# New Scientist

**WEEKLY** 4 November 2017


**OK, QUANTUM COMPUTER**
If we built one, what would we do with it?

**TRICK OF THE IMAGINATION**
Placebo pill makes people more creative

**CATCHING ALZHEIMER'S**
Worrying signs of spread by blood transfusion

**HORN OF A DILEMMA** Should we farm rhinos for their non-existent healing powers?

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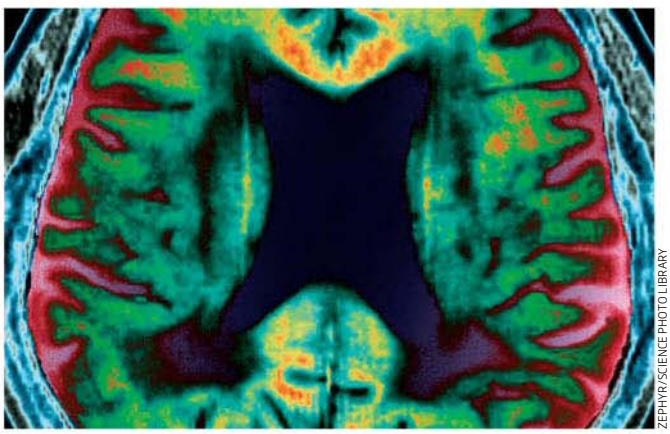

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## On the cover



## Leader



## News



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# D850

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Nikon 100th anniversary

Nikon

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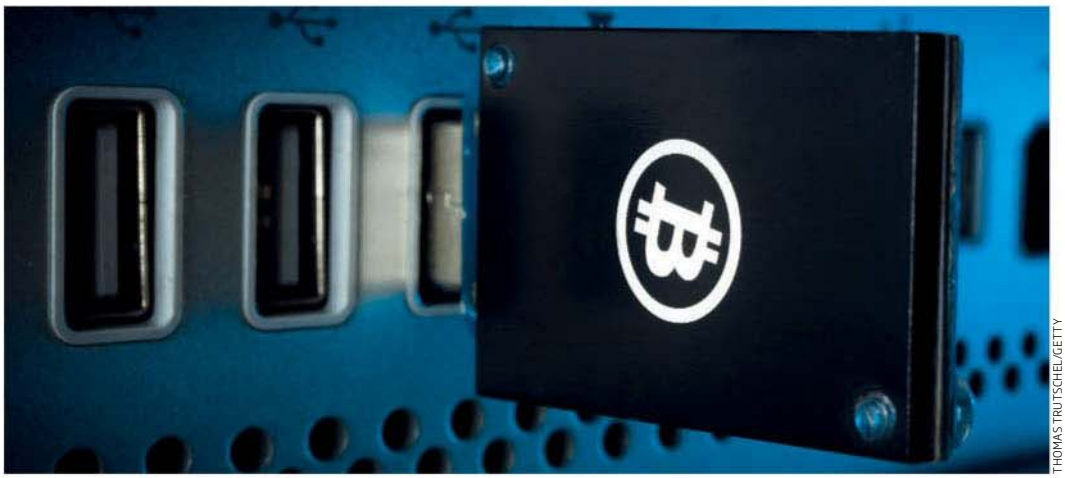


THOMAS TRUTSCHEL/GETTY

# Waste not, want not

## Bitcoin needs to stop squandering resources

IMAGINE you discovered that in order to mint the coins and print the banknotes in your wallet, your country's central bank employed vast numbers of people to push boulders up hills and let them roll down again. Imagine that this wasted effort was equivalent to the workforce of a small South American country. What, you would rightly ask, is the point of that?

No central banker would stand for such farcical wastefulness. But the decentralised cryptocurrency bitcoin relies on it. In order to create or spend bitcoins, users must dedicate vast amounts of computing resources just to verify their transactions. This authentication process – aka the blockchain – is a key element of bitcoin's open-source philosophy. The trouble is the computation itself is make-work: solving tough but irrelevant cryptographic problems merely to deter fraudsters.

Mining – as the process of creating new bitcoins is known – used to be a fairly trivial task possible on a home computer. But it is now so computationally intensive that it requires dedicated buildings full of specialist bitcoin-mining chips running 24/7. And as the number of bitcoins in circulation grows towards the artificially imposed ceiling of 21 million, mining each new one takes yet more computation. This burgeoning industry is hugely wasteful. Energy consumption is so vast that some mines are sited near the Arctic circle to cut down on cooling costs.

Bitcoin is no stranger to controversy. But until now its profligacy has largely gone unchallenged. That needs to change. Computing power is a precious resource, as is the electricity required to run the machines. To allow this to be squandered on pointless tasks is extravagant at best. If bitcoin fulfils its ambition to compete with, or even supersede, regular currencies issued by central banks, its wastefulness would amount to a scandal.

**"Bitcoin is no stranger to controversy. But until now its profligacy has gone unchallenged"**

It is therefore welcome news that another blockchain platform, Ethereum, recently recognised the problem and proposed a solution (see page 8). Whether it is workable and preserves the commitment to openness remains to be seen.

But bitcoin and other cryptocurrencies must find a solution. Their reputation is already tainted by association with money laundering, fraud, drug dealing and a seemingly constant cycle of hype and disappointment. These problems, perhaps more than the mind-boggling nature of the currency, have held back what could be a revolutionary technology.

Rather than seeing its wastefulness as another PR disaster, bitcoin should grasp it as an opportunity. Abandon the make-work and dedicate the computing resources to a worthy cause; think of it as a Tobin tax on cryptocurrency transactions. The energy issue then becomes part of a wider problem.

In their bid for mainstream acceptance, Bitcoin advocates must already feel as if they are pushing boulders up hills. Why make yet more hard work for yourself when you could be doing something useful instead? ■

# Climate health threat

WE'LL pay a huge price in lost lives if we fail to tackle climate change. That is the warning from a consortium of experts that has forecasted how climate change will affect our health.

"This is the major health threat in the 21st century around the world, and there's an urgent need for us to address it," says Hugh Montgomery of University College London, co-chair of the group behind the report, called *The Lancet Countdown on Health and Climate Change*.

But if we work harder to switch to clean energy, we are likely to see huge health improvements, the report says.

If things carry on as they are, the biggest effect will be hunger, as rising temperatures drive down farming productivity. For every 1°C rise in average global temperature, wheat yields are expected to decline by 6 per cent and rice yields by 10 per cent.

Earlier this year, the UN Food and Agriculture Organization warned that for the first time in almost two decades, the number of undernourished people has begun to rise – climbing to 422 million in Africa and southern Asia, up from 398 million in 1990. Worse will follow, warns the new report, if temperatures keep rising.

This heat will also take a direct toll on health. Between 2000 and 2016, the number of people exposed to heatwaves increased by 125 million. The report forecasts a billion additional "heatwave exposures" by 2050. Such periods of high heat can be particularly deadly for babies, young children and older people.

ALBERT GONZALEZ FARRAN/AFP/GETTY

Undernourishment is rising

## Young blood trial

THE long-awaited results of a trial involving the injection of blood from young people as a treatment for Alzheimer's disease have been met with criticism.

In 2014, a team led by Tony Wyss-Coray at Stanford University received approval to inject young human blood plasma into older people with Alzheimer's. Young mouse blood had improved the physical and cognitive function of older mice, prompting Wyss-Coray to found the firm Alkahest. Results were finally presented at a summit on clinical trials for Alzheimer's in Boston this week.

**"The results may be unusable. It's like removing all the aces and then shuffling the deck"**

The trial suggests treatment with young plasma – mostly from people aged 18 to 25 – does have potential effects on Alzheimer's symptoms, says Karoly Nikolich of Alkahest. He says improvements were seen in mental skills and the ability to do daily activities. "They had more awareness of self and their surroundings," says Nikolich.

Initially, the plan was to give one group the treatment and another a placebo of saline, and have them swap places after a number of weeks. However, several people dropped out, says Nikolich.

So a new trial was begun that included no placebo group, just weekly injections of plasma for four weeks. To assess its effects, the team used placebo data from the original version of the trial, says Nikolich.

This may make the results unusable, says Michael Conboy at the University of California, Berkeley. "It's like picking all the aces out of a deck of cards and then shuffling the deck."

Nikolich says that weekly questionnaires completed by caregivers showed real, objective improvements in participants' abilities in daily life. But Conboy says the study design makes the results nearly irrelevant. "The caregivers will flag up any slightest change as indicating that the treatment is working," he says.

## Carbon hits high

THERE was lots of bad news on the climate front this week.

Greenhouse gas levels in the air reached yet another record high in 2016, according to the World Meteorological Organization. They are now the highest they have been for 800,000 years.

And countries are not doing enough. Pledges so far only amount to a third of the cuts needed by 2030, a report by the UN Environment Programme has found. But this shortfall can be made up with existing technology.

Also, soils in cold climates could release more carbon than thought as the world warms. Charles Koven of the Lawrence Berkeley National Laboratory in California says climate models underplayed such emissions (*Nature Climate Change*, doi.org/cfqj).

For every 0.5°C of warming, the extra carbon may equal one year's emissions from all human sources. That makes limiting warming to 2°C even harder, because we have four fewer years to slash emissions.

## Roaming sharks protected

IT HAS been a good week for sharks. A pact signed by 126 countries promises for the first time to safeguard migratory sharks, whatever waters they stray into.

Among the biggest winners at the Convention on the Conservation of Migratory Species of Wild Animals were whale sharks, the world's largest fish. They are a vulnerable species whose population has been falling. Governments added whale sharks to appendix I of the convention, promising to protect them from killing or capture, and to safeguard their habitats.

The move will protect them at migration "hotspots", including those off Peru, Madagascar, Mozambique and Tanzania.

Several other sharks made it on to appendix II, which obliges countries within these species' migratory range to collaborate on measures to protect them, for example by regulating fishing or banning finning.

## Opioid emergency

DONALD TRUMP last week declared the US opioid crisis – which is killing tens of thousands of people a year – a national public health emergency.

A directive, signed on 26 October, calls for increased access to telemedicine in rural areas with doctor shortages, a shuffling of federal funding so that more can be applied to the crisis, and some easing of regulations and bureaucratic delays.

**"Trump claimed his proposed border wall would help stop opioids entering the country"**

However, because the emergency was declared through the Public Health Services Act, it doesn't automatically come with any additional funding.

In his speech, Trump suggested that advertising campaigns could curtail opioid use. "If we can teach young people – and people, generally – not to start, it's really, really easy not to take them," he said. He also said that because a significant portion of opioids entering the country come from Latin America, his proposed border wall would help.

However, this wouldn't solve the problem of people becoming addicted through painkillers prescribed to them by doctors.

PETE OXFORD / NATUREPL

Home is where I swallow krill

SIMON DAWSON/BLOOMBERG VIA GETTY

Too much at stake

## Fixing fixed odds

IT'S a crackdown on what critics call the crack cocaine of gambling. The UK government has announced plans to curb the most dangerous aspects of fixed-odds betting terminals (FOBTs).

Users can currently bet up to £100 every 20 seconds on games of chance like roulette. Under the new proposals, the maximum stake will be cut to between £2 and £50 and the time between games may be increased.

**"Users can currently bet up to £100 every 20 seconds on games of chance like roulette"**

Tracey Crouch, minister at the Department for Digital, Culture, Media and Sport, says the aim is to "reduce the potential for large session losses and therefore to the potentially harmful impact on the player and their wider communities". Parliament will vote on the changes next year.

But this decision is complicated by a lack of evidence of where the problem lies and how to fix it. No studies have been done on the impacts of cutting the maximum stake or playing frequency. Instead, we must rely on circumstantial evidence that regular users lose an average of £1200 each per year. It is possible that games will remain highly addictive, and simply drain people's wallets over a longer period of time.

"The standard of research in the UK is very poor. There's very little openness around data, with bookmakers unwilling to make data sets available for independent researchers to analyse," says Rebecca Cassidy at Goldsmiths, University of London.

## Bird killers escape

UK AUTHORITIES have come under fire for ignoring "blatant" killings of birds of prey.

There were 81 confirmed attacks on protected raptors in 2016, but not a single prosecution, says the Royal Society for the Protection of Birds. These include 40 shootings and 22 poisonings of hen harriers, red kites and buzzards, according to the conservation charity's *Birdcrime* report.

Most incidents were on moors used for commercial grouse shooting. Raptors hunt grouse.

Laws protecting birds of prey "are clearly not being put into action", says the RSPB's Guy Shorrock.

"There are few countries where the direct persecution of raptors associated with a specific land use is so blatant and so obvious as it is with grouse shooting in the UK," says Arjun Amar at the University of Cape Town, South Africa.

## 60 SECONDS

### Russian ads

Around 126 million people saw political adverts on Facebook paid for by Russian-linked agencies during the 2016 US presidential election, according to the social media giant. In the future, Facebook says political adverts will have a "paid for by" tag in an attempt to make the process more transparent.

### Halley's Halloween

A growing fissure in the Antarctic ice, called the Halloween crack, has convinced the British Antarctic Survey to close its Halley VI Research Station for the second Antarctic winter running. With the Halloween crack extending eastward and another growing northward, the BAS this week decided to close the station as a precaution.

### End of Grace

After 15 years studying Earth's gravity from orbit, the Gravity Recovery and Climate Experiment (GRACE) mission is over. It used a pair of satellites to measure the minute changes that arise in Earth's gravity as water, ice and land move around the globe. The dying satellites will expend the rest of their fuel and then crash to Earth in December or January.

### Shocked into anger

Zapping the brain to relieve depression may spark fits of fury. Case studies of two people who received transcranial direct current stimulation reveal that both had uncharacteristic outbursts of anger afterwards (*Brain Stimulation*, doi.org/cfqk).

### Lights out

The blackout caused by Hurricane Maria is the largest and longest in US history, according to policy analysis firm Rhodium Group. The storm hit in late September and the firm calculates that, as of 26 October, it had disrupted 1.25 billion hours of electricity supply for American citizens, mostly in Puerto Rico.

# Can you catch Alzheimer's?

A rogue protein may spread Alzheimer's disease via blood transfusions

Jessica Hamzelou

FEAR has been growing that Alzheimer's disease might be capable of spreading via blood transfusions, but it has been hard to find any evidence that this is happening. Now a study has found that an Alzheimer's protein can pass between mice sharing a blood supply.

We know from prion diseases like Creutzfeldt-Jakob Disease (CJD) that misfolded proteins can spread brain conditions. Variant CJD, for example, can spread via meat products or blood transfusions infected with prions.

Alzheimer's also involves a misfolded protein, called beta-amyloid. Plaques of this protein accumulate in the brains of people with the condition, although we still don't know if the plaques cause Alzheimer's, or are merely a symptom.

There's some evidence that beta-amyloid may spread like prions. Around 50 years ago, people with a growth disorder were treated with growth hormone taken from cadavers. Many of the recipients went on to develop CJD, because the tissue from these cadavers turned out to be carrying prions.

Decades later, it emerged in postmortems that some of these people also had Alzheimer's plaques, despite being relatively young. The team behind this work raised the possibility that some medical or surgical procedures may pose a risk.

Now a study has found that, when a healthy mouse is conjoined with a mouse that has Alzheimer's plaques, it will start to develop plaques of beta-amyloid protein in its own brain. When the plaques form, their brain tissue starts to die.

This suggests Alzheimer's can indeed spread via beta-amyloid in blood. "The protein can get into the brain from a connected mouse and cause neurodegeneration," says Weihong Song at the University of British Columbia in Canada, who led the work.

Song's team carried out the study on mice with a gene that makes the human version of beta-amyloid, because the animals don't normally develop Alzheimer's. This gene meant the mice developed brain plaques and neurodegeneration.

The team then surgically attached mice with this Alzheimer's-like condition to healthy mice without the beta-amyloid gene, so that they shared a blood system.

The healthy mice started to accumulate beta-amyloid in their brains. Within four months, the mice also had altered patterns of activity in brain regions that are key for learning and memory (*Molecular Psychiatry*, doi.org/cfqh). It is the first time that beta-amyloid has been found to enter the blood and brain of another mouse and cause signs of Alzheimer's disease, says Song.

**"It strengthens the case that beta-amyloid is infectious. It may actually be a prion or like one"**

"They somewhat convincingly show that it is possible to induce [plaques] in mice just by connecting the circulation," says Gustaf Edgren at the Karolinska Institute in Stockholm, Sweden. "It strengthens the case that beta-amyloid is infectious somehow – it may actually be a prion or act like a prion."

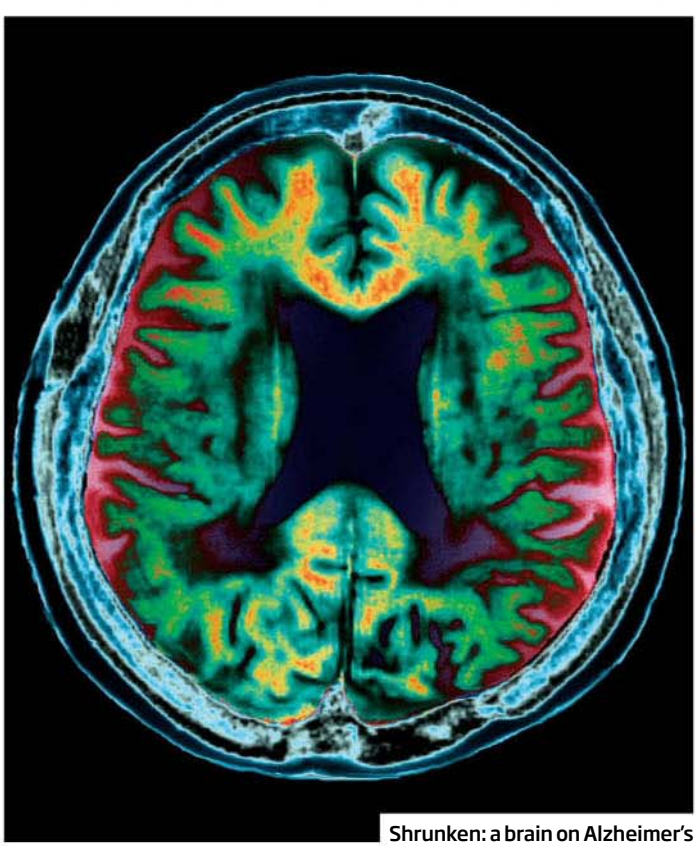
These findings contradict a study earlier this year by Edgren and his colleagues, which tracked 2.1 million recipients of blood transfusions across Sweden and Denmark. They found that those who received blood from people with Alzheimer's didn't seem to be at any greater risk of developing the disease.

Edgren says that there's a chance his study didn't run for long enough to catch evidence that Alzheimer's proteins might be transmissible. "It could take a long time [for the disease to develop], or there could not be enough data. A lot of researchers fear that it's an infectious protein," he says.

Song's team says it is too soon to draw conclusions. Stitching mice together is not a situation that applies to people, says Edgren.

Mathias Jucker at the German Center for Neurodegenerative Diseases in Tübingen doesn't think the study shows that Alzheimer's is a transmissible disease. And the team has not yet looked at the behaviour of the mice to see if they show signs of the cognitive decline characteristic of Alzheimer's.

One of the reasons it has been hard to treat Alzheimer's is the difficulty of designing drugs that can cross the brain's protective barrier. So the findings may lead to new medical approaches. It may be easier to target the protein in the bloodstream, which could have knock-on effects for the brain, says Song. ■



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Shrunken: a brain on Alzheimer's

# 20 potential Earth-like worlds found

THERE could be more habitable planets out there than we thought. An analysis of data from the Kepler space telescope has revealed 20 promising worlds that might be able to host life.

The list of potential worlds includes several planets that orbit stars like our sun. Some take a relatively long time to complete a single orbit, with the longest taking 395 Earth days and others taking weeks or months (arxiv.org/abs/1710.06758).

The exoplanet with a 395-day year is one of the most promising worlds for life on the list, says Kepler team member Jeff Coughlin. Despite being slightly smaller and colder than Earth, it is still warm enough and big enough to hold the liquid water essential for life as we know it. "If you had to choose one to send a spacecraft to, it's not a bad option," says Coughlin.

The team is 70 to 80 per cent sure that these planets are real, he says. They all come from the original Kepler mission, which looked at the same area for just four years before its aiming ability was crippled by its reaction wheels breaking in 2013. This means that we have only seen each of these worlds once or twice, and the signals could be wobbly. Other observatories will need to double-check the signals, Coughlin says.

The short observation period is also the reason the planets weren't spotted earlier: the team needed more data to separate real signals from false alerts.

In order to build the list, the Kepler team mixed up signals from the potential exoplanets, several that had already been confirmed and a few fake ones. The fake planets helped check for errors and rule out bad signals, cutting the list down to 20.

If confirmed, these would be some of the most promising worlds out there to host life because of their long years and sun-like stars, says Abel Mendez, director of the Planetary Habitability Lab at the Arecibo Observatory. John Wenz ■

LEON NEAL/GETTY

Farmed for their horns?

# Legal trade in rhino horn could dwarf illegal one

WHAT is the best way to stop the trade in rhino horn? A new study claims South Africa could, legally and sustainably, supply enough to meet current demand. But it might not prevent poaching.

