GALAXY ON GLASS

SPECTACULAR WALL ART FROM ASTROPHOTOGRAPHER CHRIS BAKER

Available as Acrylic, Framed & Backlit
or Fine Art Prints. All Limited Edition

www.galaxyonglass.com
chris@galaxyonglass.com | +44 (0) 7814 181647

THANK YOU!

To the many New Scientist readers from all over the world who purchased my art in 2020 I want to say a big Thank You!
Here's an offer for all readers - use the code newscientist at check-out for a unique **10% discount** throughout January!
Happy New Year from Chris Baker.

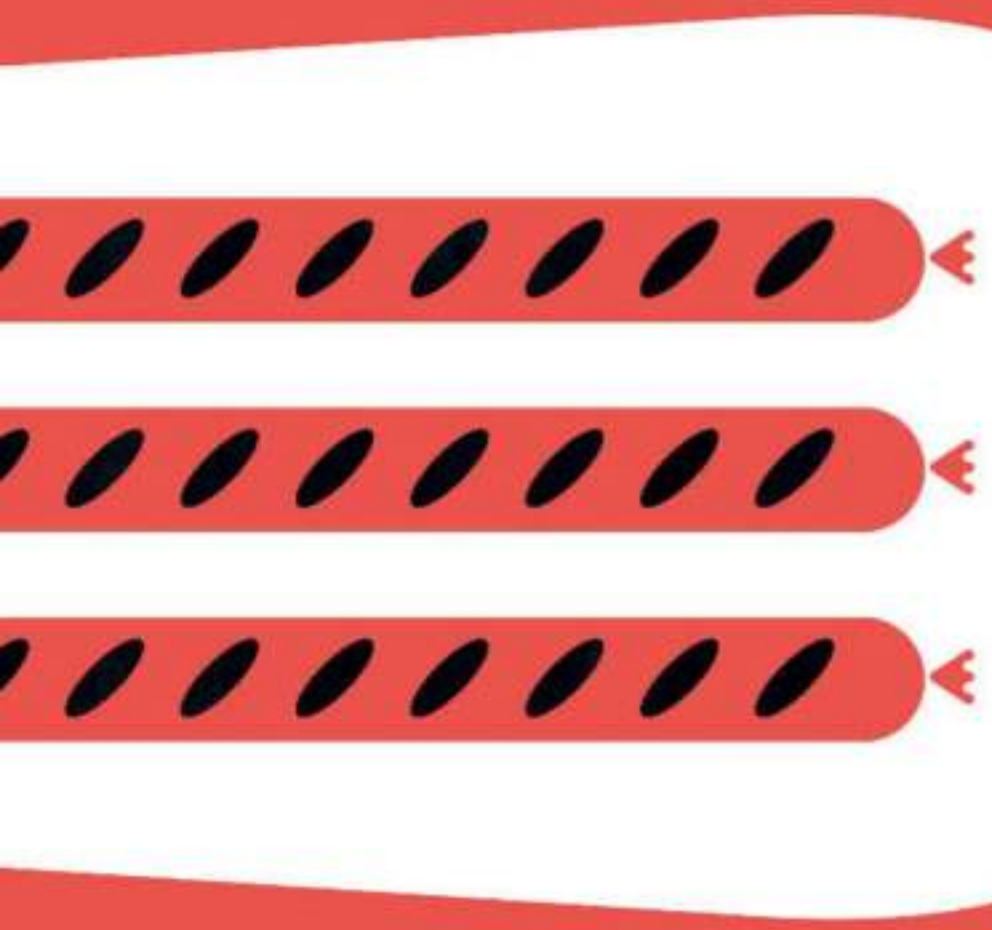
New Scientist

WEEKLY January 9–15, 2021

FOCUS ON
CORONAVIRUS
UK returns to lockdown
Why this virus is so difficult to beat
New threats from new variants
The riddle of smell loss

THE TRUTH ABOUT LOW-CARB DIETS

Are they good for you – or a recipe for a heart attack?



FARMING METAL
Meet the plants that suck up rare minerals from the earth

PLUS (ANOTHER) NEW ANCIENT HUMAN / **ORIGINS OF GALAXIES** / **THE FIGHT FOR CLEAN AIR** / FISH ARE GETTING SMALLER

Science and technology news **www.newscientist.com**

No3316 US$6.99 CAN$9.99

Wrap up warm for an Ice Age Adventure!

AQUILA Magazine is a big hit in the world of children's publishing: its thought-provoking topics are so well researched and written you will probably enjoy reading the articles yourself.

In the January issue, children can join an exciting expedition back to the last glacial period.

