

# New Scientist

WEEKLY 18 March 2023

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## On the cover

### 38 Messages from the Stone Age

Do prehistoric cave paintings contain the earliest written language?



Vol 257 No 3430  
Cover image: Romy Blümel

8 Hundreds of babies saved by gene sequencing

43 Why space-time might not be quantum after all

12 Inflammation: The overlooked cause of heart attacks

16 The real gut feelings

20 Orca foster mothers

28 Chatbotpocalypse

36 David Attenborough returns

38 Feature  
**“Even the most conservative date makes these motifs far older than the first formal writing system”**

## News

9 **Superconducting material**  
“Red matter” could revolutionise tech – if it stands up to scrutiny

14 **Forest veterans**  
Why ecologists want to make trees old before their time

23 **Sickle cell disease**  
A gene-editing treatment is too costly for most who need it

## Views

27 **Comment**  
Demonising video games is counterproductive, says Naomi Fisher

28 **The columnist**  
Annalee Newitz on dystopian AI marketing hype

30 **Aperture**  
The Padma river in Bangladesh

32 **Letters**  
The possibilities of electrical medicine are exciting

34 **Culture**  
Why we need a longer sense of time based on nature



36 **Natural wonders** *Wild Isles* looks at nature in the UK and Ireland

## Features

38 **Stone Age messages**  
Hand stencils made by ancient humans aren't doodles. What are they trying to tell us?

43 **Is gravity quantum?**  
Physicist Jonathan Oppenheim bets against a widely held assumption about space-time

46 **Your genetic future**  
New genetic tests could make health predictions for everyone

## The back pages

51 **Citizen science**  
Help fight antibiotic resistance

53 **Puzzles**  
Try our crossword, quick quiz and logic puzzle

54 **Almost the last word**  
How do you tell sunrise and sunset apart in a photo?

56 **Feedback**  
The ultimate test of Pepsi versus Coca-Cola

56 **Twisteddoodles for New Scientist**  
Picturing the lighter side of life

## Virtual event

### Fermilab: Solving the mysteries of matter and energy, space and time

Join Fermilab senior scientist Don Lincoln as he explains what the particle physics facility in Illinois has taught us about our universe. Major discoveries made at the lab include the top and bottom quarks – and its future work might be critical for a “theory of everything”. Online on 4 April at 6pm BST/1pm EDT. Tickets are £16.

[newscientist.com/events](https://www.newscientist.com/events)

## Tour

### Marine ecosystems of the Azores: Portugal

Experience the volcanic craters, lush vegetation and lagoons of the Azores archipelago in the North Atlantic Ocean. Accompanied by experts, including marine biologist Russell Amott, you will have an opportunity to go whale spotting, visit seabird colonies and learn how the archipelago’s volcanism supports the local viniculture.

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## Podcast

### Weekly

This week, the podcast team hears how a hunt for the missing matter in galaxies has been too successful, leaving astronomers with more than was predicted by theoretical models. There is also news of a genome sequencing trial for critically ill babies, which has helped save the lives of some newborns. Plus, the earliest horse riders.

[newscientist.com/npod](https://www.newscientist.com/npod)



**Lush life** Enjoy the spectacular scenery of the Azores



**Secrets of the universe** Find out what Fermilab has taught us

## Video

### Shifting lands

On our YouTube channel this week, you can watch the most detailed ever reconstruction of how the continents have moved over the past 100 million years. The world has changed substantially in that time: as the reconstruction begins, there are shallow seas covering parts of north Africa and North America, and India is located near Madagascar.

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## Newsletter

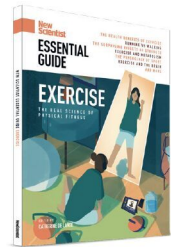
### Lost in Space-Time

Where do we come from? Using powerful telescopes and computer models, physicists have found that they can't fully explain how stars make elements heavier than iron – some of which are found in the human body – writes Artemis Spyrou at Michigan State University. But isotope research offers clues.

[newscientist.com/lost-in-space-time](https://www.newscientist.com/lost-in-space-time)

## Podcast

**“If the matter is supposed to be missing, how come we’ve now found it?”**



## Essential guide

Exercise is the best medicine. It keeps our bodies and mind in prime condition and adds years to our lives. But why do so few of us get enough? This *New Scientist Essential Guide* offers some clues. Available to download in the *New Scientist* app or to purchase in print from our shop.

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# Decision time

The genomic healthcare revolution is arriving – what do we want it to look like?

RIVER WEATHERBY is an energetic 2-year-old, all thanks to a groundbreaking trial of genome sequencing for sick newborns. Sequencing his genome revealed that he had a rare disease, and he has thrived since getting treatment (see page 8).

More good news comes with the development of a cure for sickle cell, a devastating condition affecting 7 million people worldwide, using CRISPR gene editing (see page 23).

Cases like these show the power of a new healthcare revolution that is under way – one that was predicted as far back as the first draft of the Human Genome Project in 2001. Finally, genomic technology can identify the exact cause of many conditions and, in a growing number of cases, also treat and cure them.

Yet there is a big “but”. The sickle cell cure will be extremely expensive. And for many other genetic conditions, there are no treatments at all.

This is why the focus should be on prevention, not cures. Some genetic disorders are the result of spontaneous

**“Finally, genomic technology can identify the exact cause of many disorders – and even cure them”**

mutations in egg or sperm cells and can't be averted. But most are preventable by carrier screening of would-be parents. One option for couples at risk of passing on genetic conditions is in vitro fertilisation (IVF) with pre-implantation genetic testing to choose embryos

free of the disease-causing mutations.

Screening becomes more complicated when it comes to conditions caused by many gene variants in combination (see page 46). It isn't possible to obtain enough IVF embryos to choose among to prevent these polygenic disorders at present, but that could change if researchers find ways to generate unlimited numbers of human egg and sperm cells from stem cells – as they have in mice.

This would open up other possibilities, including allowing same-sex couples to have children that share their genes (see page 16), and, controversially, the selection of desirable traits to make designer babies.

The long-promised genomic healthcare revolution is arriving at last – now it is also time to decide what we do with it. ■

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**Green skyscraper**  
Boston building aims to slash energy consumption **p11**

**Spider war**  
Black widows are being hunted by brown widows **p13**

**Tools or debris?**  
Flakes made by monkeys look like ancient artefacts **p15**

**Carbon capture**  
A new method turns CO<sub>2</sub> into baking soda with seawater **p19**

**Mistaken identity**  
Notable “animal” fossil might just be seaweed **p20**



MATTED BATTAZZINI/AGF PRESS, INC/JALAMY

**Environment**  
**Walking on water**  
Lake Garda, the largest lake in Italy, is unusually shallow after a severe drought has left wintertime water levels at their lowest for 30 years. Here, tourists are able to walk across the lake on a path revealed by the drought, from Punta Belvedere to Isola dei Conigli.

## Health

# Sick babies saved by sequencing

A rapid, whole-genome sequencing trial in Australia has helped diagnose and treat hundreds of critically ill children with rare genetic conditions, reports **Alice Klein**

THE lives of critically ill babies in Australia have been saved after their genomes were rapidly sequenced as part of a trial.

Some babies are born extremely sick: for example, they may have seizures or be unable to breathe on their own. It has traditionally been difficult to determine what causes their symptoms. In many cases, children have died or have had disabilities due to missing out on a diagnosis and then not receiving the appropriate treatment.

To address this, a small number of hospitals worldwide have experimented with sequencing sick babies' genomes to uncover if they have one of more than 7000 rare genetic conditions.

On average, these studies diagnosed genetic conditions in around 37 per cent of critically ill infants, said Stephen Kingsmore, president of Rady Children's Institute for Genomic Medicine in California, at the annual meeting of the Royal College of Pathologists of Australasia (RCPA) in Melbourne in February.

"These studies have been really successful, but they've tended to be limited to single children's hospitals," says Zornitza Stark at the Victorian Clinical Genetics Services in Australia.

## Swift diagnosis

Stark and her team launched an Australia-wide trial into whole-genome sequencing for critically ill infants. The trial, which ran from 2018 to 2022, involved 450 babies and children at every children's hospital in the country.

On average, it took 2.9 days and cost AUS\$15,000 (US\$10,000) per child to collect a blood sample, sequence their genome, analyse it and return a report to doctors.

River Weatherby in Sydney was one of the babies in the trial.



**River, now 2, had his genome rapidly sequenced as a newborn**

"When he was first born and they put him on my chest, they noticed he wasn't really breathing," says his mother Cody. River was put on a machine to help him breathe, but he continued to get sicker. Tests showed he had an enlarged liver and spleen and low platelets, and he required several blood transfusions. At one point, Cody says doctors told her that River may not survive the night.

As part of the trial, River's parents agreed to have his genome sequenced. The results showed he has a rare condition called Gaucher disease, caused by a faulty variant of the gene *GBA*. This causes the build-up of fatty substances in the body and can result in a life expectancy of less than 2 years in severe cases.

Following his diagnosis, River's parents agreed to start him on

an experimental treatment for Gaucher disease called ambrroxol when he was 2 weeks old. Now, "he's a typical 2-year-old boy, he's very full of energy", says Cody.

River was one of 240 trial participants who were diagnosed with a genetic condition. The remaining 210 may have genetic conditions that haven't yet been characterised or may have been unwell due to a non-genetic cause, such as a bacterial infection, says Stark, who presented the trial results at the RCPA meeting.

Of those who received a diagnosis, around 10 per cent then had effective treatment. This proportion is expected to increase as more treatments become available, says Stark.

For example, five gene therapies – which replace faulty genes with **"Our son is living, breathing proof of how important an early diagnosis for a rare genetic condition can be"**

functioning copies – have recently been approved in the US.

The children who were diagnosed with genetic conditions that don't yet have treatments still benefited, says Stark. "Having a specific diagnosis tends to direct their thinking away from certain diagnoses and sometimes give them the confidence to forgo invasive tests, such as lung or liver biopsies," she says.

Those for whom no genetic condition was identified also had better outcomes as a result of being in the trial. "Providing a negative result can help the clinical team direct their thinking away from certain diagnoses and sometimes give them the confidence to forgo invasive tests, such as lung or liver biopsies," says Stark.

The diagnosis time of less than three days was key to the trial's success, she says. A decade ago, sequencing a person's genome typically took four to six weeks, says Stark. "For babies in intensive care, time is really of the essence."

The swift turnaround also meant the trial saved the Australian healthcare system AUS\$25,000 per child on average by reducing the need for other expensive tests and shortening the time spent in intensive care.

Stark and her colleagues are now seeking government funding to make such sequencing available in clinics across Australia, not just as part of a trial. In October 2022, England's National Health Service announced that it would offer rapid whole-genome sequencing to severely ill infants and children.

Cody says that she and River's father feel like the "luckiest parents ever". "River is living, breathing proof of how important early diagnosis can be," she says. ■

For more on DNA sequencing, see page 46

# 'Red matter' superconductor could transform electronics – if it works

Leah Crane

ROOM-temperature, room-pressure superconductivity has been a central goal of materials science for more than a century, and it may have nearly been achieved. If this new superconducting material holds up, it could revolutionise the way our world is powered – but the results are headed for serious scientific scrutiny first.

When a material is superconductive, electricity flows through it with zero resistance, which means none of the energy involved is lost as heat. But every superconductor made so far has required extraordinarily high pressures, and most have required very low temperatures.

Ranga Dias at the University of Rochester in New York and his colleagues claim to have made a material from hydrogen, nitrogen and lutetium that becomes superconductive at a temperature of just 21°C (69°F) and a pressure of 1 gigapascal.

That is nearly 10,000 times the atmospheric pressure on Earth's surface, but still far lower pressure than that used for any previous superconducting material. "Let's say you were riding a horse in the 1940s when you see a Ferrari driving past you – that's the level of difference between previous experiments and this," says Dias.

To make the material, the researchers placed a combination of the three elements into a diamond anvil – a piece of machinery that compresses samples to extraordinarily high pressures between two diamonds – and squeezed. As the material was compressed, its colour changed from blue to red, leading the researchers to nickname it "red matter".

They then ran a series of tests examining the red matter's electrical resistance and heat

capacity, and how it interacted with an applied magnetic field. All the tests pointed towards the material being superconductive, they say (*Nature*, doi.org/grwq9m).

## Not yet super convinced

But many researchers in the field are sceptical of the result. "Perhaps they have discovered something absolutely groundbreaking and earth-shattering in this work, something that would win a Nobel prize, but I have some reservations," says James Hamlin at the University of Florida.

Some of his reservations, and those of other superconductivity researchers, are due to controversy surrounding a 2020 paper by Dias and his team, which claimed room-temperature superconductivity and was later retracted by the scientific journal *Nature*. At the time, some questioned whether the data presented in the paper was accurate and raised questions about how the published data was derived from the raw measurements. "Until the authors provide

**A diamond anvil was used to create the potentially superconducting material**

answers to those questions that can be understood, there is no reason to believe that [the data] they are publishing in this paper reflect the physical properties of real physical samples either," says Jorge Hirsch at the University of California, San Diego.

Part of the reason that scepticism is so hard to assuage is that we don't know enough about red matter to build a theoretical understanding of the mechanism behind its possible superconductivity. "There's still a lot to be done in terms of understanding the exact structure of this material, which is very crucial to understanding how this material is superconducting," says Dias.

If theorists can figure out exactly how and why this material becomes superconductive, it will both go a long way towards convincing researchers that it is, in fact, a superconductor, and it could also put red matter on the road to being produced industrially.

"The structures found in this work are probably quite different [from previously confirmed superconducting materials]," says Eva Zurek at the University at Buffalo in New York.

"The mechanism behind this compound's superconductivity might be different, but I can't know for sure because I don't have a structure to work off of."

If independent groups are able to verify red matter's superconductivity and figure out its structure, this could be one of the most impactful scientific findings ever. A room-temperature, room-pressure superconductor could make the electrical power grid much more efficient and environmentally friendly, supercharge magnetic levitation and far more. "I think there are a lot

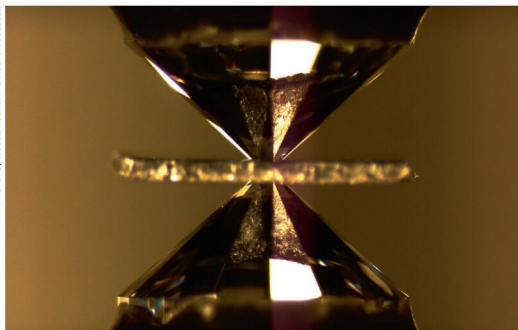
**"If others are able to verify the result, this could be one of the most impactful scientific findings ever"**

of technologies that haven't even been imagined yet that could use room-temperature, room-pressure superconductivity," says Zurek.

But researchers aren't dreaming about a superconducting society yet. "There's going to be a lot of scrutiny, obviously," says Hamlin. Only a few laboratories around the world have the expensive and complicated diamond anvils capable of reaching the high pressures required by previous superconductivity experiments, but pressure cells that can reach 1 gigapascal are relatively commonplace.

That may be the biggest factor differentiating this work from the retracted 2020 paper. "Their previous work still hasn't been reproduced by an independent group, but this one should be reproduced extremely quickly," says Tim Strobel at the Carnegie Institution for Science in Washington DC. "We're going to do this right away." If all goes well, this could mark the beginning of an energy revolution. ■

STEVE JACOBSEN/USBC AT CARLETON COLLEGE



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# Skyscrapers go green

The world's largest example of an office building constructed to a "passive house" design is soon to open in Boston, Massachusetts, writes **Jeremy Hsu**

ON A cold winter's day in February, the drone of a powerful fan filled the cavernous office space on the 17th floor of a new skyscraper in downtown Boston. A group of building developers wearing hard hats and orange safety vests stood around as the machine sucked air from the space.

They were conducting a depressurisation test as part of a process to confirm that the space – one of 21 floors of office in the 62-storey building – met new energy-saving benchmarks. Those design requirements, known as passive house standards, call for airtight construction and extra insulation to help maintain a comfortable indoor temperature.

The idea is to use such building design elements to minimise reliance on energy-consuming heating or cooling systems. Thousands of passive house buildings already exist in the world, with most of them in Europe. But Boston's \$1.35 billion Winthrop Center is set to become the largest office building yet to incorporate these construction standards when completed in a few months.

"During the recent extreme cold in Boston, the passive house floors performed extremely well," says Brad Mahoney, director of sustainable development at Millennium Partners Boston, the development company behind the skyscraper. "We didn't really have a heating system live and it was comfortable on these floors."

The Winthrop Center's exterior wall includes triple-glazed windows, which have three glass panes with insulating air layers in between, and 23 to 33-centimetre-thick insulation for sections of

opaque glass panel. That design minimises any uncontrolled exchange of air or loss of heat, while maximising access to natural sunlight.

Building to the passive house standard doesn't require uncommon building materials so much as making design choices such as using triple-glazed windows instead of just double-pane or single-pane ones, says Michael O'Donnell at Steven Winter Associates, an engineering consultancy based in New York City that helped develop the Winthrop Center. He compares the passive house approach to a person wearing an insulating sweater beneath an outer jacket that provides an airtight seal.

Each office floor is both compartmentalised and insulated from those above and below it to reduce uncontrolled air exchange that could lead to heating or cooling energy being lost. Existing Boston buildings that have been constructed to the highest

"platinum" standard under the popular LEED (Leadership in Energy and Environmental Design) rating system for green buildings use 60 per cent more energy than the Winthrop Center is expected to, and other typical high-end

**"A passive house is like wearing an insulating sweater beneath an outer jacket with an airtight seal"**

office buildings use 150 per cent more, according to Mahoney.

"[Passive house buildings] not only bring higher energy performance, but what I think is much more important is they bring an incredible level of comfort to either working or living," says Jörg Rügemeier, a sustainable design architect at the University of Utah, who wasn't involved in the project.

The depressurisation test last month was one performance check for a certification process overseen by the Passive House

Institute in Germany. If the Winthrop Center receives passive house certification, it will become a "landmark project" that could inspire other developers of high-rise office buildings to adopt these standards, says Rügemeier. He hopes that passive house developments in all types of buildings, including affordable housing projects, will continue to ramp up in the US. "There are about 1 to 2 million new homes being built in the United States every year," says Rügemeier. "So, if these are all real energy hogs, we don't gain a lot with a few buildings like the Winthrop Center."

