-desk cycling or walking desks,” he says. For now, if your job is sedentary, don't forget to stand up regularly and stretch your legs.

**Alison George**

**“We might take inspiration on how to sit from traditional cultures like the Hadza”**



CHARLOTTE ZOBEL/PLAINPICTURES

## RELAXING

After a long day at work, I commute home, put the kids to bed, eat dinner and do the washing up. Finally, at about 9 pm, I sit down with my wife and switch on that most glorious of domestic appliances, the television. It pains me to admit it, but I have been looking forward to this for hours.

All of us deserve some time to relax. It makes us feel happy and is the natural antidote to fatigue. There is also mounting evidence that continuously high levels of stress lead to chronic inflammation, which is terrible for our physical and mental health. But is watching the box the best I can do?

At least I can console myself that I am not alone. When journalist Claudia Hammond and Gemma Lewis at University College London asked 18,000 people from 134 countries what they do to relax, watching television was among the top 10 activities. And, as Hammond says in her book *The Art of Rest*, while some see it as “mindless”, it is often a shared activity and so arguably less mindless than solitary forms of relaxation. The survey also found that 68 per cent of people wanted more rest. I feel likewise and wonder whether that is partly because my second favourite relaxation activity might not actually be helping.

Running might not be restful for my body, but it clears my mind like nothing else. I ask clinical psychiatrist Patricia Gerbarg at New York Medical College whether that counts. She suggests that I think about relaxation in terms of the sympathetic and parasympathetic nervous systems. Both are involved in unconscious actions, but the sympathetic nervous system ramps up the fight-or-flight response, generating damaging particles called free radicals. The parasympathetic system kicks in when you relax, giving your body a chance to recover.

“When you’re jogging you don’t feel in danger,” says Gerbarg. This means you tap out of the sympathetic system. “Also, people often jog out in nature and there’s something about being in the natural world that is restful,” she says. On top of that, exercise produces feel-good chemicals called endorphins.



HOLLIE FERNANDO/GETTY IMAGES

Nevertheless, there are times when I feel in need of stress relief but don’t have time to jog or watch TV. What I need is a sort of micro-relaxation. Would mindfulness fit the bill? There is evidence that it reduces activity in the amygdala, part of the brain involved in the fight-or-flight response. At its simplest it involves merely stopping what you are doing and paying attention to your thoughts and environment.

A quiz developed by researchers at La Salle University in Philadelphia reveals that I am indeed “moderately mindful”. Here is a skill I can consciously cultivate to relax at any time of day. I try waiting for the bus mindfully, focusing on the details of what I see, hear, smell and feel. I find it calming – and frustrating. If I really want to crack relaxation, I’ll have to work a bit harder. **Joshua Howgego**

**“Running obviously isn’t restful for my body so does it count as relaxation?”**

## EATING

We are constantly bombarded by advice on what to eat. But what about how to eat? It turns out that this, too, can have a big impact on your waistline and your well-being.

Take mealtimes. Many of us eat our largest meal in the evening. It is worth rethinking this habit. Our bodies are more sensitive to insulin in the morning, meaning the postprandial spike in glucose falls faster after an early meal than after one late in the day. As a consequence, front-loading your daily food consumption is likely to reduce your risk of developing diabetes. It is good for gut health and digestion too. “Gastric emptying and overall gut motility are faster and many enzymes, peptides and bile acids are higher in the morning,” says Leonie Ruddick-Collins at the University of Aberdeen, UK.

You will also benefit from regular mealtimes. Eating helps regulate the genes that control your body clock, and the processes coordinated by it become disrupted if you change the times at which you eat. If weight loss is your aim, you can benefit even more from this by confining your meals to a shorter window. Simply by delaying breakfast for 90 minutes and having dinner 90 minutes earlier, people lost twice as much body fat over 10 weeks as those who kept to their usual mealtimes. ➤



How fast you eat matters too. Chewing each mouthful 100 times may be overdoing it, but you do eat less if you eat slowly, probably because it takes about 20 minutes for hormones released in response to eating to kick in and make you feel full. Fast eaters also tend to have higher levels of triglycerides in their blood, a key marker of metabolic syndrome. It isn't clear why. Nevertheless, Indira Paz-Graniel at Rovira i Virgili University in Spain, who led the research, has some tips for guzzlers. She suggests that you focus on your food: sit down and avoid distractions such as television, computer and mobile phones. Eat foods high in fibre that require more chewing. And serve meals that need cutting up, putting your knife and fork down after each mouthful.

Finally, there is the tricky question of whether it is best to eat alone or in company. Busy lives and single-occupant households mean that solo eating is more common than in the past. This might be a good thing. Helen Ruddock at the University of Liverpool, UK, has found that we eat more when dining with friends. But there is more to life than cutting calories. "There is also evidence that people who eat socially are happier and more satisfied with their life than those who eat alone," she says. One solution is to

dine with strangers. We tend to go for smaller portions then, perhaps to make a positive impression.

Alternatively, exploit the power of social contagion. "Our dietary habits converge with the habits of other people in our close social network," says Ruddock. So maybe find a friend who eats well and likes to take their time over it. Anyone want to join me for a leisurely brunch? **Julia Brown**



HERO IMAGES INC/ALAMY STOCK PHOTO

## WALKING

Bipedalism is such a precarious way to get about that few species have settled on it. Yet, despite the absurdity of moving while trying to balance on two tiny platforms, we rarely give our steps a second thought. Perhaps we should.

Although we all walk more or less the same way, there is enough variation between individuals to easily tell people apart. Such differences could even be used as a biometric password.

## TOP TIPS FOR BATHROOM BASICS

Some hints to help you get the most out of your personal hygiene routines

### TEETH CLEANING

**DO...** make this a priority. Good oral hygiene might stave off dementia because the bacteria that cause gum disease are also linked with Alzheimer's.

**DON'T...** rinse after brushing. Just spit to retain as much fluoride as possible, especially at night when you produce less saliva, your natural defence against acid attack.

### HAND WASHING

**DO...** sing "happy birthday" twice. This will ensure that you scrub for the recommended

20 seconds before rinsing.

**DON'T...** forget to dry your hands on a clean towel. Wet hands pick up germs more readily, and the friction of drying removes bacteria that remain after washing.

### SKIN CARE

**DO...** wash your face twice a day. Cleansing at night is especially important to remove pollutants that can age skin.

**DON'T...** shower every day. It strips the skin of its protective oils and may also disrupt its microbiome, allowing malign

microbes to take hold. Every other day is usually plenty.

### SHAVING

**DO...** shave in the direction of growth. This helps prevent razor bumps and burns and protects against ingrowing hairs.

**DON'T...** forget to shave against the grain afterwards for a closer shave. But be sure to reapply gel and use gentle strokes.

### NAIL CARE

**DO...** cut toenails straight across. This helps prevent ingrowth. Fingernails, however,

should be cut with a curve.