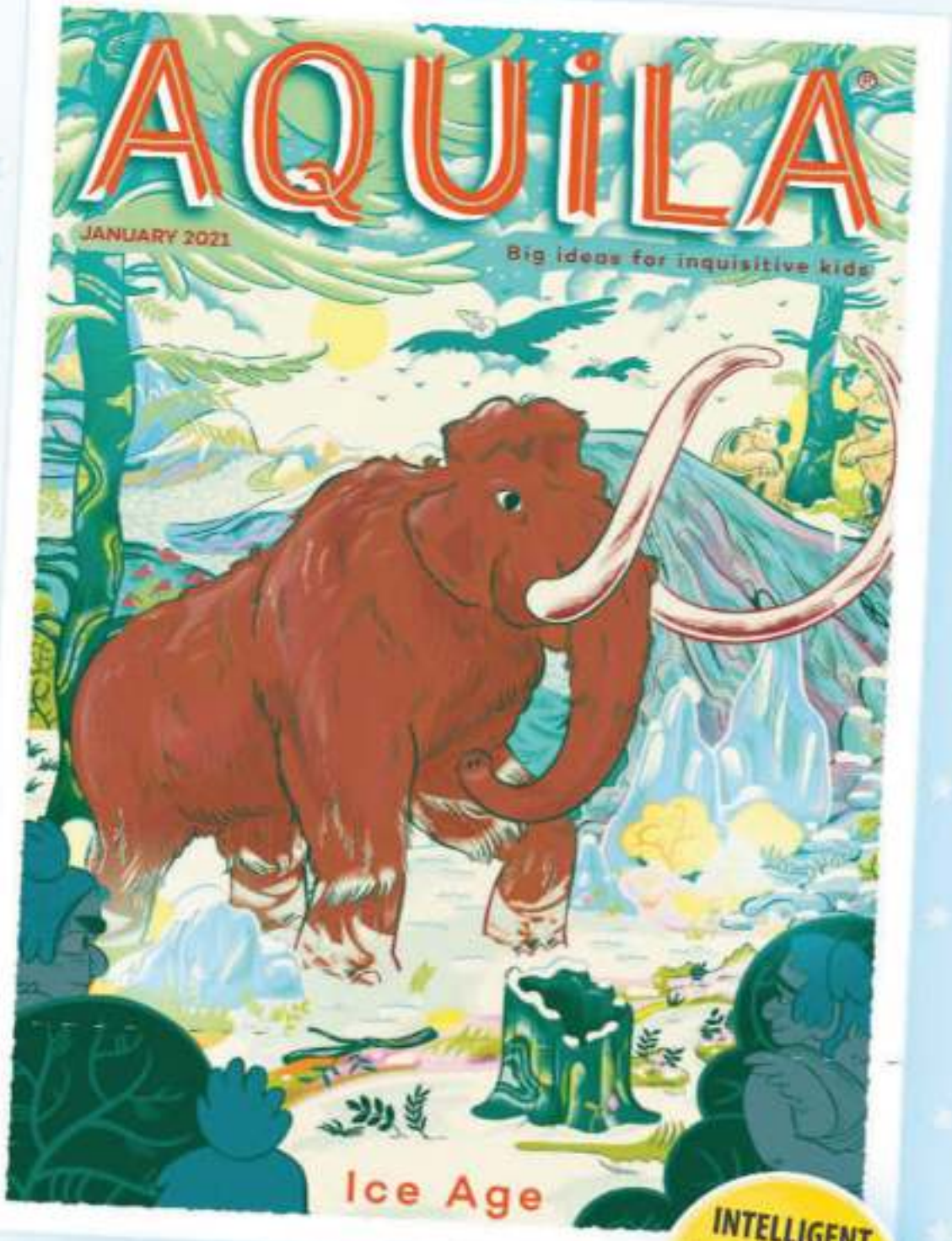
New topics for Spring 2021:

February: FUNFAIR MATHS
This dazzling topic investigates the weird paradoxes and mind-bending concepts that are present in the world of mathmatics.

March: BRILLIANT BUGS from the beautifully iridescent and the downright scary insects that share our planet to those nasty digital bugs that spoil our time online.

April: a visit to **ANCIENT EGYPT** and the River Nile makes for a very popular topic – so not to be missed!

- ✔ **BIG IDEAS** for Curious Minds
- ✔ **A Book's Worth of Reading**
- ✔ **Brilliant New Topic Every Month!**



INTELLIGENT FACTS & Serious FUN Every Month

Imagine Earth's northern lands when they were frozen into one gigantic continent: take part in a Mammoth Hunt and meet Inuit people who know how to survive freezing temperatures. PLUS: Icy Experiments, Dog Sledding and the Story of Ice Cream!

Subscriptions include:

1. **With the first issue:** a Mega Wall Map & Passport Puzzler, plus your own Personal Gift Message
2. **FREE EXTRAS:** every month, top-notch topic extension materials are available to download for the most dedicated AQUILAnauts to take their learning a step further!
3. **50% OFF** back-issues when you subscribe

www.AQUILA.co.uk

Creative, Funny & Inspiring

AQUILA is not like any other children's publication you have seen, and you won't find it on the newsstand; the editorial is witty and sophisticated, making children feel part of a very special club!

Highly recommended reading for bright 8–13-year-olds, every monthly topic brings a well-balanced feast of Science, Arts and General Knowledge into the family home, encouraging children to think beyond the school curriculum and to become self-motivated learners.

"...Advanced & Philosophical, Curious & Puzzling"

RICHARD ROBINSON – BRIGHTON SCIENCE FESTIVAL

This week's issue

On the cover

32 The truth about low-carb diets
Are they good for you – or a recipe for a heart attack?

42 Farming metal
Meet the plants that suck up rare minerals from the earth

Vol 3316 No 249
Cover image: Giulio Bonasera

Focus on coronavirus
5 UK returns to lockdown
38 Why this virus is so difficult to beat
8 New threats from new variants
10 The riddle of smell loss

12 (Another) new ancient human
20 Origins of galaxies
14 The fight for clean air
15 Fish are getting smaller

42 Features

"One relative of cabbage contains 2000 times as much nickel as a typical plant"

News

12 Controlling koalas
Koalas are being given birth control to fight overpopulation

15 Bread for growing tissue
Irish soda bread seems to work as a scaffold for cultivating muscle and bone cells

16 Stonehenge scuffle
Will a new tunnel be good or bad for archaeology?

Views

19 Comment
Investing in free public transport could have huge benefits, says Richard Webb

20 The columnist
Chanda Prescod-Weinstein on galaxies' origins

22 Letters
A possible problem with festive virus strategies

24 Culture
The forces fighting climate science have a new tactic

28 Aperture
Reviving the Great Barrier Reef

ALLISON DINNER/AFP VIA GETTY IMAGES

7 Global surge The coronavirus crisis is worsening in many countries

Features

32 Breaking with bread
People are cutting carbs to lose weight or get healthier. We look into the risks of low-carb diets

38 A pandemic like no other
Why covid-19 has been so very tough to deal with

42 Farming metal
Mining is a dirty business. Could we get the metals we need from plants instead?

The back pages

49 Citizen science
Counting penguins online could help track climate change

52 Puzzles
Try our crossword, quick quiz and logic puzzle

54 *Almost* the last word
Why are tree leaves so many shades of green?