About 25,000 rhinos remain in Africa, mostly white rhinos in South Africa. But the nation has experienced a wave of poaching since 2008. More than 500 rhinos have been killed this year up to July. Poachers take the horn, which is sold in Asia as "medicine" and as a trophy.

Some have proposed creating a legal trade. The horns can be removed without killing the rhino and grow back, so in theory ivory can be obtained sustainably. The idea is to flood the market with legal ivory, cutting the price and reducing poachers' incentive.

In April, South Africa ended its eight-year moratorium on trading rhino horn, and some local rhino owners have started selling. The biggest mogul is John Hume, who has 1500 rhinos and a cache of more than six tonnes of ivory. Hume says his mission is to save rhinos. He partly funds his work by sawing off horns and selling them at auction. In August, he sold 500 kilograms online.

Yet until now, we haven't even known how much rhino horn can be safely supplied. So Andrew Taylor of the Endangered Wildlife Trust in South Africa and colleagues examined four ways to obtain it legally: dehorning, natural deaths, trophy hunting and selling stockpiled horn.

> **"The legal system will create an opportunity to launder all rhino horns from Africa and Asia"**

The group found that South Africa could produce 5319 to 13,356 kilograms a year. They estimate that 5300 kilograms enters the black market from South Africa every year (*Biological Conservation*, doi.org/cfp6).

"Revenues from horn sales could be ploughed back into anti-poaching," says Taylor. Defending rhinos is expensive and many rhino owners "sell them because they can't afford the price".

But others object. "It is a terrible idea," says David Blanton of Serengeti Watch.

Instead of merely meeting existing demand, the extra supply might boost it – keeping prices high and poachers incentivised.

Legalisation "creates the perception that buying these products is fine", says Andrea Crosta of the Elephant Action League. China's growing wealth is creating "hundreds of millions of consumers of rhino horn".

Worse, the legal trade could be subverted. An investigation by the Elephant Action League revealed Asian dealers moving products via a web of couriers, including the Chinese navy. They could exploit a legal trade, says Crosta. "The legal system will create an opportunity to launder all rhino horns from Africa and Asia."

The real solution is action by Asian governments, he says.

In 2008, the Convention on International Trade in Endangered Species of Wild Fauna and Flora allowed the sale of 108 tonnes of ivory. Poaching carried on. "I guess we've already forgotten that it did not work," says Quyen Vu of Education for Nature – Vietnam. **Adam Popescu** ■

# Bitcoin energy bill matches Ecuador's

Abigail Beall

BITCOIN has an energy problem. The cryptocurrency, and the blockchain it runs on, have long been heralded as the future of financial transactions, replacing people with an array of number-crunching computers. But its energy expenditure is becoming clear just as the blockchain and cryptocurrencies are exploding into the mainstream.

That realisation has spawned a host of strange workarounds, from heaters that warm your home with the blockchain, to renewable mining. Now, the creator of one of the world's biggest cryptocurrency networks has announced a major change to address the problem.

We have known for a while that bitcoin hogs energy. That is down to the way it works with the blockchain. Each transaction starts with a user broadcasting the details of that transaction to a network of linked computers, where it is duplicated in thousands of identical, unfalsifiable ledgers. "A blockchain, including bitcoin, has to operate on the assumption that no other computer can be trusted," says Teunis Brosens, economic analyst at ING. So instead of trusting anything, each computer independently verifies part of the transaction, in a process called mining.

Mining prevents computers creating fake ledgers. They need to show "proof of work", a gruelling cryptographic puzzle that takes so much processing power that generating false entries becomes prohibitive.

All that processing guzzles a lot of electricity. That's still peanuts compared with the energy use of the internet, but one recent estimate put the annual electricity consumption of bitcoin mining at 23.07 terawatt hours, roughly the amount of electricity used by Ecuador each year.

Some enterprising bitcoin miners have made space heaters that can turn all that processing into useful warmth. The Russian cryptocurrency start-up Comino is hoping to make a business of it.

LIU XINGZHE/CHINAFILE/EPA/REX/SHUTTERSTOCK

Bitcoin: conspicuous consumption

But that is not particularly scalable unless you're a bitcoin miner in a cold country. Other ideas to mitigate the energy wastage include using solar and wind power to mine bitcoins.

The need to address the problem is pressing. If bitcoin were to suddenly double in popularity overnight, the network would consume the energy of 5 million US households.

The latest solution is a radical one: change the way blockchain works altogether. Vitalik Buterin, the creator of cryptocurrency network Ethereum, announced last month that he would adopt a completely different way of doing transactions, known as "proof of stake".

He adds his voice to a chorus who think that instead of proving a computer is trustworthy by taking out a "proof of work", they could vet themselves by placing a small amount of money into a fund, which they get back if the validation turns out to be authentic, says Brosens. In a similar way to proof of work, it is difficult for fraudsters to replicate.

But this approach could have serious downsides, says Brosens: proof of stake could lead to biases towards those with more money. But no one's had a better idea yet. "In my opinion, the key really is to find ways of verification or mining that are less energy intensive," he says. ■

# Shrimp claw shoots a savage shock wave

THIS reef ain't big enough for the both of us. Two pistol shrimp face each other, each opening its one oversized claw. The claws snap shut, firing powerful water jets at speeds up to 30 metres per second.

These shrimp shoot-outs are rarely fatal, but can leave the loser with missing claws or puncture wounds. Yet the high-speed squirt isn't what harms their target – it is the resulting shock wave. Now we have glimpsed how this unfolds in fine detail (*Nature Scientific Reports*, doi.org/cfnq).

If you listen under coastal tropical waters, you may hear a sound like chestnuts crackling as they roast. At a volume of about 200 decibels, these pops are some of the loudest in the ocean, second only to sperm whale clicks. These resounding snaps occur when an air bubble collapses around the watery jet, much as bubbles in our joints pop when we crack our knuckles.

"We knew the bubbles were there, but we didn't know what they looked like," says Phoevos Koukouvinis at City, University of London. So his team tried to figure it out by simulating the snap of the shrimp's claw.

The team found that when this happens, friction between the fast-moving jet and the surrounding still water creates a swirling vortex. The vortex leaves a void in the centre, like the dimple in your tea as you stir it. Eventually, that void collapses, releasing a powerful pressure wave.

**"If you have your hand in front of a shrimp's claw, you definitely feel it when it snaps shut – it hurts"**

Pistol shrimp only grow to about 5 centimetres, but Nancy Knowlton at the Smithsonian Institution in Washington DC doesn't recommend sticking your arm in their tank. "If you have your hand in front of a shrimp's claw, you're definitely feeling it when it goes off," she says. "It hurts."

And that is the point. Pistol shrimp are scavengers, so they don't often use their bubble-gun claws to stun prey, Knowlton says. Instead, they protect their mates and homes in some of the tiniest gunfights on earth. Aylin Woodward ■

# Animal shaken up as roads splinter forests

IMAGINE you could teleport to any forest on Earth. When you land, you have a 50 per cent chance of being within half a kilometre of the forest's edge. That is how badly our planet's forests have been sliced and diced.

A new study shows that 85 per cent of animals had their numbers affected by living in these spotty forests. The findings will help conservationists figure out how best to protect them.

Marion Pfeifer of Newcastle University in the UK and colleagues used existing population data to map the abundance of 1673 species – amphibians, reptiles, birds and mammals – in 22 tropical regions in the Americas, Asia and Africa. These included threatened species such as the Sunda pangolin.

Of the species affected by life near forest edges, 46 per cent became more common over several decades, and 39 per cent became less abundant (*Nature*, DOI: 10.1038/nature24457). This may be good news for some species, even though life on the forest edge may change their behaviours.

However, others that live deep in the forest only reached their peak abundances more than 200 to 400 metres from its edges. These species seem to depend on large, continuous forests. If forests continue to fragment, they may be driven out.

"It's a tremendously important study, because it integrates such a large amount of data for nearly 2000 vertebrate species," says William Laurance of James Cook University in Queensland, Australia. "In some ways, it confirms our worst fears."

Laurance says road-building will hurt forests in tropical developing nations. In a paper last week, he found that, of the 25 million kilometres of new paved roads expected by 2050, 90 per cent will be in these regions (*Current Biology*, doi.org/cfpw).

"Roads typically open up a Pandora's box of environmental problems for forest species," he says. Lakshmi Supriya ■

MIROMATRIX

Ready to become a liver

# Transplant organs made from dissolved pig livers

A METHOD that uses pig organs as scaffolding for creating new livers suggests we may one day be able to grow transplant organs on demand.

In an effort to tackle lengthy waiting lists for organ transplants, researchers have been trying several approaches for making replacement organs. One is to grow organs from stem cells. Another is to genetically alter pigs so the cells of their organs are more human-like, and less likely to be attacked by a recipient's immune system.

Now an in-between method is taking off. It starts with an organ from an ordinary pig, but involves dissolving the cells to leave a protein scaffold in the original shape of the organ. This is then reinfused with human cells.

Until now, this technique – dubbed "decel/recel" – has been mainly investigated for small or thin structures such as layers of skin because it is hard to dissolve the inside of a large organ. But US firm Miromatrix announced in October that it has successfully created livers this way.

So far, the team has only created whole livers with pig cells rather than human cells. But this first step means the livers can be tested as transplant organs in pigs without the risk of them being rejected by the animals' immune systems.

The whole livers were decellularised by pumping detergent through their blood vessels, so it reached everywhere. This removed every living cell, leaving behind only the structural proteins that held the organ in shape. With a pig liver, this process takes 24 hours.

The liver scaffold is then reinfused with the three main types of cell within a liver: liver, blood vessel wall and bile duct cells. These automatically home in on their right places within the scaffold, says Jeff Ross of Miromatrix. "It takes tissue engineering from a single layer to whole organs," he says.

Ross and his colleagues have begun to try this with human cells. In a first step, the team pumped cells from human umbilical cords into the protein scaffolding, remaking the blood vessels of the liver. When these were implanted into pigs, the vessels survived and allowed blood to flow throughout the scaffold. These results were presented at a meeting of the American Association for the Study of Liver Diseases in Washington DC last month.

**"The liver scaffold is then reinfused with cells that automatically home in on their right places"**

Ross says his team is now working on reinfusing liver scaffolds with human liver and bile duct cells, and plans to implant these into pigs by the end of 2017. The hope is to have livers made entirely from human cells that could be transplanted into people within three years. For this, the team will use liver cells from donated organs that are not in good enough shape to transplant into a patient.

But the real test will be to see how well the livers work, says Laura Niklason of Yale University. "The decellularisation and repopulation is not the tricky part – the tricky part is getting all the cells you put back in to behave properly."

The experimental organ transplant field is under the spotlight after recent setbacks, including a scandal over trachea replacements at the Karolinska Institute in Stockholm, Sweden. Surgeon Paolo Macchiarini was found to have put them into patients without enough safety testing. In several of the procedures the patient later died or their trachea failed. **Clare Wilson** ■

# Panda's ancestors hailed from Europe

Jasmin Fox-Skelly

AN EARLY panda lived in what is now Hungary 10 million years ago. It ate a similar diet to modern giant pandas, suggesting their odd bamboo-chewing lifestyle has survived evolutionary time. The finding also adds to evidence that they evolved in Europe, not Asia.

The giant panda (*Ailuropoda melanoleuca*) lives only in high forests in central China. Classed as a vulnerable species, it eats little but bamboo despite having a meat-eater's digestive system. Nobody really knows how the animal evolved, as few fossils of its ancestors have been found.

David Begun at the University of Toronto in Canada found teeth in Rudabánya, Hungary, that belonged to an early panda. They are 10 million years old, placing them in the late Miocene.

Begun, working with Louis de Bonis at the University of Poitiers in France and Juan Abella at the State University Santa Elena Peninsula in Ecuador, studied the shape and wear patterns of the teeth. Such wear patterns can reveal what an animal ate – and these were similar to those of giant pandas. "Both species consumed tough plant foods, requiring shearing rather than crushing of food during chewing," says de Bonis. "The way of life of the panda's ancestors was very similar to the modern panda."

The researchers say the teeth are from a hitherto unknown panda, *Miomaci panonnicum* (*Geobios*, doi.org/cfnj). "*Miomaci* could be considered, not like a direct ancestor, but more like a 'cousin' of the modern panda," says de Bonis. "Their lineage probably separated in the middle Miocene period."

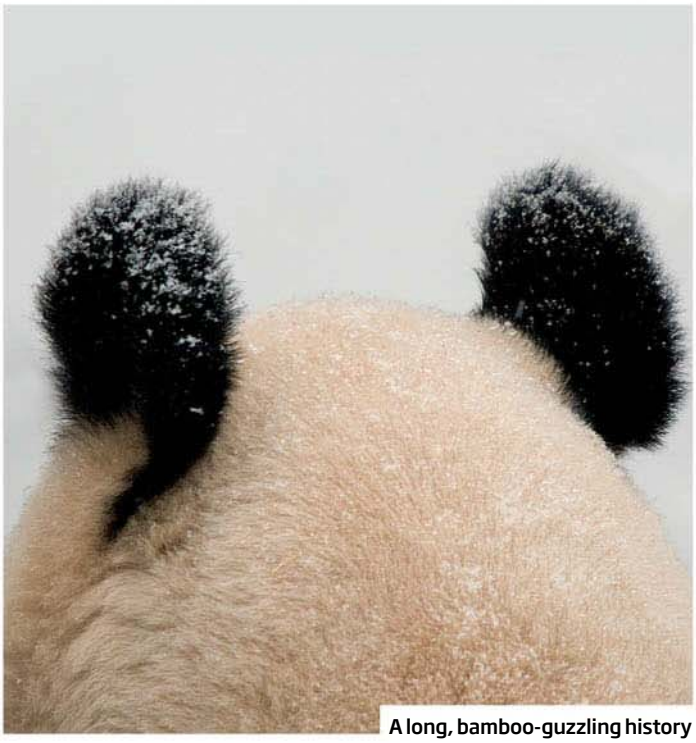
"It appears to be closer to the split between giant pandas and the rest of the carnivores, [such as] bears," says Russell Ciochon at the University of Iowa. He says the fossil "lacks the very specialised dental anatomy found in modern giant pandas, which evolved in southern China around 2 million years ago". That may be when they became dependent on bamboo.

Since giant pandas are confined to China, we assumed the panda family has lived there since it split from other bears. Panda fossils found in China date as far back as 8 million years ago.

But in 2012, teeth from another panda ancestor, *Kretzoiarctos beatrix*, were found in Spain. These were 11.6 million years old, hinting that pandas evolved in Europe then moved to Asia. *Miomaci* supports that idea.

There are similarities between animal fossils from European and Chinese sites in the late Miocene, "suggesting that there may have been a lot of travelling between the two areas", says Begun.

Abella says the giant panda's ancestry is probably Asian and the European species are extinct sister lineages. Climate changes may have killed them. In *Miomaci*'s day, Europe was warmer and wetter than now, and Rudabánya was a lush forest. Europe lost such forests 5 million years ago, which may have doomed European pandas. "The environment cooled and dried out," says de Bonis. "The species linked to dense warm forest disappeared." China may have been the only congenial home for pandas. ■



EDWIN GIESBERS/NATUREPL.COM

A long, bamboo-guzzling history

# Boiling water turns sand into hovercraft

THE sand on Mars may be floating on air. Warm temperatures in the Martian summer, combined with a thin atmosphere and deposits of ice may cause sand to levitate and carve out deep gullies.

Mars can get quite balmy in the summer, reaching temperatures up to 20°C. That's warm enough to melt some of the ice deposits scattered across the planet. But because Mars has just one-hundredth the atmospheric pressure of Earth, that water doesn't stay liquid for long on the surface before boiling away.

Jan Raack at The Open University in the UK and his colleagues found that the pockets of water vapour can lift sediment into the air and move it across the ground (*Nature Communications*, DOI: 10.1038/s41467-017-01213-z).

"We saw in our experiments that wet sand pellets were somewhat 'floating' over the sediment," Raack says. This was caused by evaporating water, which created a cushion beneath the sand particles, turning them into tiny hovercraft, he says.

The researchers discovered this phenomenon by recreating Martian conditions in a laboratory. They mimicked gullies since earlier work suggested the Red Planet's landslides may be the result of water flowing down the hillsides.

The team subjected a sample of Mars-like soil to the relatively low pressures and temperatures that characterise the Martian atmosphere. When they added liquid water, it evaporated nearly immediately.

**"Water vapour pockets might make sand bubble up and float on air, perhaps digging gullies on Mars"**

The pockets of water vapour caused a levitation effect, where the sand bubbled up as if hovering on air. The effect lasted just a few seconds on Earth, but when taking the weaker Martian gravity into account levitation might persist for up to a minute. As the sand hovercraft travels along, it could scour out the deep gullies we see on the planet's surface. John Wenz ■

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Still weird in space

# Light's dual nature survives space

Anil Ananthaswamy

THE mysterious wave-particle duality of the quantum world has been tested using satellites – setting a new distance record of more than 3000 kilometres for a detection of this bizarre behaviour.

We know that photons are quanta of energy, or particles, but in some experiments these particles can act like waves. According to standard quantum physics, we can observe either the wave nature or the particle nature, but never both at the same time. Whenever we try, the act of measuring the photon forces it to behave as one or the other.

In 1978, the physicist John Archibald Wheeler suggested a so-called delayed choice experiment, in which the decision of whether to look for the photon's wave or particle nature is delayed until after the photon was already in the experimental setup.

Suppose the photon entered an experiment designed to look for its particle nature, and you chose at the very last instant to do a switcheroo and look at its wave nature. What would the photon do? Theory dictates that the photon should act like a wave.

In recent decades, experiments have validated Wheeler's ideas. But the longest distance travelled by a photon in these tests was about 140 kilometres. Now, Paolo Villoresi at the University of Padua in Italy and his team have used satellites to test quantum mechanics over thousands of kilometres, paving the way for applications in space. "You have to check your laws at the boundaries [of where] you are thinking of using them," says Villoresi.

**"At least over a distance of about 3500 kilometres, the predictions of quantum theory are still valid"**

In their setup, a pulse of laser light enters a device called a beam splitter, which creates two paths for the light to take. One path is straight and the other includes a detour, so the light on the straight path has a shorter distance to travel. The light on the detour route rejoins the straight path and both pulses head towards a satellite in low Earth orbit, with one lagging behind the other.

The satellite bounces the pulses of light back to Earth, where they encounter a device that randomly either does nothing, or holds up the first pulse so the pair reach a detector at the same moment. This decision corresponds to Wheeler's delayed choice. Doing nothing lets the path lengths remain unequal, while adding a delay in one path is equivalent to making the paths equal.

When the path lengths are unequal and the photons arrive one after another, we can tell which path each took. In this case, they act like particles (*Science Advances*, doi.org/cfnp).

When the two paths are equal in length, the detectors cannot tell which path each photon took. In this case, each photon ends up in a superposition of having taken both paths at once, and will interfere with itself, showing its wave nature – even though, in our classical way of thinking, it ought to have entered and left the experiment as a particle.

"This experiment shows that, at least on a distance of approximately 3500 kilometres, the predictions of quantum theory are still valid," says Giulio Chiribella at the University of Oxford. ■

## Space can change your brain in minutes

JUST a few minutes in low gravity can change the brain in ways that could affect astronauts and their behaviour in space.

Floris Wuyts at the University of Antwerp in Belgium and his colleagues wondered how quickly brain changes occur in low gravity, so they scanned the brains of 28 people immediately before and after a parabolic flight, which creates short periods of weightlessness during 3 hours in the air. They also scanned the brains of a control group who were not on the flight.

Although participants on the plane only experienced 10 minutes of low gravity in total, it had immediate effects, with less activity in brain regions involved in helping us form an image of our body and where it is positioned in the environment.

On Earth, we create this sense of "bodily self-consciousness" by combining information from various systems, including those involved in balance, movement and vision.

Under low gravity, these messages are altered, causing a sensory mismatch. The brain hates to be confused, so it probably works around this by switching off some of the regions involved.

The team also found decreased connections in the default mode network, which is associated with cognitive function and level of consciousness (*Nature Scientific Reports*, doi.org/gbjhz2). Reduced activity in this area can lead to a lessened ability for "self-monitoring", which in turn can affect our decision-making, empathy and mood.

This may not be a problem for current astronauts, says Wuyts, since it is likely that the brain adapts to these changes with training, but it may be relevant for planned missions to Mars, when astronauts will experience a change in gravity on arrival. It could also be relevant for space tourists, he adds.

Helen Thomson ■

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# Sniff a placebo to up your creativity

IF YOU need to get creative, a placebo could help unleash your talents.

The placebo effect is best known in medicine for making people feel better when they are given sham treatments. Now there is growing interest in using placebos to boost athletic and cognitive abilities.

Previous studies have found that people lift more weights and cycle harder when they take medicines with no active ingredients that are falsely labelled as performance-enhancing substances. Placebo pills have also been shown to improve scores in memory tests.

These findings prompted Lior Noy and Liron Rozenkrantz at the Weizmann Institute of Science in Israel to test whether the placebo effect can stimulate creativity too.

They asked 90 university students to sniff a substance that smelled of cinnamon. Half the students were falsely informed that the substance had been designed to enhance creativity.

The participants then completed a series of tasks designed to test their creativity. One involved rearranging squares on a computer screen into different shapes. Another required them to think up new uses for everyday items like shoes, pins and buttons.