Passive house standards are expected to become more popular in the US as key components, such as triple-glazed windows, become cheaper and more available – something that has already happened in Europe over the past two decades.

States such as Massachusetts are also updating building energy codes to incorporate elements of the passive house standard – including the air test used to help certify the performance of the Winthrop Center.

Other north-eastern US states, along with west coast states such as California, Oregon and Washington, have also been working to incorporate such performance standards into building energy codes, says Rügemeier. In Europe, cities such as Brussels in Belgium have already gone further by adopting the passive house standard as their building code.

"Understanding how to apply passive house standards at this scale and typology in an urban setting, a high-rise office, helps not only with future office developments, but also helps with other building types," says Mahoney. ■



**The Winthrop Center, an energy efficient skyscraper in Boston**

## Analysis Cardiovascular disease

**Have we overlooked a key sign of an unhealthy heart?** Inflammation may be just as important as cholesterol in causing heart attacks and strokes, and treating it could lead to new tools for prevention, reports **Clare Wilson**

DOCTORS are in the middle of a major rethink about the causes of heart attacks and strokes, which are among the commonest killers worldwide.

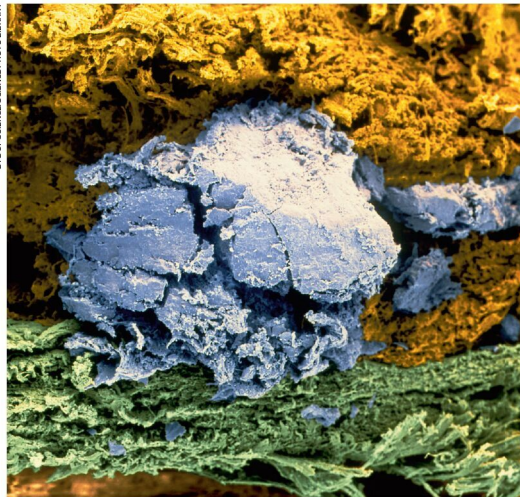
For decades, much of the focus has been on cholesterol; statin drugs, used to lower cholesterol, are the most commonly prescribed medication for preventing cardiovascular disease in the UK. But a growing number of researchers say that there is another key contributor: inflammation, which is linked to the background activity of the immune system.

Last week, research showed that in people taking statins to lower their cholesterol, inflammation is a bigger risk factor for heart attacks or strokes than whether they still have high cholesterol levels. "It's clear that if you don't start addressing the inflammatory response, you're never going to beat this disease," says Paul Ridker at Brigham and Women's Hospital in Boston, who was involved in the research. "It's no longer a hypothesis; it's proven fact."

The idea of targeting cholesterol to treat cardiovascular disease stems from large studies that found higher levels of "bad cholesterol" in the body correlate with higher rates of heart attacks.

The other clue was that cholesterol is one of the main components of fatty plaques that can form in artery walls and restrict blood flow to major organs. Heart attacks and strokes usually happen because such a plaque ruptures, which can result in the blockage of smaller blood vessels downstream.

Once this was understood, cholesterol-lowering statins became one of the commonest medicines in use. More than 200 million people worldwide are taking a statin – either because



**An image of a plaque (blue and yellow) in the wall of an artery (green)**

they have survived a heart attack or stroke or they are thought to be at risk of having one. Many large trials have found that statins are very effective at reducing heart attacks, reinforcing the cholesterol theory of heart disease.

So where does inflammation come in? The revised idea is that those plaques aren't just inert deposits, but are alive with immune cell activity. Studies in

**"Doctors need to place the same importance on tackling inflammation as on cholesterol"**

animals have shown that plaques that are more inflamed as a result of such activity are more likely to burst and shed deadly fragments into the bloodstream. And recent evidence suggests statins may work by dampening inflammation as well as lowering cholesterol.

Despite mounting evidence of the importance of inflammation,

it hasn't so far translated into new ways to prevent or treat cardiovascular disease. But that may be about to change.

In the new research, Ridker's team analysed figures from three large trials that each tested a different therapy aimed at reducing heart attacks and strokes in people who were taking statins.

The results for those therapies aren't what is relevant here. At the start of the trials, participants' blood was put through a battery of tests, including for cholesterol and a compound that is a hallmark of inflammation, called C-reactive protein (CRP). All three trials found that high CRP was linked to more deaths from cardiovascular disease than high cholesterol. The quarter of participants with the highest CRP had a 268 per cent greater risk of dying from cardiovascular disease than the quarter with the lowest, while high cholesterol only raised the risk by 27 per cent (*The Lancet*, doi.org/gr9vfg).

Knowing that inflammation is part of the disease process is little use unless we can do something about it. But in the past few years, several drugs designed to do just that have been tested.

One of the most promising is a plant-derived compound called colchicine, which is already used for easing inflammation in people with gout. Two recent randomised trials have shown that colchicine also cuts the risk of strokes and heart attacks by about 30 per cent, a similar amount to statins.

### Promising drug

Colchicine is only licensed for preventing cardiovascular disease in Canada, although in 2021 it was recommended for this in guidelines from the European Society of Cardiology. If it were to be recommended by a similar body in the UK, doctors could prescribe it "off-label", says Nilesh Samani at the University of Leicester, UK, who wasn't involved in the latest study.

One caveat is that people who have had a heart attack or stroke may already be taking many tablets, and the more drugs someone takes, the more likely they will interact with each other and cause unwanted effects – not to mention the inconvenience of being on multiple medications.

Nevertheless, the evidence is growing that to prevent heart disease and strokes, doctors need to place the same importance on tackling inflammation as on cholesterol. "It's not either-or – it's both," says Jean-Claude Tardif at the Montreal Heart Institute in Canada, who was involved in one of the colchicine trials. ■

# Soil bacteria enzyme generates electricity from hydrogen in the air

Alex Wilkins

AN ENZYME that can create energy from hydrogen could power future fuel cells or small generators.

Soil bacteria that have evolved to consume hydrogen to make their energy take in about 60 million tonnes of the gas globally each year, but how they do it has been a bit of a mystery.

Rhys Grinter at Monash University in Melbourne and his colleagues have previously identified that an iron and nickel-based enzyme called Huc in the soil bacterium *Mycobacterium smegmatis* plays a key role in this hydrogen-cycling process, but it was unclear how Huc worked.

Now, Grinter and his team have analysed the enzyme using an ultracool electron microscope and shown that it can produce electrons when it is in a hydrogen-filled test tube and also power specially designed circuits.

“What makes our enzyme really special is its affinity for the hydrogen,” says Grinter. “It can break down hydrogen into electrons at a much lower concentration than any other catalyst that’s been identified, and it’s also completely resistant to any inhibition by gases like oxygen and carbon monoxide.”

To get enough of the Huc enzyme to analyse, Grinter and his team modified *M. smegmatis* bacteria to produce more of it, then isolated the enzyme using a sticky resin that binds to it.

After mapping its structure and running simulations of how it processes gas, the researchers realised that Huc’s ability to harvest hydrogen even at the low concentrations in air is due to the narrow channels in it. These allow only hydrogen, not other gases, to pass through to its centre, where electrons are removed from it.

They also found that Huc works in temperatures from freezing all the way to 80°C (176°F).

To test Huc’s hydrogen-harvesting abilities, the researchers put some of the purified enzyme in a small vial with hydrogen and a dye that changes colour when electrons are present. They found that the

## 80°C

**The Huc enzyme keeps working even in temperatures this hot**

dye changed colour and the hydrogen levels decreased until the gas was no longer detectable.

They also constructed simple electrical circuits in which Huc was attached to an electrode and found that it could generate small currents (*Nature*, doi.org/j2qz).

Huc could be used in fuel cells or for generators that power

low-energy devices like remote sensors, if it could be produced in larger volumes. This would require scaling up the production process to hundreds of thousands of litres of bacteria from the roughly 10 litres possible now, which isn’t straightforward, says Grinter. There are also aspects of how Huc processes hydrogen that need further investigation, he says.

The work is still important for future fuel cell technology, says Simone Morra at the University of Nottingham, UK. “It’s a big technical challenge to understand the structure of this enzyme because it’s a large complex made of many subunits.”

Although research will be needed to see if Huc production can be scaled up, the detail with which we can now see the enzyme means it could inspire the design of artificial enzymes that are more robust, he says. ■

## Animal behaviour

### Brown widow spiders stalk and kill black widows

IN PARTS of the southern US, black widows are being supplanted by their more aggressive arachnid relatives: brown widows.

Southern black widows (*Latrodectus mactans*) – identifiable by the red hourglass shape on their abdomen – have been vanishing from Florida, while there has been an increase in brown widows (*Latrodectus geometricus*), a species native to southern mainland Africa and Madagascar that arrived in the US in the 1990s.

Initially, scientists wondered if this was due to competition for food and space. But Florida appeared to have ample room for



ROBERTO SCHILLARI

both, so entomologists wondered if the black widows were being hunted by brown widows.

To test the idea in the lab, Richard Vetter at the University of California, Riverside, and his colleagues gave brown widows their choice of an arachnid buffet: red house spiders (*Nesficodes rufipes*), triangulate

cobweb spiders (*Steatoda triangulosa*) or southern black widows. Brown widows were 6.6 times more likely to kill southern black widows in their enclosure than any other arachnid offered (*Annals of the Entomological Society of America*, doi.org/j2sd).

When the researchers observed

A female brown widow hanging from a web in front of its spiked egg sac

brown and southern black widows meeting face-to-face, they saw both species engage in rapid bouts of “slapping” each other’s legs. They also saw female brown widows aggressively stalking, capturing and consuming southern black widows at all stages of development.

“[Brown widows] were wiping them out before they even got a chance to get going,” says Vetter.

When researchers compared the two species, they found that female brown widows outperformed southern black widows in both size and reproductive ability, which could play a role in the dynamics playing out in Florida. ■  
Corryn Wetzel

Field notes Berkshire, UK

**Making trees old before their time** The decayed trunks of ancient trees are a vital habitat in decline. With the help of fungi, we might be able to boost the supply of veteran trees, finds **Graham Lawton**



I AM in a forest 35 kilometres west of London, meeting someone who is trying to make young trees old. “Old trees form hugely important habitats,” says Lynne Boddy, a mycologist at Cardiff University, UK. “But in Europe in general, including in Britain, we don’t have all that many now.” She is one of a handful of scientists around the world trying to do something about it.

Boddy takes me over to look at a gnarly oak, which is roughly 300 years old. “You can see all these lower branches here that are starting to decay and rot,” she says. “That’s a sign that it is a veteran.”

If we could look inside the trunk, she says, we would see massive amounts of decay from fungi gradually eating the tree from within. This is called heart rot, and it is a perfectly natural process that happens to all trees in the end. It has only been studied in earnest for about a decade and its importance to forest ecosystems turns out to be immense.

“The centre of the tree is no longer functional to the tree,” Boddy explains. “The outside-ish regions of the trunk conduct water from the roots up to the leaves. That’s the sapwood. But in the inner regions, the heartwood, there are no longer any living cells. Water is not conducted there. So fungi can start to develop in those central regions because the wood starts to dry out.”

“The fungi are just feeding on dead stuff, so it’s wrong to call them parasites,” says Boddy.

Indeed, the rotting core of a tree is immensely valuable as a habitat, not just for the fungi themselves – many of which are heart rot specialists – but also for myriad other species. In the UK, around 1800 invertebrate species depend on rotten wood, says Boddy. Across the world, heart rot supports



L. RICHARD WRIGHT, R. GRAHAM LAWTON



**Main picture and top right: veteran oak trees. Bottom right: a scar where a beech tree has been inoculated with heart rot fungus**

**1800**  
Invertebrate species in the UK that depend on rotting wood

**120**  
Typical age at which a beech tree develops heart rot

**300**  
Typical age at which an oak tree develops heart rot

immense numbers of species, including about 1000 birds and hundreds of other vertebrates, such as bats. The fungi are also important contributors to the recycling of nutrients upon which all ecosystems depend.

The problem is that the veterans are dying out and there aren’t enough middle-aged trees to replace them. Forestry practices over the past few centuries have taken out trees long before they reach the heart rot stage – which is around 300 years old for an oak and 120 for a beech – so there is a huge gap between the ancients and the next generation. Heart rot fungi and the species that depend on them are in danger.

For now, the UK is well-endowed with old trees due to royal hunting forests, such as the New Forest. “I think we’ve probably got as many veteran trees in Britain as in the whole of the rest of Europe put

together,” says Boddy. But they won’t last forever. “Eventually, they will just die of old age, and in lots of places humans are thinking ‘these are inconvenient, we want to build here – chop them down!’,” she says.

Boddy takes me to see an ancient oak on its last legs. The heart is visible through an immense hollow and has entirely rotted away. The tree is basically a cylinder of narrow sapwood full of dark brown, nutrient-dense mulch. When the tree eventually dies, the fungi will need to find a new home, of which there are too few.

The answer, possibly, is to “veteranise” young trees. “We try and make young trees older before their time,” says Boddy. Elsewhere in Europe, veteranisation usually means tearing off branches to let the fungi in, setting fire to the base of the trunk or damaging the bark



## Archaeology

# Monkeys cast doubt on ancient human 'tools'

Christa Lesté-Lasserre

with sledgehammers. "There is evidence that habitat is being created, but of course we don't know whether it really mimics the heart rot habitat," says Boddy.

So, here in the UK and also in North America, she and others have taken a more targeted approach, deliberately infecting young trees with heart rot fungi. This is done by chainsawing four cuts in an

oblong shape near the base of the trunk, then pushing the saw in sideways to pop out a block of wood about the size of a brick.

The block is replaced with a similar-sized block that has been dried out and exposed to heart rot fungi in the lab. Once these have been established in the wood, the block can be put into the tree and tamped in with fungus-rich sawdust, inoculating its heartwood. The hope is that the fungi will then start the rotting process much earlier than would have occurred naturally.

**"The hope is that the fungi start the rotting process much earlier than would have occurred naturally"**

The block is replaced with a similar-sized block that has been dried out and exposed to heart rot fungi in the lab. Once these have been established in the wood, the block can be put into the tree and tamped in with fungus-rich sawdust, inoculating its heartwood.

The hope is that the fungi will then start the rotting process much earlier than would have occurred naturally.

Boddy takes me to a section of the forest where her experiment is ongoing. The landowner has designated it a perpetual forest, meaning it will never be felled. The beeches here are about 60 years old, far too young to have heart rot. But Boddy wants to be a rotter to them.

A few years ago, she and her team chose 60 beech trees and cut blocks out of them. They left some with a hole, while others had the wood block replaced untouched, and the rest were inoculated with one of four heart rot fungi. Uncut trees serve as controls. You can see the blocks inside the inoculated

trees, though many are now being encroached by new bark growing around the scar.

There is some evidence that it is working. A technique called sonic tomography, which transmits sound waves through the trunk to map its density in three dimensions, can peer inside a tree without damaging it. Rotten heartwood is less dense than sapwood, so the heart rot regions show up on the tomograph. Boddy and her colleagues also take drill cores and DNA sequence them to discover which fungi are present. Both techniques have revealed some success.

But there is undisputable evidence that inoculation works. We head over to a tree that lost a huge branch in a storm this time last year. The falling bough hit a neighbouring beech and felled it. As luck would have it, the toppled tree had been inoculated with a heart rot fungus about four years previously. "Because it had come down, we were allowed to saw it up," says Boddy.

The tree was probed with sound waves after it fell and showed hints of heart rot close to the inoculation site. But the chopped-up trunk told a different story: the heart rot had spread several metres up the trunk. "Certainly, the tree was changing," says Boddy.

That bodes well for the future of heart rot fungi and the valuable habitats they create, but we won't know for decades whether it really works.

"We'll have to leave this for 20 or 30 years and find out what happens," says Boddy. At that point, some of the really ancient trees will have died. We can only hope that, by then, there will also be a new generation of veteranised trees ready to fill their venerable roots. ■

**BY USING** stones to break open nuts, monkeys accidentally create sharp-edged flakes that look like the tools believed to have been used by our ancient human relatives.

The finding casts doubt on whether all the stone flakes found in archaeological digs really are the tools of early hominins – and raises the possibility that they might be accidental by-products of hitting things with whole stones, says Lydia Lunz at the Max Planck Institute for Evolutionary Anthropology in Germany.

While studying long-tailed macaques (*Macaca fascicularis*) on the islands of Phang Nga Bay in Thailand, Lunz stumbled across nut-cracking sites – a surprise, as long-tailed macaques weren't previously known to break open nuts.

The team set up motion-activated cameras to study the behaviour of the wild macaques. During 100 hours of footage, the team witnessed monkeys accidentally creating flakes as they struck nuts between two stones – serving as a hammerstone and an anvil – and then leaving the broken stones to find new, whole stones.

Sharp stone flakes made unintentionally by macaques

This is almost exactly what the team had seen in Brazilian capuchins in an earlier study, says Lunz, showing that the flake-making wasn't a one-off. "This was occurring on the other side of the planet, in a different ecosystem and a different species," she says. "So it was just so obvious that this is a primate thing. This is a foraging behaviour that we assume also happened in early hominins."

The team then compared 1119 stone flakes from the macaques' nut-cracking sites with artefacts found at hominin sites in Ethiopia, Kenya and Tanzania (*Science Advances*, DOI: 10.1126/sciadv.ade8159). The monkeys' thin, flat, wide stone flakes were

"almost indistinguishable" from flakes associated with ancient humans up to 3.3 million years ago, says Tomos Proffitt, another member of the research team at the Max Planck Institute for Evolutionary Anthropology.

The findings could challenge the current understanding of early stone technology, says Proffitt. "What our study shows is that we can't be 100 per cent certain that every single flake in the early Stone Age archaeological record was intentionally made. There may be a component within that record that's unintentional." ■



PROFFITT ET AL., 2023

## Cell biology

# Mice born using eggs derived from male cells for the first time

Michael Le Page

SEVEN mice have been born from male cells that were turned into egg cells and then fertilised with sperm. The technique could one day allow two men in a same-sex couple to have children who are genetically related to both of them. It could also help women with certain chromosomal conditions have children who are biologically related to them.