55 Tom Gauld for *New Scientist*
A cartoonist's take on the world

56 Feedback
Reindeer stock picks and lunar units: the week in weird

Elsewhere on New Scientist

Virtual events

Big Thinkers

Throughout 2021, *New Scientist* is bringing you a series of 10 talks from the boldest and most compelling thinkers in science. Anil Seth will get into the nitty-gritty of consciousness. Susan Schneider will reveal how AI can change our lives. Michelle Simmons will take us inside the quantum computing revolution. There is plenty more – discover the wider range of talks online. Book individual talks now or save money by subscribing to the full series.

newscientist.com/events

Newsletters

Launchpad

Reporter Leah Crane's look at space news, delivered free to your inbox each week. The latest edition checks out plans to visit the ice giant planets, Neptune and Uranus.

newscientist.com/sign-up/launchpad

Heath Check

Clare Wilson's weekly round-up of the most important news in health and fitness. The latest newsletter looks at what to expect as covid-19 vaccines are rolled out.

newscientist.com/sign-up/health

Quantum computing Let Michelle Simmons be your expert guide

NASA/JPL

Forgotten giant Return missions to Neptune are in the works

CARLOS AVILA GONZALEZ/THE SAN FRANCISCO CHRONICLE /GETTY IMAGES

Sharp scratch How quickly can covid-19 vaccines be distributed?

Online

Covid-19 daily briefing

All the latest, most crucial coverage of the pandemic, with news, features and interviews. Updated each day at 6pm GMT.

newscientist.com/coronavirus-latest

Essential Guide

Get the low-down on our greatest and weirdest theory of reality – dead-and-alive cats and all – with *Essential Guide: Quantum physics*, the fifth instalment in our series.

shop.newscientist.com

Introducing ATEM Mini

The compact television studio that lets you create training videos and live streams!

Blackmagic Design is a leader in video for the medical industry, and now you can create your own streaming videos with ATEM Mini. Simply connect up to 4 HDMI cameras, computers or even technical equipment. Then push the buttons on the panel to switch video sources just like a professional broadcaster! You can even add titles, picture in picture overlays and mix audio! Then live stream to Zoom, Skype or YouTube!

Create Training and Educational Videos

ATEM Mini's includes everything you need. All the buttons are positioned on the front panel so it's very easy to learn. There are 4 HDMI video inputs for connecting cameras and computers, plus a USB output that looks like a webcam so you can connect to Zoom or Skype. ATEM Software Control for Mac and PC is also included, which allows access to more advanced "broadcast" features!

Use Professional Video Effects

ATEM Mini is really a professional broadcast switcher used by television stations. This means it has professional effects such as a DVE for picture in picture effects commonly used for commentating over a computer slide show. There are titles for presenter names, wipe effects for transitioning between sources and a green screen keyer for replacing backgrounds with graphics!

Live Stream Training and Conferences

The ATEM Mini Pro model has a built in hardware streaming engine for live streaming via its ethernet connection. This means you can live stream to YouTube, Facebook and Twitch in much better quality and with perfectly smooth motion. You can even connect a hard disk or flash storage to the USB connection and record your stream for upload later!

Monitor all Video Inputs!

With so many cameras, computers and effects, things can get busy fast! The ATEM Mini Pro model features a "multiview" that lets you see all cameras, titles and program, plus streaming and recording status all on a single TV or monitor. There are even tally indicators to show when a camera is on air! Only ATEM Mini is a true professional television studio in a small compact design!

ATEM Mini.....**US$295**
ATEM Mini Pro.....**US$595**
ATEM Software Control.....**Free**

Learn more at www.blackmagicdesign.com

ATEM Mini for use in training, conferencing and teaching purposes only.

Blackmagicdesign

MANCHESTER 1824
The University of Manchester

BREAK THROUGH

We're helping to build a more sustainable future through applied discovery and innovation

Mitigating climate change. Making renewable energy generation more efficient. Improving batteries and storage technologies with graphene.

Get in touch for knowledge, evidence and expertise:

manchester.ac.uk/beacons

Research beacons

GLOBAL CHALLENGES
MANCHESTER SOLUTIONS

The riddle of the coronavirus

It is the many unknowns about covid-19 that make it so tricky to beat

IN THE UK, back in July, covid-19 cases had dropped so much that politicians spurred people to dine out to boost the economy. Citizens were told that restrictions on daily life would be over "in time for Christmas". That didn't happen.

Instead, as the northern summer ended, infections climbed, and kept on climbing despite complicated systems of protection levels and tiers, as did the number of people in hospitals. With hospitalisations now perilously high, nearly all parts of the UK are back under strict lockdown conditions.

Of course, the UK isn't the only nation struggling with second or even third waves. Many countries that felt they were on top of the virus are now struggling to keep it suppressed. Vaccines should provide an escape route – new variants and any other surprises allowing. But as we have said many times on these pages, there are still hard yards ahead.

So why is this virus proving so difficult to deal with? On page 38, Jonathan R. Goodman argues that it is because this virus is a riddle, on multiple levels. We can't tell, by looking at someone, if they have it. We can't tell, even with someone's medical chart in our hands, how sick they will get from it. We are getting better at treating people who become seriously ill, but we can still only guess who will die, and why. And the greatest riddle is what we should do about it all.

"The time for underestimating the virus is over. The sooner we can get people vaccinated, the better"

Other diseases kill more of the people who are infected: MERS killed 33 per cent of those who caught the virus, SARS 10 per cent. Those sorts of death rates prompted unequivocal action from governments. But with this coronavirus, we are looking at a death rate of about 1 per cent. That opens the door to politicians and commentators getting wrapped up in cost-benefit analyses, agonising over impacts to economies and healthcare when contrasted against this relatively low death rate.