**DON'T...** believe the myth about white marks. They don't indicate a lack of calcium, but are formed when the nascent nail is damaged within its nail bed.

### EAR CLEANING

**DO...** listen to your parents' sage words and...

**DON'T...** put anything smaller than your elbow into your ear. Yes, that means no cotton buds because they can lead to infections and perforated eardrums. Ears are self-cleaning, so let them get on with it.

Some quirks of gait can be problematic though. Small variations in leg swing can mean your heel hits the floor with enough force to damage the knee cartilage. Cases of knee osteoarthritis have doubled in the past 50 years, which some people say is too fast to be explained by longer lifespan or even rising obesity. In that period, though, shoes have become more supportive, which may encourage a more forceful stride. Walking barefoot, or in flat and flexible, minimalist shoes, reduces the stress on your knees. High heels, unsurprisingly, do the opposite.

The way you walk can also affect your outlook. In experiments, people manipulated into walking with an “upbeat” gait remembered more positive words from a list, whereas those who walked with a “sad” gait remembered more negative words. Nearly anyone holding a smartphone is likely to walk with their gaze towards the floor. This not only slows you down, but risks neck strain and possible injury.

If you want to improve your walking technique, the internet is awash with guides. However, biomechanics researcher Richard Jones at the University of Salford, UK, says there is little evidence that changing your gait reduces your future risk of injury. “Gait is variable and that is fine unless there are symptoms,” he says.

“What matters more about walking is how much we do it, not how,” says evolutionary anthropologist Daniel Lieberman at Harvard University. Studies of modern hunter-gatherers and super-healthy postal workers indicate that we should aim for 2 hours of brisk walking a day. Most of us manage only a fraction of that. So never mind your idiosyncratic gait – just do it. **Caroline Williams**

**“Is squatting really better than sitting on the toilet, or is this marketing hype?”**

## DEFECATING

For the past few weeks, I have been defecating differently. All my life, when I needed to relieve myself I sat upright on the toilet, feet flat on the floor. Now, I rest my feet on a plastic stool, elevating my knees. The stool is called a Squatty Potty and it is becoming increasingly popular, partly thanks to a viral video featuring a unicorn that poops rainbow-coloured ice cream. But is squatting really better or is this all just marketing hype?

Certainly, sitting upright to void isn’t natural. For most of our species’ history, people squatted, bending their knees and sticking out their bottoms. About two-thirds of people still do this. Of course, “natural” doesn’t necessarily mean “better”. However, medical professionals are starting to implicate conventional toilet use in many abdominal disorders including constipation, bloating and possibly haemorrhoids. And a recent review of sitting upright to defecate even

concluded that it was time to “put this unfortunate experiment to an end”.

The argument for squatting is all about angles. Most of the time, a muscle called the puborectalis pulls your rectum into a sharp angle, trapping faeces inside. When you defecate, the muscle relaxes and the rectum straightens out, allowing the contents to flow. However, if you sit upright the rectum can’t properly straighten. Squatting eliminates this kink, so should make things easier.

A handful of studies have addressed the sit-or-squat dilemma. One found that squatting allowed people to empty their bowels faster and with less straining. Another showed that the rectum really was straighter when people squatted. And a third employed stopwatches to time bowel movements with and without a footstool. On average, they took just 56 seconds while squatting – half the sitting rate.

### ‘The Thinker’

So far, the studies all have small sample sizes and there are no randomised controlled trials. There is also no evidence to support wild claims that sitting to defecate makes you more susceptible to appendicitis. Nevertheless, a team led by Leila Neshatian of the Pelvic Health Center at Stanford University in California does have unpublished results that bolsters the case for squatting – at least if you have chronic constipation.

My own limited experience supports the idea that people with such medical conditions are likely to benefit most. Personally, I haven’t noticed much difference while using a Squatty Potty. However, a friend with irritable bowel syndrome found it transformative.

Even so, squatting isn’t for everybody. “Some people cannot flex their knees or hips,” says Neshatian. Luckily, there is an alternative. A 2016 study examined what happened when people sat with their feet on the floor, but then leaned forward and rested their elbows on their knees. The team called this position “The Thinker” after Auguste Rodin’s sculpture. Like squatting, this posture straightened the rectum and made defecation easier. Do try this at home. ■ **Michael Marshall**



ROBBI AKBARI/KAMARUDDINALAMY/STOCK PHOTO







# Welcome to the virosphere

There is far more to the world's weirdest organisms than nasty diseases, finds **Jonathan R. Goodman**

**I**MAGINE an alien creature floating in space. It doesn't grow, communicate or move at all under its own steam. Without a home it is inert. We know very little about it, except that it will start reproducing when it enters the atmosphere of a planet that suits it. Is it living? Is it dangerous?

This may not sound like a plausible being, but it pretty much describes viruses, which are little more than bits of genetic material able to replicate only when inside a host. Viruses may seem alien, but they are the most abundant and, arguably, the most important organisms on Earth. They are found just about everywhere, from oceans and forests to the people around you and, of course, in and on you as well. This world of strange, quasi-living things has been dubbed the virosphere, and it is a mysterious one – we know less about viruses than any other life form. But that is changing rapidly.

People generally view viruses as synonymous with infection, and there is no doubt they cause some of the most dangerous diseases, including smallpox, AIDS, Ebola and flu. Yet viruses are so much more than indiscriminate killing machines. Our ability to inspect the genetic material they are made of has improved exponentially and, in the past five years, the number of species identified has increased 20 fold. What's more, it is becoming increasingly clear that these bizarre and diverse organisms play a key role in evolution and may well have been crucial for the origins of life.

For sheer abundance, no other group of organisms matches viruses. One study estimates the population of viruses in the oceans alone is as high as  $10^{30}$ . Another puts the total virus population on Earth an order

of magnitude higher than that, at  $10^{31}$ , or over a million times more than the estimated number of stars in the universe. According to research published last year, each day some 800 million viruses attached to dust particles fall onto every square metre of Earth's surface – and we know almost nothing about most of them.

Even the perennial question of whether viruses are alive or not is still up for grabs. "Explain to me what living means and I'll tell you whether a virus is alive," says Marilyn Roossinck at Pennsylvania State University. "A virus is nothing unless it's in a host. It's not an important question as to whether these entities are living."

We do know, however, that the length of time viruses can remain viable outside their host varies hugely. Some survive only seconds while others can persist for decades. Temperature is a big factor. In very hot environments, viruses tend to die quickly, which is why heating is an effective way to kill them. This may even explain why people evolved the ability to develop fevers in response to infections. In colder temperatures, viruses can survive for months or even years before successfully infecting a host. Variola virus, also known as smallpox, can persist for decades at temperatures between 4°C and 5°C. Other factors that undermine the survival of viruses include sunlight and the presence of certain materials and organisms, especially bacteria. They are particularly susceptible to disinfectant metals such as copper.