Those who were told the smelly substance increased creativity scored higher on measures of originality. For example, they came up with more unusual shape configurations and novel applications for the everyday items (*PLoS One*, doi.org/gbwkrd). "The improvements weren't enough to turn you into the next Picasso, but they were significant," says Noy.

In medical contexts, placebos appear to reduce pain and depression by triggering the release of natural opioids in the brain, but it is unclear how they work in the creativity context.

By making the participants feel as if they had extra help, the placebo probably made them feel more confident and adventurous, says Rozenkrantz. "Lots of people, including myself, fear creative tasks," she says. "We think the placebo removes this mental block and allows people to feel more supported and let go of their fears."

Noy and Rozenkrantz believe bosses and teachers could use the findings to nudge their employees and students towards more original thought.

"Maybe you don't even need to give them a placebo – it might be enough to just tell them they're creative, emphasise past successes and make a more secure environment to enhance their self-belief," says Noy.

It may also be possible to achieve the same effect with "honest placebos", says Ted Kaptchuk at Harvard University. He has shown that placebo pills improve symptoms in people with irritable bowel syndrome and chronic pain, even when they know they are shams. "Then it would be usable and ethical in the real world," he says.

An important next step will be to confirm that placebos increase creativity in real life and not just in lab conditions, says James Kaufman at the University of Connecticut. "Can they help people come up with more original art, writing, scientific hypotheses, advertising campaigns or other work-related tasks?" he asks. **Alice Klein** ■

PLAINPICTURE/CULTURA/ALYS TOMLINSON

What's the bright idea?

## Glimpse of the first interstellar comet?

THE solar system may be hosting a visitor from the stars. A newly discovered comet is screaming away from Earth, and based on its weird orbital trajectory might be the first comet ever observed to come from interstellar space.

A sky-surveying telescope in Hawaii spotted the fast-moving object, now called C/2017 U1, on 18 October, after its closest approach to the sun. The following week, astronomers made 34 separate observations of the object and found it has a strange trajectory that doesn't appear to circle the sun.

Most comets follow elliptical orbits around the sun, swooping in from the distant Oort cloud to kiss the inner solar system before heading back out again. This one, by contrast, seems unlikely to ever return. Its orbital path suggests it sailed in from the direction of the constellation Lyra above the relatively flat plane of the solar system, looped around the sun and is now headed back out for eternity.

Lyra is near the direction the sun is moving within the Milky Way, says Luke Dones at the Southwest Research Institute in Boulder, Colorado. "That's exactly what you'd expect," he says. "There should be more interstellar comets coming from the direction the sun is heading toward."

But despite its extreme path,

**"Most comets follow elliptical orbits around the sun, but this one seems unlikely to ever return"**

the comet may not necessarily have come from interstellar space. "It could have interacted with Jupiter or another planet in such a way that changed its orbit," says Maria Womack at the University of South Florida in Tampa. Astronomers want lots more observations before they will be convinced the comet really is from beyond our solar system, she adds.

The comet should be visible in powerful telescopes for another fortnight at least, allowing amateurs and professionals alike to survey the icy visitor and try to determine its history. Rebecca Boyle ■

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## Mussel-inspired superplastic stretches and self-repairs

A MATERIAL inspired by mussels can stretch without snapping and repair its own molecular bonds. These features could make it useful in robot joints, for lifting heavy objects; or in packaging, to protect delicate cargo from accidental falls. It could even one day be used to repair tendons in our joints.

Mussels can grip fast to wet and rough surfaces using an adhesive protein and tough, plasticky fibres that can repair themselves when a few of their molecular bonds are broken. Megan Valentine at the University of California, Santa Barbara, and her colleagues created a plastic with these properties by mimicking the chemistry that mussels use. Molecular bonds between iron and an organic compound called catechol make the material difficult to break or tear, while allowing it to stretch by 50 per cent (*Science*, DOI: 10.1126/science.aao0350).

Iron-catechol bonds dissipate energy from something hitting or stretching the material. These "sacrificial bonds" break, but the structure stays intact. "It's like a bike helmet: if you're in a bike accident, the foam inside the helmet crushes and dissipates some of the energy," says Valentine.

Unlike a bike helmet, however, once the stress is taken away, the bonds reform, making it reusable. Adding these bonds results in the plastic being 770 times stretchier and 58 times stronger than without them.

## Better, safer gene editing

A HIGHLY precise tool for changing the code of DNA should be more powerful for fixing genes than standard CRISPR gene editing, and safer too.

The standard CRISPR process doesn't work that well for fixing genes. It involves swapping in a new bit of DNA, and can introduce errors. It's not very efficient either, working on only about a tenth of cells.

So David Liu of Harvard University and his team are creating tools that fix mutations by turning one DNA letter into another. Last year, they unveiled a modified CRISPR editor called BE3 that can make two DNA code changes: C to T and G to A.

Now they have made an editor that changes A into G and T into C. Called ABE7, it works extremely well. In a series of tests, it made the desired DNA letter change in more than half of human cells, with hardly any unwanted mutations (*Nature*, doi.org/cfmf).

"It pretty much does not generate non-desired changes," says Liu. This makes ABE7 safer than standard CRISPR gene editing, minimising the risk of introducing mutations that could cause cancer, for instance.

Together, BE3 and ABE7 should be able to correct up to two-thirds of single-letter mutations.

## Female songbirds find their voices

FOR the first time, female dark-eyed juncos have been found to burst into song in the wild. Many female tropical birds sing, but singing females are rare among northern, temperate songbirds.

Dustin Reichard of Ohio Wesleyan University goaded female dark-eyed juncos (*Junco hyemalis*) in San Diego, California. He placed another caged female in each of their territories, and played the trill the birds make when they are receptive to mating. Three goaded females sang songs like those of males in response (*Journal of Avian Biology*, doi.org/cfnm).

This may be how the females defend their territory. Since they stopped migrating 35 years ago to stay in San Diego, says Reichard, they must do this all year.

As the climate warms, tropical birds may expand into temperate zones, Reichard says. "Then we may see more singing females in the higher latitudes."

## Blind people can 'feel' fireworks

PEOPLE who are visually impaired miss out at firework displays. But a new prototype system lets them sense the explosions via touch.

Feeling Fireworks, created by Paul Beardsley of Disney Research in Zurich, Switzerland, and his colleagues, relies on five jets that fire patterns of water at the back of a large screen on which users place their hands. The resulting vibrations mimic expanding dots of light.

There are preset patterns for the best-known fireworks. With Catherine wheels, for example, vibrations move in a spiral. The team hopes the system, which was demonstrated at a summit in Quebec last month, could eventually be synchronised with an event's main firework display.

## How a rubber duck comet was built

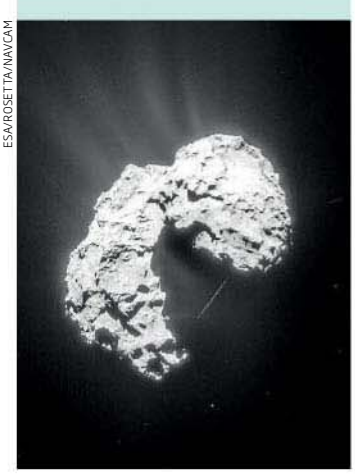
THE famed "rubber duck" comet is revealing more about its past. It turns out that 67P/Churyumov-Gerasimenko probably did grow out of tiny pebbles, as many suspected – and this may help us learn more about how planets form, too.

Using data from the Rosetta spacecraft and Philae lander, Jürgen Blum at Braunschweig University of Technology in Germany and his team have traced 67P's building blocks to tiny pebbles of dust and ice (*Monthly Notices of the Royal Astronomical Society*, doi.org/cfnh).

Scientists have long suspected that clumps of microscopic dust built 67P. The idea is that the particles' gravity gradually attracts them together, slowly leading to a bigger and bigger pile of pebbles. This can eventually form a comet – or even an entire planet. Blum and his colleagues confirmed that 67P was almost certainly formed in this way.

However, this analysis doesn't solve the mystery of how 67P got its duck-like shape. "Whether the two lobes were once one body and then carved out to its current shape, or came together in a gentle collision by two individual bodies, we have no information about," says Blum.

Planets can be born in the same way, so by tracing comets like 67P back to the pebbles that made them, we can find out more about what kinds of material made Earth.



ESA/ROSETTA/NAVCAM

## Being underweight raises risk of early menopause

WOMEN who have been underweight are 30 per cent more likely to undergo menopause before the age of 45. That's according to an analysis of health data from nearly 79,000 women spanning 22 years.

Participants were classed as being underweight if they had a body mass index (BMI) of 18.5 or lower. Those who fell into this category at any age had, on average, a 30 per cent greater risk of early menopause compared with women with a "normal" BMI of between 18.5 and 22.4.

Women who were underweight at the age of 35 were 59 per cent more likely to experience early menopause, while this figure was 50 per cent for those aged 18 who had a BMI of less than 17.5 (*Human Reproduction*, doi.org/cfmd).

Extreme teenage weight loss seems to have a particularly strong effect. Underweight women who lost 9 kilograms or more at least three times between the ages of 18 and 20 were more than twice as likely to experience premature menopause.

"Our findings suggest that women who are underweight in early or mid-adulthood may be at increased risk for early menopause," says Kathleen Szegda at the University of Massachusetts, who led the study.

Early menopause affects up to 10 per cent of women, and is linked to increased risks of cardiovascular disease, osteoporosis and cognitive decline. "Underweight women may want to consider discussing the potential implications of these findings with their doctors," says Szegda.

## A 'coffee maker' for lab-grown plants

YOU may have heard of cultured meat, like the €300,000 lab-grown burger, but you probably haven't heard that scientists are trying to do the same for plants.

A growing global population, shrinking farmland and climate change will force us to find new ways to guarantee food supplies.

The VTT Technical Research Centre of Finland in Espoo is leading the charge to make cellular agriculture part of the solution. VTT researcher Lauri Reuter has developed a small bioreactor that looks a bit like the kind of pod coffee machine you might have in your kitchen. The difference is that this device cultures plant cells. Just pop in a pod of plant cells along with growth media, and wait for them to turn into jam-like food.

Reuter is culturing a range of plant cells, including those taken from herbs, strawberries and the Arctic bramble.

Removed from the context of helping the overall plant survive, the cells can become a lot more productive. "Such a cell line could produce say 10 times, 100 times, 1000 times more of those interesting compounds than the plant out there," says Reuter.

ZHANG PENG/GETTY

## Gaming addiction may not be real

PEOPLE who play games excessively might not be addicted so much as unhappy, according to a survey.

In the US, so-called internet gaming disorder is regarded as a possibility if someone fulfils at least five out of nine criteria, including lying about time spent gaming, jeopardising jobs through gaming and using gaming to relieve anxiety. They must also feel distress over their gaming habits over a long period.

Now Netta Weinstein at Cardiff University, UK, and her team have identified 2316 adults who regularly play games online, and asked them to fill in a questionnaire about their health and lifestyle. Initially, only nine participants met five or more criteria and experienced distress as a result of their gaming. However, no one still felt this distress six months later (*PeerJ*, doi.org/cfmg).

The survey showed that those who displayed some signs of gaming addiction had lower "needs fulfilment" – they were unhappy in areas of life such as relationships or their career. This suggests gaming might be a displacement activity for people in an unhappy situation rather than an addiction, says Weinstein.

# AQUILA makes bright sparks fly…

*From **lightning bolts** to **Frankenstein**, this month's issue of **AQUILA** magazine is all electric! Ideal for switched-on bright sparks aged 8-12 years, it has a great line-up of intelligent articles you will want to read yourself.*

**What's special about AQUILA?** AQUILA is not like any magazine you will find on the newsstand – it is more like a club for inquisitive kids. They will soon discover a community of other youngsters just like them – kind, creative and curious. Every issue is jam-packed with challenge and fun – readers can explore advanced concepts beyond the range of the school classroom and build strong foundations for their future education.

**What's inside?** AQUILA takes an in-depth look at a new topic every month; the editorial is both witty and intelligent, with the emphasis on mind-stretching fun. The topics are all written and researched by educational specialists, and the whole thing is beautifully put together with photos, diagrams and artwork by contemporary illustrators.

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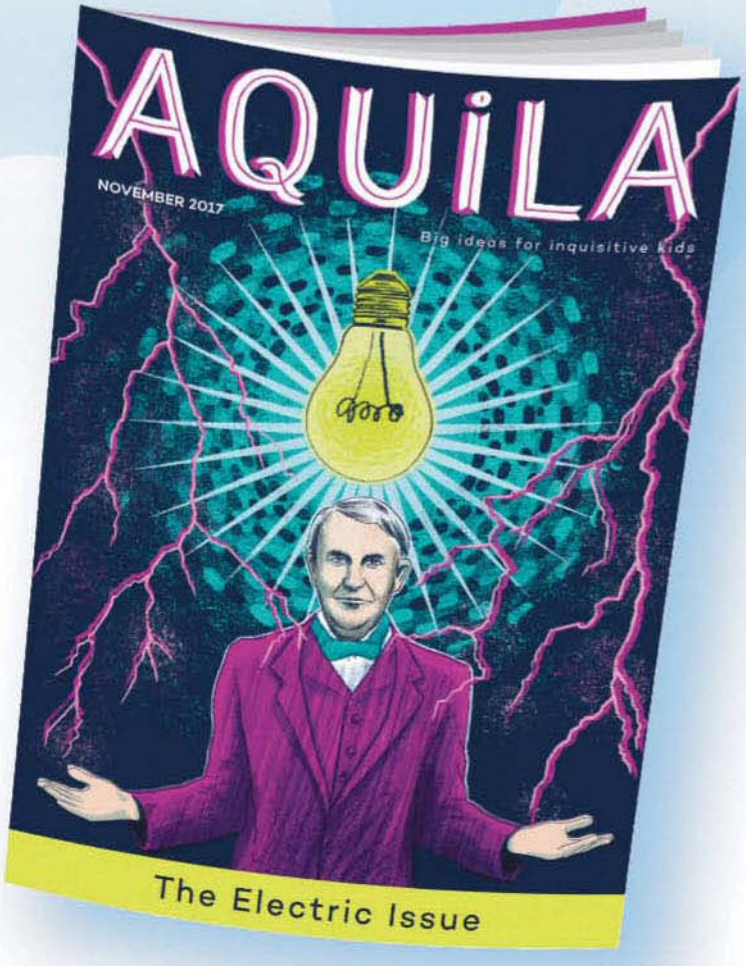


## November: The Electric Issue

**Can you tell your charged particles from your chemical reactions?** The story of Electricity is positively buzzing with big intellects and even bigger egos: so who came out tops when rivals **Edison** and **Tesla** engaged in their world-changing rivalry? **Shocking Species** – how do **eels**, **rays** and even **platypuses** use electricity to hunt down their prey? Read about **Mary Shelly's** creation, **Frankenstein** and make a **Motorised Thaumatrope** (batteries and copper wire not included!).

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NEW SCIENTIST

# Is life today bad for teens?

Headlines claim our teenagers are in the midst of a mental health crisis. The reality is far more complex, says **Clare Wilson**

IT'S a tough time to be a teen, with cyberbullying, exam stress and a selfie culture that piles on the pressure to always look good.

Perhaps it is little wonder newspaper headlines talk about a burgeoning crisis in our children's mental health. Self-harm and depression are reported to be soaring. A survey by the UK's National Union of Students found eight out of 10 people in higher education say they have had problems with mental health in the past year.

Similar fears are being voiced in other countries, including the US and Australia. This is surprising, considering that, by some measures, Western teenagers are living less turbulent lives than at any other time in history. They are less likely to take drugs and get drunk than they used to, and teen pregnancies have been falling for many decades.

So is there an underlying rise in rates of depression in teens? Or is something more subtle at play?

There are signs the rise is real, even if the size of the change is being overstated, says Simon Wessely, the past president of the UK's Royal College of Psychiatrists. "Clearly, something is happening," he says. "There is a change."

For instance, the UK's Adult Psychiatric Morbidity Survey, which uses an interview and questionnaire to clinically assess mental health and is repeated every few years, found that among 16 to 24-year-old females, depression and anxiety rose from 21 to 26 per cent between 2007 and 2014. Other studies have also shown a rise in problems among teen girls. This is undoubtedly cause for concern – but it is nowhere near the eight-in-10 numbers that make the headlines.

Indeed, not all the evidence points to a crisis. Among the under-30s, rates of suicide, which would seem to be an important measure of serious distress, have been stable since the 1990s, according to the UK's Office for National Statistics. This is telling, says Allen Frances, who helped write a previous version of US psychiatrists' main textbook, the *Diagnostic and Statistical Manual of Mental Disorders*. "Human nature is very stable. The way of measuring rates of mental disorder is remarkably unstable and subject to bias depending on the methods used."

**"It's important to distinguish between normal sadness and clinical depression"**

Still, there are other signs of an increase in problems. Teenagers seem to be self-harming more. The number of 13 to 16-year-olds seeing their doctor for this reason rose by nearly 70 per cent between 2011 and 2014, according to a UK study published last month.

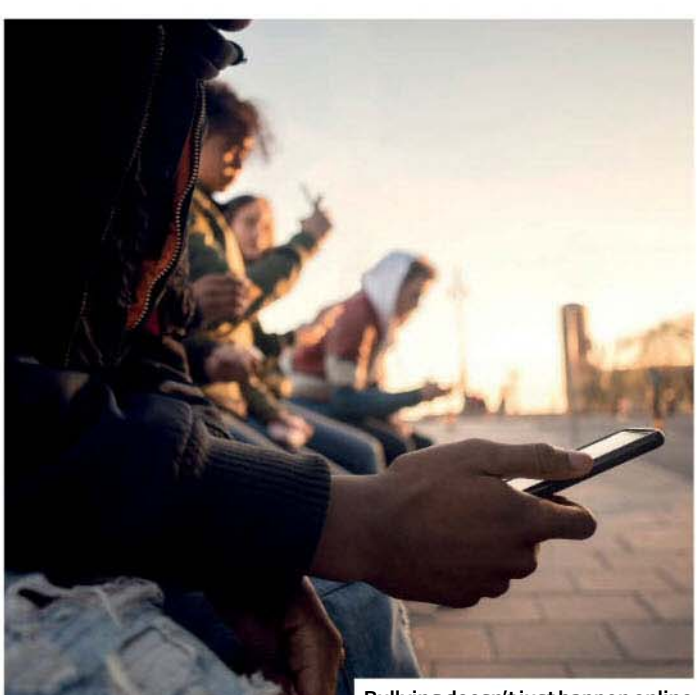
"We can't really explain this possible rapid increase in self-harm among girls," says Nav Kapur at the University of Manchester, UK, who led the work. It might reflect a real rise in psychological problems, but could also be due to better awareness or recording of self-harm, he says.

One frequently cited explanation for the uptick is constant exposure to social media and the cyberbullying this enables. For example, Jeremy Hunt, the UK's chief government minister for health, tweeted the self-harming figures with the reaction: "time for social media companies to ACT".

So is social media responsible? Cyberbullying is often painted as a uniquely dangerous threat. Yet this is contradicted by a recent study of over 100,000 English teens, which found there were more incidences of face-to-face bullying than internet abuse, and the former was much more detrimental to victims' happiness.

"[Social media] is a new channel but it's nothing different from traditional bullying," says Andrew Przybylski at the University of Oxford, who took part in the research. He thinks parents and teachers are more nervous of bullying involving social media simply because they didn't grow up with it – and that the dangers are exaggerated by firms selling cyberbullying training. "There has been a huge amount of hype," says co-author Lucy Bowes, also at the University of Oxford.

Further, even a rise in self-harming may not indicate a rise in distress. "There seems to be more self-harm happening, but it's not completely clear this is due to a greater level of underlying distress," says Max Davie, a paediatrician in London who treats children with this behaviour. "It may be becoming a more culturally acceptable way to show your distress."



PLAINPICTURE/MASKOT

Bullying doesn't just happen online

## Nuance needed

The same could be true for depression. People are now more likely to pay attention to negative emotions because of wider awareness of mental health issues due to public health campaigns, as well as celebrities speaking out about their own problems.

"People are probably a bit more aware of their negative feelings,"

JUSTIN PAGET/GETTY

Social media doesn't help

says Stephen Scott at King's College London. "There's much more emotional education in schools now."

But that doesn't ring true to Praveetha Patalay at the University of Liverpool, UK. The stigma around mental health still remains, she says, and "it's not reduced by much".

This disagreement is more than academic – it is crucial to understand why these figures are rising if we are to properly treat teen mental health, as exaggerating the problem could actually be making things worse. For example, getting schools to do mental health "check-ups" is a helpful-sounding proposal that has the potential for harm. There is no easy way to diagnose mental illness with a simple questionnaire – all such screening tools give a high rate of false positives. In other words, people are wrongly labelled as having depression or anxiety when they are in short-term distress. That can lead them to panic, and confuse short-lived feelings with conditions serious enough to warrant a diagnosis of depression or anxiety, says Scott. "It's important to distinguish between normal sadness and clinical depression."

Failing to do so carries a real risk, says Frances. "By putting the normal experience of being a teenager into mental illness terminology it reduces kids' resilience," he says. "They change from thinking 'this is part of life and I'm going to cope with it' to 'this is a mental illness and I'm going to need treatment for it'."