What should be clear now is that the time for underestimating the coronavirus is over. The sooner we can get people vaccinated, and stop this virus running around populations with unknown outcomes, the better. Until then, life cannot return to normal. ▮

PUBLISHING & COMMERCIAL

Commercial and events director Adrian Newton

Display advertising
Tel +44 (0)20 7611 1291 **Email** displayads@newscientist.com
Sales director Justin Viljoen
Sales manager Rosie Bolam

Recruitment advertising
Tel +44 (0)20 7611 1204 **Email** nssales@newscientist.com
Recruitment sales manager Viren Vadgama

New Scientist Events
Tel +44 (0)20 7611 1245 **Email** live@newscientist.com
Creative director Valerie Jamieson
Sales director Jacqui McCarron
Event manager Henry Gomm
Marketing manager Emiley Partington
Events team support manager Rose Garton

New Scientist Discovery Tours
Director Kevin Currie

Marketing
Marketing director Jo Adams
Head of campaign marketing James Nicholson
Head of customer experience Emma Robinson
Email/CRM manager Rose Broomes
Digital marketing manager Craig Walker
Customer experience marketing manager Esha Bhabuta
Marketing executive Amelia Parmiter

Digital & Data
Digital product development director Laurence Taylor
Head of audience data Rachael Dunderdale

Technology
CTO and programme director Debora Brooksbank-Taylor
Head of technology Tom McQuillan
Maria Moreno Garrido, Amardeep Sian, Ben Townsend, Piotr Walków

NewScientist

Chief executive Nina Wright
Executive assistant Lorraine Lodge

Finance & operations
Chief financial officer Amee Dixon
Financial controller Taryn Skorjenko
Management Accountant Alfred Princewill
Facilities manager Ricci Welch
Receptionist Alice Catling

Human resources
Human resources director Shirley Spencer
HR business partner Katy Le Poidevin

Non executives
Non-exec chair Bernard Gray
Senior non-exec director Louise Rogers

CONTACT US

newscientist.com/contact

General & media enquiries
US PO Box 80247, Portland, OR 97280
UK **Tel** +44 (0)20 7611 1200
25 Bedford Street, London WC2E 9ES
Australia 418A Elizabeth St, Surry Hills, NSW 2010

US Newsstand **Tel** +1 973 909 5819
Distributed by Time Inc. Retail, a division of Meredith Corporation, 6 Upper Pond Road, Parsippany, NJ 07054

Syndication Tribune Content Agency
Tel 1-800-346-8798 **Email** tca-articlesales@tribpub.com

Subscriptions **newscientist.com/subscribe**
Tel 1 888 822 3242
Email subscriptions.us@newscientist.com
Post New Scientist, PO Box 3806, Chesterfield MO 63006-9953

Periodicals postage paid at New York, NY and other mailing offices
Postmaster: Send address changes to New Scientist, PO Box 3806, Chesterfield, MO 63006-9953, USA. Registered at the Post Office as a newspaper and printed in USA by Fry Communications Inc, Mechanicsburg, PA 17055

EDITORIAL

Editor Emily Wilson
Executive editor Richard Webb
Creative director Craig Mackie

News
News editor Penny Sarchet
Editors Jacob Aron, Chelsea Whyte
Reporters (UK) Jessica Hamzelou, Michael Le Page, Layal Liverpool, Adam Vaughan, Clare Wilson (US) Leah Crane, (Aus) Alice Klein, Donna Lu
Interns Ibrahim Sawal, Karina Shah, Krista Charles

Digital
Digital editor Conrad Quilty-Harper
Podcast editor Rowan Hooper
Web team Emily Bates, Anne Marie Conlon, Alexander McNamara, David Stock, Sam Wong

Features
Head of features Catherine de Lange and Tiffany O'Callaghan
Editors Daniel Cossins, Anna Demming, Kate Douglas, Alison George, Joshua Howgego
Feature writer Graham Lawton

Culture and Community
Comment and culture editor Timothy Revell
Liz Else

Subeditors
Chief subeditor Eleanor Parsons
Bethan Ackerley, Tom Campbell, Chris Simms, Jon White

Design
Art editor Kathryn Brazier
Joe Hetzel, Ryan Wills

Picture desk
Picture editor Helen Benians
Tim Boddy

Production
Production manager Joanne Keogh
Robin Burton

It's hard to know what lies ahead

Whatever happens in 2021, get the clearest possible view with *New Scientist*

Find out for yourself with our January sale offer:
12 weeks for half price

***New Scientist* subscribers get so much more than the magazine:**

51
print editions through your letter box

365
days of unlimited access to newscientist.com

400+
issues in the *New Scientist* app

200+
video science talks to immerse yourself in

200+
interactive puzzles and crosswords

4
exclusive subscriber-only online events

All this for just $2.50 a week*

Visit newscientist.com/jansale
Call: 1 888 822 3242, quoting 16092

*Weekly price based on a 12 week bundle subscription (print + app + web). After your first 12 weeks your subscription will continue at the full rate. You can cancel anytime before the first full payment and no further charges will be applied. Offer closes 15th March 2021.

JANUARY SALE
HALF PRICE
FOR 12 WEEKS

New Scientist.
The world, better understood

KYODO NEWS VIA GETTY IMAGES

People on the streets of Tokyo, where strict new measures are likely

Coronavirus

Global crisis worsens

Many countries around the world are seeing cases surge while others are having fresh outbreaks, reports **Clare Wilson**

CORONAVIRUS infections are on the rise in many countries around the world, with cases soaring in some nations and fresh outbreaks in several places where the virus was previously thought to be under control.

This week, England and Scotland began new lockdowns, joining Wales and Northern Ireland, which already had similar restrictions in place.

Without such action, the countries' chief medical officers warned that hospitals would become overwhelmed within 21 days. Hospitals in England are treating 40 per cent more covid-19 patients than during the peak of the first wave. Elsewhere in Europe, several countries, including Greece and Germany, are extending existing lockdowns.