Once inside a host, viruses spring into action. Hosts can be any kind of living thing, or even another virus, as became clear a decade ago with the discovery of a virus called Sputnik living within a giant, complex virus known as mamavirus. Within a cell, the virus hijacks ➤



## The social life of viruses

Viruses may be inert when outside their host but, once inside, their behaviour is surprisingly sophisticated. Two decades ago, researchers discovered that some send out signals that help them decide whether to compete or cooperate with one another in a viral version of the prisoner's dilemma game.

Recent discoveries reveal that this communication relies on tiny proteins called peptides to convey information. Such peptide-based signalling has been found in a variety of viruses, including those that cause flu, measles and polio. However, most of the research has been done in bacteriophages, a group of viruses that infect bacteria. They communicate to coordinate their behaviour, especially when they need to decide whether to attack or stay dormant. It turns out that different virus species have secret signals all of their own. They are also capable of eavesdropping on other viruses and on host species.

We could use these discoveries to our advantage – to fight diseases, for example. In fact, researchers at Princeton University have engineered viral assassins that can sense signals unique to other microbes, including *E. coli* and *Salmonella*, and then home in and destroy them. This suggests that we may one day be able to manipulate bacteriophages to kill any bacterium on demand. As antibiotic resistance increases worldwide, this could become a crucial alternative treatment for some major diseases.

the biological machinery it lacks and uses it to copy its genetic material. In the case of Sputnik, the virus competes with mamavirus for its metabolites. Viruses replicate rapidly. The process can begin within a few hours of infection. Within days, they may be in all of a host's cells.

Despite our preconceptions, the interactions between virus and host aren't all one-sided: viruses can be beneficial as well as harmful. Take the fungus *Pseudogymnoascus destructans*, which causes a disease called white nose syndrome that has severely depleted bat populations in North America. When infected with a virus, the fungus is more successful, producing spores in greater numbers. Humans benefit from some viruses too. A group called bacteriophages help keep us well by killing disease-causing bacteria. Researchers are starting to use these phages to treat bacterial infections. Viruses can even become an essential part of a host's genetic code, providing genes required for survival.

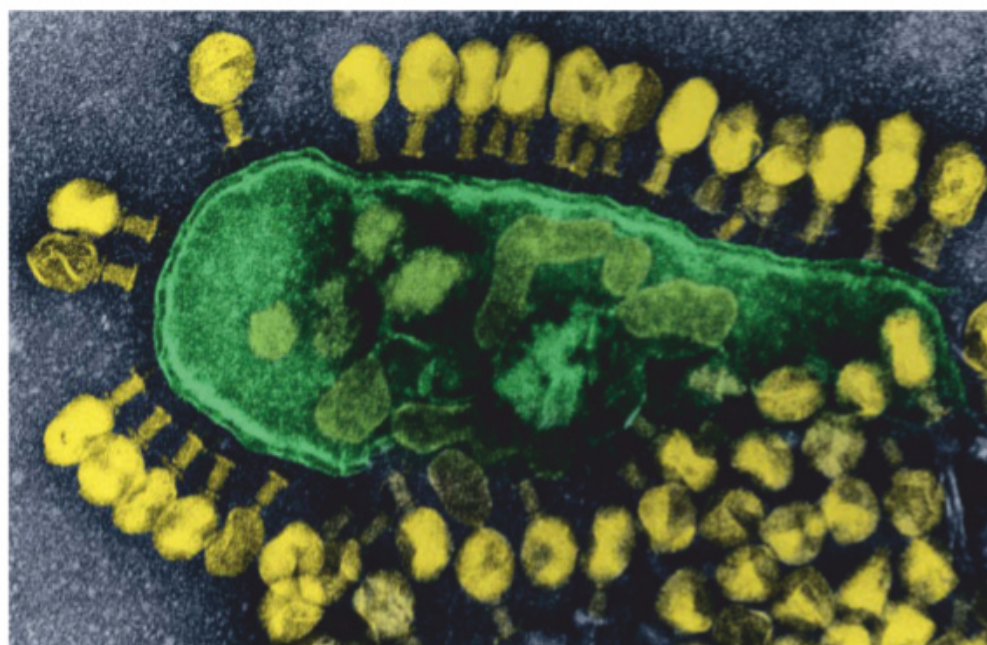
A new field of study known as viral ecology is providing insights into the interactions between viruses and their hosts. It is a gargantuan task. Consider, for instance, the human microbiome: the vast array of microorganisms that live in and on every one of us. Our bodies contain hundreds of different cell types – including those that make up our complex immune systems and that constantly try to fight off alien organisms – all of which interact with the thousands or even millions of types of viruses and bacteria in our microbiome. Add the fact that these microbes can both help and compete with one another (see “The social life of viruses”, left), and the number of possible interactions might as well be infinite.

Nevertheless, we are starting to see the bigger picture of viral ecology. A 2017 study offered the first map of virus-host networks covering all viral species known then. The authors looked at the distribution of viruses in different environments and their movements between them (see “Viruses, viruses, everywhere”, right). The study also revealed that most viruses have a surprisingly narrow range of habitats, infecting only one or two types of host. Another study from 2017 shed light on an enigmatic part of the virosphere, a whole other world of viruses that infect a domain of single-celled organisms called archaea.

## Myriad kinds

This is just the tip of the iceberg, however. We have long suspected that viruses are the most diverse group of organisms on Earth, but we still have only the vaguest idea of how many types there are. In the past two decades, more have been identified than ever before. Until 2003, we didn't even know of the existence of giant viruses, which have more than 1000 genes, compared with as few as 10 in tiny viruses. As of April last year, researchers had identified 195,000 species of virus. That is nearly 20 times more than were known in 2015. Given that viruses tend to be specialised to just a few hosts, their diversity is likely to be far greater than all other species put together.

The recent advances in our knowledge of viral diversity have been enabled by the advent of metagenomics. This allows researchers to identify viral genes present in an environmental sample without having to isolate individual organisms. They literally scoop up seawater or soil and analyse it to see how much viral genetic material it contains.



Phages attack an *E. coli* bacterium. These viruses coordinate their activity using proteins

LEE D. SIMON/SCIENCE SOURCE

But there is a downside. “The frustrating thing is that metagenomic data contain lots of unidentified sequences – what we call the ‘dark matter,’” says Edward Holmes at the University of Sydney, Australia. Currently, it is difficult to work out what this dark matter actually is. Assigning genes to a particular species of virus is made even harder because of the incredible rate at which these organisms evolve. To properly analyse viruses, we need to be able to “see” them, says Holmes. That will require looking at features beyond genetic sequences, such as the structure of virus proteins.