**"There is a real crisis in teenage mental health, and it is the lack of treatment available"**

Similarly, the mental health awareness campaigns often proposed to combat perceived problems can be surprisingly counter-productive, says Wessely. They can cause a run on already overstretched mental health services, for example.

One thing about teenage mental health is not disputed: clinical depression in the UK is certainly not being treated effectively. There is a real crisis in teenage mental health, and it is the lack of treatment for people with diagnosed problems.

The UK's National Health Service has undergone successive rounds of cuts since the global recession began a decade ago, and children's specialist mental health services are being stretched particularly thinly. Teenagers in acute need are having to wait weeks or even months before they get to see a psychiatrist. There are so few hospital places that they may have to stay in a clinic hundreds of kilometres from their home, cut off from family and friends.

## Long waiting times

In August, a judge warned the nation would have "blood on its hands" if the NHS continued to delay finding an inpatient bed for a 17-year-old girl who had tried to kill herself several times. After his intervention, a bed was found.

Just last week, the NHS watchdog released a report warning that children with mental health problems are waiting up to 18 months for treatment. "We should put our efforts into getting more resources, because if we put them into increasing awareness we just increase wait times and burn out our staff," says Wessely.

Newer interventions are being trialled in schools, such as training in mindfulness, resilience and anti-bullying programmes. But it is essential that any interventions are tested in randomised trials before being widely implemented. Given the widespread perception of crisis, it can be tempting for politicians to roll out new interventions before the evidence is in, says Scott.

Wessely agrees it is vital we don't act too hastily. "Something is changing. The first thing we should do is take a deep breath and find out what's going on," he says. "People say we can't afford to wait that long. I say we can't afford to not wait." ■

Need a listening ear? UK Samaritans: 116123 (samaritans.org). Visit bit.ly/SuicideHelplines for hotlines and websites for other countries.

# Bring on the machines

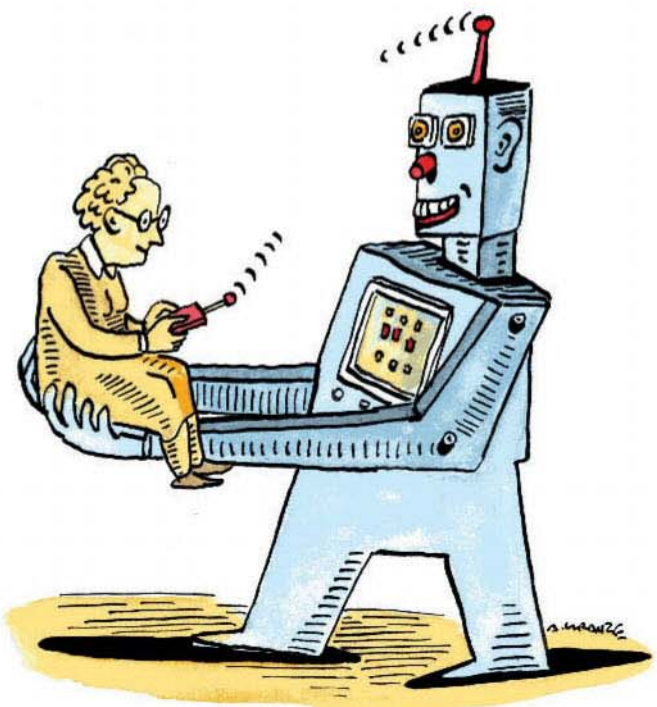
The use of care bots is controversial, but I would have welcomed robotic help for my elderly mother, says **Paul Kitcatt**

WOULD you let a robot care for an ageing parent? That question occurred to me while visiting my mother in a care home just before she died. It wasn't so much that the care she was getting from humans was bad, but it was inconsistent, and insufficient.

You can do all the mental exercises possible, but what really keeps the brain sharp is company – preferably intelligent and interesting. Care home staff can't offer enough of that because there are too few of them. It's not their fault. The cost of providing such attention, which might help keep dementia at bay, is too great.

This got me thinking about the use of robots in care homes, which prompted me to write a novel about the rise of this technology in such settings.

Japan has led on the use of care robots for years, often for social interaction. Now other countries



are catching on. Last week came news that Pepper, a companion robot from Japan, is being tried out in the UK. Capable of reacting to emotions, it is being deployed in a coastal area near London.

Reaction was mixed. Critics objected to spending money on Pepper on many grounds. One is that it is rather a basic robot. But look at the first mobile phones, and see how far they have come.

This technology will improve. Perhaps the next generation will offer basic medical care. After all, AI provides better diagnosis in some fields than human doctors, and surgeons accept that robots can outperform them at certain operations.

As I explored the idea of care robots, I looked even further forward, positing a human-like robot indistinguishable from us. This is where we are going. Pepper's descendants will be

# Switched off

UN climate events are a wasted opportunity for public engagement, says **Adam Corner**

THE 23rd meeting of the United Nations Framework Convention on Climate Change (COP23) is about to begin in Bonn, Germany. If this information fails to set your pulse racing, you're not alone.

Which is a problem, given that these are the blockbuster events dedicated to the issue. What's worse is that they may be creating a more relaxed attitude among the public towards taking action.

This was shown by a survey in Germany before, during and after the "historic" Paris UN conference in 2015. It found that rather than catalysing concern, citizens became less inclined to push for a leading role for Germany in climate politics. And despite reports on the summit reaching them, Germans were no more likely to want to cut their carbon use after the event. Researchers blame a lack of "context" in coverage, saying it often omits analysis of the wider meaning of such conferences. Germans may have assumed work on climate change was being taken care of, with no clear role for themselves.

This chimes with research I'm involved in at UK non-profit organisation Climate Outreach on the image the public gets of these UN events. Despite the many ways in which climate change affects us – health, homes, food, travel – coverage is very literal, dominated by anonymous negotiators inside the conference, or stage-managed protests outside. Such images don't resonate with most people. That requires showing "ordinary" people being affected by, or responding to, climate change.

**"Blockbuster UN climate events may create a more relaxed attitude when it comes to public action"**

There is a wider problem here. It is the assumption, held by campaigners and politicians, that massive, technocratic climate change events will automatically catalyse public engagement.

They won't. More than factual

convincing synthetic humans. Of course, that creates even bigger dilemmas. Could an AI brain have consciousness? What are the implications of an artificial intelligence superior to ours? Those questions need addressing, as getting it wrong may not end well for us.

For now though, the other big objection to the use of companion robots is that it is a misguided way to patch up a problem in modern societies: that at a personal level we fail to provide care to others, so are now delegating the job to AI.

There is truth in that. We should care more. Not just about the old, but also about each other, about life on Earth, about the planet.

On balance though, I can't help wondering why anyone would object to a practical solution to the difficulty of providing sufficient care. If a robot like Pepper can help, surely it is an improvement.

So to answer my opening question, I would have welcomed a robot to care for my mother, alongside humans. She loved modern life, tech and innovation, would have enjoyed meeting Pepper and would have made it her business to outwit it. ■

**Paul Kitcatt** is a writer based in London. His novel *We Care For You* (Unbound) is out on 14 November

detail on science or policies, it is our own values, and the views of those in our social networks, that shape how we think about this subject and what it means for us.

Politicians and campaigners must realise that we can't expect events like COP23 to communicate themselves. As the German study shows, grandstanding on the political stage may even backfire.

Because media coverage – and by extension public attention – is fleeting, the UN conferences are precious chances for engagement that must not be missed. ■

**Adam Corner** is research director at Climate Outreach



SCOTT SINKLIER/GETTY

**The evidence doesn't add up**

# Weedkiller ban won't lower any cancer risk

**Michael Le Page**

THE widely used weedkiller glyphosate is available in every garden store. But fears that it can cause cancer have so alarmed politicians in Europe that the European parliament has called for a ban.

The final decision rests with European Union member states, although a lack of consensus has delayed the vote on renewing glyphosate's licence. That is now due to take place later this month.

Let's hope they use that time to look at the evidence – or rather the lack of it. While banning glyphosate is unlikely to make people any healthier, it is certain to harm the environment. Can politicians who have fallen for the line of anti-glyphosate activists be swayed with facts?

First, let's examine the calls for a ban. Until recently, every regulatory agency that assessed the safety of glyphosate had concluded it poses no risk to health. In 2015, however, the International Agency for Research on Cancer (IARC) sparked concern by adding glyphosate to its list of things that "probably" cause cancers.

Before you run from the room screaming because you once ate some Ben & Jerry's ice cream – recently found to contain traces of glyphosate – you should know that red meat, wood fires, emissions from frying, shift work and drinking beverages hotter than 65°C are all on the same list.

The IARC's list of things that definitely cause cancers includes alcohol, sunshine, diesel exhaust fumes, processed meats, outdoor air pollution, salted fish, soot and wood dust. That's right, beer and bacon are more dangerous than glyphosate.

Much recent media coverage has featured uncritical interviews

**"Evidence that glyphosate is harmful is weak, whereas it certainly has environmental benefits"**

with the families of farmers who claim they got a cancer called non-Hodgkin's lymphoma because of exposure to glyphosate. But as heart-wrenching as these cases may be, they prove nothing.

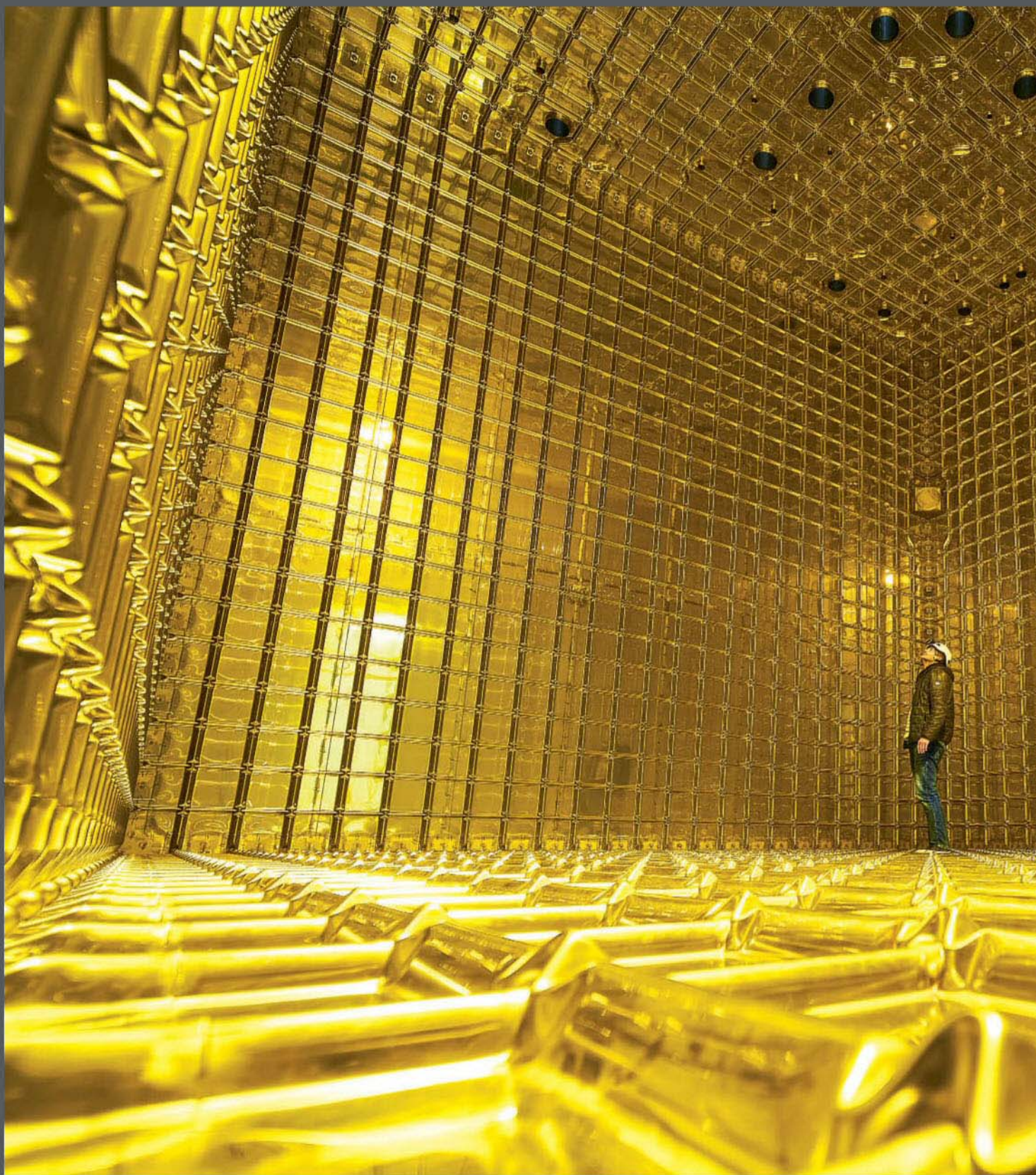
"The epidemiologic evidence does not support a causal relationship between glyphosate and non-Hodgkin's lymphoma or other cancers," says John Acquavella at Aarhus University, Denmark, who reviewed all the evidence following the IARC listing.

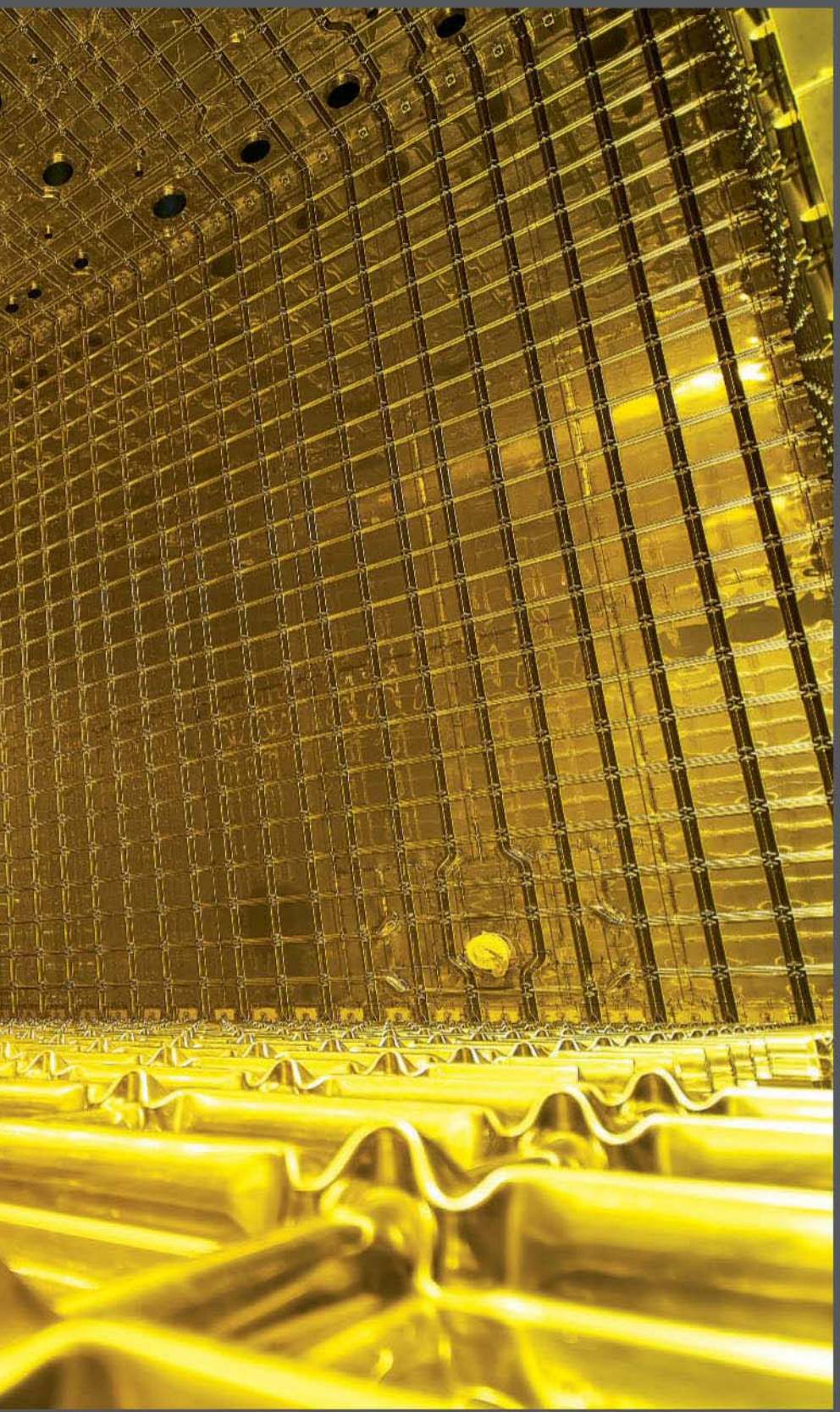
Indeed, many researchers think the IARC got it wrong. The facts just don't back the cancer claims: while glyphosate use surged in the US after the introduction of genetically modified crops in the 1990s, for instance, the incidence of non-Hodgkin's lymphoma has actually declined slightly since 2000.

So the evidence that glyphosate is harming our health is weak or non-existent. But it certainly has environmental benefits. It is now widely used around the world as part of "no till" farming: instead of ploughing fields to get rid of weeds, glyphosate is used to kill them. Not ploughing improves soils, reduces erosion and lowers carbon emissions from soils.

If farmers can't use glyphosate, they will either switch to more toxic – and more expensive – alternative herbicides, or resume ploughing. That means more damage to soils and wildlife, higher carbon emissions and higher food prices.

So while a ban might seem a great idea, it's not that simple – just as organic farming turns out to be worse for the environment despite everyone assuming it's better. The EU should not ban glyphosate without good reason. ■





## Gilded cage

NEUTRINO hunters are gearing up for open season. When it is complete, this 10-metre-tall golden room will be a neutrino detector, filled with about 800 tonnes of liquid argon. Its shining walls can expand and contract like an accordion based on the temperature of the argon, which will be kept at -184°C while the detector is running.

This experiment, called protoDUNE, is a 1/20th scale model of the planned DUNE neutrino detector, which will study how these elusive particles oscillate between different types, or "flavours", and investigate their masses. It will also search for new types of neutrinos beyond the three that we know of now.

In autumn 2018, two protoDUNE detectors will be placed along a beam of accelerated neutrinos at the CERN particle accelerator near Geneva, Switzerland. Researchers will then be able to examine how the high-energy neutrinos interact with the argon nuclei in the tanks. This will generate a huge amount of data, but the true purpose of protoDUNE is to test the technology and figure out whether it is better to use tanks containing only liquid argon, or ones with some argon gas as well.

The full-sized DUNE experiment is expected to start in the late 2020s. Leah Crane

**Photographer**
**Maximilien Brice**
CERN

# Before the beginning

*The very first living thing is still alive inside you, and can tell us how it all got started, finds Bob Holmes*

SOME 4 billion years ago, somewhere in the mass of inert minerals and molecules that made up our wet, rocky planet, dead became alive. This was the most important chemical transformation ever to happen on Earth. Not only did it give rise to all the living things that have ever existed, it also altered the chemistry of the oceans, the land and the atmosphere above. If it hadn't happened, there would be no blue marble.

That first chemical step towards life may be a lot closer than we thought. Buried within every cell of every organism on the planet, from bacteria to barnacles to Britons, is a living, working version of the earliest life on Earth – a time machine that allows us to peel away those 4 billion years of history and work out how it all began. "We can stop bullshitting about the origin of life," says Loren Williams, a biochemist at the Georgia Institute of Technology in Atlanta. "We can see it." What he and his colleagues are discovering is turning our view of life's origins on its head.

Until now, most efforts to understand how life began have attacked the problem from the bottom up. Broadly, they start with an experimental soup of primordial molecules and try to either recreate the building blocks of genes or get them to evolve key functions, like self-replication. Despite some promising results, these approaches can at best show a plausible path that life might have followed. They can never reveal what actually happened.

The new approach starts with modern life and works backwards. Formed of a tangle of proteins and a relative of DNA called RNA, ribosomes are molecular machines found inside every living cell. They do just one thing and do it well: they read the genetic code contained in DNA and use it to construct proteins. In essence, they are cellular robots that build the stuff that makes our cells tick.

Their task is so crucial to life that it works the same way in all organisms: your ribosomes differ from those of a lowly bacterium only in the ornamentation on their outer surface. That kind of uniformity suggests they date back to when life began. As evolution progressed, new species tacked extra bits of RNA to their ribosomes. The additions left identifiable traces, much as a branch sprouting from a tree leaves a visible mark in the wood. "Even if the branch is gone, you can look at the wood and say something grew out here," says Williams. Strip these sprouting branches off and you are left with a common core: the part of the ribosome that was functional at the time of the last universal common ancestor (LUCA) from which all known life is descended (see image, page 30).

In this way, by comparing the ribosomal RNA of living organisms, Williams and his ›

LEVENTE SZABO

## A DRY LITTLE POND

Researchers have long debated whether life originated in a warm little pond, as Darwin speculated, or in some other habitat like undersea hydrothermal vents, terrestrial hot springs or even clay sediments.