The US is seeing recorded daily cases surge to their highest levels in the pandemic so far, at times over 250,000 a day, with California among the hardest hit. Some hospitals in the state are making plans for how to ration care, if needed.

Even nations regarded as managing the pandemic well and keeping case numbers low are seeing infections reach their highest levels yet. Thailand, which has recorded only 8900 cases of covid-19 so far, and just 65 deaths, has seen a rise in infections after an outbreak that reportedly started in a seafood market. New daily cases have reached a record high of over 800 and new restrictions have been imposed in over half of the country's provinces, including Bangkok.

Japan, which managed to contain its first and second waves, is now experiencing a third wave. On 5 January, it saw 8400 new cases, its highest daily total so far. The Japanese government is considering declaring a state of emergency in the Tokyo region, the worst hit area, which would involve new restrictions. It seems increasingly unlikely that Tokyo will be able to host the Olympics as planned in July.

Meanwhile, Australia has seen several small outbreaks in the past month, including clusters in Sydney and Melbourne totalling about 200 cases. The resurgence triggered strict new measures, including bans on travel between states.

Globally the outlook has worsened since the discovery of two variants of the coronavirus (see page 8). One was discovered in Kent in the UK, and seems to be much more transmissible than previous kinds. Because it causes more infections, this variant is likely to lead to more deaths.

"The UK government failed to bring in restrictions in September and that led to the surge"

"The [UK] government failed to introduce greater restrictions in September and that led to the surge in December, however, the new variant has clearly played a large role and that could not necessarily have been predicted," says David Hunter at the University of Oxford.

Another fast-spreading variant was discovered in South Africa in December, and seems to be largely responsible for a second wave there. The country's daily cases topped 17,000 in December, higher than during its first wave in July.

The race is now on to vaccinate as many people as possible. The first immunisations using the vaccine developed by the University of Oxford and pharmaceutical firm AstraZeneca began this week in the UK, the first country to administer the vaccine.

UK prime minister Boris Johnson said this week that if all went well, by mid-February the country should have immunised groups including those over-70 and those clinically extremely vulnerable, allowing schools to reopen.

Other nations have also been scrambling to deliver vaccines, after a slow start in several countries.

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

Evolution

Threats from new variants

Mutated forms of the coronavirus from the UK and South Africa are providing fresh challenges for controlling the pandemic, reports **Michael Le Page**

TOLGA AKMEN/AFP VIA GETTY IMAGES

SINCE the start of the pandemic, there have been concerns that the coronavirus could evolve to become more dangerous. Now, hospitals in the UK are at risk of being overwhelmed by surging numbers of covid-19 cases and there is growing evidence that this is partly due to a new variant of the virus that spreads more readily. This variant has already reached many other countries.

Hospitals in South Africa are also being overrun, due to a resurgence of covid-19 being blamed on another variant of SARS-CoV-2, the virus responsible.

It isn't yet clear how much faster this variant, called B.1.351, spreads. Yet initial studies of the variant from the UK, known as B.1.1.7, estimate that it is around 40 to 74 per cent more transmissible. This may be because people infected with it shed more of the virus.

In response to these initial studies and high UK transmission rates, England and Scotland this week joined Wales and Northern Ireland in another period of strict lockdown, during which most schools and universities will use remote learning.

"No matter how the virus changes, it needs us to be close enough to each other and to have interactions to let it jump between us," says Emma Hodcroft at the University of Basel in Switzerland. "If we don't give the virus those opportunities, it simply can't spread no matter what variant it is."

Neither new variant appears any deadlier. But there is concern that current vaccines could be less effective against B.1.351.

The new variants were discovered by sequencing the entire genome of the virus, which is around 30,000 RNA letters long. Researchers around the world routinely sequence samples to track the spread of the coronavirus and see how it is evolving.

Such efforts have found there are already tens of thousands of "mutant" viruses that differ from each other by at least one mutation. This is unsurprising as viruses constantly mutate.

In fact, the coronavirus changes less than many other viruses. Any two SARS-CoV-2 viruses from anywhere in the world will usually differ by fewer than 30 mutations, and they are regarded as all belonging to the same strain. Researchers instead talk about different lineages or variants.

"There is concern that vaccines could be less effective against the variant from South Africa"

B.1.1.7 was first sequenced in the UK on 20 September. It caught the attention of scientists on 8 December, when they were looking for reasons for the surge of cases in south-east England.

B.1.1.7 has 23 mutations compared with the original SARS-CoV-2 virus first discovered in Wuhan, China. Seventeen lead to changes in viral proteins. Many of these mutations have been found before and their overall number isn't unusual, but this combination is unique.

In particular, eight of the mutations in B.1.1.7 change the shape of the outer spike protein. One of these mutations, called N501Y, is in the part of the spike protein that binds to receptors protruding from human cells and helps the virus infect them – the receptor binding domain.

The N501Y mutation might help make the virus more infectious by binding more tightly to the human receptors. However, this can't be the whole story, as this mutation has been around for a while. It was first seen in Brazil in April and has since been detected in several other countries with no apparent effect on transmission.

So if B.1.1.7 is more infectious, it must be due to a combination of mutations. Lab studies are under way to try to understand the effects of its mutations, but, for now, the main evidence of higher transmissibility comes from the fact that it is spreading faster than other, older variants.

Normally, the only way to truly tell if one particular variant is spreading faster than others is to sequence entire viruses. But in one way, health authorities in the UK got lucky. The standard test for the coronavirus involves looking for

Guy's Hospital in London. UK health services are at risk of being overrun

any of three small parts of the viral genome. By chance, in some tests used in the UK, one of these parts is the region where one of the mutations in B.1.1.7 occurs, causing this element of the test to produce a negative result with the variant.

So by looking at standard test results that came back positive for only two of the three parts, called an S gene dropout, we have been able to get a better idea of how fast the variant is spreading in the UK than would be possible from genome sequence data alone.