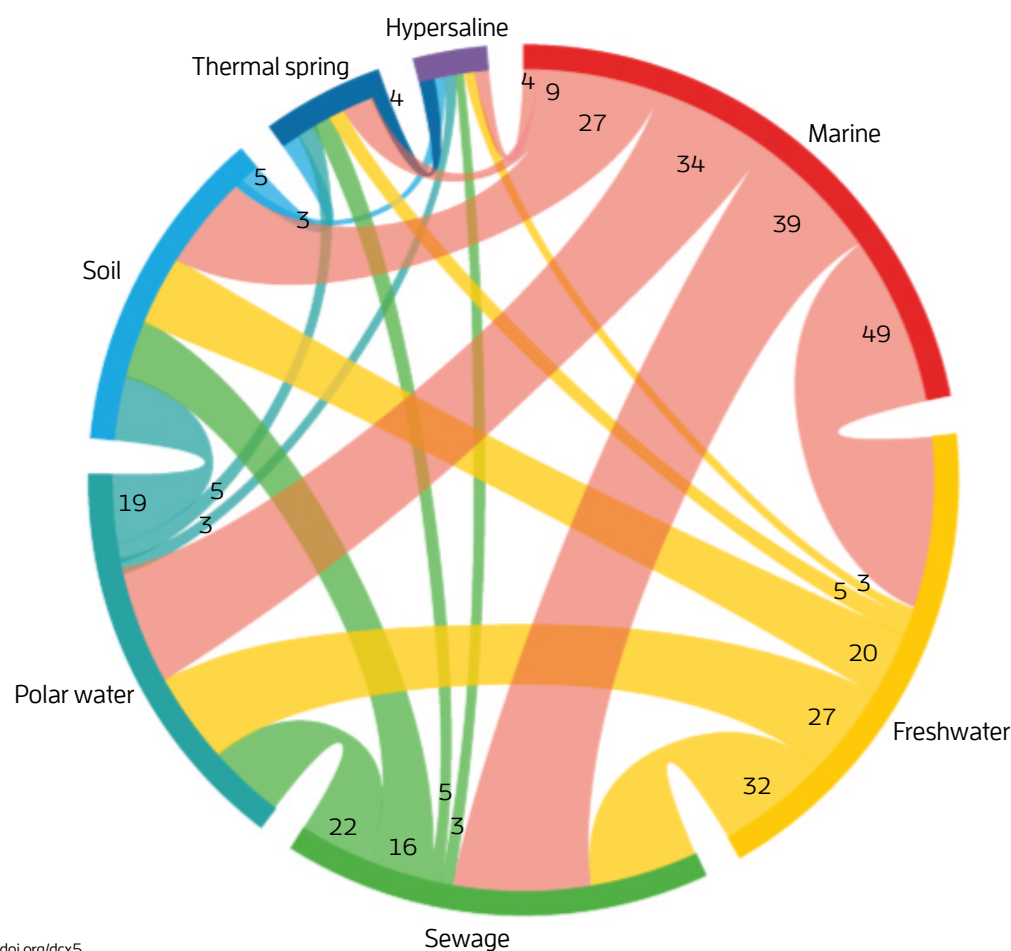
Another problem with mapping the virosphere is that researchers are unsure how to categorise viruses. At the moment, they use a system similar to the one used to classify all organisms, with categories ranging from kingdom (viriae) to genus and species. So far, fewer than 5000 viruses have been classified in this way. What’s more, there is a growing realisation that the current classification system has vast gaps and is wrong in places. There is a push to do something about this, though. In March, the International Committee on Taxonomy of Viruses called for classification of the entire virosphere. It acknowledges this is a massive undertaking, but argues that the potential benefits are huge. “We cannot know what the trove of ‘unimportant’ viruses could possibly amount to until we have examined them,” it wrote in *Nature*. “Virus classification is a straightforward way to contribute today to solving the global problems of tomorrow.”

That may sound grandiose, but it is justified. Viruses aren’t simply a threat to people’s health and livelihoods, they are also essential to life on Earth. What they offer, evolutionary biologists are starting to realise, is access to new genetic material that can help organisms adapt and survive. Viruses evolve much more quickly than any other known entity – as much as a million times faster than we do – giving them a constant supply of new genetic material. They can share these genes with their hosts in a process called horizontal gene transfer. Think of it as a trading game where players can swap cards to improve their deck. Two players will soon have both acquired the best possible combinations. But if they can swap with new players with rapidly changing decks (viruses), they can build a far more competitive hand.

Horizontal gene transfer with viruses doesn’t help individual people directly, as our genome is pretty much defined from conception. But gene swapping may help to explain the complexity of life on Earth: fast evolution, coupled with the ability to trade

## Viruses, viruses, everywhere

A massive study of global viral diversity in seven environments reveals the number of viral groups they have in common. Despite the virosphere's huge diversity, most groups are found in only a couple of environments



SOURCE: doi.org/dcx5

genes, allows simple organisms to quickly adapt to almost any environment. This was crucial for the earliest forms of life – and viruses may have played an important part in their success. So, learning more about the relationships between viruses, hosts and their environments should give us key insights into the evolution of life and even its origins.

In addition, studies of viral ecology can help us understand – and one day possibly even predict – the outcomes of interactions between viruses and their hosts. The benefits are clear when that host is us. One large-scale project, known as the Global Virome Project, aims “to detect the majority of our planet’s unknown viral threats”, to predict which viruses are likely to jump hosts and infect and possibly kill us.

That won’t be easy. “The sequencing of a virus itself tells you nothing about the odds of its emerging in humans,” say Holmes, who has expressed some doubts about the project. “Lots more needs to be done, including studies about how the viruses actually behave.”

Historically, our approach to virus research has been almost completely anthropocentric – focused primarily on viruses likely to harm our health or economic well-being. Now, virologists are arguing that things must change. We should confront our biased view of viruses as being inherently dangerous, they argue. We need a greater understanding of what viruses actually are, where they come from and how they continue to affect every aspect of life on Earth.

Opening our eyes to this weird world will do everything from helping us to prevent disease to understanding life’s origins. It could even give us insights into how the natural world is likely to change in the future. ■

**“There are over a million times more viruses on Earth than stars in the universe”**



Jonathan R. Goodman is a doctoral student at the Leverhulme Centre for Human Evolutionary Studies, University of Cambridge





DANIEL AUF DER MAUER/13 PHOTO

# “Trees can have a massive impact – if we get it right”

British ecologist Tom Crowther came under fire for suggesting we should plant a trillion trees. But it may be the best and cheapest way to draw down carbon from the atmosphere, he tells **Fred Pearce**

**T**WO years ago, British ecologist Tom Crowther set up a lab at ETH Zurich in Switzerland with the aim of doing high-impact science to show how and where we can restore the planet. His 30-strong team is already making waves. Crowther’s lab typically starts by counting things – from trees to nematodes – before bringing the numbers together to see global trends and quantify the effects of potential interventions.

Last July, his team made headlines around the world for claiming we have space to plant a trillion trees in areas of new forest amounting almost to the size of the US, and that doing so would be one of the most effective ways to address climate change.