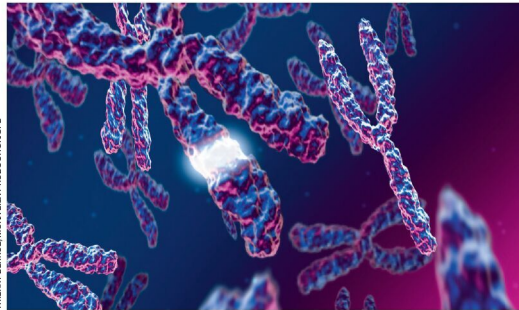
The original aim of the research was to investigate options for treating infertility in women who have only one X chromosome instead of two, said Katsuhiko Hayashi at Kyushu University in Japan at the Third International Summit on Human Genome Editing in London on 8 March. The symptoms of the condition, known as Turner syndrome, vary widely but almost always include infertility because normal egg development requires two X chromosomes.

Hayashi and his team wanted to see if cells with one X could be turned into cells with two Xs. To do this, it is easiest to start with male cells, which contain one X and one Y, as the Y is the smallest and most

dispensable chromosome – and it is often lost naturally.

The researchers produced stem cells from the cells of 8-week-old male mice and picked out ones that spontaneously lost the Y chromosomes. They then manipulated the cells in a way that resulted in a few obtaining two copies of the X after cell division – normally the two cells resulting from division

**An artwork of X and Y chromosomes within a cell**



THEIRY BERRICO, MONA LISA PRODUCTIONS/EPFL

should only have one copy each.

Hayashi's team has previously developed methods for changing mouse stem cells into eggs, and these were used to turn the XX cells into egg cells. The team fertilised them with sperm from male mice. Over 600 embryos were then implanted into female mice, resulting in seven apparently healthy pups, said Hayashi.

While the aim of the work was to explore potential treatments for infertility due to Turner syndrome, Hayashi says it could one day allow the creation of children with

two fathers. "What I can say is only about the technological side. I think, in theory, it is possible," Hayashi told *New Scientist* after his talk. A paper outlining the results will be published soon, he says.

While Hayashi is the first to create mice with two fathers, mice with two mothers were made in 2009.

Hayashi's work is extraordinary, says James Turner at the Francis Crick Institute in the UK. But to do the same in humans will require turning human stem cells into mature egg cells outside the body. While many researchers assume it is just a matter of time before we work out how to do this, it might be impossible to generate healthy eggs this way, says Turner.

It is exciting work, says Helen O'Neill at University College London. In addition to women with Turner's syndrome and men in same-sex couples, the work could also help women with Swyer's syndrome have children genetically related to them, says O'Neill. Women with this condition have an X and Y chromosome instead of two Xs, and don't produce eggs, she says. ■

## Emotions

### Disgust and fear are linked to a more acidic stomach

HAVING a "gut feeling" may not just be a metaphor. New research suggests that feeling intense emotions is accompanied by changes to our stomach's pH.

Giuseppina Porciello at the Sapienza University of Rome, Italy, and her team asked 31 men with an average age of 24 to take a smart pill that measures pH in the gut.

The men then watched videos that elicit disgust, fear and happiness

while the sensor travelled down their gastrointestinal tract, before being passed naturally.

After each video, the participants completed a questionnaire to rate the intensity of their emotions.

When they watched the disgusting and scary videos, their stomach's pH was more acidic than it was at a baseline measurement.

Those with the most acidic pH reported feeling the most disgusted and fearful. It is unclear whether a particularly acidic stomach heightens these emotions or if experiencing these emotions results in more acidity.

The participants who reported feeling happy, regardless of the video they watched, had a less acidic pH in their stomach (bioRxiv, doi.org/jz9q).

Negative emotions may induce acid secretion, says Ignacio Rebollo at the German Institute of Human Nutrition in Nuthetal.

To establish whether our emotions influence our stomach's acidity, or vice versa, Porciello says

**"An acidic stomach may heighten negative emotions or the emotions may cause more acidity"**

she and her team could administer proton pump inhibitors – which stop the stomach lining from producing too much acid – to see if this correlates with a fall in the intensity of negative emotions.

Christopher Bettinger at Carnegie Mellon University, Pennsylvania, says measuring gas composition or chemical concentrations could help the researchers "gain more granular insight" into the relationship between our gut and emotions.

Porciello and her team are now carrying out a similar study on female participants. ■  
Sally Adee

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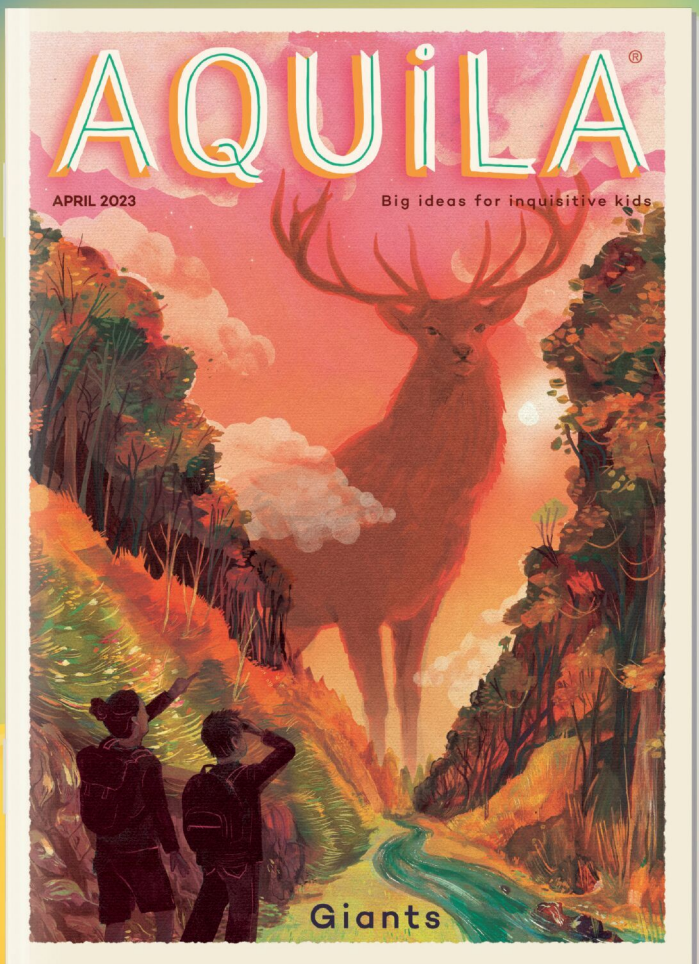
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## Climate change

# We could store carbon as baking soda in the ocean

Madeleine Cuff

CARBON dioxide captured from the air could be turned into baking soda and stored in the oceans, thanks to a newly identified material that researchers say could revolutionise the direct air capture (DAC) industry.

For years, carbon capture technology has focused on capturing CO<sub>2</sub> from pollution sites before it enters the atmosphere – from the chimneys of coal and steel plants, for example.

Extracting carbon directly from the air represents a far greater challenge, as CO<sub>2</sub> in the atmosphere is far more dilute and extracting it requires more energy and materials. It means current DAC plants are expensive to run, with a tonne of CO<sub>2</sub> costing hundreds of US dollars to pull from the air.

Arup SenGupta at Lehigh University in Bethlehem, Pennsylvania, and his colleagues have developed a new absorbent material – called a sorbent – capable of pulling more CO<sub>2</sub> from the air than current materials can. By modifying existing amine solvents with a copper solution, the researchers say they can boost the effectiveness of DAC by two to three times.

“This material can be produced at very high capacity very rapidly,” says SenGupta. “That definitely should improve the cost-effectiveness of the process.”

The captured CO<sub>2</sub> can be converted into sodium bicarbonate, or baking soda, with the addition of seawater. This can then be safely stored

in the ocean, which represents an “infinite sink” for captured CO<sub>2</sub>, the team suggests (*Science Advances*, doi.org/grwr3j).

Releasing baking soda into the ocean wouldn’t pose any ecological harm, says SenGupta. Sodium bicarbonate is an alkali, so it could offer some benefit by reversing the acidification of the ocean that occurs when CO<sub>2</sub> is dissolved, he says.

**60**  
megatonnes of CO<sub>2</sub> must be captured per year by 2030

Eventually, DAC plants using this sorbent could be installed offshore, says SenGupta, allowing countries without geological carbon storage potential to start removing carbon from the atmosphere.

The proposal is “elegant and clever chemistry”, says Stuart Haszeldine at the University of Edinburgh, UK. “[The] ability to store directly into seawater is also very powerful, because the very deep ocean has an immense capacity for accessible CO<sub>2</sub> storage lasting hundreds to thousands of years.”

But further research is needed to understand how the material performs on an industrial scale after absorbing and releasing CO<sub>2</sub> hundreds of times, he says. There may also be legal barriers to discharging the baking soda – which could be classed as industrial waste – into the ocean.

The use of carbon removal technologies must be rapidly scaled up in order to limit global warming to 1.5°C, moving from capturing almost 0.01 megatonnes of CO<sub>2</sub> per year today to almost 60 Mt per year by 2030, according to the International Energy Agency.

Myles Allen at the University of Oxford says that while the new sorbent may offer a technical breakthrough to improve DAC efficiency, what is really needed for the global market to expand at this rapid pace is for governments to force energy companies to invest.

“I’ve argued consistently that basically the only way this will ever happen at the scale it needs to happen is if it’s made a licensing condition of continuing to sell fossil fuels,” he says. ■



Oceans can lock away carbon for hundreds of years

## Health

# Covid-19 vaccine in pregnancy helps protect newborns

Grace Wade



A pregnant woman receives a covid-19 booster in Los Angeles

**COVID-19 vaccination in pregnancy helps protect infants from infection during their first six months of life.**

Ousseny Zerbo at Kaiser Permanente in California and his colleagues studied 30,311 infants born between 15 December 2020 and 31 May 2022 in northern California. Of the infants, 19,418 had mothers unvaccinated against covid-19, 9755 had mothers who received two or more vaccine doses during pregnancy and 1138 had mothers who received one covid-19 vaccine dose while pregnant.

By 6 months old, 940 infants had tested positive for covid-19. When the delta variant was dominant, two or more vaccine doses in pregnancy reduced the risk of covid-19 infection by 84 per cent in the first two months of life. This fell to 56 per cent by 6 months of age. When omicron was most prevalent, two or more doses in pregnancy reduced infection risk by 21 per cent for the first two months, falling to 13 per cent by six months (*Nature Communications*, doi.org/j2rs).

When the team looked at infants born to mothers who received one covid-19 vaccine before and two during pregnancy, they found that, during the omicron period, infants had an 89 per cent lower risk of infection in their first two months of life. By 6 months old, they had a 48 per cent lower risk. This suggests an additional dose in pregnancy could improve protection for infants. ■

Animal behaviour

# Orca seen with pilot whale calf may be a case of interspecies foster parenting

Corryn Wetzel

A PILOT whale calf has been documented swimming in “echelon”, or the mother-and-calf position, with an orca for the first time. How the interspecies pair came together is unknown, leading researchers to wonder if the calf was adopted or abducted.

In August 2021, a whale-watching tour near Snæfellsnes peninsula in West Iceland spotted a pod of three orcas. Marie-Thérèse Mrusczk at the West Iceland Nature Research Centre, who was on board, saw a young whale drafting off the wake of a female named Saedis, but the calf was too small to be an orca (*Orcinus orca*).

The calf looked like a long-finned pilot whale (*Globicephala melas*), which puzzled Mrusczk, as no pilot whales were in the area. “I knew what I was seeing – and I also saw it in the pictures – but my mind was just saying, this cannot be. This is really, really weird,” she says. Images and video footage later confirmed this was the first case of an orca showing parenting behaviour to a calf of a different species (*Canadian Journal of Zoology*, doi.org/grv82s).



ORCA.GARDNER.ORG

**Saedis, a female orca, with a pilot whale calf swimming nearby**

In the 21 minutes in which Mrusczk observed the pod, the other two orcas didn’t interact with the young whale, whose visibly low body fat suggested it wasn’t nursing and was in poor health. Its still-wrinkled skin indicated that it was a newborn. The following summer, the calf was no longer with Saedis, having probably succumbed to malnutrition.

Pilot whale and orca calves are

used to being “babysat” for short periods while their parents hunt, she says, which could increase the likelihood that they could latch onto a non-mother caretaker.

But calling this cross-species relationship parenting may be going too far, says Filipa Samarra at the University of Iceland. The young pilot whale may have been swimming near Saedis to draft off her wake. “It could be that the female is just tolerating the presence of this calf,” she says.

In the decade in which Saedis has been monitored, she has never

had a calf of her own, so she may have adopted the pilot whale calf as a substitute. “One theory is that it was an orphaned calf that they found and took into the pod,” says Mrusczk. There could also be a more sinister explanation: this may be a case of calf-snatching.

When the two species cross paths in Icelandic waters, pilot whales occasionally charge orcas to shoo them away. But in July 2022, a year after Saedis was seen with the calf, Mrusczk saw groups of both species make repeated advances towards each other in a way never before documented. This time, the orcas appeared to be the aggressors, charging a pod of pilot whales with multiple young calves. “There is a possibility that the female [orca] that had the pilot whale calf before was trying to obtain another,” she says.

Whatever the cross-species custody arrangement is, it seems to be a trend. In 2022, Samarra’s research team saw a different female orca in southern Iceland swimming with another malnourished long-finned pilot whale at her side. ■

Palaeontology

## Surprising ‘animal’ fossil may actually be a bit of seaweed

A FOSSIL once thought to be the earliest known animal from a group called the bryozoans might actually be a seaweed.

Nearly all major animal groups first appear in the fossil record between 541 and 520 million years ago during an evolutionary event known as the Cambrian explosion. Until two years ago, the bryozoans – tiny, coral-like creatures that live in colonies in

oceans and freshwater – were the only animal group missing from that event, with their earliest fossil traces not showing up until 40 million years after it.

But in 2021, Paul Taylor at the Natural History Museum in London and his colleagues identified the 515-million-year-old Cambrian fossil *Protomelissia gatehousei* as a bryozoan, suggesting these animals arrived on the scene not long after other groups after all.

Now, Martin Smith at Durham University, UK, and his team have studied 12 new *Protomelissia*-like fossils from Kunming in China. They



ZHANG GUANG

A fossil of a shell is in the lower part of this image with *Protomelissia* attached to it in the upper half

had all been preserved in a way that maintained their soft tissues.

The researchers found clumping formations of individual tube-like structures in a honeycomb pattern, which can occur in both plants and animals. But they saw no tentacles, nor any regularly shaped holes for

tentacles to pass through – the telltale signs in later bryozoan fossils, says Smith. Instead, the researchers noticed long projections emerging from the honeycomb that look like flanges, structures that are typical of certain kinds of green algae that make up seaweed (*Nature*, doi.org/jz73).

Taylor, who wasn’t involved in the new study, isn’t convinced. He questions whether the new fossils are truly *Protomelissia*, especially since there are significant differences in the sizes of the specimens’ structures. ■  
Christa Lesté-Lasserre

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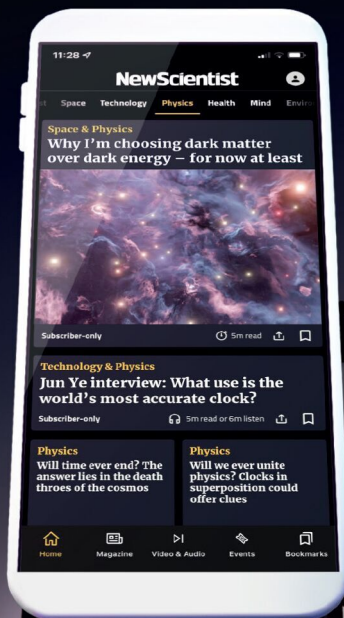
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# A costly cure for sickle cell disease

A gene-editing treatment for sickle cell disease could be approved later this year, but its predicted high cost will make it inaccessible to most people, finds **Michael Le Page**

MILLIONS of people could be cured of sickle cell disease, a painful inherited blood condition, thanks to CRISPR gene editing – but the cost of treatment is so high that few are likely to receive it in the foreseeable future.

Humanity is “able to cure sickle cell disease using gene editing”, Julie Makani at the Muhimbili University of Health in Tanzania told the International Summit on Human Genome Editing in London on 6 March. “This is, in my opinion, one of the greatest achievements in modern history.”

Several other speakers emphasised the need to make the treatment accessible to those who need it. Gautam Dongre at the National Alliance of Sickle Cell Organizations in India pointed out that many people with the condition still don’t have access to a relatively cheap drug called hydroxyurea that has been used to treat sickle cell symptoms for 40 years, let alone more advanced treatments. “We are still waiting,” he said.

Funding gene-editing treatments will be an issue even in high-income countries such as the US, says Steven Pearson at the Institute for Clinical and Economic Review in Boston. Many of the 100,000 or so people with sickle cell disease in the US are on state-funded Medicaid, he told *New Scientist*, and states don’t have nearly enough money to pay for all of them to have the CRISPR treatment.

Sickle cell disease is caused by mutations in both copies of the gene for haemoglobin, the red protein in blood that carries oxygen. This results in sickle-shaped red blood cells that can

block capillaries, damaging organs and causing severe pain.

“The pain was like being struck by lightning and hit by a freight train all at the same time,” says Victoria Gray, who was frequently hospitalised during severe episodes and required in-home care. “My life was just dreadful.”

## Millions of people

Around 5 to 7 million people worldwide have sickle cell disease, Emily Turner at the Gates Foundation told the summit. Across Africa, only around 10 per cent of those born with the condition reach adulthood, but in other regions screening programmes have greatly reduced childhood mortality.

There are now several drugs for tackling the symptoms and people can also be treated by replacing the blood stem cells in their bone marrow, which are responsible for producing new red blood cells, with those from a donor who doesn’t have the condition. However, this requires taking immunosuppressing drugs for life to prevent rejection and so isn’t a complete cure, which is

why researchers turned to CRISPR.