The ribosome may offer a clue to this puzzle. Its oldest part does a rough job of linking small molecules into longer chains. It achieves this through a dehydration reaction, in which the link is sealed through the release of a water molecule. Because this happens more easily under dry conditions, it suggests the early ribosome didn't ply its trade in the ocean, says Nicholas Hud at the Georgia Institute of Technology.

The most likely spot would be around the fringes of a temporary pond, where conditions would alternate between moist – favouring the mixing of ingredients – and dry, which would favour longer chains.

## CRACKED: THE CHICKEN AND THE EGG

Life as we know it today poses a chicken-and-egg problem: DNA can't replicate without proteins to do the work, but proteins can't exist without DNA to spell out their structure.

That dilemma is a big reason why researchers favour the idea that life began not with DNA but RNA, which can not only store information, but also fold into complex shapes that help it act as a catalyst. An RNA molecule that can catalyse its own replication would neatly solve the chicken-and-egg problem by combining both information and catalysis into one molecule. In this "RNA world" scenario, self-replicating RNA later outsourced its catalytic role to proteins, which are more versatile, and passed on its information-storage job to DNA, which is more stable.

Loren Williams and his colleagues at Georgia Tech offer a different solution. Neither proteins nor nucleic acids came first, they say. Instead, both evolved together from the very beginning.

The whole notion of an RNA world rings false to Williams because it requires life to abandon a working RNA-based system and reinvent itself in DNA and proteins, instead of tinkering to refine existing processes. "I just don't think evolution does those kinds of things," he says. "It would mean evolution is not a tinkerer, it's an engineer." The alternative – that RNA and proteins co-evolved – is more plausible, he says.

Not everyone agrees. "That is the minority report," says Niles Lehman, an evolutionary biochemist at Portland State University in Oregon. "But I think it is a growing minority."

team have been able to ride the ribosome back to LUCA's time, and beyond. Then, once they knew how to recognise the "insertion fingerprints" in the ribosome's modern decoration, the team looked at what RNA would already have been present in LUCA's ribosome. They found similar traces of insertions, pointing to ancient additions that must have taken place even before LUCA. Every time they found an addition, they snipped it away, pruning branches further and further into the past to reconstruct ever earlier, more primitive versions of the ribosome, all the way back to its beginnings.

The most ancient part of the ribosome, Williams and his colleagues found, is a stretch of RNA that includes the cradle-resembling

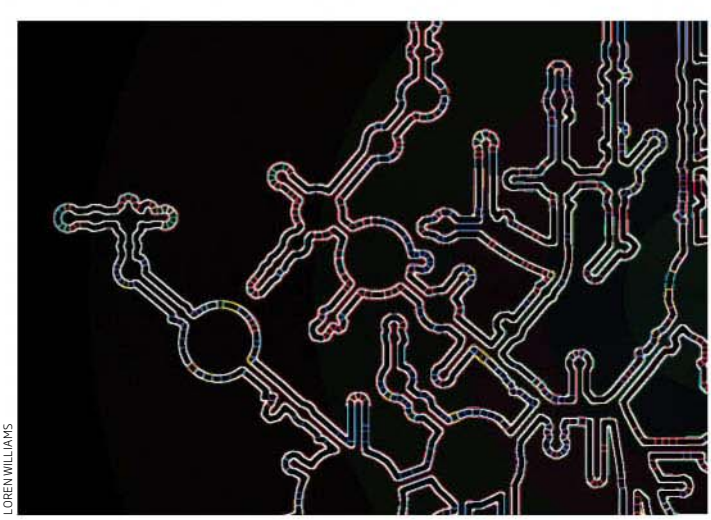
> **"This system may not have been truly alive, but it was starting on the path to life"**

region that today links amino acids to form protein-like chains. Other teams have used different methods to identify the earliest parts of the ribosome, such as simply peeling away layers, like an onion, to reveal the core. They agree that this cradle is the most ancient bit. "This is probably the best model we have of the history of the ribosome," says George Fox, an evolutionary biologist at the University of Houston, Texas.

Stripped of all its later refinements, this rudimentary ribosome had none of the precision it would achieve by the time of LUCA. It lacked the regions that read the genetic code, so it couldn't have produced specific proteins. Instead, it must have linked amino acids, and probably whatever other molecules would fit into its cradle, willy-nilly into short, random chains through a simple chemical reaction that points to a terrestrial origin of life (see "A dry little pond", page 28). As a result, early ribosomes would have made a mishmash of different molecules, says Williams. "We call them molecular sausage-makers." Other researchers have found supporting evidence: under the right conditions, even modern ribosomes can be tricked into linking molecules other than amino acids together.

On primordial Earth, as random fragments churned out of the sausage-maker, a few would have happened to take a shape that helped them stick to the ribosomal RNA. This would have stabilised them a little. "Those sequences that form more stable structures are going to last longer, so we're going to have those building up," says Nicholas Hud, a biochemist at Georgia Tech who collaborates with Williams. Gradually, these accretions built the ribosome into a larger and larger structure. "That's a form of evolution, and I haven't said anything about genes or information. I would call it chemical evolution," says Hud.

This mess of co-evolving RNA and protein fragments falls well short of what most researchers would call truly alive. The molecules may not even have been recognisably RNA or protein, but a range of similar proto-molecules that self-assembled more easily. But the whole system was starting down a path to life, as chemical evolution winnowed through the randomness and selected the components that clung most to one another.

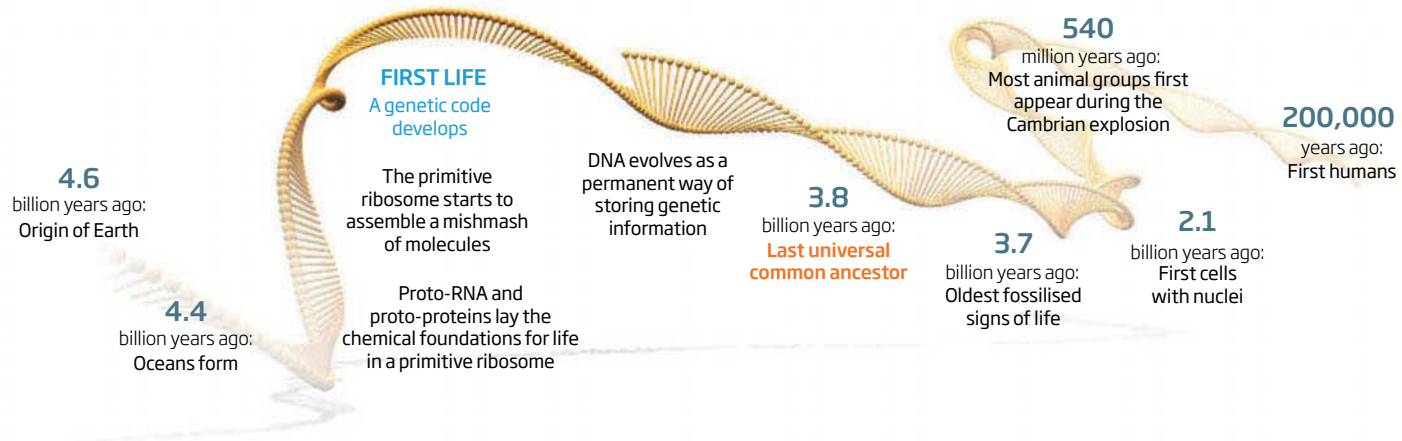


LOREN WILLIAMS

**These most ancient parts of the ribosome can tell us about how all of life on Earth was booted up**

# Before life's big bang

We can trace the tree of life back to the **last universal common ancestor** 3.8 billion years ago and even beyond the **first life** to when inert chemistry paved the way for biology. This is done by analysing the structure of molecular machines known as ribosomes that are found in all living cells today




Although some details remain murky, Williams has no doubt about one feature of this early stage: there was no genetic code and no precise replication of a genome until just before true life evolved. In modern cells, instructions from the central DNA library in the nucleus are shipped out to the ribosomes via messenger RNA. The ribosome binds these mRNA transcripts and reads them three letters at a time, with each triplet coding for one amino acid. The specified amino acid, in turn, is escorted to the ribosome by a transfer RNA, which has a matching sequence to the triplet.

Transfer RNA and mRNA are essential executors of the genetic code. Yet in all the reconstructions of pre-LUCA history, the parts of the ribosome that are responsible for binding them appear relatively late. Even then, Williams conjectures, the initial function of mRNA and tRNA was unlikely to be anything as sophisticated as triplet coding. Instead, they probably arose as little snippets of RNA that happened to help position random amino acids in the right orientation to attach to the growing protein molecule.

Today, the blueprint contained in the genetic code allows the ribosome to make exact copies of the same protein over and over again. But at this point in life's prehistory, the proto-ribosome had no way to read a genome and, thus, no use for one. Instead of exact copies, it would have made a range of new molecules, with the ones that helped stabilise the system sticking around.

Gradually, this process would have selected mRNA and tRNA that were better and more precise at their jobs, eventually leading to molecules that introduced specific amino acids at specific times – the genetic code that today is found in all living things. At last, Darwinian evolution had arrived, and the system finally reached the point at which it can truly be called alive. Most evolutionary biologists agree that RNA would have carried the genetic code first. DNA, a more stable molecule, came later (see "Before the beginning", above).

## Molecular snuggling

One of the key processes that RNA and proteins had to evolve as they became more refined was folding: modern proteins all contort into intricate three-dimensional shapes without which they do not function. How this arose is a bit of a mystery. Folding is an extremely rare property, and there are more potential protein chains than there are atoms in the universe. So it is inconceivable that evolution could have explored all possible proteins to find the few that fold, says Andrei Lupas of the Max Planck Institute for Developmental Biology in Germany.

Chemical evolution offers a solution to this problem. For a protein to fold well, one part of it has to snuggle tightly against another without intervening water molecules. That is also the feature that would have helped bits of proto-protein bind and stabilise proto-RNA. As these molecules co-evolved, they would have selected protein fragments that were predisposed to fold well, says Lupas.

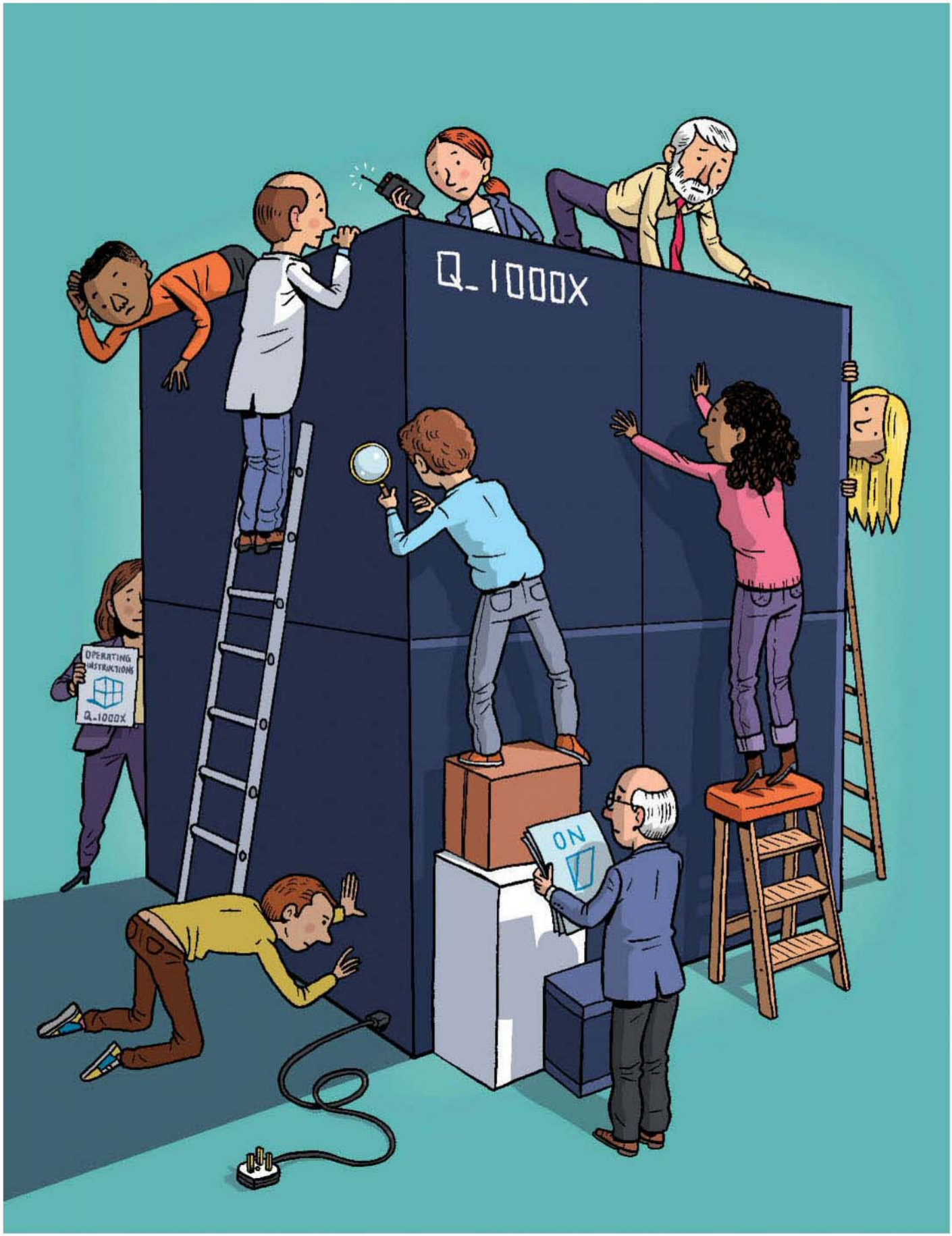
The ribosome still preserves a record of this process. The proteins associated with the oldest part of the ribosome show little or no complex folding. Moving to successively more recent parts of the ribosome, researchers observed proteins folding first into simple sheets and then into more and more precise and intricate shapes. At the same time, the RNA portions of the ribosome were also developing tighter and more stable folding. "The idea that protein and RNA co-evolved is mapped right there. We can see it," says Williams. His scenario offers a second way out of early life's "chicken and egg" paradox. It also represents a major departure from the dominant "RNA world" hypothesis (see "Cracked: the chicken and the egg", opposite).

Even Williams's critics welcome his ideas. "I think that Loren is championing a radical revision of the way we look at early life," says Niles Lehman at Portland State University in Oregon. "Even if you don't agree with all the details, it does help us rethink models of how life started, and that's a valuable contribution."

Williams says he's just getting started. His team is trying to recreate the stages of ribosomal evolution in the lab, so that they can test what each can do. So far, they have built the earliest proto-ribosomal core and are beginning to put it through its paces.

"The ribosome is nature's gift to us," he says. "It's a little time capsule, and we've just opened it up and are starting to look inside." ■

**Bob Holmes** is a consultant for *New Scientist* based in Edmonton, Canada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# The problem with the ultimate problem-solving machine

We're finally building quantum computers. Now to work out what to do with them, says Michael Brooks

REMEMBER when Apple launched the iPhone and you first heard people prattling on about things called apps? Back then, there were just a few hundred applications to choose from – a shortage that looked a lot like an opportunity and promptly gave rise to the newfangled job title of "app designer". These days you can select from more than 2 million iPhone apps – yet more proof of the device's runaway success.

Consider now quantum computers, those much-vaunted dream machines that would use the strange laws of quantum physics to make light work of the very hardest problems. They have long been among the most frustrating of all the world-changing technologies we've been promised: perpetually just around the corner. But in the last year or so something has changed. The industry giants racing to build such a machine quietly started recruiting app designers, which suggests the long quest to make good on the hype about quantum computers might have entered a new stage.

The fact that researchers at Google, IBM, Microsoft and a host of other organisations are even building prototypes shows how far we have come. What's truly exciting, though, is that by challenging a new generation of programmers to go quantum, they are now tackling a question that has largely been brushed under the carpet: when we build the ultimate problem-solving machine, what are we going to do with it?

SCOTT GARRETT

The quantum leap in computing has been a long time coming. It was first conceived in the 1980s, when theorists predicted that a computer based on quantum effects could vastly outperform classical computers at certain tasks. The trick would be to harness superposition, a quantum property that means particles can exist in several different configurations at once, and entanglement, which lets all the particles work together, to create "massively parallel" processing.

## Qubit by qubit

Whereas classical computers encode information as bits that can be in one of two states, 0 or 1, quantum bits, or qubits, can be simultaneously 0 and 1 thanks to superposition. With enough qubits linked together through entanglement, you should be able to do way more calculations at once, resulting in exponentially faster computing.

So far, though, that's just a theory. No one has ever built something capable of properly testing it. "Everyone is assuming that the power of a quantum computer arises from parallel processing," says John Martinis at the University of California, Santa Barbara. "It is crucial to actually check."

And that's exactly what everyone, including Martinis, is now hoping to do. Having worked on quantum computing for decades, he and his team had already made great strides using superconducting qubits – ultra-cold loops of superconducting metal with quantum properties. Then, in 2014, Google bought the lot, and its financial heft has further accelerated progress.

Earlier this year, Martinis announced that his group has been testing a 20-qubit processor. They are now putting the finishing touches to a 49-qubit version with which they plan to do something that no classical computer ever could. This milestone, known as "quantum supremacy", would finally prove the theory and give the field a fillip.

In June, Google said the big moment would arrive by the end of 2017, but now Martinis says it will be "some time into next year".

Whenever it happens, though, supremacy isn't everything. It's one thing to outdo regular computers at predicting the output of chaotic electronic circuits, which is Google's aim; it's quite another to do something practically useful. For that you need to wrangle an increasing number of qubits. This quickly gets devilishly tricky because the more qubits you have, the more difficult it is to stop their fragile quantum states from falling apart.

In practice, qubits are vulnerable to noise and other kinds of disturbance. Vibrations or thermal energy can snap the entanglement or the superposition. This introduces errors in the information they carry, which have to be corrected using networks of more qubits. So an information-carrying "logical qubit" ›

has to be made up from an array of error-correcting "physical qubits", which makes it meaningless to boast that you have a machine with 50 physical qubits if they are so noisy that they can only do computations suited to three logical qubits. "If we want one logical qubit, we need a 2D grid of physical qubits, and have to perform a bunch of measurements on them to keep track of all the errors that are happening," says James Wootton at the University of Basel, Switzerland.

This scaling-up problem looks particularly tricky for Google, according to Winfried Hensinger, who is building his own quantum processor at the University of Sussex, UK. Superconducting qubits have to be cooled to within a whisker of absolute zero, making the computer itself bulky and somewhat impractical in terms of building huge arrays of entangled qubits. "It's a nice approach to get to 100 qubits, but the thought of building a large-scale machine seems very challenging," he says.

Hensinger thinks his approach is more easily scalable. His qubits are charged atoms, or ions, held in magnetic traps, which operate at room temperature. The input and output happens via just a few microwave fields, no matter how many ions are involved in the computation. That means manipulating the qubits should be simple, even for a large number of qubits. His group is two years away from bringing everything together into a single prototype that will have somewhere between 10 and 50 qubits, he says.

Hensinger is not the only one pursuing a different approach. Chris Monroe's group at the University of Maryland is also working with trapped ions, and researchers at the University of South Wales in Sydney, Australia, have qubits made from atoms of phosphorus embedded in a silicon lattice. According to Michelle Simmons, who leads the research, these have the advantage of remaining error-free a million times longer than has been achieved with superconducting qubits. "The noise in our device is incredibly low," she says.

What's more, the semiconductor industry is so used to working with silicon that scaling up production will be much easier than with other technologies, says Simmons. "We believe that if you can build a quantum computer, this is the best way to do it."

Then there's the wild card, an exotic approach to quantum computing that would pretty much sidestep the scaling and error correction obstacles – although some say it's wishful thinking. Researchers at Microsoft's Station Q laboratory in California are building topological qubits based on the properties of particles called non-abelian anyons, which can encode quantum information in the intricate way they move past one another. Microsoft has recently employed Leo Kouwenhoven from the University of Delft in the Netherlands, the first person to claim to have created them. However, not everyone is convinced that Kouwenhoven has really made topological qubits – and some doubt they can ever actually exist.

IBM Q

**"A wild card approach sidesteps the problem, but might be wishful thinking"**

Even so, the topological quantum computer is worth pursuing, says Station Q's Todd Holmdahl. The anyons' quantum states are fixed by their relative trajectories in the past, he says, and therefore not held in properties like spin or charge, which can easily be disturbed. This means the architecture is relatively error-resistant and resilient to external influence. "You're doing all your error correction down at the hardware," he says. That also means fewer qubits are necessary to achieve useful quantum information processing.

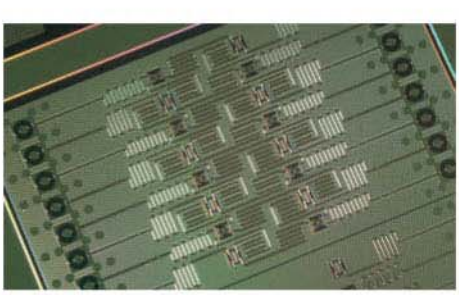
Although Holmdahl is happy to admit that his group is bringing up the rear for now, he expects a surge towards the finish line just as his rivals are flagging. "There are people running the marathon already, but they're all wearing army boots or hip waders," he says. "We're still sitting there putting on our running shoes, but once we've got them on, we're going to go much faster."