The media loved it, but pushback from Crowther’s fellow academics was huge. Some grassland ecologists feared that the “tree counter” wanted to plant over their savannahs. Others said his proposed forests could end up having a warming effect by altering how sunlight is reflected, or that he had got his carbon numbers wrong. Crowther recognises these concerns, and is working to address them with ambitious new research.

**Fred Pearce: Where did the trillion trees idea come from?**

Tom Crowther: A friend of mine was working for an organisation that wanted to plant a billion trees to save the climate. But they didn't know if that was a lot or a little. So we started collecting data on tree density around the world. In 2015, we published the first ever attempt to answer a seemingly obvious question. We found there were probably 3 trillion trees on the planet today, nearly eight times more than previously thought.

**How accurate is that figure?**

Not very. There is a lot of uncertainty. I am sure the error bar probably runs from around 2 trillion to 4 trillion. Within that, we are quite confident, however.

**And we can have a trillion more trees?**

Yes, I think so. If you ignore urban and agricultural areas, and places that have climates unsuitable for trees, we estimate that forests would naturally grow on an additional 900 million hectares around the world, which is probably room for 1.2 trillion trees. We also estimate that, when fully mature, these ecosystems could potentially store 100 to 200 billion extra tonnes of carbon.

**The criticism from other scientists was intense.**

Yes, and it has been really hard to take. A lot of the responses basically said the land wasn't there. That we ignored competing land use demands, such as agricultural needs. Or that we ignored non-carbon impacts on climate from forests, such as the potential warming effects of dark foliage changing Earth's reflectiveness.

Fair enough. We did. But we only ever had a simple aim: to map all the land that was potentially available. We would never say whether the world should or should not restore trees to specific places, only whether they could. So it is only the start of a discussion, not the end.

**But you were also slammed for suggesting that trees were the answer to climate change.**

I agree that we got the messaging totally wrong. To call reforestation the most effective climate-change solution, which we sometimes did, was a naive mistake. We only meant that the restoration of natural ecosystems is quantitatively the largest single method available for drawing carbon out of the atmosphere. It is also the cheapest, if we do it right. But it is not a silver bullet. It is one of many solutions to climate change that we need to adopt in combination.

**Would the new forests be plantations or natural growth?**

Where possible, the latter. Nature always does it better. But it is not always possible. So people need to help out by spreading seeds or planting saplings. We are trying to figure out which regions will restore themselves naturally, and where we need to assist.

**What other areas are on your agenda?**

I think that soils are the most important part of the puzzle for carbon storage. Soils are not visible, and assessing how much carbon they contain is hard. But they certainly contain more than the planet's vegetation and atmosphere combined. So there is huge potential in encouraging the world's soil to accumulate more. Not just in forests, but beneath grasslands, in peatlands and even on farms.



HINDUSTANTIMES/GETTY IMAGES

Restoration of ecosystems is one of many solutions to climate change

Key to that are soil organisms. We just had a paper out trying to do for soil organisms what we did for trees: get an idea of how many there are and where they are distributed. We started with nematodes. These worms feed on plants, bacteria and fungi, and are a good, measurable indicator of soil activity and carbon cycling. They are also just big enough to count under a microscope.

We reckon there are 57 billion nematodes for every human. Interestingly, there are more in far northern latitudes than in the tropics. In these cold areas, they are slow and inactive, but as those areas warm, they could potentially become important for future climate stability.

**What else are you working on?**

Clouds. The world needs to know how ecosystems like forests affect climate. We know about their carbon storage, but the production of clouds is important, too.

Trees release massive amounts of moisture into the atmosphere every day. That moisture makes clouds that deliver rain to water other trees downwind. These clouds also influence temperature. They reflect a lot of the sun's radiation away from Earth, but can also have a warming effect by preventing heat from escaping.

Climate modellers say clouds are one of their biggest uncertainties. So we want to quantify how reforesting the planet could make clouds and assess the climate impact of that.

**Some say you are as much an activist as a scientist.**

We are extremely rigorous in our research, but it is certainly targeted to what we think matters. I would not want activism to get in the way, but as long as the science is robust, then I want to do all I can to encourage a responsible restoration movement. A lot of people have asked us to help them with ecosystem restoration. So we are setting up a team to do this in a way that helps science too, by allowing us to monitor progress and how much carbon ecosystems absorb.

**What are the limitations on replanting the planet?**

There are so many challenges. First, it would take an immense effort to restore the world's forests, and they would take more than 100 years to reach their full carbon-holding potential. That is why we want to help communities around the world to get going now.

But it can be dangerous to restore the wrong areas. If you plant trees in a native grassland, you can destroy local biodiversity, and if you restore forests in the high latitudes that would otherwise be covered with reflective snow, you can warm the planet. So the right ecological information is vital.

Then there is the social context. We know that too many reforestation projects don't last. Organisations just plant trees and walk away. But as soon as the project teams have gone, the trees get cut down for timber or land that is desperately needed for people's livelihoods. Only when the local communities benefit from ecosystem restoration can the projects be truly sustainable. So this is about science, but it's about scientists being good citizens, too. ■



Fred Pearce is a *New Scientist* consultant and the author of *When the Rivers Run Dry: The global water crisis and how to solve it*



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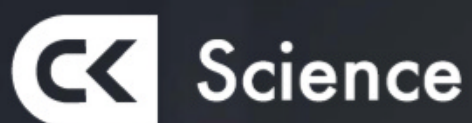
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*Richard Robinson, Brighton Science Festival*

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## Almost the last word

The wit of owls and choosing a PIN: readers respond **p54**

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Paul Ramchandani on play and how it benefits kids **p56**



Science of cooking **Week 2**

# How to make cheese

It's easier than you think to harness ancient biotechnology and make two types of cheese, says **Sam Wong**



Sam Wong is a digital reporter at New Scientist. Follow him @samwong1

## What you need

**Milk**  
**White vinegar**  
**Salt**  
**Rennet**  
**A thermometer**  
**A skimmer or slotted spoon**  
**Cheesecloth**  
**Small baskets (to hold curds)**

## For next week

**Cooking oil**  
**Potatoes**  
**Wok or large pan**  
**Thermometer**  
**Skimmer**

## Next in the series

- 1 Caramelising onions
- 2 Making cheese
- 3 **Science of crispiness**  
**Perfect fries every time**
- 4 Tofu and Sichuan pepper
- 5 Gravlax and curing
- 6 Tempering chocolate
- 7 Umami and flavour
- 8 Perfect pancakes
- 9 Kimchi and fermentation
- 10 Sourdough bread

IT STARTED with bad milk. Thousands of years ago, someone realised that the unsightly blobs in off milk didn't taste too bad. Then people learned that these curds could be salted and pressed to make a food far more durable and delicious than anyone who drank sour milk could have predicted.

This week, I'm going to show you how to do it yourself. What's more, you will be able to make two types of cheese from one batch of milk: halloumi (pictured) and ricotta.

Milk contains dozens of proteins, which can be split into curds and whey. When exposed to acid, the curd proteins, or caseins, clump into a solid mass, while the whey stays suspended in liquid.