Based on this, an initial analysis by Neil Ferguson at Imperial College London and his colleagues concludes that B.1.1.7 has "a substantial transmission advantage", spreading 40 to 70 per cent faster than other variants.

Another analysis, by Nick Davies at the London School of Hygiene & Tropical Medicine and his colleagues, put B.1.1.7's increased transmissibility at 50 to 74 per cent.

Preliminary numbers from Denmark also add to the evidence that B.1.1.7 spreads faster. So far, only 86 cases of the variant have been detected in Denmark. However, the percentage of B.1.1.7 in sequenced samples has risen every week for the past four weeks.

Meanwhile, a study of 600 nose or throat swabs by Michael Kidd at Public Health England's public health laboratory in Birmingham and his colleagues found higher than normal levels of the virus in 35 per cent of S gene-dropout samples – that is, ones from people who probably had B.1.1.7 – compared with 10 per cent of samples without S gene dropout. This suggests that B.1.1.7 is more infectious because people shed more viruses on average, but this has yet to be confirmed.

All this is bad news because it means tougher measures are needed. "Without effective control policies, rapid surges are predicted and the burden in the first six months of 2021 may be greater than what was seen in 2020," Davies tweeted before Christmas about the threat posed to England.

Early data suggested that B.1.1.7 might spread especially readily among children. It now appears that this was just an artefact related to schools being open during the second lockdown in England in November, says Davies.

Nonetheless, his analysis suggests that imposing a similar lockdown won't be enough to stop B.1.1.7. It will be necessary to close schools and universities too, as has largely happened in the UK.

The good news is that an initial study by Public Health England found that people infected with B.1.1.7 were no more likely to be hospitalised or to die than those infected with other variants.

The B.1.351 variant in South Africa also seems to cause higher transmission rates. In October, coronavirus cases began rising unusually fast in Nelson Mandela Bay Municipality. They soon started rising fast in surrounding areas too.

This prompted the sequencing of thousands of viral genomes to see if a new variant had arisen. That revealed the B.1.351 lineage, which, when first sequenced on 15 October, had various mutations including six in the spike protein. By the end of November, it had acquired another three in the spike protein. Only one of the mutations, the N501Y one, is the same as in B.1.1.7.

What is worrying some researchers is that B.1.351 has three mutations, including N501Y, in the receptor binding domain of the spike protein. This is an important region for immunity as well as infectivity because many of our antibodies work by attaching themselves to this region.

This might mean that vaccines confer less protection against B.1.351 than they do against other variants, but we just don't know yet. "It's all speculation still," says Áine O'Toole at the University of Edinburgh, UK. "We have no confirmation."

Lab studies are now under way to try to find out, for instance by measuring how well antibodies from people who have been vaccinated bind to these variants.

Meanwhile, other countries are trying to avoid importing the new variants, but it may be too late. B.1.351 has reached at least eight countries besides South Africa, including the UK and Australia, although it isn't reported to be spreading locally, says O'Toole, who is part of a team monitoring the variants' spread.

B.1.1.7 has reached at least 39 countries, including the US, China, Australia and New Zealand, and is definitely spreading locally in a few. So far, Denmark has reported the most cases besides the UK, but this is likely to be because it does more sequencing than most other countries.

More people from the UK travel to countries such as Spain and Germany than Denmark, O'Toole points out, so the expectation is that there should be more cases of B.1.1.7 in these places. "The virus moves with people," she says.

Both O'Toole and Hodcroft think other nations should do all they can to prevent more introductions of this new variant. This will help keep down the number of cases and make them easier to control, says Hodcroft. "The goal here is more to buy time," she says. ▮

40–74%

How much more transmissible the new coronavirus variant from the UK is thought to be

9

Number of mutations on the spike protein of the variant from South Africa

39

Number of countries that have reported cases of the variant from the UK

The resuscitation room of the covid-19 ward, Khayelitsha Hospital, South Africa

RODGER BOSCH/AFP VIA GETTY IMAGES

Symptoms

The significance of smell loss

The loss of smell and taste is one of the most consistent symptoms of covid-19, so what can that tell us about the condition, asks **Kayt Sukel**

A WEEK or so after Jackie Dishner lost both her sense of taste and smell, her diagnosis was confirmed – she had covid-19.

Dishner, an artist living in Phoenix, Arizona, knew that anosmia was a possible symptom of the disease, but she never imagined that after six months, most smells would still elude her, except perhaps the whiff of a particularly strong cup of coffee. She would also occasionally detect phantom odours.

Studies reveal that between 40 and 85 per cent of people with covid-19 experience the loss of their olfactory senses, making it one of the most consistent indicators of infection.

"Unfortunately, if you can't smell at the year mark, you probably won't get your sense of smell back"

Perhaps more importantly, anosmia often shows up days before more concerning, and sometimes life-threatening, respiratory issues. We are now building a picture of why the virus causes smell loss, how this symptom could be used for better diagnosis, and how likely people are to get their sense of smell back.

Certainly, other viruses, including those behind flu and the common cold, can diminish our sense of smell. But this tends to be because the airways are blocked by mucus, preventing air from reaching the olfactory receptors in the nose. The sense of taste is also affected because much of what we perceive as flavour comes from odour molecules in food. The issue then clears up, along with the other symptoms. The smell loss due to SARS-CoV-2, the virus that causes covid-19, is very different.

"You don't really see the same kind of nasal congestion with covid-19. Which raises questions: what molecular mechanisms might be leading to this smell loss, what does it mean and what does it tell us about this virus?" says Michael Xydakis, an ear, nose and throat surgeon with the US Air Force who studies anosmia.