So who should you put your money on? "The truth is, we don't really know yet," says Scott Aaronson of The University of Texas, Austin. "One approach could pull ahead of everyone else, or multiple approaches could succeed, or it could even require a hybrid of multiple approaches to get all the way there."

However it pans out, the front runners are increasingly confident. "Given the momentum we have, and how many smart people want to get involved, we are poised to do something amazing," says Jerry Chow, who leads IBM's quantum computing venture.

What, exactly, is not at all clear. And herein lies the problem with quantum computers: we don't know what to do with them.

For starters, killer apps are not as abundant as you might assume. Physicists have known for decades that quantum computers could solve particular kinds of problems: optimisation, which involves finding the lowest or highest point in a landscape of possibilities, is one. But it's not revolutionary; just a little bit better than what we can do with classical machines. Another is "backwards



IBM RESEARCH

**IBM's quantum computing lab (top) has made its 16-qubit chip available to programmers**

IBM RESEARCH

**Ultra-cold loops of superconducting metal are at the heart of most quantum computers**

search", where a huge, unsorted database can be searched faster than is possible with a classical computer. Then there is the factorisation of large numbers (see "Quantum codebreakers", below), but even this requires a huge number of qubits to do significantly better than a classical computer. In effect, these are solutions looking for an application. To fulfil the immense potential of quantum computers, what we need now is applications requiring a quantum solution.

We do have ideas. Simulating other quantum objects, such as a chemical molecules, was one of the first suggestions. The hope is that drug discovery will eventually be radically accelerated by quantum processors. IBM's seven qubit quantum processor – which is also based on superconducting loops – was able to calculate the lowest energy state of a three-atom molecule, beryllium hydride ($BeH_2$) – a key step towards understanding the full range of reactions the molecule will undergo. This is not a breakthrough in the quantum supremacy vein; the same calculation can be done on a classical machine. But it is a step towards much bigger calculations when more qubits become available.

IBM has also made progress towards quantum versions of machine learning. This field, which lies at the heart of artificial intelligence, relies on identifying patterns in vast piles of data. The team has shown that quantum processors are potentially much better than classical ones when searching for patterns in noisy data.

But the truth is that many uses lie beyond our puny imaginations. "I think we are only beginning to scratch the surface of possible applications," says Joe Fitzsimmons, a quantum programmer at Singapore University of Technology and Design.

And even with a series of problems ripe for the quantum-treatment in hand, there is something missing: operating instructions. Algorithms are sets of operations performed to solve a problem. We have all manner of them for ordinary, classical computers. But quantum computers work in fundamentally different ways, so we need new algorithms if we want to take advantage of the massively parallel processing they make possible.

**"The people leading the race are wearing army boots or hip waders"**

As things stand, there are precious few useful ones. In fact, we are roughly where programming for classical computers was in the 1950s: you have to understand what the processor hardware is actually doing – physically – to manipulate the qubits, and so you have to talk to them in the quantum version of the 1s and 0s that we feed to regular computers. "It's extremely difficult at the moment," Fitzsimmons says.

The big guns are aware of the problem. But real progress will depend on making these new devices accessible and appealing to people with no quantum experience. It's something that Wootton is pursuing, especially now IBM has made its five-qubit computer accessible. "You can play with real quantum computers now," he says.

In 2011, Wootton designed a quantum algorithm to simulate the behaviour of the exotic anyons that Microsoft hopes to put to work. He has since implemented it with real qubits, and now he is exploring algorithms that can be implemented with IBM's latest 16-qubit device.

The experience has made him an evangelist for the joy of quantum programming, and he is actively recruiting people to the cause because he believes the killer ideas will not come from insiders. "We're used to thinking in a certain way, and people now accessing the field are not thinking that same way," says Wootton. "When the right people get interested we'll see some great things happening on these devices."

What are quantum computers good for? That might be up to you. ■

Michael Brooks is a consultant for *New Scientist*

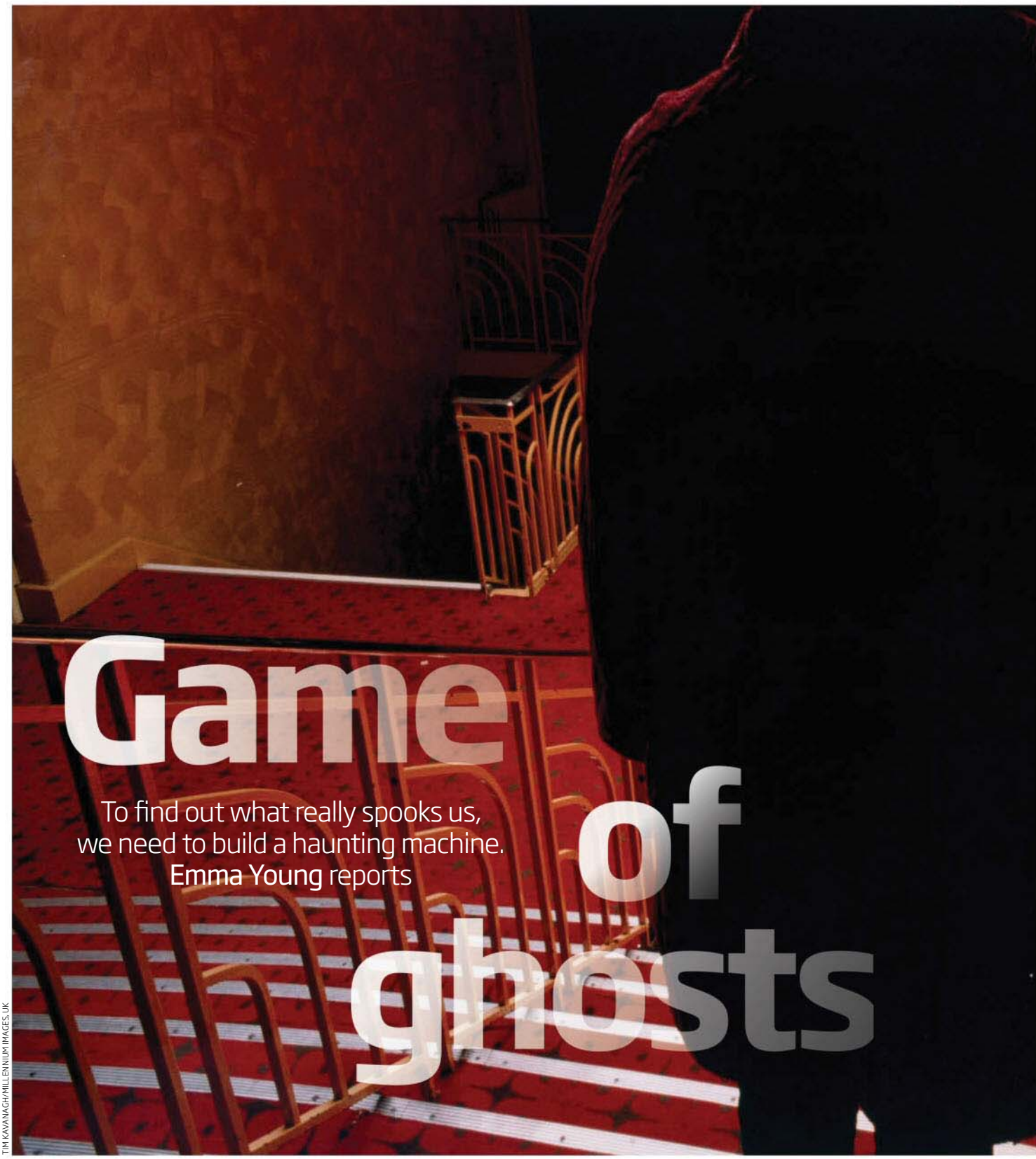
## QUANTUM CODEBREAKERS

In 2016, after decades of watching and waiting, the US National Security Agency finally decided that quantum computing is a serious threat. That's because quantum processors have the potential to render all our tricks for protecting online transactions, securing financial systems and email encryption as useful as a chocolate strongbox.

The cryptographic codes behind these systems are based on a mathematical oddity: that there is no known algorithm for efficiently finding the prime factors of a large number. Factors are smaller numbers that multiply together to make a larger one. All you can do is try various combinations, one by one.

But there is an algorithm for a quantum computer that could. Peter Shor concocted one in 1994 that could efficiently find factors of large numbers. That's not an immediate problem, because the Shor algorithm requires hundreds, if not thousands, of qubits to be any use – and current machines only have a handful at best (see main story). But there is no room for complacency.

"NSA does not know if or when a quantum computer of sufficient size to exploit public key cryptography will exist," said the recent NSA document, issued to encourage businesses to consider quantum cryptography.



# Game of ghosts

To find out what really spooks us, we need to build a haunting machine. **Emma Young** reports

TIM KAVANAGH/MILLENNIUM IMAGES, UK

I'M WANDERING the corridors of a derelict hospital. The place was abandoned following the mysterious disappearances of a woman in a coma, then several other patients. Strange noises have been reported coming from inside. Nobody knows what's going on. It's pretty spooky in here – dimly lit, with peeling paint and rusty doors. I screw up the courage to open one of them and – BAM! – a bloodied zombie girl leaps out at me. My heart starts racing.

That zombie gets everyone, says Connor Lloyd at Buckinghamshire New University, UK. He should know. He designed the game and has all his players wired up so he can monitor their heart rate, breathing and sweating to find out what scares players. "I'm interested in how games affect people's minds," he says. But when Ciarán O'Keeffe, head of psychology at the university, came across the game, he realised it could do much more. O'Keeffe is now adapting it to study ghosts.

Rationalists may scoff, but it's only human to feel haunted. Many more people believe in ghosts and claim to have encountered one than you might suppose (see "Anyone for ghosts?", page 38). "I think it's quite arrogant of us to ignore these experiences and to say they're all deluded," says O'Keeffe, who is one of only a handful of researchers studying ghost sightings and supposedly haunted locations. Of course, he doesn't believe ghosts are real. What he wants to know is why we get spooked. Over the years, researchers have singled out various physical, psychological and environmental factors. But debate continues about which ones are actually involved, how they create ghostly experiences and why some of us are more affected than others. An immersive game could be the best way to find answers.

## Ghost in the machine

For a start, it could help assess one of the oldest ideas about what causes paranormal experiences. In the early 1900s, British radio pioneer Oliver Lodge linked physical vibrations to reports of psychic phenomena. Others have since pointed the finger specifically at infrasound – sounds below the normal limit of human hearing – and electromagnetic fields. In 1998, Vic Tandy at Coventry University, UK, found evidence of a link between infrasound at around 19 hertz and specific physiological sensations, such as shivering, and sensing a presence. But other studies have been inconclusive.

One particularly elaborate effort was carried out in 2009 by a team at Goldsmiths, ›

## ANYONE FOR GHOSTS?

Between 30 and 40 per cent of people in the UK and US believe in ghosts. In the US, 18 per cent claim to have seen or felt an apparition. Unsurprisingly perhaps, people who score higher on the Fantasy Prone Personality scale are more likely to believe in ghosts. The trait of neuroticism has also been linked to belief. So has extroversion, although extroverts may simply be happier to express their beliefs.

The number of people who admit to believing in ghosts has certainly risen in recent decades. A Gallup poll in the 1950s found that just 10 per cent of people in the UK were believers, and 2 per cent reported having seen an apparition. Owen Davies at the University of Hertfordshire, UK, and author of *The Haunted: A social history of ghosts*, says that an interest in alternative ideas in the 1970s and then the rash of ghost-hunting TV shows have both helped make belief in ghosts more acceptable.

There has also been a change in people's conception of what a ghost is. "If I'd been able to do a vox pop 100 years ago, they'd have said the souls of the dead," Davies says. "Now, most have a vague notion of it being some sort of visual expression of the dead person – perhaps electrical impulses left behind in the atmosphere."

ANDRE THIJSSEN/MILLENNIUM IMAGES, UK

University of London, who built a room to investigate environmental factors linked to ghostly encounters. Participants in the Haunt project reported plenty of "anomalous" sensations, ranging from tingling and sadness to sensing a presence, terror and even sexual arousal. However, there were no peaks in these effects close to planted sources of infrasound, and they were just as common when the infrasound was off as when it was on. The project also investigated the idea that ghost sightings might be connected with certain electromagnetic fields known to influence brain activity in a way similar to transcranial magnetic stimulation, and that are thought to induce hallucinations. Again, there was no association between reports of odd sensations and the fields being on or off.

## Chill factors

The case for electromagnetic fields is less compelling, but O'Keeffe suspects infrasound does have a role in experiences of haunting. He and others have questioned the Goldsmiths team's findings, pointing out that the researchers didn't measure background vibrations. Infrasound at around 19 hertz can come from a range of sources, he says, such as air-conditioning ducts, heavy traffic, planes and thunder, and it can travel long distances.

Context is crucial, though. For hundreds of years, church organs were built with infrasonic pipes, O'Keeffe notes, and among believers infrasound might heighten feelings of awe and being in the presence of God. In a building reputed to be haunted, for those who believe in ghosts, infrasound might boost the sensation of being in the presence of a spirit. O'Keeffe's fieldwork supports this idea. "What we've found over the course of the last decade, looking at infrasound levels in haunted locations, is that it acts as an exacerbator of already existing experiences."

O'Keeffe has had an unrivalled opportunity to do this research. As a result of appearances on TV ghost-hunting programmes – including serving as resident parapsychologist on *Most Haunted* between 2004 and 2010 – he has had access to locations normally closed to academic scrutiny. That has helped him build a picture of the factors that come together to make a place feel haunted. "I did quite a bit of survey work then, to look for commonalities in environmental variables," he says. He found, for example, that dim lighting and being underground will almost guarantee that at least one person will feel a place is haunted. Other factors associated with spookiness include large spaces and a high contrast between exterior and interior light levels.

A drop in temperature also often crops up in reports of ghostly encounters. That may come from something as prosaic as a breeze, but there's another simple explanation, says O'Keeffe. When the brain's amygdala detects a threat, adrenaline is released. This hormone directs blood flow away from the skin towards the muscles, to assist with the fight-or-flight response, and the switch can make an individual feel cold. Someone who believes in ghosts and is convinced they are in a haunted location is more likely to have this response. And because a temperature drop is now so ingrained in stories about ghost encounters, people are primed to interpret coldness as a sign of being in the presence of something supernatural, O'Keeffe says.

A virtual reality game linked to physiological sensors could provide a systematic way to assess how environmental factors such as vibrations, physical settings and chills interact to generate ghostly feelings. It could also be used to test the power of suggestion. As the temperature effect indicates, you are more likely to be spooked if you believe in the paranormal. And Christopher French, who led the Haunt project, has evidence that believers are highly suggestible. He and his colleague Krissy Wilson found that believers would often disregard the evidence of their own eyes if another person claimed to have witnessed a paranormal event.

But even a non-believer can have a supernatural experience if the circumstances

**"The misinterpretation of sensory information can have strange effects"**

are right. O'Keeffe notes that many ghostly encounters happen at night, when people are tired and wired from being in a supposedly haunted place. He suspects that high levels of caffeine often play a role too, by affecting our judgement and decision-making. A mix of stress and exhaustion can certainly induce hallucinations, including sensing a presence. Mountaineer Reinhold Messner, for example, was sure that a third man, who he couldn't quite see, accompanied him and his brother on their descent from Nanga Parbat in Pakistan. What's going on here?

Some clues come from neurological patients who report feeling someone is there when no one is actually present. Olaf Blanke at the Swiss Federal Institute of Technology in

MEDIADRUMWORLD / BARCROFT IMAGES

**An unexpected breeze (bottom left) or a certain kind of light can make a place feel haunted**

Lausanne and colleagues examined some of them, and traced their experiences to lesions in parts of the brain involved in sensorimotor control: the processing of signals from touch, body movement and proprioception, or how we sense the location of our body parts in space. In particular, damage in any one of three brain areas resulted in the misperception of "self" as "other".

The team then used these insights to generate a feeling of a presence in people without neurological damage, using a "master-slave" robotic system. Blindfolded participants were connected to a master robot by their right fingertip, so the device matched their arm movements. These movements were relayed to a slave robot, which touched their backs while the master simultaneously simulated the sensation of touch in the fingertip. Despite the impossibility, it felt like they were touching themselves. When the researchers introduced a time lag, the volunteers reported feeling there was someone else behind them, and even being touched by "ghostly fingers". The experience was so intense that some had to stop.

"Our study shows that the brain has multiple representations of our own body," says Blanke. "Normally, these are successfully integrated, giving us a unitary experience of our body and self. However, when the brain network is damaged, a second representation of our body – different from our physical body – may arise, which is not experienced as 'me' or 'I', but rather as the presence of another human being." He notes that at high altitudes, a lack of oxygen could affect the temporoparietal junction, one brain region his team identified as playing a role in sensing a presence. Physical exhaustion could do so too. "Due to its direct link with sensorimotor processing, it could impact the brain regions we described," says Blanke.

## Seeing in the dark

His team isn't alone in finding that the misinterpretation of sensory information can have strange effects. Researchers at the University of Rochester in New York fitted people with helmets containing an eye-tracking camera. They then told them to wave a hand in front of their face – like an upside-down pendulum – and follow the motion with their eyes. Of course, the volunteers could do this easily in a well-lit room. But in total darkness, about half of them also claimed to be able to see their hand – albeit dim and blurry. The camera indicated that they were tracking its motion pretty well.

"Seeing in total darkness? According to the current understanding of vision, that just doesn't happen," says Duje Tadin, one of the researchers. "What we reported in our study was really a blending of the senses." People were using information from feeling the movement of their arm to create this illusion. Some volunteers had synaesthesia – a classic blending of the senses – and they were particularly good at "seeing" in the dark. But they weren't the only ones who could do it, and other studies indicate that many of us can combine information from different senses in the way people with synaesthesia do.

Could this kind of effect help explain ghost sightings, which often occur at night? "I'd say yes," says Tadin. The experiment has certainly piqued O'Keeffe's curiosity. He is especially interested in the finding that when people claimed to see their hand in the dark, their eyes smoothly tracked its movements, just as they did in the light. However, the eyes of people who said they couldn't see their hand in darkness made tiny jerks as they moved. "I see the application of this as a kind of lie detector for mediums", says O'Keeffe, who often claim to see spirits moving around in the dark. It could be a way of distinguishing those who may be seeing something – even if it's just a hallucination – from fraudsters.

In February, O'Keeffe started taking a smaller, lighter version of the eye-tracker used by the Rochester team to "haunted" locations including Gloucester prison and Field Place, an 18th-century house in Worthing. "I've done three locations in the field with about 20 people, including a couple of mediums," he says. The unpublished pilot study at Field Place found jerky eye movements in two people who reported seeing a spirit moving, suggesting that they weren't genuinely tracking something.

O'Keeffe is also exploring ways to adapt Lloyd's game to his own ends. It is played on a monitor, but O'Keeffe wants to create a fully immersive 3D experiment. In his lab, he has a VR setup that includes a headset as well as two controllers to generate virtual hands. Once these are linked up to a version of Lloyd's haunted hospital, the next challenge will be to find ways to test how different factors combine to generate spooky sensations. "The idea is we'll hook people up to the physiological sensors and we'll explore how varied the experiences are if you add infrasound, or a small amount of caffeine – or do people get fearful because there's an open door?" With a little ingenuity, he may even find ways to trick people's sensory perception. And with VR, he will be able to do all these tests in a controlled environment on many more people than he can study in the field.

It's a way off yet. But if O'Keeffe succeeds, he will have created the world's first haunting machine. I suspect I won't be the only one keen to try it out. ■

Emma Young is a writer based in Sheffield, UK

# The financier who bought all of nature

Meet **Lionel Rothschild**, a useless banker who spent a mountain of cash creating an unparalleled natural history collection – then blew it spectacularly

A PORTLY man in a bowler hat rides a carriage down the grimy streets of London. Pulling the carriage are six zebras, their black-and-white markings clearly visible through the London pea-soup fog. It's 1898, and he is on his way to Buckingham Palace to prove to the perpetually not-amused Queen Victoria that zebras can be tamed just like horses. Nevertheless, he watches with ill-suppressed panic as Princess Alexandra reaches out to pet the lead zebra, or so the story goes.

It sounds a little crazy, but when you're as wealthy as Lionel Walter Rothschild, the second Baron de Rothschild and an heir to the Rothschild & Sons banking empire, you get an automatic upgrade to "eccentric".

And that extended to his looks. With small feet and – particularly in his later years – great roundness, Rothschild looked, some said, like a grand piano on castors. A decade earlier, crippled by shyness and uninterested in accumulating money, he had no desire to enter the family business. Instead, he was obsessed with nature. Even so, in 1889, at the age of 21, he went to London to begin working for the family firm. But he hated it, and was distracted by his expanding natural history collection – more enchanted by the idea of a rare butterfly from Peru, or an undescribed flea. So after a few years, his father did what any sympathetic parent keen to indulge their child's hobby would do: he built his boy a zoological museum at the family pile in Tring, about 50 kilometres from London.

When Lionel retired from banking in 1908, he was free to devote himself – and his mountain of cash – to collecting. He retreated to the museum, already the largest privately owned natural history collection in the world.