At some point, people discovered that the curds became more cohesive if the milk was curdled in an animal stomach. That is thanks to the enzyme chymosin, which cleaves caseins in a way that allows them to bond together. Rennet, an extract of calf, lamb or goat stomach containing chymosin, was the first semi-purified enzyme to be used in food-making, an early milestone in biotechnology.

In cooler parts of the world, cheese-makers found they could mature cheese for longer and develop complex flavours using friendly bacteria and moulds. But the simplest cheeses don't need these. For example, ricotta is made by curdling milk using acid from vinegar or lemon juice.

To make halloumi and other cheeses, you will need rennet,



JAMES WINSPEAR

## Science of cooking online

All projects are posted at [newscientist.com/cooking](https://www.newscientist.com/cooking) Email: [cooking@newscientist.com](mailto:cooking@newscientist.com)

either animal or vegetarian. You can get this in a cheese-making kit, or separately online. You will also need a thermometer and some small baskets to hold the curds while they are pressed.

Heat 7 litres of full fat milk to 32°C, then stir in a teaspoon of rennet. Take the mix off the heat and let it settle for an hour. Then take a knife and slice the curds into 2-centimetre cubes. Leave for 5 minutes to settle, then gently heat the mixture to 38°C, stirring frequently. Use a slotted spoon to scoop the curds into your baskets. Stack them on top of each other to gently press them, and leave in a baking tray to catch draining liquid, then set aside.

You can now make ricotta from

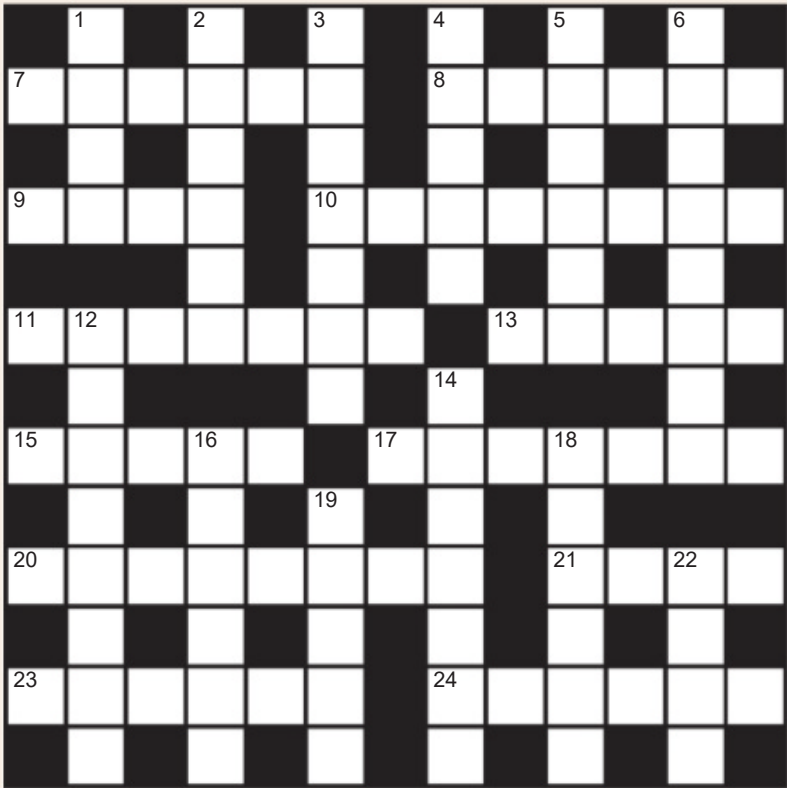
the remaining whey protein. This is because chymosin works on only one milk protein, kappa casein, leaving others that can be solidified with acid.

Heat the whey to 90°C, then turn off the heat and add 30 millilitres of white vinegar and 15 grams of salt. After 5 minutes, spoon the curds into a colander lined with cheesecloth. Leave to drain for half an hour, or longer for firmer ricotta.

When the halloumi is firm, cut it into large pieces. Heat the whey again, this time to 85°C, and cook the pieces in it for 20 minutes, or until they rise to the top. Drain, cool and store the cheese in brine until you want to eat it – perhaps fried with pitta bread. ■



Cryptic crossword #22 Set by Wingding



- ACROSS**
- 7 Lubricated glucocorticoid receptor? Simple (6)
- 8 Call AI misguided and secular (6)
- 9 Gamble on a software test (4)
- 10 Clean and repair icy hinge (8)
- 11 Grain mostly eaten by old biannual event (7)
- 13 Number one agreement describes a law-abiding gas? (5)
- 15 Tout leaving vegetable gets skin disease (5)
- DOWN**
- 1/6 Release fundamentalists – they can damage cells (4,8)
- 2 Pungent food used to be in front of religious building, so we hear (6)
- 3 New York photo ruined by storm (7)
- 4 Second gravitational wave detector somewhere in Ireland (5)
- 5 American soldier to take charge of dystopian society (6)
- 6 See 1 Down
- 17 Bottom feeders assume a false identity (7)
- 20 For mother, perhaps, top of abdomen moved forward before birth (8)
- 21 First group of alien hunters (4)
- 23 When a melon has piece cut out to get hard material (6)
- 24 Possible murder weapon? Polonium is one after losing an electron (6)
- 12 Nitrogen found in ecologist's frame in part of a plane (8)
- 14 Moves quickly in bile procedures (7)
- 16 DNA of small man taking pill (6)
- 18 Member of the far right – no saint – with a band of connective tissue (6)
- 19 Head of school to discuss STEM (5)
- 22 Conservative's stomach turns in ancient city (4)

Answers and the next quick crossword next week.

Quick quiz #34

- 1 What was the most famous cargo carried by the Soviet satellite Sputnik 2, the second artificial object to orbit Earth?
- 2 What is a SQUID used to measure?
- 3 What stiff, long-chain polymer with the chemical formula (C<sub>8</sub>H<sub>13</sub>O<sub>5</sub>N) is a primary component of fish scales, insect exoskeletons, fungal cell walls and squid beaks?
- 4 Earth's atmosphere has four principal jet streams, a polar jet stream and a subtropical jet in each hemisphere. In which direction do they flow?
- 5 The Hunterian Museum in London, the Museum Vrolik in Amsterdam and Harvard University's Warren Museum are devoted to which branch of science?