JEAN-CHRISTOPHE VERHAEGEN/AFP VIA GETTY IMAGES

A nurse in France who experienced smell loss from covid-19 undergoes tests

Olfaction is a complex process. Each time we breathe in air, odour molecules from the environment travel up the nose to the olfactory epithelium. This small patch of tissue contains millions of specialised nerve cells that process smells. Each of these neurons is equipped with tiny hairs, called cilia, that reach through surface mucus to catch the odour molecules as they go floating by. The molecules can then be picked up by receptors on the olfactory neurons. When a particular odour molecule binds to a receptor on one of these cells, it triggers a neural signal that then travels on towards the brain.

Unique pattern

Each receptor is activated only by a specific odour molecule, so the resulting neural firing pattern is unique to that odour, allowing humans to differentiate between thousands of different smells.

In the past few months, we have started to build a picture of how SARS-CoV-2 infection leads to anosmia.

The nose provides an entry for any respiratory pathogen, including SARS-CoV-2. Some viruses, like polio, invade through the nasal passages and directly infect the olfactory neurons, damaging these cells and leading to a temporary or even prolonged loss of taste and smell.

SARS-CoV-2, however, works a little differently. We know that the virus enters cells in the lungs and other parts of the body via proteins called ACE2 receptors. Research by Andrew Lane at Johns Hopkins School of Medicine in Baltimore, Maryland, and his colleagues has shown that the virus also attaches to this protein on sustentacular cells in the nose, a type of cell that provides structural and metabolic support to the olfactory epithelium.

"It's a protein we see expressed in many places in the body, like the lungs and kidneys, which helps to regulate blood pressure," says Lane. "It also happens to be highly expressed in sustentacular cells and, for whatever reason, this virus uses that protein to gain access to those cells."

Once the virus enters these support cells, the immune system kicks in, triggering inflammation in the olfactory epithelium.

According to one recent study that looked both at covid-19 patients and at animals infected with SARS-CoV-2, the inflammation causes the olfactory neurons to lose their cilia. Without those little hairs waving odour molecules in, it is hard for these molecules to be picked up by the receptors on olfactory neurons. The sense of smell usually returns once

inflammation has dampened, and new cilia can grow.

This mechanism helps explain why, unlike with a cold, the smell loss with covid-19 is often sudden and severe. These properties might also make it a useful diagnostic tool.

"People tend to experience a very sudden loss of smell with this virus," says Valentina Parma, a chemosensory researcher at Temple University in Philadelphia, Pennsylvania. "It doesn't fluctuate over the course of the day, there's not a stuffy nose – your sense of smell is just gone. And this happens quite early in the course of the disease. This means it could be a diagnostic symptom."

Sniffing-out spread

Parma points out that many businesses as well as schools rely on temperature checks to help pick up positive cases. "But we see more smell-and-taste dysfunction in covid-19 cases than we do high temperatures, especially in the first few days after infection."

Parma and her team are working on a standardised smell test to help diagnose people with covid-19, or to at least identify those who should go on for further testing. They have found that using an objective test picks up around 30 per cent more infections than using self reports of anosmia.

However, even self-reported smell loss could help to flag the spread of SARS-CoV-2 throughout a population. In one study, Parma and her colleagues showed that reports of loss of smell and taste in a population predicted pressure on the healthcare systems in different communities, and might be a cheaper and easier way to track the spread of covid-19 than widespread testing.

There is little evidence that the loss of these senses can predict how bad a case of covid-19 will be, says Justin Turner at Vanderbilt University in Tennessee. "Patients with smell dysfunction tend to have less severe disease. They are less likely to be hospitalised or, if they are, to be intubated. But there are a lot of confounding variables," he says. "There's still a lot of work that we need to do to understand what relationship is there, if there even is one."

Typically, anosmia is short-lived. "The good news is that, for most people, once that inflammation clears up, within 10 days or so, smell comes back and everything is fine," says Beverly Cowart at the Monell Chemical Senses Center in Philadelphia. But some people, like Dishner, have sustained smell loss for months.

This area of research is pressing because the loss of smell and taste, particularly over the longer term, can be debilitating.

REUTERS/CHRISTINNE MUSCHI

The loss of smell means we can't tell if our food is delicious or has gone off

As well as affecting our enjoyment of food, the olfactory senses are protective, says Turner. Without them "you don't notice noxious or dangerous smells like smoke, gas or spoiled food. It's important to realise that anosmia can really affect people negatively, both in terms of the way they feel and in basic daily functioning."

It is possible that in some cases, the inflammation is severe enough to damage olfactory neurons, leading to long-term smell loss, says Cowart, but we don't yet know for certain.

"Unfortunately, if you still can't smell at the year mark, you probably aren't going to get your smell back," says Xydakis. "But we don't know what's happening there. These are questions that we are trying to answer."

Phantom smells, like those experienced by Dishner, are a good sign. It suggests that her olfactory system is recovering, with damaged neurons regenerating or rewiring themselves, says Mark Albers at Harvard Medical School. We are still some way off understanding the extent of damage to the olfactory system in both the short and long term, however. "There's a lot of interesting mechanistic biology that this virus is going to teach us," he says. "But it's going to take some time." ▮

"Without these senses, you don't notice dangerous odours like smoke, gas or spoiled food"

Smell tests for all?

Viral infection isn't the only condition that can alter our sense of smell, and the risk of developing a defect increases with age. Recent research also shows that smell loss, or anosmia, is an early symptom in neurodegenerative disorders such as Parkinson's disease and Alzheimer's disease.

"Olfactory circuits are pretty vulnerable circuits, so it's a place where the neurodegeneration pathology can manifest fairly early on," says Mark Albers at Harvard Medical School. "Knowing that this happens often a decade before any other symptoms offers us a window where we could diagnose people early and then provide interventions before too much damage is done to the brain."

Self reports regarding the ability to smell can be unreliable: many people may not be aware they are losing the sense because it happens gradually in many conditions. One solution is for doctors to regularly test patients with standardised smell tests.

"We have routine testing for the visual and auditory systems," says Valentina Parma at Temple University in Philadelphia, Pennsylvania. "We should be including routine smell testing in clinical practice, too. It could be extremely beneficial in identifying potential issues early, and in supporting the ageing population."