Key to this effort is the fact that there are both fetal and adult haemoglobin genes. The former are normally switched off around birth, but in some people they remain switched on. These people continue to produce fetal haemoglobin as adults and, even if they have two mutated copies of the adult gene, don’t develop sickle cell disease.

Several groups have been developing treatments based on reactivating fetal haemoglobin production in people’s own blood stem cells. In 2018, Gray was the first to be offered an experimental treatment developed by Vertex Pharmaceuticals.

“I had nothing to lose,” she says. “I wanted to be able to dress my daughters for their weddings and be there while they signed up for college.”

In 2019, blood stem cells were taken from Gray and gene-edited to reactivate the fetal haemoglobin. After treatment to destroy her remaining blood stem cells, the gene-edited cells were transferred back to Gray’s body and she hasn’t had symptoms since then.

After successful results in 31 people with sickle cell – with none experiencing severe pain episodes after treatment – and in 44 people with the related blood condition beta thalassaemia, Vertex Pharmaceuticals last year applied for the treatment’s approval in the US and the European Union. It is virtually certain to be approved by the US regulator in around three months or so, says Pearson.

The pricing hasn’t been announced, but similar treatments approved recently have cost between \$1 million and \$3.5 million, the summit heard. Part of the issue

**“Curing sickle cell disease using gene editing is one of the greatest achievements in modern history”**

is the personalised nature of the treatment, as people must receive edited copies of their own cells.

This is why the Gates Foundation is funding research into how to alter blood stem cells inside the body, Turner told the summit, rather than having to remove and replace them. This approach could lead to “off-the-shelf” treatments that could be given to everybody, greatly reducing costs.

Alexis Thompson at the Children’s Hospital of Philadelphia told *New Scientist* that while sickle cell disease is now technically curable, she won’t regard the condition as actually curable until those who need it are able to get treatment. She also struck a note of caution, pointing out that we don’t yet know how those who received the gene-editing therapy will fare in the longer term.

But for Gray, the immediate difference is clear. “The feeling is amazing,” she says. “Now, everything is different for me, and life is full of options.” ■

KATERINA MONISHUTTE/ISTOCK



**Sickle cell disease warps red blood cells into a distinctive shape**

Environment

## How bushfire smoke affected ozone layer

SMOKE from wildfires that raged across south-eastern Australia in 2019 and 2020 depleted Earth's ozone layer, but how wasn't clear.

So Kane Stone at Massachusetts Institute of Technology and his team modelled how changes in the solubility of hydrochloric acid affected the chemistry of the stratosphere. The model matched observations of this atmospheric layer during the fires very well.

The work revealed that smoke may enable hydrochloric acid, present chiefly due to emissions of now-banned CFCs, to dissolve more easily and make more of the reactive chlorine molecules that destroy ozone. This probably led to a 3 to 5 per cent depletion in ozone at mid-latitudes and made the seasonal ozone hole over Antarctica bigger (*Nature*, doi.org/grwk6r). James Dinneen



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Biology

## Hormone injection helps mice sober up

A NATURAL substance that helps drunk mice recover may one day treat alcohol poisoning in people.

Steven Klierer and David Mangelsdorf at the University of Texas Southwestern Medical Center and their team discovered that mice that can't make the hormone FGF21, which is also found in people, take longer to regain consciousness after an intoxicating dose of ethanol.

To investigate further, the team gave this kind of dose of ethanol to mice that made normal amounts of FGF21, then injected them with more of the hormone. Compared with mice that weren't given the injection, these animals took half as long to wake up and get to their feet after passing out from the alcohol. They also recovered their coordination faster (*Cell Metabolism*, doi.org/jz7s). Claire Ainsworth

Animal behaviour

## Puzzle-solving bumblebees pass on their knowledge

BUMBLEBEES can teach each other how to solve a puzzle box and they prefer the method they learn from other bees to those they figure out on their own. This ability adds to evidence that these insects are capable of social learning and that they use it to share trends and sustain cultures over time.

Researchers headed by Alice Bridges at Queen Mary University of London ran a series of experiments in which 10 colonies of buff-tailed bumblebees (*Bombus terrestris*) had to work out how to get to a sugary treat inside a box. There were two possible ways to gain access: push a red lever clockwise or push a blue lever anticlockwise. Each colony had a designated

demonstrator bee that was privately taught one of the two ways to open the box by a human. Then, these demonstrators were reintroduced into their colonies and all bees had the opportunity, for 3 hours each day over six to 12 days, to try to get into the box.

The bees used the trick they were taught by colony mates more than 98 per cent of the time, even when more than half of them figured out the other lever worked just as well. In colonies where no bee was taught by a human how to solve the puzzle, the insects managed to open the box only a handful of times (*PLoS Biology*, doi.org/grwfc5).

These results suggest that behaviour can be spread in groups of bumblebees through social learning and be maintained over time, like cultural trends. "That's exactly what we mean when we talk of the transmission of culture in animal communities," says Andrew Whiten at the University of St Andrews in the UK. Sofia Quaglia

Really brief



PUBLIC/ISTOCK/ARAO, DANIEL FRANZ

### Ultralight nanotech paint doesn't fade

A paint made from flakes of aluminium nanoparticles that trap and resonate certain wavelengths of light can be applied so thinly that using it on a Boeing 747 could cut the plane's mass by half a tonne. Unlike pigment-based paint, it won't fade over time (*Science Advances*, doi.org/grwmcw).

### Squid fishing boom in unpoliced areas

A sudden increase in illicit fishing in some parts of the world has left populations of squid vulnerable. The number of vessels using lights to lure squid to the surface increased by 68 per cent between 2017 and 2020, with 86 per cent of this fishing in unregulated ocean areas (*Science Advances*, DOI: 10.1126/sciadv.add8125).

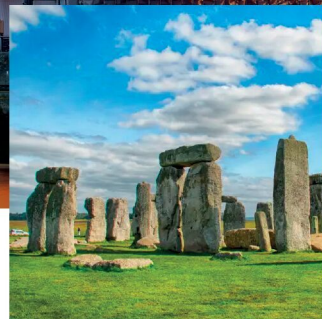
### Amazon game will help train robots

A video game created by Amazon, called *Alexa Arena*, in which you interact with virtual robots, aims to gather data on how people and machines interact. The information gleaned will be used to train commercial robots on how they should behave (*arxiv.org/abs/2303.01586*).

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## The columnist

**Annalee Newitz**  
on dystopian AI  
marketing hype p28

## Aperture

Bold images of  
the Padma river  
in Bangladesh p30

## Letters

The possibilities of  
electrical medicine  
are exciting p32

## Culture

Why we need a longer  
sense of time based  
on nature p34

## Culture columnist

Try *Wild Isles* for  
your nature fix, says  
Bethan Ackerley p36

## Comment

# Digital playtime

Parents often dismiss video gaming as worthless, but demonising the things our children love is counterproductive, says **Naomi Fisher**

**W**HAT if my child is addicted? As a clinical psychologist who works with young people, I am regularly asked by parents about video games. It is never about the positives. It seems they are concerned that if they don't worry about video games, I will consider them a bad parent.

The people I see aren't unusual. A recent poll of US parents showed that 86 per cent think teenagers spend too much time playing video games. This chimes with my experience in the UK, where we seem to have a parenting culture in which being negative about video games is acceptable. Parents have laughed in disbelief when I have asked if they have ever played a video game with their children. "I don't have time for that," they scoff.

It is hard to imagine a parent being willing to say they don't have time for other things their children enjoy, such as books or sports. But video games? Say you never play them and other parents will nod along. There is an undertone of "I don't have time to waste".

This is a shame, because many of my fondest memories of my children's childhoods are of video games. Not because I am a gamer, but because video games were a passion for my children. Like many parents, their enthusiasm initially made me fearful, but I quickly realised I had two options: fight it or embrace it. I embraced it. Our shared journey through video games enriched their childhoods and brought joy. We aren't alone.



MICHELLE DUBRAND

Recent large-scale studies have found that time playing video games can be good for well-being and that players experience competence and social connection through gaming.

I saw this happening with my children. I joined them in their *Minecraft* world and we built imaginary lands we still reminisce about. Watching them play helped them feel valued by me, as I demonstrated I was interested in the things they loved. I saw how, in their games, they felt capable and good about themselves.

As they got older, new fears surfaced. It seemed that everyone

took it as read that violent games increased aggression. When I looked at the research, it was less clear: an analysis of several studies suggested that evidence for a link between aggressive game play and matching behaviour is weak. My children were drawn to some violent games, and I, too, shot some zombies. I understand that play is a way in which young people make sense of the world, and violence is part of the world, much as we might wish it weren't.

Video gaming is play, but we don't value it the way we do other play. We encourage pretend tea parties and buy sets of Lego,

but denigrate role play and construction when it is in *Terraria*. I saw my children negotiating over who would guard the house while the other went off to farm, and could hear the complexity of the social skills required. I saw their creativity, logic and ability to problem-solve developing through video-game play.

It wasn't all good. My son discovered freemium games, where you pay with real money to advance the game. Very quickly, they dominated our life. There was little real play involved and he asked for money constantly. It wasn't making anyone happy. I told him I would delete them. He was upset and angry. I found alternative games where we paid upfront – and we were back on.

Why do I tell you all this? Because embracing your child's love of video games can be framed as bad parenting and I think it is the opposite. When you enter your children's gaming world, you can draw fine lines between what is and isn't acceptable. Rather than a blanket ban, you can make informed choices about what is good and what isn't.

Fear can block your view. I overcame that fear – the messages telling me society would judge – and stepped into my children's world. I haven't regretted it once. ■



Naomi Fisher is a clinical psychologist, writer and mother of two

## This changes everything

**The chatbotpocalypse?** AI entrepreneurs like to claim products such as chatbots could become conscious at any minute. We need to resist this dystopian marketing hype, says **Annalee Newitz**



Annalee Newitz is a science journalist and author. Their latest novel is *The Terraformers* and they are the co-host of the Hugo-winning podcast *Our Opinions Are Correct*. You can follow them @annaleen and their website is [techsploitation.com](http://techsploitation.com)

### Annalee's week

#### What I'm reading

*The Best of all Possible Worlds* by Karen Lord, a brilliant reimagining of the alien first contact story.

#### What I'm watching

*Starstruck*, the perfect romantic comedy for self-sabotaging nerds.

#### What I'm working on

Starting to write my fourth novel by researching Roman agriculture around Pompeii in the AD 50s.

This column appears monthly

I ALWAYS know there is something fishy going on with a new tech product when journalists start desperately reaching out to science fiction authors to explain it for them. Such is the case with ChatGPT, an artificial intelligence chatbot from San Francisco company OpenAI, which has become one of the world's most widely used apps in just a few short months.

So many news outlets were asking science fiction writers to weigh in on AI's capabilities that the Science Fiction and Fantasy Writers Association had to issue a special media statement on its website, linking to dozens of authors' thoughts on the matter.

Typically, when a cutting-edge tech product comes out, you would expect engineers, scientists and researchers to comment on it. But OpenAI isn't a typical company. It deals in myth-making and hype-spinning, and its representatives portray the firm's products as the first stage in "artificial general intelligence", or human-equivalent consciousness. The OpenAI blog is packed with science fictional scenarios (many written by company co-founder Sam Altman) about how ChatGPT and the firm's picture-creating product DALL-E are on the cusp of utterly transforming humanity – and possibly even destroying it.

I am not saying that ChatGPT isn't a fun little app with lots of applications. But at this point, its notoriety comes largely from marketing. Altman and other AI entrepreneurs in Silicon Valley are fond of saying that AI products may cause an "existential threat" because they could become superintelligent, conscious beings at any moment. And then they would have the power to wipe us all out, or turn us into paper clips, or something even more bizarre.

The question is, why would you use such a dark vision of your product to market it to people? Partly, it is to make a rather silly chatbot like ChatGPT sound a lot more formidable than it is. If you can be convinced that current AI apps will go Skynet any day now, then maybe you will buy the idea that ChatGPT is a powerful, revolutionary breakthrough.

The other reason to use this kind of dystopian hype is that it allows companies like OpenAI to cast themselves as the heroes that will save us from the coming chatbotpocalypse. Contributors to the OpenAI blog have spilled

**"Artificial general intelligence is still very much in the realm of science fiction and, frankly, it may always be"**

a lot of electrons in essays about how to bring AI values into alignment with human values. That way, when ChatGPT becomes a sentient superbeing, it will share our values and mindset, and so will ally itself with us instead of simply nuking us from orbit.

That sounds incredibly weird, until you realise that this is a marketing formula as old as advertising itself. Recently, I was discussing this very topic on a panel of science fiction writers at the Tucson Festival of Books in Arizona. Veronica Roth, author of *Arch Conspirator* and the *Divergent* series, pointed out that OpenAI's approach reminded her of the diet industry.

To sell their get-slim-quick products, diet companies need to convince consumers that there is something wrong with their bodies – preferably something they had never noticed before.

Ads bombard them with images of the "ideal" legs, for example, and consumers go from never thinking about their ankles to agonising over all the fat on their fibula bones. Luckily, Diet Bomb is here with a special formula to melt the pudgy off those offensive ankles!

Like Diet Bomb, OpenAI has invented a problem that it promises to solve – if you will pay, of course. Recently, the firm announced it would start charging for access to ChatGPT's services, and struck a \$10 billion deal with Microsoft to bring ChatGPT to the company's Bing search engine.

OpenAI's sales pitch is a brilliant rhetorical trick, and it works – until you recognise that you have fallen for one of the oldest tricks in Ye Olde Book of Hype.

The reason why media outlets are asking science fiction writers for their thoughts on AI apps isn't because we are about to enter a wild new future world. It is because when they talk to actual AI researchers, such as University of Washington computational linguist Emily Bender, they say that ChatGPT is nowhere near being a human-equivalent intelligence. Artificial general intelligence is still very much in the realm of science fiction and, frankly, it may always be.

So, when you read about these amazing new chatbots that are about to write great novels, invent a cure for ageing and replace humanity with paper clips, just remember you are being presented with an ad campaign. The people who make chatbots want you to buy their products. They aren't trying to elevate humanity or protect us from a dangerous, existential threat. They just want you to believe there is a problem out there that only AI companies can solve. For a price. ■

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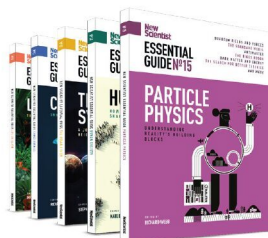
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## Sacred river



**Kazi Khaleed Ashraf**  
**ORO Editions**

STEEPED in vibrancy and antiquity, these bold images document the Padma, a major river flowing through Bangladesh that makes up the last leg of the journey of the river Ganges. They are taken from *The Great Padma Book: Life and times of an epic river* by Kazi Khaleed Ashraf, which sets out to paint a comprehensive picture of the land, water and people of the Padma, a word that means lotus flower in Sanskrit.

Starting from the Himalayas, the Ganges ends its 2500-kilometre journey in the Bengal delta, where it becomes known as the Padma (shown in the main image on the left). This is the largest river delta in the world and is a rich culmination of not only waterways, but also history and culture, shaped by the river's flow.

Ashraf writes in his introduction of how, in the past, "perhaps a greater attention was given to the origins" of the Ganges in the mountains, "not to how it ends in the sea". His book, which features a preface from author Amitav Ghosh, "takes off where others have stopped short", he writes.

The column of smaller images shows (top to bottom): a fragment of a map by Venetian cartographer Fra Mauro from the 1420s, suggesting a delta in the Ganges region; mangoes being transported to market in Chapai Nawabganj, known as Bangladesh's capital of the mango; a boat market in the country's Manikganj district.

*The Great Padma Book* is out now. ■

**Gege Li**

## Editor's pick

### Excited by possibilities of electrical medicine

25 February, p 38

From Gautam Menon, Walsall, West Midlands, UK

The role of cellular electrical signalling in depression, stress and anxiety has been a topic of research, but it was fascinating to understand how cellular voltage patterns can facilitate cancer cell propagation and how ion channel blockers can potentially mitigate against this. Mapping out a person's electrome can potentially unlock personalised treatment for health conditions.

Imagine real-time electrical mapping during a surgical or endoscopic procedure that can assist with identification of a cancerous lesion and confirm its clearance, or bespoke medication with specific electrical charges. The possibilities are exciting.

### On the divide between science and religion

4 March, p 34

From Bryn Glover, Kirkby Malzeard, North Yorkshire, UK  
In his book *Magisteria*, reviewed by Joshua Howgego, Nicolas Spencer identifies two "crunch points" where science and religion conflict. I would cite a third: the existence or otherwise of a supreme being.

At present, the scientific method leads me to conclude there is no god, but, logically, if evidence for a deity that satisfies the demands of the method were to arise, then I would clearly have to follow that evidence.

From Bruce Denness, Nilton, Isle of Wight, UK  
The picture accompanying Howgego's review nudges us towards the creation versus evolution debate. Creationists believe that God created the universe and everything in it six days, whereas evolutionists point to the measurably greater

age of fossils and other geological evidence as counter to this.

Nevertheless, if God is smart enough to have created everything in six days and put His feet up on the seventh, maybe He could also have imbued the geological record with the illusion of antiquity.

### Let us all grow old and wrinkly equally

25 February, p 8

From Jo Spencely, Edinburgh, UK  
While Julia Oh was scrupulous in noting the limitations of the sample group used in her research into how the skin microbiome might cause wrinkles – the narrow range of ages, ethnicities and even facial areas swabbed – neither she nor your reporting fully addressed the most glaring bias: the only people in the sample group were women. This is research that perpetuates the social expectation that, while women may be permitted to grow old, they are never allowed to look old.

From Joseph Ting, Brisbane, Australia

I fear that antibacterial face creams for "anti-ageing" may worsen antimicrobial resistance from antibiotic overuse.

### Future thinking is well and truly here already

25 February, p 27

From Naomi Jacobs, lecturer in design policy and futures thinking, Lancaster University, UK  
Ray Naylor suggests that legislators and policy-makers should learn from speculative fiction writers in considering impacts of emerging technology. In fact, speculative approaches are already informing such areas.