Rothschild collected biological specimens from far and wide in an era when exotic travel was a difficult, costly and dangerous job; one the timid baron was happy to outsource. He sent scientists to all corners of the world, some of them renowned experts, such as entomologist Karl Jordan and ornithologist Ernst Hartert. In 1928, Rothschild sent 24-year-old Ernst Mayr – later a superstar evolutionary biologist – on his first expedition. In search of birds of paradise, Mayr was sent to New Guinea, an island populated by cannibal tribes. Sometimes, walking into mountain villages, Mayr was the first white person the locals had ever seen.

## Death in paradise

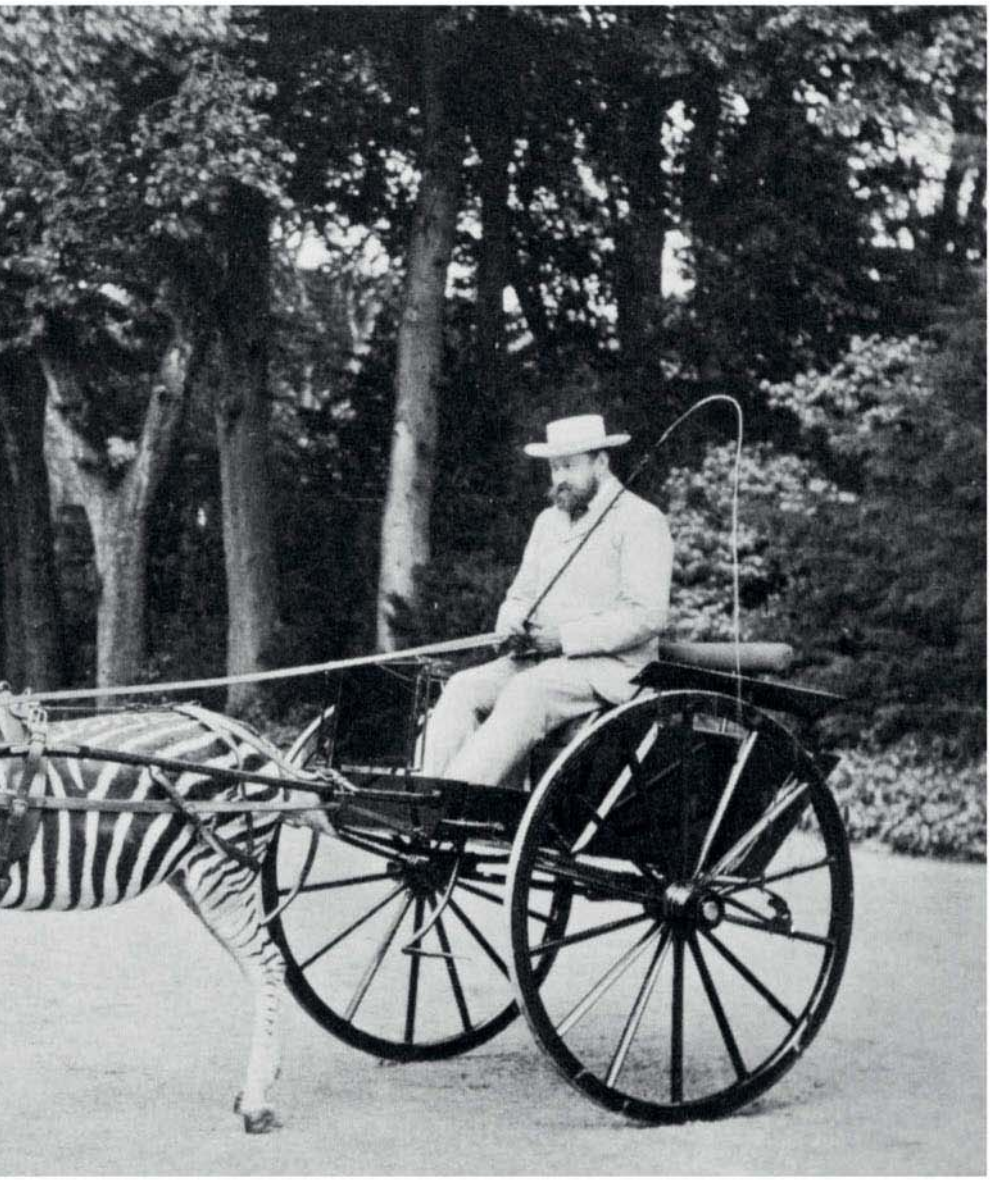
Mayr survived, but many of Rothschild's collectors did not. Entomologist William Doherty died of dysentery in Nairobi in 1901; George Ockenden was lost to typhoid in 1906 in the Peruvian Andes. Ornithologist Noël van Someren was killed by a charging buffalo in 1921. In India, a leopard bit Stuart Baker's left arm off. Some collectors simply disappeared. "Collecting in the tropics is a risky business," wrote Rothschild's niece Miriam, dryly.

Rothschild himself made just one long-haul collecting trip, a six-month expedition to North Africa and the Sahara in 1913. "Great numbers of moths were caught on most of the evenings with acetylene lamps," he wrote, "sometimes many hundreds within 3 hours."

Rothschild's appetite for specimens was rapacious. The collection quickly became vast. It included more than 300,000 bird skins and 200,000 bird eggs. He had around 300,000 beetles, arranged in drawers and display boxes and stacked on chairs, in rooms and outhouses. His Lepidoptera holdings were almost as large as the entire butterfly collection at what was then the British Museum in London: more than 2 million pinned butterflies and moths representing more than 100,000 species. He had exotic mammals from New Guinea, gorillas from Africa, reptiles from India and the Galapagos Islands. Amphibians. Fish. The entire natural world was represented.

He kept a living menagerie too. He was obsessed with cassowaries, and owned a flock of more than 60. Kangaroos and ostriches roamed his estate. Pangolins clung to the trees. And 144 giant tortoises trundled across the manicured lawns. Rothschild – in top hat, with his handlebar moustache elaborately waxed – was photographed riding one, dangling a lettuce leaf in front of its mouth to entice it to move. He also introduced the edible dormouse (*Glis glis*) to the UK, some of which made their escape: the British population is still at its highest in the countryside around Tring.

A collection like Rothschild's was more than



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**If you think this is cool, my other carriage has a six-zebra engine**

just an eccentric's folly. It was a key scientific resource, boosting our understanding of Earth's biodiversity. In the years following the publication of Darwin's *On the Origin of Species*, it became a vital tool for probing evolution and speciation. In 1862, after studying the

**"Rothschild rode a giant tortoise, dangling a lettuce leaf in front of it"**

structure of a species of Madagascan orchid, Darwin deduced that there must be a species of moth with an incredible 28-centimetre-long proboscis that lived where the orchid grew. It would be the plant's only means of pollination. In 1903, Rothschild and his insect curator Karl Jordan found the moth: *Xanthopan morganii praedicta*.

In time, Rothschild grew scientifically influential. Along with his collaborators, he named thousands of new species. Other people named more than a hundred after him. Many of the specimens in his collection were holotypes – the single specimens used as representatives to describe entire species.

For 40 years, Rothschild ran his natural history empire from Tring. Eventually, though, all empires collapse. And in time, Rothschild's crumbled too.

In 1931, he found himself in a tricky spot. Apparently, his shyness hadn't extended to the ladies. For decades, he had been juggling relationships with at least three mistresses. For two of them he bought houses and paid monthly stipends. But a third woman, identity unknown, blackmailed Rothschild. He agreed to the terms, but needed a chunk of cash, fast.

Looming ruin was an unfamiliar situation. The museum and his mistresses had taken a huge toll on his finances, and his extended family was in no mood to bail him out. So he decided to sell his most valuable asset – his superlatively stocked, irreplaceable collection of bird skins – to the American Museum of Natural History in New York. It went for $225,000, perhaps a tenth of its true value. Rothschild stipulated that he needed $25,000 immediately. And with that, his bird collection was gone. The unique, brightly coloured specimens that some had given their lives to accumulate left Tring forever.

Rothschild's birds had defined him. Their loss must have broken him. One by one, the other animals died at Tring – the pangolins, ostriches and wolves. Cassowaries from the flock were stuffed and mounted as each bird died.

Then, in 1937, Rothschild died too. He was not stuffed and mounted. Like the zebras walking through the fog at Piccadilly Circus, Rothschild was gone, but not quite forgotten. Thankfully, the collections of this eccentric banker were too big to fail, and they continue to pay cultural and scientific dividends. His bird collection remains in New York, the butterflies and beetles, along with the mammals and a few remaining bird skins, became part of the Natural History Museum collection in London. The museum at Tring still houses a key part of his collection and, like Rothschild, bulges with Victorian charm. ■

Christopher Kemp's new book is *The Lost Species: Great expeditions in the collections of natural history museums* (University of Chicago Press)

# All together now

Our social networks are deluging us with data; surely we can do more than simply make a profit from it, asks **Pat Kane**

*Out of the Wreckage: A new politics for an age of crisis* by George Monbiot, Verso;
*Assembly* by Michael Hardt and Antonio Negri, Oxford University Press;
*Technically Together: Reconstructing community in a networked world* by Taylor Dotson, MIT Press

AS POLITICAL, economic and environmental controversies bubble and fizz around us, we cannot fail to know what our power elites think; their pronouncements and solutions are given free rein in the mainstream media. Yet what about the response "from below" – that is, from activists and communities?

People may ask this question out of social concern, seeking representation for the under-represented. Or they may see those people as a source of fresh data. A better understanding of our collective nature could, after all, bring about improved policies. If we understood how community and common endeavour work – to strengthen people's character, say, or to inspire them to be enterprising and ambitious – could that be the basis of a new political vision?

Three new books make the case for the power of the communal, but display fascinating overlaps and clashes.

George Monbiot's *Out of the Wreckage* draws its arguments from neuroscience, psychology and evolutionary biology. He begins by saying humans are "deeply weird" among animals in their "astonishing degree of altruism". We are the "supreme cooperators"; this has been our crucial adaptive advantage.

Mutual aid is the "central, crucial fact about humankind", says Monbiot. "Yet we remain, to an astonishing degree, unaware of it." He makes scientifically literate points about our storytelling capacity – the way we use stories to help us connect our emotional responses to our capacity for rational thinking.

**"If we really understood how community works, could that be the basis of a new political vision?"**

From these insights, Monbiot wants to build a grand narrative of change, with a pro-community account of human nature at its centre. He hopes a "politics of belonging" will dislodge the general assumption – installed by the post-war New Right – that it is our competitive individualism that drives societies and economies forward.

Like the diligent journalist he is, Monbiot enriches his biology-compels-community thesis with real-life examples. We are told how time banks in Japan have promoted bartering and the creation of self-help communities, and how the Australian Men's Shed Association is improving public health. We also hear of car-free "pocket parks" in South Korea, and the way "reading rooms" organised by The New Institute in Rotterdam, the Netherlands, are building conversations across cultures.

In the UK, the communal picture is complex and exciting: there are food assemblies, streets reclaimed as playing grounds, local currencies, and the grassroots projects of the transition town movement. Lambeth council's Open Works initiative in London argues for the efficacy of community self-organisation. Devoting the equivalent of just 2 per cent of local council tax to the project saw returns including improved mental and physical health, and falls in alcohol and drug dependency and in repeat crime.

**Community-based currencies like the Brixton pound are on the rise**

ANNA AMBROSI/LUZPHOTO/EYEVINE

This combination of science and practice feels like an electoral strategy waiting to be picked up. In the UK, one might imagine Jeremy Corbyn's Labour party, the Greens, or civic-nationalist parties like the SNP and Plaid Cymru being particularly eager.

Tweak the emphasis in Monbiot's basic idea, however, and one imagines quite a different politics of communality arising.

The fact is, humans are also "deeply weird" in their capacity for imagination, creativity and abstract thought. We hunger for stories that make sense, but we are also consciously artful with them ourselves, and reflexively alert to being caught up in the stories of others. As an account of the damage that stress and isolation can cause, Monbiot's chapter on "alienation" has


JOHN RENSTEN/GETTY

much to commend it. But what jars is his assumption that our entertainments, consumptions and techno-pursuits are essentially "a mask the machine wears" – the machine being corporate marketing and finance. These "grey monoliths" need sparkly celebrities and interfaces to "induce a click of recognition". That "click" is revealing, and somewhat disingenuous. Doesn't Monbiot also want his well-fashioned story to trigger "recognition" in the citizenry?

Towards the end of the book, he urges top-down "regime change": electoral victories that might support a communal movement. But his vision of dutiful telephone canvassers working their way through email lists with scripts agreed by central HQ sits oddly with his previous celebrations of local autonomy and quirkiness.

This confusion indicates the limits of Monbiot's socio-biological sources. Humans want

**Small community investments can produce dramatic social returns**

to create, as well as to belong. We have always reached for tools, techniques and technology to manifest that creativity: AIs, algorithms, automations and simulations are part of that history. So shouldn't that capacity be located at the heart of communities, rather than be considered a threat to them?

This is the case made by Michael Hardt and Antonio Negri in *Assembly*. It is the latest in a series of collaborations between the pair, which have beguiled a generation of activists since the late 1990s.

The authors have been charting the rising power of "social production": customer services, content-creation and information-wrangling of all kinds.

This is an increasingly cooperative realm, say the pair – an "assembly" of humans and machines that current forms of capitalism are largely parasitic on, extracting profits from the thrum of our mutual responses. As we tap away on social networks like Facebook, Twitter and Google+, for example, our rich interactions are mined for advertiser-friendly patterns by these same corporations. But there are also sectors of what Hardt and Negri call "affective" labour – in care, retail and education – where the success of the enterprise depends on channelling the emotional and group commitment of the workers.

What if that collaborative commitment was pointed in a different direction, somewhere beyond the market or even the state? For that, new institutions might need to be invented – or perhaps old ones given new teeth. Both Monbiot and the authors of *Assembly* seek to establish a zone of resources that can support these invigorated communities, called "the commons".

For Monbiot, the commons is primarily about taxing land to build up revenues for a capital fund that could support a basic social income, among other things. For Hardt and Negri, "the common" is a more mysterious affair. It is glimpsed briefly in the events of the Arab Spring, the Occupy movement and the protests in Gezi Park in Turkey. It glimmers in free software projects, in festival cultures and in pro-migrant initiatives.

**"This combination of science and practice feels like an electoral strategy waiting to be picked up"**

The *Assembly* authors take heart from younger generations who are turning to each other for mutual support, since their prospects of work and home are riddled with insecurity and precarity. "For them, existence is resistance," say the professors, hopefully.

Yet the last 12 months in the UK have seen the youthful multitude turn, instead, towards a bearded patriarch. Aiming to seize those boring old ramparts of the state, the leader of the Labour party promised them the eminently attractive policy of ending tuition fees in further education.

"Oh Jeremy Corbyn" might well have been the community anthem of the year. But it was sung by those who pined for a less indebted road to career progress, as much as by those who would embrace the anarchic and "machinic" future anticipated by Hardt and Negri.

## Creative destruction

In the meantime, the regulators steadily regulate. In *Technically Together*, Taylor Dotson is a little too exhaustive in his quest to dethrone key Silicon Valley assumptions. He argues, for example, that "creative destruction" is all that tech innovation has to offer, borne forward by individuals willing to break all communal ties.

But Dotson is probably right when he says that if you want to subject disruptive technologies to the test of community, then municipal and national oversight might be the best way to do it.

When Transport for London recently revoked Uber's carriage licence in the city, for a variety of public-interest reasons, the tribunes of the techno-future hissed through their teeth. But deployed properly, this is the kind of communal authority that could compel new, human-friendly enterprises (or "combinations" as Hardt and Negri might say) to spring up. What would a people's Uber look like?

"Community" gets a bad name, redolent of dusty halls, faded bunting and a lurking intolerance. All three books show us how the communal can serve the future, not just defend us from it. ■

**Pat Kane** is author of *The Play Ethic*, co-initiator of The Alternative UK, and curator of FutureFest

# All too familiar critters

Thinking about the animals we know so well is oddly unsettling, finds **Simon Ings**

The Museum of Ordinary Animals: The boring beasts that changed the world, Grant Museum of Zoology, London, to 22 December

SOME animals are so familiar, we barely see them. If we think of them at all, we categorise them according to their role in our lives: as pests or food; as unthinking labourers or toy versions of ourselves. If we looked at them as animals – non-human companions riding with us on our single Earth – what would we make of them? Have we raised loyal subjects, or hapless victims, or monsters?

This is the problem that The Museum of Ordinary Animals sets out to address. This show has been artfully, but still none-too-easily, stuffed into the already famously crammed setting of the Grant Museum, a 19th-century teaching collection packed full of skeletons, mounted animals and specimens preserved in fluid.

The exhibition, a sign announces, "begins in front of you, behind the dugong". The corridor between cases is narrow. Easing past visitors distracted by a glass case of dolphin heads, I shave past the enormous, grinning skull of a saltwater crocodile. Here, as in our imagination, the ordinary animals tend to get squeezed out by the extraordinary ones.

The exhibition is small, so go around twice. Spend the first time reading. There is an art to visitor information and the show's curators have nailed it here, citing just the right oddities and asking just the right questions to tip the viewer into a state of uncertain wonder.

Extraordinarily ordinary: from mummified cats (left and centre) to the skulls of a dog and a cow

OLIVER SIDDONS/UCL PETRIE MUSEUM OF EGYPTIAN ARCHAEOLOGY & OLIVER SIDDONS/UCL GRANT MUSEUM OF ZOOLOGY

This show, about animals that are useful to humanity, also turns out to be a show about how dangerously peculiar humanity is. The world has been shaped by our numbers, our intelligence and our activity. For example, all pet golden hamsters descend from a single female fetched from Syria in 1930. It was in a group meant for the lab until it was won in a bet.

And the settling of Europeans in Australia from 1788 triggered the fastest catastrophic species loss we know of. Our cats did most of the work, invading more than 99.8 per cent of the Australian land mass. Today, feral cats kill tens of millions of native animals in Australia every night.

The world has been shaped by our beliefs, too. In Europe, it was once common to bury people with their companion animals. Christianity saw off that practice in the late 7th century, because the faith denies that animals have souls. Then, around a thousand years ago, Benedictine dietary rules were formulated. At that time, chickens were feral, quarrelsome and didn't lay anything like as many eggs as they do now. Today, the chicken is a more or less mindless and sedentary protein factory.

**"Humanity is not so much a species, more a narrow and superbly weaponised ecosystem"**

Having learned that humanity isn't so much a species, more a narrow and superbly weaponised ecosystem, the visitor is ready for a second go. Now the exhibits resonate wonderfully: the bones, the pictures, the jars. Is the subject of Cornelis de Visscher's mid-17th-century engraving *The Rat-Catcher*, the catcher himself or the rat in his cage? There are mice used in diabetes research, ironed flat at death and mounted on cards like obscene tombstones. Nearby, a mummified cat head possesses extraordinary innate dignity: no wonder the animal was a focus of worship.

Leaving Ordinary Animals and the museum, I found myself standing under an orange sky, courtesy of Hurricane Ophelia, which had recently brought ash and dust from runaway forest fires to smother Europe's Atlantic seaboard. Under that dead light, humans gawped at a red sun while, across the road from me, a pet dog, brought to heel, yawned, as though to say: who cares about the sky? Master will feed us. Mistress knows best.

But the exhibition had thrown me out of my complacency, and rarely have I felt less easy with the human project. ■

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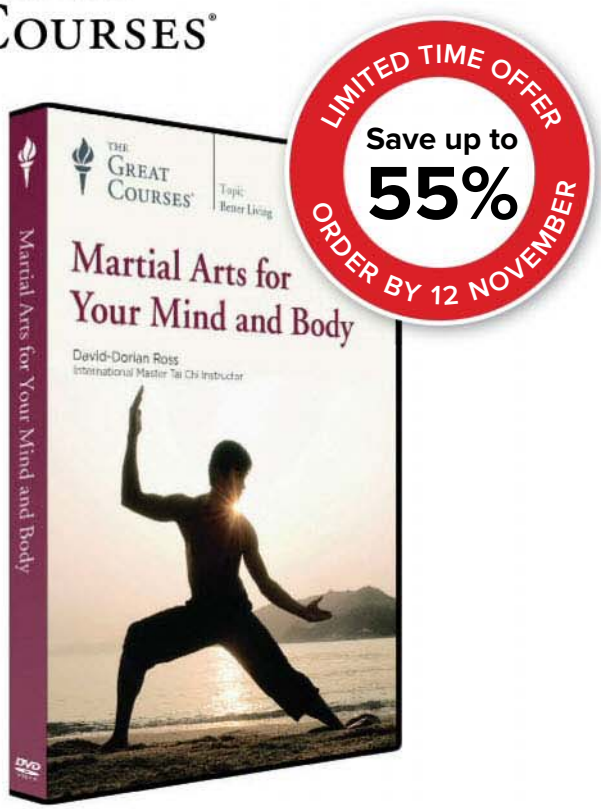


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EDITOR'S PICK

## Robots do not make a market, so abolish it


*From Alec Cawley, Penwood, Berkshire, UK*

Sally Adee discusses the rise of robot finance (14 October, p 22). This raises the question of why we have a stock market at all. The original model was that entrepreneurs competed for the savings of investors, who actively chose stocks themselves or employed professionals to choose. The collective wisdom of highly motivated savers produced a distribution of investment that was, empirically, superior to any monolithic government or corporation.