Answers below

Quick Crossword #48 Answers

**ACROSS** 1 NISTADS, 5 Twitter, 9 Paradoxes, 10 Padua, 11 Tetrode, 12 Astilbe, 13 Anhedonia, 15 Smart, 17 Basic, 19 Helvetica, 22 Uppsala, 25 Regular, 26 Orris, 27 Greenwich, 28 Dehisce, 29 Start-up

**DOWN** 1 Naphtha, 2 Stretches, 3 Android, 4 Sixteenth, 5 Tesla, 6 Iapetus, 7 Tidal, 8 Reagent, 14 Allergens, 16 Axial tilt, 17 Bluford, 18 Chassis, 20 Eugenia, 21 Airship, 23 Perch, 24 Angle

Quick quiz #34 Answers

- 1 Laika, the first dog in space
- 2 Very small magnetic fields. It stands for superconducting quantum interference device
- 3 Chitin
- 4 They all flow west to east
- 5 Anatomy

Puzzle set by Zoe Mensch

#41 Hen party dorm

Ten friends have rented a dormitory for the night of a hen party. Each person picks a bed for the night before heading out on the town. At 2 am, they start heading home, a little the worse for wear.

Amy, the first to arrive back at the dorm, can't remember which bed she chose, so she picks one at random. The next person to return, Bethan, heads for her own bed, but if she finds it has already been taken, she randomly picks another.

The remaining friends adopt the same approach of going to their bed if it is available and randomly picking another if it isn't. Janice is the last to get home. What is the chance that her own bed is still empty? And was Janice more or less likely to find the bed she first chose empty than Iona, who got back just before her?

Answer next week

#40 Light bulb moment Solution

Only two light bulb flashes and one climb of the stairs are needed.

Join two wires at the bottom (e.g. A and B). Climb the stairs. Identify which pair at the other end make a circuit (e.g. 1 and 3).

Now connect one wire from that pair (e.g. 3) to a new wire (e.g. 4) and go back down to the ground floor. The other end of 3 must be A or B, and the other end of 4 must be C or D. Find which pair now makes a circuit (e.g. A and D). You now have all the information you need to identify all four wires.

For example, if the first circuit is A and B – 1 and 3 and the second circuit is A and D – 3 and 4, then A must be 3, so B is 1, D is 4 and hence C is 2.



Our crosswords are now solvable online Available at [newscientist.com/crosswords](https://www.newscientist.com/crosswords)

## What if...

January ticks along apace, but Feedback still hasn't quite recovered from Christmas. Not the indulgence in food, wine and song, mind, but a festive press release issued on behalf of the operator of a network of electric vehicle charging points, which haunted our holiday season like the ghost of Christmas nonsensical. "Brits cook enough turkeys to travel the world over 10,000 times in an EV", it was titled.

This raises the urgent question of why a large number of turkeys should be a prerequisite for circumnavigating the globe in an electric vehicle. Thankfully, the message goes on to clarify that it is concerned with the amount of power being used to cook the UK's Christmas dinners, and not the biomass of domestic fowl per se.

"If everyone was to cook their turkey in an oven that cooks it instantly at the exact same time in the UK there would be issues, especially considering the estimated combined capacity of around 90 GW," said Chris Burghardt, managing director for Europe at ChargePoint. "The thing is, they don't!"

Similarly alarming hypotheticals have been nagging us ever since. What would the energy implications be if we all had robot chefs powered by quantum computers, and chose to eat lab-grown turkeys while sitting in hot tubs and watching films on 88-inch ultra-high-definition TVs? What if Father Christmas charged his electric drone-sleigh and Rudolph's LED-nose at the same time? What if the Queen's speech were broadcast directly into Feedback's brain using transcranial direct-current stimulation? Fortunately, these things don't happen, but if they did... well, there would certainly be issues.

## High-flyers

Feedback isn't above admitting to the occasional mistake. Especially when it happened in the dear, dim

past of a bygone year like 2019. After all, the Feedback of 2019 was weak of judgement and loose of syntax; 2020's Feedback is older, wiser, a new product fit for a new decade. By the end of it, we may well have become an AI.

So we are happy to report that on 7 December 2019, a date that will live in infamy, Feedback made the unforgivable boo-boo of mixing up satellite orbital paths. While passing judgement on Spelfie, an app that lets you take self-portraits with the help of passing spacecraft, we claimed that the photographs would be shot from 36,000 kilometres up.

We are grateful to the keen eyes of Bryn Glover and Dave Hardy for pointing out that the satellites in question are closer to 600 kilometres overhead. This is closer up than we usually like our photographs to be taken.

## We're SEO confused

A new frontier has emerged in the long-standing conflict between economy and ecology. Brands that have appropriated the names of animals are increasingly deploying search engine optimisation specialists to secure the top-ranked spots in Google results.

In Feedback's neck of the woods, at least, a squid is now a cashless payment card. It should not be confused with an octopus, which is a many-armed investment vehicle. A dolphin is a games console emulator and a shark is a vacuum cleaner. Elephants supply a range of car insurance quotes, while zebras offer "enterprise-level data capture and automatic identification solutions that provide businesses with operational visibility". No, us neither. An eagle, meanwhile, is a nightclub in Vauxhall, London. Actually, we had that last one bookmarked, but you get the point.

Feedback is deeply troubled by this assault on common meaning. With animals unable to learn the dark arts of SEO for themselves, are they doomed to disappear from human awareness as soon as they slip onto the second page of results?

## Twisteddoodles for New Scientist



## Stiff upper forehead

Feedback has never been much of a risk-taker. Our idea of a daredevil exploit is trying to sneak a series of uncapitalised brand names past our ever-vigilant subeditors. But a hunger for adrenaline seems to be a prerequisite for modern life. How is one supposed to build an Instagram following without diving off a zip line into a shark-infested canyon?

Pausing for a moment to wonder how all those vacuum cleaners got down there, we are intrigued by a paper in the journal *Emotion* that suggests a way to lower our risk-averseness without the traditional need for liquid courage. The paper, "Disrupting facial action increases risk taking", was based on the premise that, just as it is almost impossible to smile without feeling one's mood

improve, preventing one's facial muscles from registering anxiety will lead to greater risk-taking.

Having watched one too many old-school war films over the festive period, Feedback wonders whether the researchers have discovered the scientific basis for that supposedly most British of virtues, the stiff upper lip. But no: the method involves attaching inflexible medical tape to the forehead. That's right, readers: instead of getting plastered to overcome your fears, get plastered. The results were surprisingly positive. "When these facial responses are disrupted," the researchers concluded, "the decision-maker feels freer to take the risk". Having slapped 12 sticky notes onto our face, we can confirm that we feel ready for anything. Even a showdown with the *new scientist* subeditors. ■

## Got a story for Feedback?

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## Twit or true?

**Owls are a symbol of wisdom. Are they really so intelligent compared with other birds?**

**Bill Naylor**

*Wilsford, Lincolnshire, UK*

An owl's supposed wisdom is based on the shape of its face. We have an instinctive emotional connection to the child-like appearance of animals and birds with large eyes, so maybe we imbue it with human qualities like wisdom or intelligence. The owl also has to turn its head to stare, giving the impression of undivided attention.

However, it isn't among the social birds, which are considered intelligent. These include crows and other corvids, starlings and house sparrows, which have all shown problem-solving ability, and parrots, which can associate words and phrases with objects and events. Many social birds have a wide vocabulary including calls for certain predators. Some even learn to dupe rivals by mimicking predators' calls to scare other birds away from food sources.