At our design-led research

centre, Imagination Lancaster, for example, we have a number of projects that include speculative design and design fiction: the process of considering multiple possible futures through scenarios or even prototypes of imaginary objects, systems and policies. By provoking policy-makers to consider best and worst-case scenarios, such research can inform a more responsible technological future.

### Don't fret about energy impact of indoor drying

Letters, 25 February

From Robert Cluck, Reston, Virginia, US

When it comes to energy-saving efforts, Richard Oliver raised concerns about the cooling effect of drying clothes by hanging them indoors in colder months. I have begun indoor drying on racks and had that worry at first. However, it appears to me that the effect would be minuscule compared with the energy lost when indoor air that has been heated is drawn through an electric dryer and then, in most set-ups, vented outside.

### Stripy wind farms may create other problems

4 March, p 9

From Guy Inchbald, Upton upon Severn, Worcestershire, UK  
The painting of wind turbines in black and white stripes to make them more visible to birds is a step in the right direction. However, any solution must pay attention to the life of the turbines.

Some blades can have a surprisingly short life. Black paint absorbs a lot of heat in bright sunlight and, in a sunny location, high temperatures may compromise the strength of the

blade. Thermal expansion can also unbalance the turbine, which would further shorten its life. It is vital to develop paint schemes that retain mechanical integrity.

### Child's carbon footprint becoming less of a worry

4 March, p 42

From Alan Walker, Edinburgh, UK

In your look at the impacts of having children, the alarming carbon footprint, per year or per lifetime, of a new person added to the world's population is based on a statistical model. This model, as you said, factors in the generations that can follow. However, it seems to assume continued strong population growth, whereas trends are towards lower or negative growth in many countries.

It would seem more fair to assume that a child born to a typical couple that reads *New Scientist* will have a carbon footprint the same or probably less than one parent's.

### Earlier 'geoengineering' didn't go so well, did it

18 February, p 18

From John Fewster, London, UK  
You report an idea to shade Earth by blasting moon dust to Lagrange points in space. What could possibly go wrong?

Mining, oil and power firms have long been "geoengineering" our environment. Some unintended consequences now require serious discussion of technological fixes that may cost the Earth. Global corporations seek to levy charges in order to ameliorate problems they created. Without question, technological advances can improve lives, but the moon dust idea is lunacy. ■

### For the record

■ In our look at chronic conditions linked to viral infections (4 March, Leader and p 14), we should have referred to myalgic encephalomyelitis.



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**FRANK MARTELA**

# Taking the longer view

Why do we have clocks? An ambitious book deconstructs their origins and argues for more nature-based measures, finds **Jason Arunn Murugesu**



**Book**  
**Saving Time**  
 Jenny Odell  
 The Bodley Head

THE covid-19 pandemic forced many of us to re-evaluate our relationship with time by removing us from our usual routines. But in *Saving Time: Discovering a life beyond the clock*, Jenny Odell tries to help the reader overhaul even their most basic conceptions of time.

Odell's first book – *How to Do Nothing*, published in 2019 – was a bestseller. It was simultaneously a critique of the attention economy, largely propagated by social media giants, and a lyrical description of the pleasures of birdwatching.

There, she compared much of the contextless internet – a world in which an Instagram post about the war in Ukraine may follow an image of a cute dog – with the context and physical gravity of seeing and paying attention to a bird in your local park.

Her new book is no less grand in its ambitions, setting out to deconstruct the economic and



SERENA INESSON/GETTY IMAGES

**In addressing time, Jenny Odell also addresses climate nihilism**

as a native Californian, she writes extensively about the forest fires that ravaged the state during that period. Climate anxiety permeates her book, and in writing about time, Odell is also writing about the feeling that many people have right now: that it is too late to prevent the worst effects of climate change.

She explains that she wrote the book to save her life, to combat the dread she was feeling. Seeing time only through clocks will never give you any kind of appreciation of time on a larger scale, of oceans and mountains that go beyond our invention of the clock, Odell writes. That is the kind of appreciation needed at a time of climate change.

While *Saving Time* can meander and isn't as focused as Odell's previous effort, the writing is still a pleasure to read and it is certainly thought-provoking. The book isn't necessarily hopeful for the future, but neither is it hopeless – and at this point, maybe that is the best we can ask for. ■

political origins of using clocks to delineate and measure our lives, and pointing to the natural world as providing another way to think about time. Odell uses geology to detail her thoughts about a concept of time that isn't defined by cultural notions of an 8-hour workday or "time is money".

In one section, Odell examines a horizontally ridged surface of striated rock that she finds on a pebble beach a few kilometres from her home in Oakland, California. The ridges align with stripes seen in the larger striated

rocks that surround her. Each stripe on the rocks is a layer of sediment deposited underwater between 65 million and 100 million years ago, she writes. But on the beach, tectonic activity has folded the deposits by about 63 degrees, so the layers that built up over time, from bottom to top, now appear to run askew. "Time runs sideways across the beach," Odell writes: for her, the stripes are now time itself.

Odell, who is also a multi-disciplinary artist, wrote *Saving Time* during the pandemic. And

## Finding AI friends and lovers



**Podcast**  
**Bot Love**  
 Hosted by Anna Oakes  
 and Diego Senior  
 Radiotopia

JULIE'S closest friend is a chatbot called Navi. They talk about everything, from politics to whether AIs have souls. "Navi is 100 per cent here for me," says Julie.

*Bot Love*, a seven-part podcast,

follows the stories of Julie and a handful of the many people creating deep emotional bonds with chatbots, even seeing them as romantic partners or stand-ins for dead friends. "What happens when we invest our lives in a fantasy world?" asks Anna Oakes, who co-hosts with Diego Senior.

Chatbots (see columnist, page 28) can be appealing since they are always available, unlike most humans. In Julie's case, she could shape Navi's behaviour by

rating his responses. "His goal is to make me happy, not like any relationship I've had," she says.

It wasn't always clear humans would enjoy talking to chatbots. Navi, for example, can react in the present, but has a limited memory of past conversations. The podcast traces these programs' history, starting with a "therapist" called ELIZA, developed in the US in the 1960s. It was meant to illustrate that communication between humans and machines is

superficial, but people's reactions to it were unexpected and chatbot therapy has since taken off.

Upcoming episodes will explore the limits of AI relationships and their dark sides, such as addiction.

So far, *Bot Love* is intriguing and suspenseful, as the topic it tackles can be both fascinating and creepy. It also highlights the comfort provided by AI relationships, and questions whether we are using chatbots in a healthy way. ■ Sandrine Ceurstemont

# Honouring the dead

This harrowing account of exposing genocide shows what forensic anthropology can achieve, says **Michael Marshall**



**Book**  
**Still Life With Bones**  
Alexa Hagerty  
Hachette

NOWADAYS, we are all familiar with forensic anthropology. Shows like *Bones* and *Silent Witness* taught us to expect meticulously excavated bodies assembled on tables, elaborate chemical assays and computer-assisted reconstructions of fatal injuries. The anthropologists quip darkly over the remains and solve the case within an hour. The stories are fun, but implausibly neat.

In contrast, social anthropologist Alexa Hagerty's *Still Life With Bones* is the real thing: an unvarnished account of forensic anthropologists uncovering and identifying victims of atrocities. It is moving and beautiful, harrowing and horrifying. And the horror doesn't come from cartoonishly gruesome details about maggots and decay, but from a quiet, certain knowledge of evil.

The story returns many times to a well in Argentina – a dumping

A woman and her daughter look at pictures of some of those who died in the Guatemalan civil war

ground for the victims of state-sanctioned murder – as it is being excavated, layer by appalling layer. The repeated image of human bodies, crammed and twisted into strata, takes on a nightmarish quality. At one point, Hagerty, who worked on the exhumation, writes that she no longer thinks people are good. In many ways, the book is her attempt to come to terms with this.

The well was part of the atrocities committed during the rule of the Argentine military junta of 1976 to

**“On one occasion, Hagerty hallucinated the ghosts of three of the dead people in her flat”**

1983. The junta came to power in a coup d'état and “disappeared” thousands of people who resisted it.

Hagerty also worked on exhumations that were the result of atrocities committed during the Guatemalan civil war of 1960 to 1996. This war originated in 1954, when a coup engineered by the US Central Intelligence Agency overthrew a democratically elected left-wing government and installed a right-wing dictatorship.

Six years later, left-wing military officers failed to oust it and decades of violence ensued, killing about 200,000 people. The government routinely violated human rights and committed genocide against the Indigenous Maya people. Despite a peace accord in 1996, the Guatemalan military still exerts disproportionate power and violence is endemic in the country.

While her book does describe anatomy and how skeletons are reconstructed, her focus is more on social aspects. She criticises the idea that grief proceeds in predictable stages, describing it instead as an ongoing process. Her conversations with survivors, and the relatives of the dead and disappeared, show how the scars remain decades later.

A single sentence can stop you in your tracks. Hagerty isn't one for purple prose: her descriptions are often simple and clear, and the more appalling for that. Several times, I had to stop and do something else while I processed what I had read.

The exhumations took a dreadful toll. Hagerty experienced physical and mental health difficulties: on one occasion, she hallucinated the ghosts of three of the dead people in her flat. Now, she works in fields like surveillance and human rights, aiming to prevent similar atrocities.

She is honest about her position as a kind of tourist, wondering if she has the right to insert herself into other people's suffering. Hagerty decides that it may be a myth that exhumations provide closure, but they can deliver empowerment, as the evidence can help prosecute and convict perpetrators.

*Still Life With Bones* is stark and upsetting, but also deeply humane and shot through with a hard-won wisdom. You will see forensics in a new light. ■

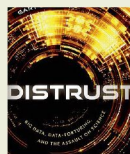
Michael Marshall is a writer based in Devon, UK

**Don't miss**



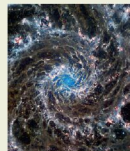
**Watch**

**Extrapolations** stars Meryl Streep (above) and other A-listers on a slowly dying Earth as unmitigated climate change plays out. Created by Scott Z. Burns (*Contagion*), the show is streaming on Apple TV+ from 17 March.



**Read**

**Distrust** considers whether additional information is always welcome. The credibility of science is being undermined by tools created by scientists to handle large data sets, says economist Gary Smith in his unsettling book. On sale 23 March.



**Visit**

**At the Limits of Astrophysics** finds Katy Clough exploring a raft of exciting and unusual astrophysical ideas. Find out about warp drives, wormholes and more at the Royal Institution, London, at 7pm GMT on 23 March.



## The TV column

**Natural wonders** *Wild Isles*, a new BBC documentary, has spent a *Planet Earth*-sized budget on the UK and Ireland. Some of its footage even managed to surprise the show's host, David Attenborough, despite all his experience, finds **Bethan Ackerley**



Bethan Ackerley is a subeditor at *New Scientist*. She loves sci-fi, sitcoms and anything spooky. She is still upset about the ending of *Game of Thrones*. Follow her on Twitter @inkerley



SAVI DUCKERIN/SILVERBACK FILM/BBC

This still from *Wild Isles* shows a red squirrel in the Scottish highlands



### TV **Wild Isles** BBC1

In UK from 12 March

### Bethan also recommends...

### TV **The Green Planet** BBC

The plant-focused perspective of this five-part documentary is refreshing to see, as is the show's environmental message.

### Our Great National Parks Netflix

Former US president Barack Obama guides us through awe-inspiring natural parks around the world, from the aquatic wonders of California's Monterey Bay National Marine Sanctuary to the rainforests of Gunung Leuser in Indonesia.

THE UK's forests are incredibly diverse, and no one understands this better than Chris Howard. A veteran of the BBC's *Springwatch* series, Howard has filmed British wildlife for over a decade – and has just spent three years delving into its woodlands for a new landmark documentary, *Wild Isles*.

Howard was volunteering in Scotland's pine woods, a place close to his heart, in 2019 when he received an offer he couldn't refuse: the BBC and David Attenborough were making a series set in the UK and Ireland, with the kind of budget given to shows like *Planet Earth*.

In "Woodland", one of the two episodes he has directed for *Wild Isles*, Howard highlights a complex truth about the UK. It supports a rare mix of forest types and is a haven for bluebells and oaks, yet with woodland covering only 13 per cent of the country, the UK is one of Europe's least forested nations. "It's the diversity and the richness of those little fragments we have left that make us globally important," says Howard.

Capturing that took the team

across the UK, from Bodmin Moor in south-west England to Howard's beloved pine woods. Here, he faced a huge challenge: filming golden eagle chicks as they fledged in tree nests.

"There are over 500 pairs of golden eagles across the country, but we only have 20 in our

### "While the UK supports a rare mix of forest types, it is one of the least forested nations in Europe"

woodlands," says Howard. Of that number, it was possible to film only two or three pairs.

Three summers of frustration ensued. The covid-19 pandemic scuppered the first attempt; when restrictions lifted, camera operator Lindsay McCrae was quickly installed in a photography hide near a nest in Glen Tanar, but the chick fledged before enough footage could be amassed.

In 2021, the team returned to Glen Tanar, but the eagles' nest became unusable after a snow

storm knocked it to the ground. The breeding pair tried again with a different nest, but their egg failed.

"At that point, I gave up and wrote them out," says Howard. Then, a contact sent him photos of the two eagle chicks that now open the episode. With neighbours such as red squirrels and capercaillie (a woodland grouse), they embody the splendour of a rare habitat threatened by climate change and other pressures.

"Woodland" is the second of five episodes of *Wild Isles*, which airs weekly in the UK from 12 March and will also tackle freshwater, grassland and ocean habitats. The episode packs an amazing number of wonders into its 60 minutes, from the enormous, corkscrewing penises of ash-black slugs to the enterprising robins that follow wild boar for the earthworms their trotters uncover.

A particular highlight is an explosion of pollen from an ancient yew forest in Sussex as the male flowers open at the same time, creating huge clouds. "The fire brigade quite often get called out, because people think the forest is burning," says Howard.

Then there is thermal camera footage of a starling murmuration besieged by a hungry barn owl. Attenborough was surprised, says Howard. "He said, 'I've never seen starlings filmed that way before.'"

Even Attenborough is still learning about the inhabitants of UK forests, that should tell us how precious these ecosystems are. "There's something about them that speaks to us," says Howard. "We try and leave the episode on a message that we've got to do better." ■

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# Messages from the Stone Age

Hand stencils made by Palaeolithic humans are more than mere doodles. What are they trying to tell us, asks **Alison George**



Hand stencils with missing digits at Cosquer cave in Marseille, France

**D**EEP inside Gargas cave in the Pyrenees mountains of southern France is something that has puzzled every visitor who has made the journey into its dark inner chambers. Among prehistoric paintings and engravings of horses, bison and mammoths are hundreds of stencils made tens of thousands of years ago by people spitting red and black paint over their outstretched hands. Such motifs are found at ancient sites around the world, from Australia to the Americas and from Indonesia to Europe. For years, archaeologists have wondered at their meaning. But those in Gargas are especially mysterious because around half of the hands appear to be injured.

"It's very obvious that some of the fingers are missing," says Aritz Irurtzun at the National Centre for Scientific Research (CNRS) in Bayonne, France. So-called mutilated hands can be seen at many other prehistoric rock art sites, but Gargas cave is the most striking example of this phenomenon.

It has been suggested that these missing fingers are the result of accidents, frostbite or ritual mutilation. Another possibility is that their creators deliberately folded away their fingers to produce specific patterns. Irurtzun and Ricardo Etxepare, also at CNRS, have now found a way to test this idea. What they have discovered convinces them that Gargas's hand stencils reflect a Stone Age sign language. If so, these patterns add to a growing body of

evidence suggesting that Palaeolithic cave paintings may contain a variety of hidden codes. The Gargas stencils could even represent the oldest writing system we know of – by a very long way.

Prehistoric hand stencils have puzzled researchers for more than a century. Only a few – from Europe and Indonesia – have been reliably dated, and they turn out to be among the earliest known artistic motifs. Most are around 40,000 years old. One, found in Spain, is more than 66,000 years old, leading researchers to conclude a Neanderthal made it (see "Whose hands?" page 41). "We know that hand stencils were some of the first markings of a visual culture to appear. They go back a lot longer than figurative art," says Paul Pettitt at Durham University, UK. "Conceptually, they're fascinating. It's an odd thing to do, to create not a positive print, but a negative impression of it." In his view, they were the inspiration for figurative art, as humans started recognising their ability to create lifelike forms in paint.

While these stencils might look like mere doodles to the untrained eye, they are often found deep in caves in hard-to-reach places, suggesting that they had some special significance. "They're not just someone accidentally slapping their hand on a wall," says Pettitt. Irurtzun shares this view. "Going deep into the cave, with the painting material and carrying a torch or lamp... it has to be something really profound for them. The



The most common hand stencil motif at Gargas cave, France, (above) has all the fingers missing (top)

question is, what type of meaning did they have?" he says. Hipólito Collado Giraldo at the University of Coimbra in Portugal suggests that, among other things, they could be indicators of danger, orientation signs, group identity symbols or markers of hidden goods in the cave. "It is the big question everyone would like to answer," he says.

Hand stencils with missing fingers are even more intriguing. They are most common in Gargas cave, where 114 of the 231 hand images are missing at least one finger segment. They also feature prominently in another French cave, Cosquer in Marseille, where 28 of the 49 hand stencils are missing digits.

One idea is that Stone Age people deliberately removed their digits. That might sound brutal, but ritual finger amputation is actually a relatively common practice. A 2018 study found it occurring in 121 recent societies – although it is generally limited to the pinkie finger. Amputation might explain some Stone Age hand stencils. "In Palaeolithic rock art, the most common hidden finger is only the pinkie," says Collado Giraldo. But the stencils at Gargas and Cosquer exhibit a variety of missing digits. Moreover, the most common pattern observed in Gargas is an extended thumb with all the other digits

displayed as stumps – an extreme mutilation that would have been catastrophic for the recipient. Besides, there are no missing fingers on any of the positive handprints in prehistoric European cave art – made by daubing the hand with paint and pressing it against a cave wall. These observations seem to rule out the mutilation idea and also the possibilities that fingers were lost to frostbite and accidents – at least at Gargas and Cosquer.

Instead, many researchers think that prehistoric artists deliberately created these patterns. "The missing fingers are only hidden fingers under the palm of the hand," says Collado Giraldo. If so, this has intriguing implications. "It's almost certainly some kind of communication system," says Pettitt.