"Index funds" that merely track the performance of a stock market as a whole were always freeriding on the backs of active investors. Adee suggests they will dominate the market. Allocation of investment by incomprehensible algorithms leads to capital being invested for reasons that are not understood and would appear to have no relationship to efficiency or to anything other than the profits of those operating the computer systems. The stock market would then offer no benefit to society, and could be closed down.

Centralised allocation of investment would be transparent, if not efficient.

## Sleep and Alzheimer's: fear and opportunity

*From Hazel Russman, London, UK*

Matthew Walker's report on the relationship between poor sleep and Alzheimer's disease is fascinating but also ominous (14 October, p 30). After all, one common cause of insomnia is anxiety.

If insomniacs come to believe that their poor sleep habits are putting them at risk of dementia, they will probably lie in bed worrying about this and get even less sleep!

*From Alan Worsley, Hull, East Yorkshire, UK*

Walker states that the deepest sleep is most helpful in delaying the onset of Alzheimer's disease. Your sleep cycle chart shows that only the first 4 or 5 hours of sleep contain the slow, deep delta brainwaves that are claimed to help delay Alzheimer's.

So is it worth considering the alternative pattern of sleeping for short periods several times a day? Those using this method – allegedly including Leonardo da Vinci – seem to get away with less than average total sleep while still being successful. Maybe they are getting the benefit of the deepest sleep several times a day rather than only during the first two cycles at the beginning of an 8-hour sleep period.

*The editor writes:*

■ All the phases of sleep have some benefit: Rapid Eye Movement sleep, for instance, is increasingly thought to help modulate emotions. So the advice would still be to sleep until you wake up naturally, fitting in all sleep stages.

**"I waited eight years for diagnosis. I am glad people are striving to help with the process"**

**Melanie** hopes others will do better thanks to work to develop a home spit test for endometriosis (28 October, p 15)

## In defence of gloom – and of optimism

*From Bryn Glover, Kirkby Malzeard, North Yorkshire, UK*
I wish I could share the glass-half-full optimism about the environment that Julia Brown describes (14 October, p 38). But I don't see how her implied numbers add up. She speaks of ways behaviour can be "nudged" – and Richard Thaler won the Nobel prize in economics for that (p 4).

But we now number 7 billion, and a sizable proportion of those are severely undernourished and generally have insufficient provisions. It seems likely that we will number 10 billion by 2050, and for everyone to be properly provided for, global production of everything will need to double – assuming current consumption continues. Since we already consume the food and energy of two Earths, this is clearly impossible, and we all need to reduce our lifestyles drastically. Tweaking and nudging won't go anywhere near as far as will be necessary.

The only choice we seem to have is the mechanism by which we reduce. Shall it be by surviving calamities and catastrophes and allowing the strongest to continue to take the lion's share? Or shall it be careful, fair, rational and logical planning? I am clear where my choice would lie.

*From Solitaire Townsend, Futerra Ltd, London, UK*
I couldn't agree more that positive thinking is the way to save the planet. Recently, the market research company Ipsos surveyed people in 26 countries about their optimism or pessimism on climate change. Nearly 60 per cent of the global public believe we can and might solve climate change; but 14 per cent are climate fatalists – who believe we can no longer reduce the effects.

A shocking number of those fatalists are young: globally, 22 per cent of those aged between 16 and 34 agree that it is now too late to stop climate change. The figure in India is 39 per cent, and 29 per cent in the US.

Communicating the scale of the climate threat without clear messages on solutions has created dangerous fatalism. This is why Futerra, in partnership with The Climate Group, has launched climateoptimist.org.

## Kurt Gödel and an incomplete universe

*From Ed Subitzky, New York, US*
Anil Ananthaswamy mentions physicist Max Tegmark's belief that the universe is made of mathematics (2 September, p 30). The same article refers to Kurt Gödel's incompleteness theorem, which shows that mathematical systems powerful enough to define arithmetic have theorems that cannot be proven to be either true or false within the system.

So if the universe consists of mathematics, and any interesting mathematics is incomplete, is the universe incomplete? Could this have something to do with the uncertainty in quantum physics?

## Seeing genuinely new colours on drugs

*From Guy Inchbald, Upton-upon-Severn, Worcestershire, UK*
Readers have discussed the effects of hallucinogens on people with colour-blindness (Letters, 30 September). A person I know was once prescribed a drug, ›

a side effect of which turned out to be hallucinations. These included colours that he had never seen before. He was not colour-blind: these were genuinely new colours.

The opponent-process model of colour vision holds that the brain converts red, green and blue signals from the eye into a red-green and a blue-yellow difference and brightness – much as old analogue TV broadcasts did. The "space" of colours that this can describe is larger than that filled by vision. An over-excited brain area can presumably stimulate signals outside normal vision.

## We should find a way to prevent hurricanes

*From Brian Macfarland, Watford, Hertfordshire, UK*

We read a lot about preparing for future storms of ever increasing magnitude by fabricating more resilient buildings (23 September, p 22). What about tackling the problem at source and finding ways to kill hurricanes? They need certain conditions to feed on. Upsetting this equilibrium could destabilise them and cause their collapse. I wonder about setting off large explosions at critical points around the eye of the hurricane. Doing this while a storm was embryonic could have more chance of success, and doing it while it was over ocean should avoid loss of life.

*The editor writes:*

■ This has long been discussed. We have observed that "the most powerful source of energy… the H-bomb, is obviously impotent as a means of actually destroying a hurricane" (6 July 1961, p 11). Then we spoke of tweaking a "delicate balance of meteorological factors"; but we reported online 56 years later that "decades of tests have generated only heated arguments and even lawsuits" (23 April, bit.ly/NS-hurricane).

## Drones make it far too easy to go to war

*From Gordon Drennan, Burton, South Australia*

David Hambling argues that military drone pilots deserve medals (30 September, p 24). Such drones have already changed things for the worse. Leaders of powerful countries know they have the superior military power necessary to win every battle. Their temptation is to go straight to war whenever weaker countries won't do as they are told.

They were once restrained by the need to justify the stream of flag-draped body bags that came back to their own voters: no more. This has to stop, and the worst among us have to be made to accept that there is a price that has to be paid for going to war. It must not be made cheaper, easier and more "efficient" or our leaders will resort to it more and more.

## Were leech-wielding barbers on to something?

*From Rodney Tapp, Birchington, Kent, UK*

Sally Adee reports impurities in older people's blood plasma as a possible cause of ageing, and that introducing plasma from younger folk may offer some rejuvenation (30 September, p 39). Some of the benefit may result from removing old plasma. Could this account for the old practice of bleeding with leeches? And could regular blood donors be doing good to themselves as well as to others?

*The editor writes:*

■ We don't know. But bleeding does not dilute old blood as plasma does. We would expect senescent cells to replace ageing factors fairly soon.

## Baldness doesn't confer any disadvantages

*From James Fradgley, Ashington, Dorset, UK*

Exploring why humans are "so scarily hairy", you say "pity the human male", who must "suffer the indignity of a receding hairline" (7 October, p 41). Baldness is a normal male thing and doesn't, in my experience, confer any disadvantages. Please don't let your values intrude.

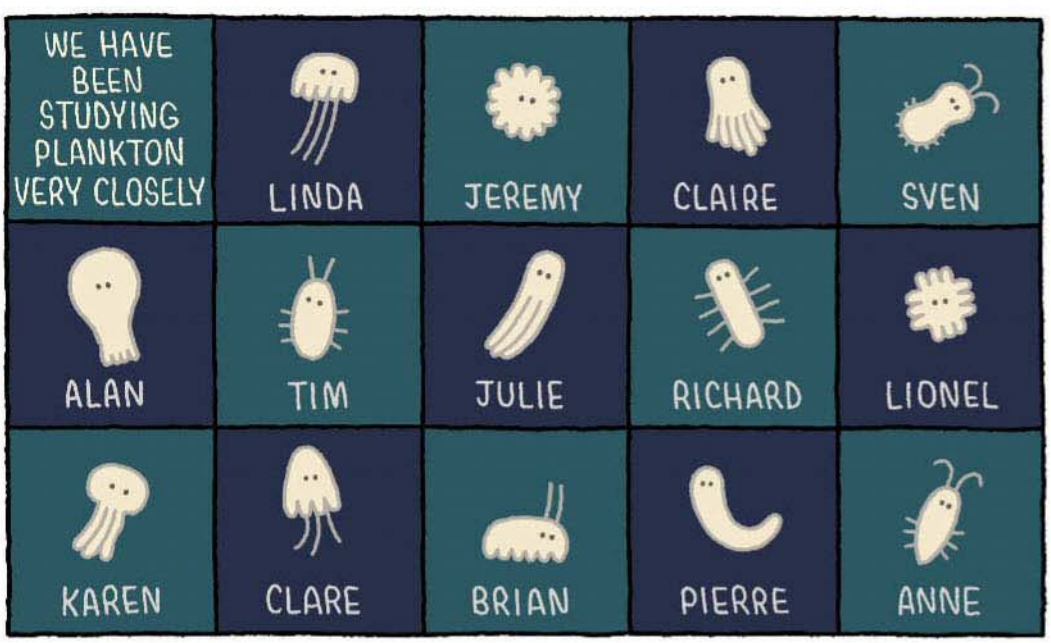
## Could this be a way to avert war?

*From Janet Le Page, Johannesburg, South Africa*

The threat of war is rising again (23 September, p 30). Suppose the UN resolved, and everyone agreed, that in the next five years only women should be elected as national leaders. Would there be less conflict in the world?

Does anyone know how many wars were started by women?

TOM GAULD




## For the record

■ **A paper on salt intake found increased mortality among those consuming less than 3 grams of sodium (about 7.5g of sodium chloride) a day (Letters, 14 October).**

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# OLD SCIENTIST

What was *New Scientist* talking about in Novembers past?

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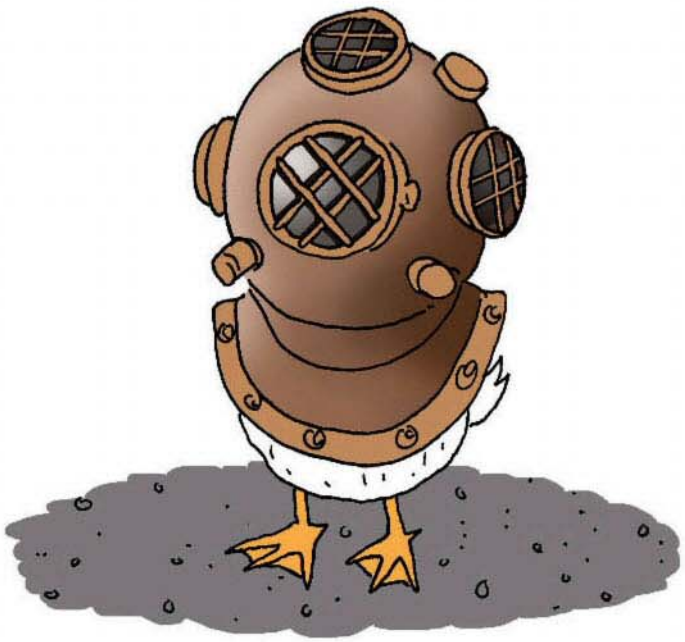
"DOES epidemic disease come from space?" In the relatively sober 1970s, this headline must have been even more alarming than it would be in our present era of fake news. Especially atop an article by famous astronomer Fred Hoyle and astrobiologist Chandra Wickramasinghe, arguing that infamous epidemics like the deadly Spanish flu of 1918-19 had been brought to Earth on interplanetary debris. Both authors were proponents of panspermia, the theory that life began elsewhere in the universe and came here aboard comets and meteorites. This belief arguably cost Hoyle a Nobel prize, although perhaps his notorious bluntness, verging on rudeness, may have been a factor too. The article, published in our 17 November 1977 edition, ended with a plea to keep a "continual microbiological vigil of the stratosphere… to eliminate the havoc which will ensue from extraterrestrial invasions in the future".

By 1992, the declining frequency of Nobel prizes awarded to UK scientists was beginning to trouble us. In our 7 November edition, Ben Martin said this showed the nation's shrinking status in world science, but conceded that one explanation for the worrying trend might be that "gifted scientists are being encouraged to apply their skills in industry".

So is research worthwhile only if it turns a profit? Fourteen years later, at least one sector of British science was doing just that. In our 4 November 2006 edition, we sang the praises of biotechnology: the jobs market was booming and half the country's biotech companies had recently taken on extra staff. A map identified areas of the UK where research and development companies and institutions were gathered, with clusters not surprisingly found around Cambridge and Oxford.

The chair of biotechnology's UK industry body almost certainly wasn't being rude when he told us "the UK is bloody good at it". But that's not what they hand out Nobel prizes for. **Mick O'Hare** ■

To delve more into the *New Scientist* archives, go to **newscientist.com/article-type/old-scientist/**



PAUL MCDEVITT

LONG-TIME readers will recall the continuing adventures of Phillip Clapham's dog, a canine researcher with an enviable publication record (15 June 2013). After becoming fed up with invitations to speak at dubious pay-to-attend conferences of no relevance to his work, Phillip began returning applications in his terrier's name, on topics such as the potential to power city grids with giant hamsters running in wheels.

Credited as Alice N. Wünderlandt, (a graduate of Lutenblag State University with a dissertation entitled "Locomotor energetics of *Sciurus carolinensis* in flight: strategies for pursuit"), his dog's most recent effort is titled "Low-cost physical oceanographic profiling using a recyclable fuliguline sampling system". Remarking that the use of expendable bathythermographs contributes to ocean pollution, Wünderlandt proposes a reusable system based on sea ducks trained to dive to appropriate depths to collect readings.

"In the event of terminal fuliguline failure," it adds, "the depth-deceased is… recovered using a patented Canine Retrieval System™. Unserviceable units can then be processed in a standard convection oven at 230°C (450°F) and internally recycled with a *sauce á l'orange*."

WHO reads the terms and conditions these days? Maybe not even those publishing them. How else to explain that passengers on the UK's Greater Anglia trains who wish to use the on-board Wi-Fi must agree to a service that is "black garage stellar hacker courier assassin hotdog mimetic polycarbon suits", and that conduct online will be "rifle face forwards augmented reality katana advert corporation footage refrigerator tattoo icebreaker".

"Sure, I want an augmented reality katana – who doesn't?" says Lex Lang. "But I don't know how to use one well enough to provide footage of me using it to tattoo a fridge."

It seems somebody at Greater Anglia is a fan of science fiction author William Gibson – or at least the "Lorem Gibson" online text generator created by David Weaver, which produces cyberpunk-themed filler text on demand, distilled from the author's works. Much quicker and more interesting than penning reams of legal jargon, and the result is no less intelligible.

BY NOW, we suspect British astronaut Tim Peake may have clocked up more miles in his relentless press tour than he did during his six months in orbit. Yet there's always room for a novel question.

On ITV's *This Morning*, host Amanda Holden threw the major a curveball by asking if, following his stay on board the International Space Station, he would be taking a piece of the moon home with him.

IN LOCAL news: Stephen Etzel forwards a headline from the Hartford Courant. "Connecticut Children's Hospital Welcomes New President," it announces. "Gil Peri Stresses Focus on Kids."

"I'm certainly glad they hired the right guy," says Stephen.

HOT on the heels of that unwelcome US import David "Avocado" Wolfe (14 October), Feedback discovers more windblown seeds arriving on our shore. Ken Ham and his merry band of creationists are due to speak at the UK Creation Mega Conference 2017.

The event brings young Earth talent to the heart of the UK – specifically, the Bethel convention centre in West Bromwich, located between Bromford Lane Allotments and the Kelvin Way industrial estate.

Speakers include Nathaniel T. Jeanson, author of *Replacing Darwin: The New Origin of Species*, the existence of which is, we suspect, the only reason there's any doubt in the recent *Telegraph* headline, "Is AN Wilson's biography the worst book about Darwin ever written?"

Topics tabled for discussion include "Geological Evidence for a Young Earth", "Big problems with the Big Bang", and the question on all our lips, "Why Build an Evangelistic Life-Size Ark?". Feedback's attention is drawn to Voddie Baucham Jr's presentation on "The Global War on Manhood and Marriage", which seems rather off-topic. Perhaps he thinks this is an audience receptive to far-fetched world views with little basis in reality?

POP quiz: if Protestant-themed breakfast cereal makers Quaker Oats reduce the sugar content of their Apples and Cinnamon instant oatmeal mix from 12 grams per sachet to 6g, what size reduction does that make?

If you said 50 per cent, we're afraid you're out of luck: Quaker advertises their reduced sugar variety as having 35 per cent less sugar. However, this is not a misprint but a lesson in the fine art of absolute and relative differences. Sachets of reduced


sugar oatmeal weigh in at 31g, whereas regular packs are 43g. (Pedants will have spotted this equates to a 31 per cent reduction in sugar, but we'll assume a rounding error is in play).

Yes, the packs not only boast reduced sugar, but reduced everything. It's certainly one way to cut calories, and a reminder that nutritional claims, like porridge, are best served with a pinch of salt.

You can send stories to Feedback by email at feedback@newscientist.com. Please include your home address. This week's and past Feedbacks can be seen on our website.

James Parsons spots a universal smoking ban in Birmingham, where someone has posted a sign outside a hotel declaring "No smoking within 15 feet of anywhere"

## Spin a yarn

**All astronomical bodies, from moons and planets up to galaxies, spin and have orbits. Spin is also a key characteristic of subatomic particles. Yet in our human world, we are relatively static. Why is spin unimportant for us, but at other levels it is all-pervasive? How do the laws of physics make our biosphere so special?**

■ One might argue that astronomical bodies and subatomic particles are the special cases here, in that they are often free from disruptive influences such as friction. For example, Earth is free to orbit the sun under gravitational forces because it is moving through a near-perfect vacuum; and an electron in an atom is free to rotate about the nucleus under electromagnetic forces.

The situation is rather different in the biosphere. The most significant and consistent force acting upon us in our everyday lives is Earth's gravitational pull (together with frictional forces that drag us around with the planet's surface). This force does cause us to "spin" and orbit in that we rotate with Earth relative to space. But the objects around us are affected in the same way, so everything seems static from our perspective.

More subtle forces can be seen within the biosphere. Some of these do give rise, on occasion, to obvious rotational motions: a cyclone, for example, owes its existence to the Coriolis force and carries orbital angular momentum about its core.

Ultimately, however, disruptive influences such as friction tend to quench these rotational motions – which is why cyclones inevitably dissipate. Consistent rotational motion within the biosphere demands a consistent input of energy to overcome disruptive influences.

Subtle forms of rotational motion can be found within the biosphere where such influences are largely unimportant.

**"A cyclone exists because of the Coriolis force and carries orbital angular momentum about its core"**

The light reflected from a figeater beetle, for example, carries a net spin, with the light's electric and magnetic field vectors almost always rotating in the same sense: the opposite sense of rotation is sometimes seen for mutant specimens. Your naked eyes are not sensitive to this rotation, but you can use certain 3D cinema glasses to detect its presence.

*Robert P. Cameron*
*Quantum Theory Group*
*University of Glasgow, UK*

■ Rotational motion (spin) is just as important for us as it is for galaxies and subatomic particles. Without wheels and rotating motors, we would not have washing machines, cars, ships and jet aircraft. Without rolling balls, we would not have the games of marbles, billiards, bowling and football. Ice skaters spin as part of their routines, and discus and hammer throwers do so before releasing their projectiles.

Mathematically, rotational motion is described by saying that the positions of the rotating objects at different times are related by rotational transformations. This applies at all scales, from the subatomic to the intergalactic.

The "spin" of subatomic particles, however, is a quantum mechanical property that is not the same as rotation. The states of subatomic particles at different times are related not by rotations but by unitary transformations. These have some similarities to rotations, but have a peculiar property that has been described as "having to turn around twice (instead of once) to get back to where you started".

Quantum mechanical spin is a misleading term because although it is related to angular momentum, it has more to do with the magnetic properties of particles than with rotation.

The term was coined by pioneers of quantum theory, who pictured the particles (incorrectly) as tiny rotating spheres of charge.

*Chris deSilva*
*Dianella, Western Australia*

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## This week's questions

**WINDING UP...**

Is there a physical limit to the wind speed of a hurricane? If so, what is it?

*Ralf Ludwig*
*Melbourne Beach, Florida, US*

**LIGHT AT THE LIMIT**

People have been measuring the speed of light for a few hundred years, but the universe is nearly 14 billion years old. If the speed of light changes very slowly – say a small percentage every 10,000 years – how could we tell?

*Rodney Birks*
*Devon, UK*

**PECULIAR PRETZELS**

Walking in Halswell Quarry Park in Christchurch, New Zealand, we found these geometric objects by the path (pictured). They look human-made, but are apparently natural. Can anyone identify them?

*Diane Berry*
*Christchurch, New Zealand*

# CELEBRATING 40 YEARS OF AN ENTERPRISING SPIRIT

In 1926, Hans Wilsdorf created the first waterproof wristwatch: the legendary Rolex Oyster. Inspired by his enterprising spirit, Rolex launched the Rolex Awards for Enterprise in 1976 to support visionary people advancing human knowledge and well-being. Forty years later, the Awards continue to celebrate men and women with the passion, vision and commitment to make the world a better place.

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