Owls are mainly solitary. While they are marvellously adapted predators, their behaviour is very hardwired, and their vocalisation limited. Owls have many special attributes, but being avian eggheads isn't one of them.

**Richard Swifte**

*Darmstadt, Germany*

Birds in the crow and parrot families have large brains for their head size. In particular, a region known as the nidopallium caudolaterale is well developed compared with other bird families. It is considered equivalent to the prefrontal cortex in mammals that is associated with higher brain functions.

Owls don't have such relatively large, well-developed brains, and when tested in captivity haven't shown above-average intelligence. In western cultures, the myth of the wise owl might have arisen because Athena, Greek goddess



RENE B/ALAMY STOCK PHOTO

## This week's new questions

**Unripe mulberries** Why does the juice of unripe, red mulberries remove the stains on your hands from ripe, black mulberries? *Anna Butcher, Brookton, Western Australia*

**Mulberries and milk** If you dip fabric stained by mulberry juice briefly in boiling milk, the stain is instantly removed. How does this very old and largely forgotten remedy work? *Andrew Taylor, Sydney, Australia*

of wisdom, is often portrayed with an owl on her shoulder. In some Indian cultures, the owl is actually considered stupid. Owls evolved senses and physical attributes perfectly adapted to their night hunter lifestyles, and presumably had no need for extra abilities such as curiosity, which can result in greater intelligence.

**Jenny Furness**

*Doncaster, South Yorkshire, UK*

Trying to compare the intelligence of owls with that of other birds is a bit like comparing cats with dogs. They are all good at what they do.

Behaviours of some birds, such as corvids, which can solve problems and use tools, or Harris's hawks and falcons, which can undo knots, are very relatable to our own behaviour and are more likely to be judged as "intelligent".

However, some types of owl do have complex behaviours. The little owl uses stashed meat to grow maggots for food in a way that other birds of prey don't, for example. Its cousin, the burrowing owl, will take dung into its burrow

and cultivate dung beetles.

Injured wild tawny owls often seem to recognise when they are being helped and cooperate with rescuers. Barn owls, on the other hand, are very sweet if they have been captive bred, but I can't convince myself that I have ever met a bright one.

**Mike Bersin**

*Gresham, Norfolk, UK*

An owl expert once told me that, were you to see the head of an owl devoid of its feathers, you would find nearly all eyes and very little skull or brain. Not long after, the person running an owl display at the Royal Armouries museum in Leeds, UK, talked about the abilities of the massive European eagle owl. He said it was difficult to teach it a routine more complex than "fly to the back of the crowd, fly back for a snack".

Why does unripe mulberry juice remove stains made by ripe berries?

## Number games

**My bank has given me a new PIN, advising me that I can change the number for one that is "more memorable". Anything I chose, say based on my birthday, would surely be easier for a fraudster to discover. Should I keep the randomly generated PIN?**

**Brian Pollard**

*Launceston, Cornwall, UK*

I received a random PIN many years ago, and realised it was an easily memorable scientific constant plus another number. Another random PIN was a well-known date plus a palindromic number. Maybe I was lucky, but I would suggest a two-part scheme for reconstructing a PIN might be a solution that works for you.

**Hillary Judd**

*Exeter, Devon, UK*

Don't confuse "memorable" with "obvious". For 4-digit PINs, dates from history can be good. 1066, the most memorable in English history, may be too obvious, but there are other less well known ones that could be memorable but not obvious. Another source of possible PIN numbers comes from combining two atomic weights: those of sodium and chlorine in sodium chloride give you 2335, for example. Anything that you find interesting and memorable that isn't personal will do it.

**Spencer Weart**

*Hastings-on-Hudson, New York, US*  
Randomness, like beauty, is in the eye of the beholder. If the PIN your bank assigned happens to be your birthday or phone number, you'd better fire up a random number generator and make a new one. ■



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Everyone loves games, but what if they were central to your life's work? **Paul Ramchandani** describes what it is like to be a professor of play

### As a child, what did you want to do when you grew up?

At times, I wanted to be a radio DJ, a musician and a forester. One consistent thread was a love of science, so when I found out I could train to be a doctor and study what makes people tick, I knew I had a plan.

### Explain your work in one easy paragraph.

The biggest part of my work is focused on the role of play in child development, including in learning and in physical and mental health. We try to use that knowledge to develop interventions or therapies to give children the best start in life.

### How does play benefit children?

Play is the language of childhood, certainly early childhood. Children learn, explore, express themselves, develop relationships, imagine and manage emotions and experiences through play. It's clear that active, engaged play has particular benefits for both physical and mental health.

### Are some kinds of play better than others?

A key part of play is that it can just be fun. Having fun has value in itself, and not just for children. But different aspects and types of play help children develop all sorts of skills: physical play for fitness and coordination, for example, or play with peers and parents to help develop social skills. Children should have the space and the time to try out different types of play, and also to follow their interests.

### Do you have a favourite game?

My kids are now older, so we tend to play more board games together. My favourite at the moment is probably Settlers of Catan. At the next family party, we'll be trying out a game called Happy Salmon, which one of my colleagues introduced us to.

### Did you have to overcome any particular challenges to get where you are today?

As recently as the 1980s, at least one medical school that I applied to was using an algorithm to select students that was systematically biased against women and "foreign-sounding names".

### What achievement are you most proud of?

Together with some colleagues at the University of Oxford, I did some work looking at how depression in new fathers could affect family life and child development. We were among the first people to explore those links.

### Is there a discovery or achievement you wish you'd made yourself?

A bit over 10 years ago, a team at Cardiff University started studying families attending IVF clinics, to look at links between mental health in parents and, later, in children. They were able to look at parents and children who had different genetic and environmental relationships with each other, and so begin to disentangle these effects. It was a simple idea, and yet so brilliant.

### How has your field of study changed in the time you have been working in it?

We understand a lot more about how many mental health problems originate in early life. Experience in pregnancy sends a kind of weather report to the fetus to give it indicators of how life might be and to begin the process of preparation for that life. That is extraordinary and there is still a huge amount to learn.



### What scientific development do you hope to see in your lifetime?

I have to hope that someone makes huge advances in carbon capture technology, or some other development that renders fossil fuels redundant. Without that, or some other unforeseen change, it's hard to feel hopeful for future generations.

### How useful will your skills be after the apocalypse?

I probably wouldn't be as useful as Bear Grylls, but being able to introduce games to people will allow them to have fun, and also build relationships. That might help us all to survive a bit better and make life feel a little bit more worthwhile.

### What's the best piece of advice anyone ever gave you?

"When you're chewing on life's gristle, don't grumble, give a whistle, and this'll help things turn out for the best, annnnnnd..." – not specifically for me, but thanks Eric Idle, it's been helpful. ■

"Having fun has value in itself, and not just for children"

Paul Ramchandani is the LEGO Professor of Play at the University of Cambridge

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