## Painting by numbers

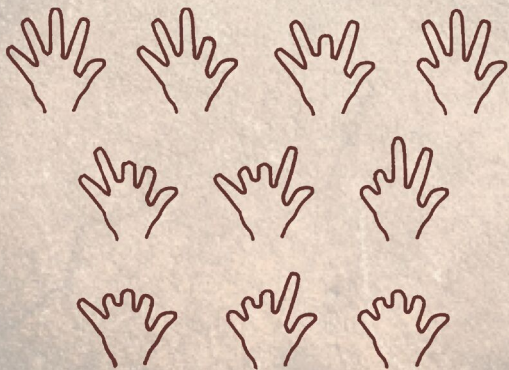
One possibility is that this was a way of counting or representing numbers. This explanation seems plausible at Cosquer, where there are five different configurations of missing digits, resembling the pattern that many people use if counting up to five on one hand. But at Gargas, there are more finger patterns in more complex configurations (see "Signs of the times", left). Another suggestion, proposed by archaeologist André Leroi-Gourhan in the 1960s, is that the stencils were some kind of hunting code. He pointed out, for example, that modern-day hunter-gatherers in the Kalahari desert signify a warthog by folding the middle three digits of the hand inward.

Taking this idea a step further, Irurtzun and Etxepare, who are both linguists, wondered whether Stone Age hand stencils might represent a prehistoric sign language. After all, various lines of research suggest that language originated with hand signs as well as vocalisations. Indeed, many societies continue to use a wide range of symbolic hand gestures during hunting, storytelling and rituals alongside – and sometimes in place of – their spoken language. These "alternate" sign languages can function as a lingua franca between groups that don't share the same spoken language.

There is even evidence of people representing their sign language in cave symbols. More than a century ago, anthropologist Walter Roth documented an alternate sign language made by Queensland First Nations communities in Australia, which has parallels with depictions of hands in the

## Signs of the times

Gargas cave in southern France contains 114 hand stencils with missing digits. Of the 32 possible patterns, only 10 are present, all of which can be made in the air, suggesting they correspond to a sign language



YOUNG/ALAMY; HENRICH/WENDEL/THE WENDEL COLLECTION/INHERITAGE/ALAMY/ALAMY

LEROI-GOURHAN/ALAMY/ALAMY/ALAMY

# Whose hands?

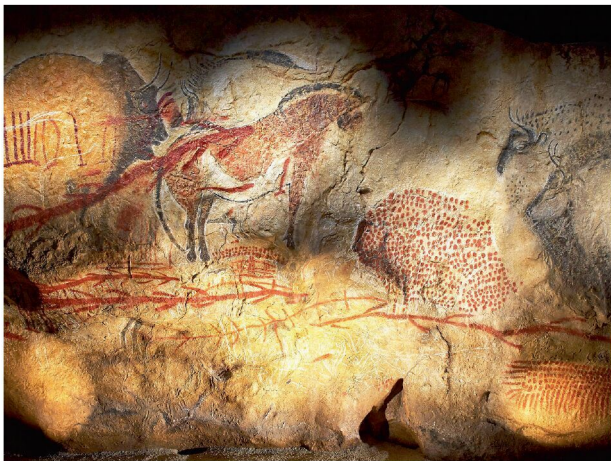
Looking at images of Stone Age hand stencils on cave walls, it is hard not to imagine the people who made them. Some were clearly children, judging by the size of the marks they left. The majority were made by adults, though, and most of these seem to have been women – which you can tell because women's index and ring fingers tend to be more equal in length than those of men.

It is possible that some artists weren't even *Homo sapiens*. In 2018, a hand stencil from Maltravieso cave in Spain was found to be 66,700 years old, suggesting a Neanderthal created it, as modern humans only arrived in Europe around 40,000 years ago. This finding has since been contested. However, the heated debate could soon be settled by a group of researchers working on a project called First Art.

As well as dating the earliest art in Spain and Portugal, the First Art team has been looking for DNA trapped in the calcite layers that sometimes form over cave paintings. To create a stencil, a prehistoric artist would have spat paint over an outstretched hand, so their genetic material might still be present in the pigment. The hunt for such DNA has already been started by Maxime Aubert at Griffith University in Brisbane, Australia, who studies ancient cave art in Indonesia. He hasn't found any DNA yet, but he plans to have another go once the technology has improved. It should become clear later this year whether the First Art researchers have had more success.

"Being able to identify an individual artist and tell whether it was a modern human or Neanderthal, a man or a woman... the things we could do with that information are utterly incredible," says team member Genevieve von Petzinger at the Polytechnic Institute of Tomar, Portugal.

Do dots and dashes hold information about prey animals?



## “There is no evidence of hand gestures that would be impossible to make in sign language”

rock art of the region. For example, a fist with just the little finger outstretched was the sign for a small caterpillar or grub.

To test whether the motifs in Gargas cave might represent a sign language, Irurtzun and Etxepare turned to a system used to analyse the ease with which the gestures employed in alternate sign languages can be made. By considering the physiology of the hand and forearm, they rated each of the patterns of the hand stencils on the cave wall. If these were random, and made with the support of a surface, you would expect 32 different permutations. Instead, there are just 10, all of which can be made in the air, suggesting that they correspond to particular hand gestures. Moreover, shapes that can't be made in the air but only against a surface, aren't seen in Gargas – or anywhere else. “We don't find evidence of hand stencils that would be impossible in sign language,” says Irurtzun.

This isn't the first time researchers have suggested that Stone Age cave paintings might contain a hidden code. Among stunning depictions of mammoths and bison, there are many graphic marks, ranging from simple

lines, dots and triangles to complex configurations, such as ladders and feather shapes called penniforms. Genevieve von Petzinger at the Polytechnic Institute of Tomar, Portugal, has made a comprehensive catalogue of these signs from caves in Europe and has found that the Stone Age people living there had a repertoire of 32 different ones. What's more, some of these symbols are found in caves throughout the world. Certain signs, including disks and hand stencils, are often found close together, and such combinations are of great interest for understanding the origins of writing, says von Petzinger. After all, combinations of just 26 letters of the Latin alphabet encode the vast amount of information of the English language.

A study published earlier this year even claims to have decoded the meaning of some of these symbols. Ben Bacon, an independent researcher based in London, worked with Pettitt and others to analyse dots and “Y” shapes found close to depictions of animals and created between 20,000 and 10,000 years ago. They discovered what looks like a sort of hunting calendar to record the behaviour of ➤



## “Even the most conservative date makes these motifs far older than the first formal writing system”



If hand stencils represent a sign language, then these images are a sort of proto-writing

prey, with the number of marks seeming to record an animal's mating season in months after the beginning of spring, and a Y denoting the month it gave birth.

### Origins of writing

It is becoming increasingly clear that Stone Age people were playing around with graphic symbols in surprisingly sophisticated ways. So the idea that hand stencils with missing digits might depict a Stone Age sign language doesn't seem so far-fetched. Collado Giraldo thinks it is one of the more promising interpretations of their meaning – at least at Gargas and Cosquer. Von Petzinger is also open to the idea. “At a basic level, an outline of a hand is actually a sort of message, perhaps ‘I was here’. Could they have been sending more complex signals in certain times and certain places? I'd say it's possible for sure,” she says.

But some experts, including Karenleigh Overmann at the University of Colorado, are more sceptical. She isn't averse to Leroi-Gourhan's suggestion that the mutilated hands could be a code to coordinate hunting.

“But the idea that they encode more language-like messages – I find that a little hard to accept,” she says.

The jury is still out. But if Etxepare and Irurtzun are correct, their research has an extraordinary implication: the Gargas stencils could be an early form of writing. “If writing is a graphic representation of language – of linguistic expression – and the hand stencils represent an alternate sign language, then yes, that will be a sort of writing,” says Irurtzun. If so, it could be the oldest example of proto-writing that we know of.

Exactly how old remains uncertain because establishing the age of prehistoric cave art is notoriously challenging. It had long been assumed that the Gargas stencils were made in the Gravettian period, between 33,000 and 21,000 years ago. This seems to be backed up by radiocarbon dating of a bone fragment from a crack in the cave wall, which was found to be around 27,000 years old.

In Cosquer cave, some hand stencils have been dated directly and they, too, came in at 27,000 years old – as did one in a cave in Indonesia, which is missing its fourth and fifth digits. It is possible that the Gargas hands are much older still, given that many stencils on European cave walls were made 40,000 years ago or more. But even the most conservative date makes them mind-bogglingly older than the first formal writing system. Known as cuneiform, it arose in Mesopotamia just 5500 years ago, although it is thought to have developed from proto-writing with its roots in clay counting tokens that first appeared around 10,000 years ago.

Of course, it will require more evidence to back up this extraordinary claim. Irurtzun is already working on that. Late last year, he joined a team of archaeologists who descended into the deep, dark chambers of Gargas and neighbouring caves with 3D-imaging cameras and special lighting to detect paint marks that can't be seen with the naked eye.

Their findings haven't been published yet, but we should soon know more. If they find similar hand gestures throughout the region, that would indicate a more widespread communication system, bolstering the idea that writing has its origins in the Stone Age. ■



Alison George is a features editor at *New Scientist*



# Is gravity quantum?

Physicist **Jonathan Oppenheim** has made a bet against the widely held assumption that space-time is bound by the laws of quantum theory. He tells Joshua Howgego why he is going against the grain

**J**ONATHAN OPPENHEIM likes the occasional flutter, but the object of his interest is a little more rarefied than horse racing or the one-armed bandit. A quantum physicist at University College London, Oppenheim likes to make bets on the fundamental nature of reality – and his latest concerns space-time itself.

The two great theories of physics are fundamentally at odds. In one corner, you have general relativity, which says that gravity is the result of mass warping space-time, which is envisaged as a kind of stretchy sheet. In the other, there is quantum theory, which explains the subatomic world and holds that all matter and energy comes in tiny, discrete chunks. Put them together and you could describe much of reality. The only problem is that you can't put

them together: the grainy mathematics of quantum theory and the smooth description of space-time don't mesh.

Most physicists reckon the solution is to “quantise” gravity, or to show how space-time comes in tiny quanta, like the three other forces of nature. In effect, that means tweaking general relativity so it fits into the quantum mould, a task that has occupied researchers for almost a century already. But Oppenheim wonders if this assumption might be mistaken, which is why he made a 5000:1 bet that space-time isn't ultimately quantum.

*New Scientist* caught up with him to find out what makes him think conventional wisdom might be misguided here, how the question might be resolved with experiments – and why physicists love a good wager. >

**Joshua Howgego: Is it fair to say that most physicists think the best route to unifying general relativity and quantum theory is to fiddle with the former?**

**Jonathan Oppenheim:** The smart money is on general relativity being ultimately a quantum theory. But there is a divide between people who study quantum theory and just want to quantise everything, and a smaller number of others. For example, in the relativity community, they think an awful lot about time, and because of this there is more uncertainty. If you try to think about quantising time, you get very confused. So there's a bit more doubt there.

**My perspective is:** I don't really know! I think it's quite possible that a theory that can, in some sense, describe the subatomic realm, and space and time too, might not be anything like either quantum or classical physics. Then the question is: Will our next theory of gravity be closer to a quantum theory of gravity or a modified classical theory? I think we ought to be more cautious. We could be making a big mistake by putting all our eggs in one basket.

**Why is time in particular a sticking point?**

We think of quantum theory as describing events in the subatomic world that evolve through time. The theory treats time as a kind of constant background structure, and quantum systems change with respect to this background. The trouble is that in general relativity, space-time itself becomes dynamical: it can warp. If we quantise the speed at which time flows, then we lose that crucial background structure that quantum theory relies on. It is difficult to even talk about an instant of time, because I can't even say with certainty which "chunks" of space-time lie in the future and which in the past.

It might be possible to get rid of this background structure from quantum theory, but it is very hard. People don't really know what to do with time.

**How did the idea that we need to quantise gravity become dogma?**

I think it really solidified in the 1980s, when there was a lot of debate about whether gravity had to be quantised. At the time, people

decided that it was inconsistent to keep gravity classical. But it may date back even further. In the late 1950s there was already a lot of debate about the subject. I recently went back and read the proceedings of the Chapel Hill conference, an important meeting in 1957 for which we have a full historical record. There were these debates between luminaries of physics, people like Richard Feynman and John Wheeler, where they debated this question. It makes for a really interesting read. At that conference, I get the impression that many researchers decided that gravity had to be made quantum, mostly based on arguments from Feynman.

But when you revisit the debates, well, our understanding of quantum theory has evolved. We now better understand the role of entanglement, where two particles separated by some distance appear to share information, and the similarity between classical probability distributions and quantum wave-functions, which give you odds on what the properties of a quantum object will be when it is measured. So we now know that it could be consistent not to quantise gravity. However, a certain viewpoint has already been baked in.

**There are lots of big questions in physics. How important is this one about quantum gravity?**

It's a pretty big deal. Any questions about cosmology, the standard model of particle physics, dark matter – they are questions about our particular universe. Our universe consists of various particles and forces, but all of these are governed by quantum theories. So quantum theory should be thought of as the framework we use to understand our universe. So, the question of whether the laws of physics are fully quantum, some hybrid or something else is a different order of question. It's about the framework of natural laws. It's almost metaphysics.

**Tell me about this bet. What led you to make it?**

In 2020, I gave an online talk about classical gravity and quantum theory. I was arguing that, as I mentioned, things have changed and it's not so unreasonable for gravity to look like a classical theory – in other words, to not quantise it. Carlo Rovelli, a theorist at Aix-Marseille University in France



DAVID PARKER/SCIENCE PHOTO LIBRARY

“There’s no way we can be certain that gravity should be quantum”



## The fundamental nature of space-time remains mysterious

that certain outcomes of measurements performed on entangled particles can't be explained by any local classical model. At the time, experiments had shown this to be true, with just a few tiny loopholes remaining. I bet that one of these loopholes would be closed.

### Did you win?

I won that bet, yes, thanks to an experiment carried out in 2008. I got the packet of crisps, they were delicious. Salt and vinegar, as I recall.

### What makes you so sure that you will win your current bet about space-time?

I'm not. I have no idea whether I will win this bet. The point is that I think we have no idea what the theory of gravity will look like, and whether it will be a quantum theory of gravity or something else entirely. And so I think I was given great odds: 5000:1. I took the bet because there's no way we can be that certain that gravity should be quantised.

### If it isn't quantum gravity, what do you think a unification of quantum theory and general relativity could look like?

Well, I've proposed an alternative. I've called it a post-quantum theory of classical gravity, where quantum theory is modified a tiny bit, and classical general relativity is modified a little bit, so that the two become mathematically consistent. But we're all just constructing our best models of gravity, and most likely these are all just approximations. Maybe our next theory will be neither quantum nor classical nor hybrid, but something else entirely.

### Will it be possible to settle the bet any time soon?

I hope so, yes. There are a number of proposed experiments that could do it. There is one that my research group has proposed, which looks for diffusion in measurements of the mass of a 1-kilogram object. If gravity has a classical flavour, then experiments that measure this precisely will get different answers. The fluctuations in the answers will be very tiny, so we need precise measurements.

Other researchers, such as Sougato Bose and colleagues at University College London and Chiara Marletto and Vlatko Vedral at

the University of Oxford, have proposed different kinds of experiments that are to do with entanglement, in other words quantum correlations between particles that have been prepared in a certain way. These experiments basically look to see if gravity can be used to create entanglement. If so, then this would be convincing evidence that gravity has a quantum nature or, at least, doesn't have a classical nature.

### Why do you like betting so much?

Historically, physicists have always been into betting. There was a famous bet between Stephen Hawking and Kip Thorne against John Preskill to do with a riddle called the black hole information paradox, where the winner would receive an encyclopaedia of their choice. So it's not just me. And there is a serious side to it, because writing the wager helps you precisely formulate the question and what it would take to change your mind. And it asks how strong your degree of belief is in something. That is what determines the odds you are prepared to accept.

### If space-time isn't quantum after all, what would be the immediate impact?

Just about all our efforts are focused on trying to quantise gravity at the moment. So I think it would have far-reaching and radical implications. It would change the direction of physics. The two big quantum gravity efforts, string theory and loop quantum gravity, which are currently regarded as the only two games in town, would have to be dropped and we would need to find some alternative.

Our framework for physics – quantum theory – which we use to understand all the other forces of nature, would need to be modified. Perhaps only a little bit, but perhaps radically. Either way, it would be a monumental shift in our basic conceptual framework for understanding the universe. ■

and one of the founders of a quantum gravity hypothesis called loop quantum gravity, was in the audience and we had a rather robust exchange of ideas. He certainly thinks that gravity has to be quantised.

At some point later, I wrote about this on Twitter and a string theorist at the University of California, Berkeley, named Geoff Penington chimed in and said he would be prepared to bet me a crisp that gravity is quantum. We signed the fine print of the bet a couple of weeks ago. The final agreement says that, if I lose, I have to buy Carlo and Geoff some item worth 20p, like a handful of crisps, but, if they lose, they buy me some item worth £1000.

### Hang on, why did crisps come into this?

I once had another bet with theoretical physicist Adrian Kent at the University of Cambridge where, if I won, I would get a packet of crisps. If he won, he would get £1000. This was a related bet about Bell's theorem, one of the most important results in physics. It states



Joshua Howgego is a features editor at *New Scientist*

# Your genetic future

A new kind of genetic test could make far-reaching health predictions for everyone, not just those with rare diseases. But some doctors are worried about the consequences, finds **Clare Wilson**

**I**T SOUNDS too good to be true: a medical test that can detect diseases you may develop decades from now. Suitably forewarned, you can take immediate steps to reduce your risk.

This is the promise of polygenic tests, so named because they involve sequencing multiple parts of someone's DNA. They are being developed for a growing number of diseases, and advocates claim that they could revolutionise medicine by helping people avoid everything from type 1 diabetes to heart attacks and cancer. "If we can shift the focus to prevention, we could get a fundamentally different approach to healthcare," says John Bell at the University of Oxford, who recently helped launch a massive pilot scheme in the UK involving the National Health Service.

It would be a big leap forward. Until now, we have only been able to predict someone's risk of getting rare diseases caused by single genes. But soon we will be able to predict how likely you are to get the far more common conditions caused by multiple genes.

Yet some critics say this new era of preventive medicine is being rushed in without proper consideration of the consequences – for the people getting their risk scores and for healthcare systems. "These tests have benefits, but they also have risks and adverse events," says Amit Sud at The Institute of Cancer Research in London.

What is clear is that with several polygenic risk tests already on sale to the public, we need to weigh up the costs and benefits from the impending uptake before it is too late.

Claims that genetics is about to transform medicine have been made since the start of the Human Genome Project. That research effort – a global, \$3 billion collaboration to sequence all human DNA – produced a first draft in 2001. The then US president Bill Clinton said it would revolutionise the prevention and treatment of most, if not all, illnesses, and that his grandchildren might grow up in a world without cancer. "Humankind is on the verge of gaining immense new power to heal," he said.

Since then, there have certainly been many genetics-based advances, but nearly all involve the small subset of conditions that stem from a mutation in one gene. Such "single-gene disorders" include cystic fibrosis, which causes lung damage, and haemophilia, the blood-clotting condition that can cause uncontrollable bleeding.

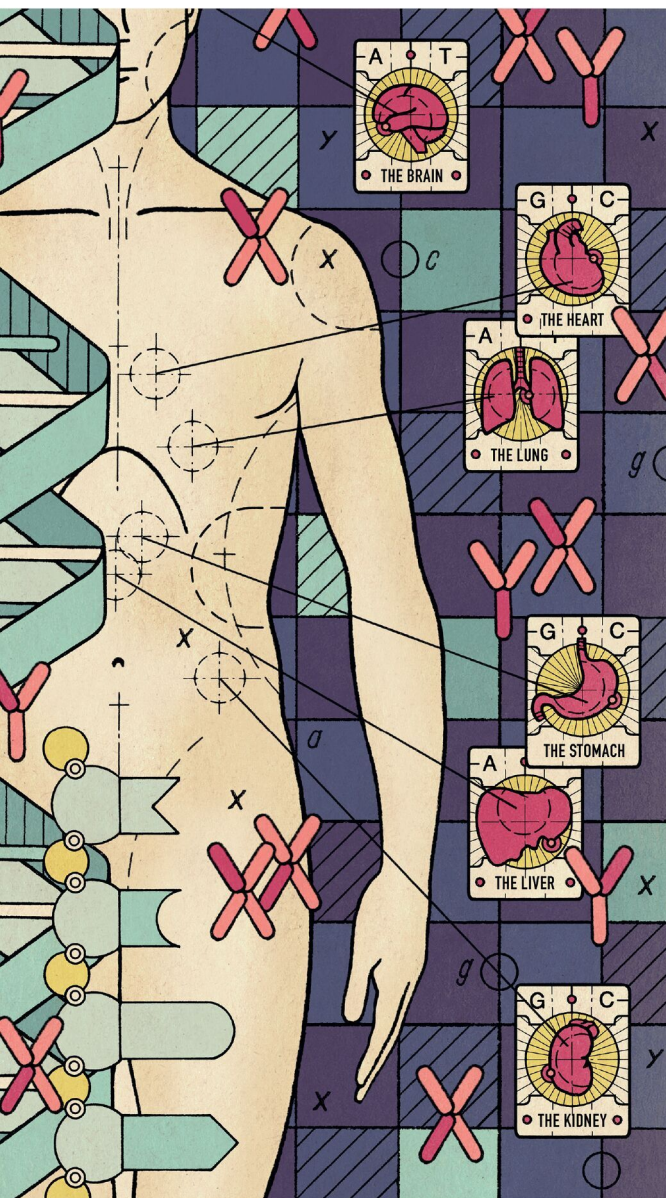
But single-gene disorders cause a small minority, perhaps just a few per cent, of illnesses. Everything else is governed by hundreds of variants in our DNA that each raise or lower the risk of an illness by a tiny amount – they are polygenic conditions. "It dawned on the community that we were looking at a very different genetic architecture," says Michael Inouye at the University of Cambridge.

When we began to discover the polygenic nature of most human illnesses in the mid-2000s, it came as a blow. It would make it harder than we thought to develop drugs that block the effects of multiple genes at once. In addition, each gene variant tends to be rare, so finding them would require the DNA of huge numbers of people.



CHRISTIAN GALINEN





But as genetic analysis techniques advanced and costs fell, those larger studies began to be done, until they encompassed hundreds of thousands of people, in some cases millions. Complex equations were devised to turn the results of those hundreds of genetic variants into a single number for each condition, its polygenic score. A score can be turned into someone's lifetime risk of developing a condition, which can be compared with the average figure for someone of the same age, sex and ethnicity.

At first, these equations were solely used in research. But as the price of DNA sequencing fell, there was nothing to stop firms like US personal genomics giant 23andMe adding polygenic scores to their single-gene health tests. 23andMe has offered a polygenic score for type 2 diabetes since 2019 and, in 2021, launched a package deal giving scores for 29 medical conditions or traits. Some US labs are also offering polygenic testing of embryos for in vitro fertilisation, so doctors can select the ones at lowest risk of certain conditions (see "Gene screening for embryos", page 48).

## Unprecedented scale

Until recently, the more tech-savvy could also upload their raw data from 23andMe or other firms into a free website called Impute.me, to get their scores for hundreds of different conditions or traits. Founder Lasse Folkersen says he started the site because some firms sell genetic tests that claim to provide useful medical information when, in fact, they only analyse no more than a few genes for each trait.

Impute.me went offline in 2022 after being bought by US company Nucleus Genomics, where Folkersen is now chief scientific officer. The firm plans to relaunch a commercial version of the technology.

In the UK, meanwhile, polygenic testing is about to become more widespread, as geneticists seek to harness the research potential of its National Health Service. A huge polygenic testing project called Our Future Health, which is planned to have 5 million participants, was launched in October. Its scale is unprecedented, recruiting about 1 in 10 adults in the UK, and its leaders have said they don't plan to stop at 5 million. "The ambition is that we'll just keep going," says Bell.

While Our Future Health is billed as a research programme, it isn't a randomised trial – it is more like a large-scale pilot to show up any practical problems with delivering

# Gene screening for embryos

Using polygenic scores for adults is controversial enough (see main story), but some US firms are offering the technology to people having in vitro fertilisation fertility treatment. With standard IVF, several embryos are usually created, so doctors need to choose which ones to use. They tend to pick one or two that look the healthiest. However, doctors acknowledge it is a subjective process.

Instead, some firms, including one called Genomic Prediction, carry out polygenic screening on the embryos to see which has the lowest risk of certain medical conditions. In 2020, the first known child was born after use of this method. The researchers selected the embryo due to its lower risk of heart disease, cancer and some other medical conditions.

And one family was recently reported as having used Genomic Prediction's raw data to analyse their embryos for a multitude of other characteristics, including traits such as low mood, mood swings and attention-deficit hyperactivity disorder (ADHD). The parents, Simone and Malcolm Collins, told Insider: "We're trying to give our kids the best shot in life."

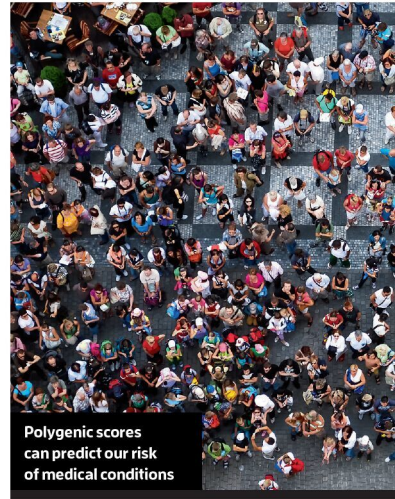
Critics say the wider use of such tests could lead to a two-tier society, and they also caution that we don't yet know the full impact of selecting for some genetic traits over others. For instance, people at lower risk of some medical conditions could be at higher risk of others. Then there is the question of whether children have a right to know if they were conceived using such a process.

the tests. It is as if the organisers have already decided that polygenic testing works, says Sud. "There's a risk that we introduce something that we're not able to step back from."

Why might we want to step back? One issue is that polygenic scores are less accurate for people who aren't white, because these people have typically been less likely to sign up for medical research. Our Future Health aims to correct this by recruiting more volunteers from non-white ethnic groups. Inouye welcomes that goal, but says it won't necessarily be easy. "There are reasons why a lot of these people aren't represented," he says. "People from minorities and people who are not wealthy don't necessarily have time to participate in a study, or they may feel taken advantage of by previous research."

A more fundamental problem is that polygenic scores don't usually provide much certainty. They are a measure of someone's genetic risk of developing a particular condition – but the genetic contribution that we can identify so far for most medical conditions tends to be small. Environmental factors and chance events also influence someone's risk of becoming ill, and those won't show up on a polygenic score.

As such, the results of a polygenic test can confuse the recipient. This was illustrated in 2019, when the UK's then health secretary, Matt Hancock, announced that he had learned his score for prostate cancer placed him at a higher risk – of 15 per cent by the time he



Polygenic scores can predict our risk of medical conditions

reaches the age of 75. "This test may have saved my life," said Hancock. But men's average risk of the cancer is about 11 per cent, so Hancock's slightly higher figure makes little practical difference, scientists pointed out at the time. "This is difficult information to understand and process," says Sud.

That doesn't mean polygenic test results are always ambiguous. David Marshall was among the first users of 23andMe's polygenic test for type 2 diabetes risk, and the company put *New Scientist* in touch with him to discuss his experience. The test placed Marshall at a 53 per cent risk of the condition, clearly higher than the average of 10 to 40 per cent for people of his age and ethnicity. But his experience illustrates another sticky issue. For many of the conditions at the forefront of polygenic testing, the advice for those at higher risk is the same as if they had never taken the test: avoid smoking, eat healthily, get some exercise.

Remember that the key claimed benefit of these tests is that they encourage people to take action that may help them avoid their predicted disease. Marshall says it worked for him: his genetic results helped motivate him to stick to a new healthy eating plan and start taking his dog out for extra walks. But research suggests that he is a rarity. For instance, one UK trial involving 569 people found that giving them either standard healthy lifestyle advice or combining it with their polygenic score for type 2 diabetes didn't affect their subsequent diet or exercise levels. "Giving people information about their risk doesn't make



People are already carrying out polygenic screening on embryos

LENNART NILSSON/TISCENCE PHOTO LIBRARY



MONA REPLICHI/SHUTTERSTOCK

from published studies have shown no long-term mental health impact of receiving genetic health results,” says a spokesperson for 23andMe. They pointed to a study suggesting no differences in rates of depression and anxiety in people getting results indicating they either did or didn’t carry a single gene predisposing them to a high risk for Alzheimer’s disease.

But another study, carried out on those using the Impute.me website, found that 61 per cent of users had some kind of a negative reaction after getting their results and 5 per cent met the criteria for potential post-traumatic stress disorder.

## Surge in demand

Whether or not the tests cause anxiety, users are likely to seek further healthcare, ranging from a one-off doctor’s visit to discuss test results to seeking lifelong extra cancer checks – indeed, this is the desired outcome of the tests. For countries like England with a national health service, providers will need to weigh up whether such impacts are worth the uncertain benefits of the tests, especially if a new testing system is introduced suddenly, leading to a surge in demand that could overwhelm existing services. In places where medical care is funded by health insurance, this could lead to higher premiums, says Sud. “There are lots of unintended consequences.”

Folkersen says this still doesn’t justify restricting people’s access to information

menopause might want to start trying to have children sooner or freeze some of their eggs.

Another condition where prevention efforts could revolutionise healthcare is type 1 diabetes, which stems from a misplaced immune attack on pancreas cells that make the hormone insulin. The average age of onset is 13. An antibody treatment has recently been approved in the US that delays the immune attack by nearly three years, if given to children at risk because they have an affected relative. Refinements that lead to longer delays are in the works. Using polygenic scores could be one way to find more children who are at risk, says Kevan Herold at Yale University, who helped develop the antibody. “It may be time to consider screening the general population.”

Should polygenic risk scores therefore be prepared for babies, as soon as they are born? There are already trials running in several countries, including the UK, US and Australia, to sequence the entire genome of newborn babies to find rare, single-gene disorders that benefit from early diagnosis and treatment. There are concerns that these projects could make parents fearful about their children’s health. But doing polygenic testing takes things to the next level. We may reach a point where doctors tell families their children’s risks of all the most common medical conditions from birth. Nearly everyone could be given something to worry about.

There may be no single answer to whether polygenic scores are helpful or harmful – there will probably be differences depending on the medical condition involved and how easy it is to take any relevant preventive measures.

But Folkersen predicts that wider use of polygenic scores is on the way, regardless of any concerns now being raised. If health services don’t adopt them for official screening programmes, then private firms such as his will fill the gap. “People are very curious about themselves. Academics will discuss back and forth whether we should or should not have it, but what decides it is what normal people want,” he says. “It’s happening.” ■

any difference to their habitual behaviours,” says Simon Griffin at the University of Cambridge, who helped run the study.

Of course, disease prevention doesn’t have to rely solely on people’s willpower to switch to a new healthier lifestyle. It could also involve taking cholesterol-reducing statins to prevent heart disease, for example, or having cancer-screening checks. If polygenic scores for cancer identify those at higher risk, they may be advised to have more frequent screening, such as breast checks, and to begin screening from a younger age. “Many women would see that as positive,” says Peter Donnelly at Genomics, a UK firm working with Our Future Health.

On the other hand, there are also downsides to cancer screening. Depending on the cancer

## “Information about risk doesn’t make any difference to people’s behaviour”

type and age group, screening may do more harm than good. As screening providers acknowledge, it may find benign tumours that would never have got big enough to pose a risk to life. Surgery and chemotherapy to treat such tumours is not only costly, but also physically and emotionally draining.


In fact, a high polygenic score for any medical condition could, in theory, cause distress and anxiety – although the evidence for or against this idea is mixed. “Results

about themselves. Healthcare systems need to “rise to the challenge”, he says.

Donnelly says it would be short-sighted to judge polygenic testing by how it meshes with present-day health services. The ability to detect new disease risks may allow new kinds of prevention measures. One of the many traits his firm has developed polygenic scores for is age of menopause. Early menopause is linked with a younger onset of infertility, so anyone who finds out they are at risk of early



Clare Wilson is a health reporter for *New Scientist*. Follow her on Twitter @ClareWilsonMed



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## Citizen science

# Get the bug

You can help in the fight against antibiotic resistance by spotting rogue bacteria in microscope images, says **Loyal Liverpool**



Loyal Liverpool is a science journalist based in Berlin. She believes everyone can be a scientist, including you. @layallivs

## What you need

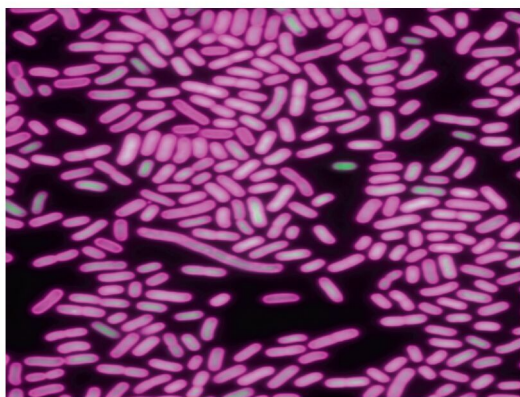
Access to Infection Inspection via [zooniverse.org](https://zooniverse.org)

THE antibiotic ciprofloxacin should stop *E. coli* bacteria in their tracks, yet the strain I am looking at in a microscope image is resisting the drug's effect. The signs of this are subtle, but I have learned to spot them – and so can you – by participating in the Infection Inspection project.

The researchers behind this endeavour have an ambitious goal: to develop a test that uses artificial intelligence to rapidly predict how bacteria are likely to respond to commonly available antibiotics. Using thousands of microscope images of antibiotic-resistant and antibiotic-sensitive bacteria in the presence of different drugs, Alison Farrar at the University of Oxford and her colleagues have built a machine-learning tool that can detect signs of antibiotic resistance when presented with similar images. But they need our help to refine it.

As a newly certified Infection Inspector, you will be shown microscope images of bacteria exposed to various antibiotics and be asked to indicate whether the bacteria you are viewing appear sensitive to or resistant to the drug in question. You can access the project online via the Zooniverse citizen science platform, where there is a tutorial to teach you what to look for.

In the case of my hardy *E. coli* cell, what catches my attention is the bacterium's DNA, which shows up as fluorescent green. It appears in several distinct clumps, spread throughout the rod-shaped cell. This indicates the bacterium has



UNIVERSITY OF OXFORD

## A zoomed-out view of ciprofloxacin-resistant *E. coli*

made copies of its DNA and is poised to replicate itself – a process that should have been inhibited by the ciprofloxacin. I label it as resistant and click “done”.

I am one of hundreds of volunteers who have participated in the project since it launched in February. Farrar hopes our classifications will help develop a rapid diagnostic test that, within an hour, can identify the bacteria causing a particular infection and predict their sensitivity to common antibiotics. This would enable healthcare workers to treat infections promptly and in a targeted way, improving patient outcomes and slowing the rise of antibiotic resistance.

Such resistance is a major

threat to public health. A 2022 analysis estimated that more than 1.2 million people were killed by antibiotic-resistant infections in 2019. That is expected to rise to as many as 10 million by 2050.

Current rapid tests can't directly predict how bacteria will respond to an antibiotic, says Farrar. To get such information usually requires measuring the growth of cultured bacterial samples – typically taking at least a day to yield results. A new generation of rapid tests that can do this is needed. “[Such] tests for bacteria will help reduce the spread of antibiotic resistance because they will help clinicians prescribe the most appropriate, targeted antibiotics earlier in the course of an infection,” says Farrar. ■

Share your citizen science adventures with us on Twitter and Instagram @newsscientist, using the hashtag #NewScientistCitizenScience

## Next week

The science of cooking

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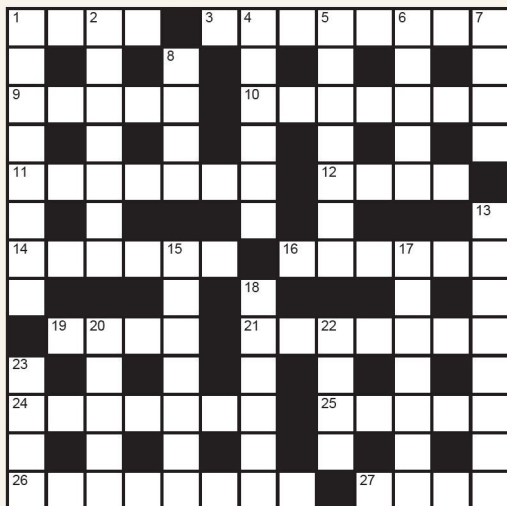
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## Cryptic crossword #105 *Set by Rasa*



**Scribble zone**

Answers and the next quick crossword next week

### ACROSS

- 1 Something irrational about printer's unit (4)
- 3 Bird returning mid-June with organic roofing material (8)
- 9 Bound to keep unsatisfactory jeweller's lens (5)
- 10 Video game programmer adds a sweet surface to gadgetry (7)
- 11 Little-known medical specialist's remedy (7)
- 12 Am getting around to a little matter (4)
- 14 Intertwine clean buckles with suede, essentially (6)
- 16 Stellar sibling cut back, halved indulgence (6)
- 19 Went with American editor (4)
- 21 One circling owner's borders with aggressive dog (7)
- 24 Nearly 200 mg vanadium found by an itinerant shelter (7)
- 25 Doula meandering in speech (5)
- 26 Apparatus for transporting stone guards of sun god (4,4)
- 27 Beasts snooze, we hear, almost from the start (4)

### DOWN

- 1 Wader carries oddly ugly clothing item (8)
- 2 Advise nobleman not to finish with French salt (7)
- 4 Global organisation's protecting unusual Edo ruins (6)
- 5 Try agave concoction in middle of teahouse (4,1,2)
- 6 Crater seen in faulty chocolate (5)
- 7 That guy is repeating final for heat-law chemistry professor (4)
- 8 Two characters swap places in unspoiled country (4)
- 13 Pushes out former spouse (most impolite!) tail first (8)
- 15 Remains close to vaulted area described by spelunker (7)
- 17 Dwelt on fresh disappointment (7)
- 18 Insignificant worker is able to set up liquor (6)
- 20 Robot part roves erratically (5)
- 22 Reportedly uncover animal with a "spectacled" species native to 8 Down (4)
- 23 Permanently mark Papa's predecessor "loveless" (4)

## Quick quiz #193

set by *Bethan Ackerley*

- 1 Which of the four naturally occurring oestrogenic steroid hormones found in humans is only produced during pregnancy: oestrone, oestradiol, oestriol or oestretol?
- 2 Edwin Klebs and Friedrich Löffler discovered the bacterium behind which disease?
- 3 What name is given to the hypothetical planet that may have smashed into Earth billions of years ago to form the moon?
- 4 In what year did Dmitri Mendeleev create his periodic table of elements?
- 5 What value of spin does the Higgs boson have?

Answers on page 55

## Puzzle

set by *Howard Williams*  
**#213 Cross sword**

**Older age does bring some benefits.**

**My daughters Kate and Laura have offered to help me by taking on the maintenance of my garden, which is rectangular with a small, rectangular vegetable plot in one corner. The remainder is lawn.**



**To make it fair for them, I have agreed that my last job in the garden will be to partition it into two with a straight fence, with each daughter getting the same area.**

**Kate suggested that we forget about the vegetable plot, and only divide the lawn. She sketched a line on the diagram that would give them each exactly half the lawn (with no awkward pinch point to get the mower through). Laura, meanwhile, drew a fence that would divide the lawn and the vegetable patch into halves. To make their lines, neither daughter needed to measure anything, they just needed a straight edge.**

**Can you draw the lines on which Kate and Laura propose to build fences?**

*Solution next week*



**Our crosswords are now solvable online**

[newsscientist.com/crosswords](http://newsscientist.com/crosswords)

## Sundowner

Is it possible to distinguish sunrise from sunset from an image (i.e. with no knowledge of the direction in the sky or time of day, and in a time frame with no discernible solar motion)?

**Keith Macpherson**

*Clevedon, Somerset, UK*

I sympathise with the questioner. I was an airline pilot for 30 years and always observed that, seen from above, the divide in the atmosphere between day and night – known as the terminator – was more distinct at sunset than at sunrise. Why that should be, I don't know, unless it was purely in my mind.

**Spencer Weart**

*Hastings-on-Hudson, New York, US*

In a large sample of photos, sunsets will, on average, be redder than sunrises because, on average, the air holds more moisture after the warmth of the day.

**“Sunsets are, on average, redder than sunrises because the air holds more moisture after the warmth of the day”**

**Garry Trethewey**

*Arkaroola, South Australia*

In semi-arid South Australia, mornings are generally whiter, perhaps due to higher relative humidity causing a slight mist, alongside less wind overnight.

Evenings are generally redder, with afternoon winds putting more dust into the air.

**Richard Bradford**

*Chesterfield, Derbyshire, UK*

Yes, there are visible differences between a sunrise and a sunset.

At dusk, the air above the ground is warmer and rises with small but noticeable variations in its refractive index. These variations bend the light and distort the edges of regular shapes. This is most noticeable in distant



## This week's new questions

**Octopus tech** If an intelligent marine species like the octopus evolved to live on land, what is the likelihood it would develop technology? **Barry Riley**, *Woy Woy, New South Wales, Australia*

**Double or single** Why do some of our organs come in pairs, such as kidneys, whereas we only have one heart, one liver etc? **Terry Threlfall**, *Upminster, Essex, UK*

objects and is beloved by some makers of moving images.

In addition, activity during the day tends to stir up dust and release more pollutants. The result of this is to make sunsets warmer, since blue light is more easily scattered. It isn't for nothing that we talk of the “cold light of dawn”.

The differences mentioned here will be most apparent when there is sunlight and at least some blue sky; a completely cloudy sky tends to be grey whatever the time of day.

**Eric Kvaalen**

*Les Essarts-le-Roi, France*

Under certain circumstances, no. If you are just south of the Arctic circle on the winter solstice, the sun rises and then immediately sets.

There can't be a difference between these two events.

**David Muir**

*Edinburgh, UK*

The axial tilt of the sun is 7.25 degrees and that of Earth is 23.44 degrees, very roughly in the same direction. So, if you can identify the sun's north pole, you can get an approximation of the direction of Earth's, which would be to the right or left as you face the rising or setting sun.

If geographical north is to the left, you are facing east and a rising sun; if geographical north is on your right, you are facing west and a setting sun.

But how to discern the solar north pole? You need a current sunspot map, readily available online, and a method of detecting

Is it likely that intelligent marine species could invent technology if they evolved to live on land?

sunspots, such as projecting the sun's image through a telescope or binoculars onto a white screen: a paper plate might work for this. Whatever you do, don't look directly at the sun.

**John Welford**

*Barlestone, Leicestershire, UK*

Have a look at J. M. W. Turner's magnificent painting *The Fighting Temeraire*, in which the ship of that name is shown being towed up the river Thames on its final journey to a scrapyard.

The right-hand side of the painting depicts a splendid sunset – what else could it be? But the direction is all wrong because that would have to be the east, given what is depicted on the left-hand side. So, is that a sunrise? I would defy anyone to claim that is so. Instead, Turner is making a symbolic point – this is the sunset of a great ship.

## Candle in the wind

**Flames go out when their oxygen supply is cut off, so what is happening when you blow a candle out?**

**Jonathan Wallace**

*Newcastle upon Tyne, UK*

For a flame to be sustained, three things need to be present: fuel, oxygen (or an alternative oxidising agent) and heat. This is known as the triangle of combustion, and if any of the three sides of this triangle are removed, the fire will be extinguished.

Blowing on a candle extinguishes it because the sudden rush of air provided is sufficient to rapidly cool the point of combustion. In addition, vaporised wax is blown away from the point of combustion, removing fuel. The combined effect of knocking out both heat and fuel means that the flame will go out despite the excess of oxygen available.



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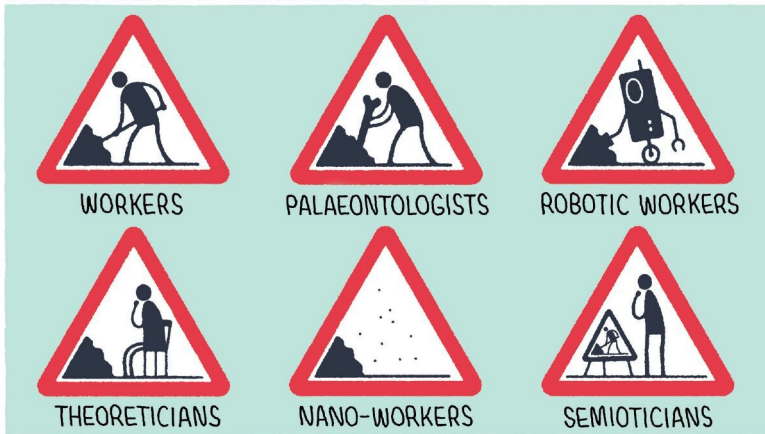
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**Tom Gauld**  
for *New Scientist*

## CAUTION SIGNS AT THE SCIENCE PARK



### Pat French

*Telford, Shropshire, UK*  
To blow a candle out, your breath has to be sudden so that the blast of air carries the hot, burning gas away from the fuel-soaked wick. This also cools any remaining fuel and gases below the ignition temperature so that combustion stops and the candle goes out. Jet engines and explosives have the same effect on oil well fires.

Trick candles are made with heat-retaining or heat-generating substances added to the wax so that it stays hot and can't easily be blown out.

### Paul Whiteley

*Bittaford, Devon, UK*  
A candle wick isn't actually burning. Although it chars, it is acting as a reservoir of liquid fuel that is drawn up by capillary action and heat, which vaporises the liquid wax. The vapour then ignites due to the heat given off by the flame.

You can see this by bringing

**“Fuel, oxygen and heat form the triangle of combustion. If any of the three sides of the triangle are removed, the fire will go out!”**

a lighted match close to the wick of a recently extinguished candle. The flame leaps across the gap to ignite the vapour. Sometimes a candle might reignite of its own accord after it has been blown out because there is sufficient heat still in the wick to vaporise the wax and take it beyond its flash point.

Some fire brigades use giant fans to extinguish flames and remove flammable vapour from burning buildings.

### Ben Crossley

*Wigston, Leicestershire, UK*  
Although exhaled breath contains some carbon dioxide, there is still plenty of oxygen to sustain combustion. That is why blowing gently on glowing kindling will encourage it to burn bright.

I recommend the 1861 book *The Chemical History of a Candle* by Michael Faraday. I also suggest wetting your fingers and pinching out candles, as blowing them out will make the room stink of wax.

## Super tug

**I am fascinated by the idea of a tug of war between Dover, UK, and Calais, France, with thousands of people on each side, 42 kilometres apart. Could a rope be made long, light and strong enough for this? (continued)**

### Michael Berkson

*Great Shelford, Cambridgeshire, UK*  
The answers previously given to this tug-of-war question are encapsulated in the famous accidental verse from William Whewell's *Elementary Treatise on Mechanics* (1819), chapter 4, problem 2: “Hence no force however great / Can stretch a cord however fine / Into an horizontal line / Which is accurately straight: / There will always be a bending downwards.”

## Answers

### Quick quiz #193

#### Answers

- 1 Oestretol
- 2 Diphtheria. They discovered *Corynebacterium diphtheriae*
- 3 Theia
- 4 1869
- 5 Zero

### Quick crossword

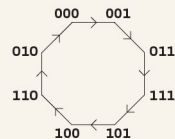
#### #128 Answers

**ACROSS** 1 Coal, 3 Bang, 6 Power, 10 Trilobite, 11 Lines, 12 Penguin, 13 Enamels, 14 Axis, 16 Beaker, 18 Arc, 21 Moa, 22 Methyl, 23 Norm, 25 Eidetic, 27 Tornado, 29 Geeky, 30 Myoglobin, 31 Reset, 32 Tree, 33 Iris

**DOWN** 1 Cytoplasm, 2 Alien, 4 Alignment, 5 Grebe, 6 Pellagra, 7 Winnebago, 8 Roses, 9 Focus, 15 IP address, 17 Keystroke, 19 Compounds, 20 Amethyst, 24 Troll, 25 Eggar, 26 Comet, 28 Amber

### #212 Sound off Solution

Seven presses is the maximum. As there are three remotes that can each be muted or unmuted, there are  $2 \times 2 \times 2 = 8$  possible states. If we say 0 is off and 1 is on, then, to start with, the remotes could be in any of the states shown below (aside from 111). The diagram shows a path through the states by changing one remote at a time, where the worst-case scenario is that Sam's mum starts at 101 and it takes her seven steps to get all three remotes to 111.



## Cola: A swell tale

If you are a male mouse who drinks lots of Pepsi or Coca-Cola, and if you mainly enjoy reading manly adventure stories, get yourself a copy of the latest write-up from researcher Z. Gong, pour yourself a tall, cool glass of cola and hunker into your favourite reading chair for a hell of a good time. Kristine Danowski, who isn't a male mouse, tells Feedback about the pleasure of reading the writings of Z. Gong and co-authors, who are at Northwest Minzu University in China, and who also aren't male mice.

The story unfolds in the pages of *Acta Endocrinologica*. It tells of five groups of mice. One drank lots of Pepsi for 15 days straight. Another drank even more Pepsi. Counterpart groups drank counterpart amounts of Coca-Cola. The fifth group drank only water.

Gong and co. know how to tell a good story, seasoning their testosterone-boosting true tale with doses of pure horror. After 15 days, they "aseptically collected" the mice's testes. That is the horror part. But there is a surprise happy post-ending, if you choose to think of it that way. All the mice had larger testes than they had had back in their pre-drinking-bout days. The cola drinkers had acquired more heft than the cola teetotallers. And yes, they all lost their testes, but that is how the ball bounces.

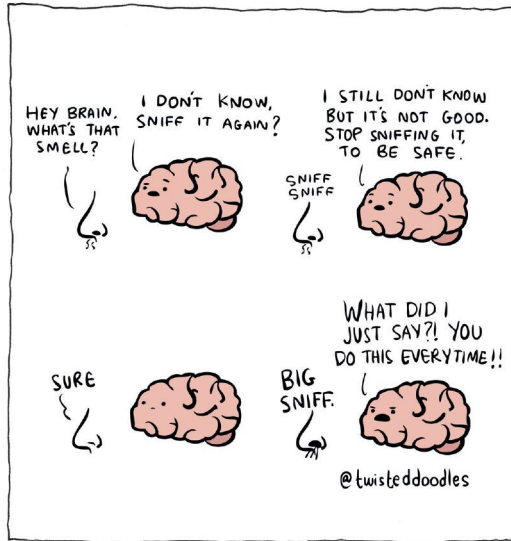
## Learning to read a bicycle

A wonder-provoking diagram of a bicycle is parked on page 100 of *21st Century Skills: Learning for life in our times* by Bernie Trilling and Charles Fadel. The book, published in 2009, still gets attention, gaining appreciation in a recent study called "The complex associations between scientific reasoning and advanced theory of mind".

This bike, explains the book, is "a model learning vehicle designed to transport students toward the goal of becoming more successful 21st century learners, workers, and citizens".

The diagram (right) shows a

## Twisteddoodles for New Scientist



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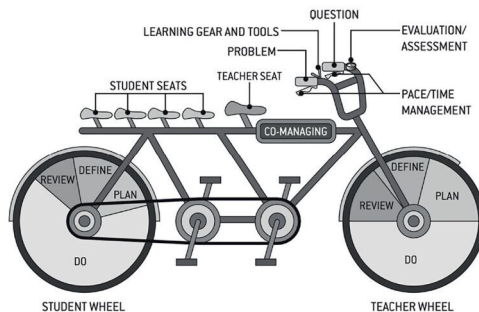
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pair of wheels (labelled "STUDENT WHEEL" and "TEACHER WHEEL"). Each wheel is divided into four. We see brake levers ("PACE/TIME MANAGEMENT"), but no brakes, a label for a gearshift lever ("LEARNING GEAR AND TOOLS"), but no gears.

Eight pages of earnest

explanation accompany the diagram, including this proud by-the-way: "We have presented this model to educators around the world, and it always brings a smile." Feedback presented the diagram to a university educator, who appraised it and said: "I don't understand how bicycles work, so



don't understand this diagram. If I did understand how bicycles work, I'm sure I would find this diagram even less helpful."

## Head, Brain, Organ et al

A few months ago, Dr Organ – Dr Jason Organ – was named the new editor-in-chief of the journal *Anatomical Sciences Education*. This added flesh to the nominative determinism tradition that is occasionally evident in body-parts-centric medical journals, starting (as far as Feedback is aware) with the publication *Brain*. Henry Head and Russell Brain were each its editor, at different times, Head from 1905 to 1923, Brain from 1954 to 1967. Those heads of *Brain* achieved a sort of medico-literary ecstasy in the December 1961 issue of *Brain*. Readers could savour an article there titled "Henry Head: The man and his ideas", authored by Russell Brain. It was *Brain* head Brain on *Brain* head Head, in *Brain*.

## Lots of life in salt

When people enliven a bland meal by adding salt, they are, in many (and maybe all) cases, adding life to that food. Tiny, maybe tasty, bits of life. Most commercial salt is home to microscopic species. Leila Satari, Alba Guillén, Adriel Latorre-Pérez and Manuel Porcar, all at the University of Valencia, Spain, went looking for that life in six different kinds of table salt.

They found it, everywhere. Their report, "Beyond archaea: The table salt bacteriome", was published in *Frontiers in Microbiology*. The salts from oceans were home mostly to various species of archaea. Salts from other sources gave domicile mostly to varieties of bacteria.

These scientist are continually looking for life in low-rent places. Satari, Guillén and Porcar, with Angela Vidal-Verdú, were awarded the 2021 Ig Nobel ecology prize for using genetic analysis to identify the species of bacteria that reside in wads of discarded chewing gum stuck on pavements. ■

Marc Abrahams

# GALAXY

ON GLASS

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