Human evolution

Ancient human remains may be a new species

Michael Marshall

A TREASURE trove of ancient human remains discovered in a cave in South Africa could give us a new picture of human evolution – and evidence of a previously undiscovered species.

Lee Berger at the University of the Witwatersrand in Johannesburg and his colleagues call the cave simply UW 105 because it is the 105th site they have identified. It is a short walk from the Rising Star cave, where his team discovered a new species called *Homo naledi* in 2013. The following year, the group found a fragment of a lower jaw with a single tooth in UW 105. They belonged to a hominin, but at the time the Rising Star excavation was a priority.

Then covid-19 happened and gave the team an opportunity to gather remains from UW 105. Berger estimates that his team has found between 100 and 150 pieces of bone there in the past few months, including bits of skull, shoulder blades, teeth and limb bones. He says there are at least four individuals, of which one seems to be an adult and two are juveniles.

They aren't modern humans, nor are they *H. naledi* or *Australopithecus sediba*, the other species Berger's group has discovered. The teeth are too big for any of those.

Berger says the teeth look similar to a molar found in the nearby Gondolin cave thought to belong to *Paranthropus robustus*, a big-bodied hominin that lived between 1 and 2 million years ago. Its large teeth may have been used for chewing tough plants like grass.

LEE BERGER

A wealth of human remains have been found in Cave UW 105

Large teeth have been thought of as "primitive", so this might suggest that the owners of the big teeth in UW 105 belong to an early species, but Berger says estimating age based on shape is "a fool's errand". Evolution doesn't go in straight lines, he says, so sometimes seemingly primitive traits can emerge in recent species. He points to *H. naledi*, which had a skull only slightly larger than that of a chimpanzee, yet lived just 250,000 years ago.

Instead, Berger is waiting for the results of independent dating analyses. The fossils all originated in a layer of rock in the cave that is covered by flowstone: a layer formed when minerals were deposited by flowing water. It should be possible to determine the flowstone's age, giving a minimum age for the fossil-bearing rock.

LEE BERGER

A human-like tooth discovered in cave UW 105

It is too early to say whether the remains are of a new species of early human or a known one, but they seem unlike anything else known. Tracy Kivell at the University of Kent, UK, one of Berger's regular collaborators, says that both the back and front teeth are large, unlike with *P. robustus*, which only had big back teeth. Also, the bones from the rest of the body are relatively small, suggesting a slim build, which is unusual for a large-toothed hominin.

"To me, that suggests a different way of adapting to one's environment," says Kivell. "Even if they look fairly similar, things that adapt to their environment in different ways are probably different species. Based on the little information we have for now, I would say it's looking like it's heading in that direction." ▮

Animals

Birth control helps koalas avoid death by starvation

Donna Lu

KOALAS in parts of Australia have been sterilised and given long-term contraceptives to tackle overpopulation and the loss of key trees they feed on – and it seems to have worked.

David Ramsey at the Arthur Rylah Institute for Environmental Research in Melbourne, Australia, and his team analysed the effect of two fertility control programmes on koala populations in areas where the animals have bred too successfully, risking starvation as numbers outstripped food supply.

The researchers studied a programme that was implemented between 2004 and 2013 in Budj Bim National Park, Victoria, in which female koalas were captured and treated with an implant of levonorgestrel hormone, a contraceptive that usually lasts for 10 to 12 years. They also looked at a sterilisation programme on Kangaroo Island, South Australia, between 1997 and 2013.

In some Australian states, such as Queensland and New South Wales, koalas are listed as a vulnerable species. But in parts of Victoria and South Australia, populations have increased to such high densities that the trees they feed on are at risk.

Koalas prefer to eat the foliage of only a few species of eucalyptus trees – the manna gum (*Eucalyptus viminalis*) in particular, found only in south-east Australia. Overbrowsing of manna gums – eating of all leaves on a specimen – kills the trees.

Overpopulation has previously led to koala starvation and drops in their numbers in some areas – with more than 70 per cent of koalas dying in one case. The team found that the fertility efforts led to the recovery of manna gum trees with light or moderate defoliation, and significantly cut tree deaths in Budj Bim National Park, meaning more food for the animals (*Biological Conservation*, doi.org/fpc6). ▮

AN IMPORTANT MESSAGE FROM PROFESSOR NICK LEMOINE MD PHD FMEDSCI, CHAIR OF THE MEDICAL RESEARCH FOUNDATION

Gifts in Wills could be the key to protecting the future of human health

Our experience of COVID-19 shows how suddenly a global health challenge can appear. As someone interested in science, you will understand that while nobody can predict what we will face next, we can be certain that the future will bring many more threats to human health.

As Chair of the Medical Research Foundation – the charitable arm of the Medical Research Council – I have seen the incredible impact that individuals who remember the Foundation in their Wills can have on the future of our health and wellbeing here in the UK. These gifts fund research and researchers which can have far-reaching implications for human health.

With a gift in your Will you can play a key role in providing the science that will protect the health of future generations.

Right now, the Foundation is funding research to tackle antimicrobial resistance, and investing in researchers like Dr Myrsini Kaforou – who will make the fight against antimicrobial resistance her life's work.

Without support at the crucial early stages, researchers like Dr Kaforou can be forced to abandon their passion and leave science altogether, with an immeasurable loss to future human health. Gifts in Wills provide the long term funding and security that allows the Foundation to invest in projects like Dr Kaforou's and lay the foundations for quality research in years to come.

"As scientists, our duty is to secure the future of research for the generations that follow."

Professor Fiona Watt, President of the Medical Research Foundation and Executive Chair of the Medical Research Council.

Your Will can fund the rational response to health challenges that medical science provides.

While we don't know what the future holds for human health in the UK, we do know that research, and the brilliant scientists driving that research forward, are the key to meeting those challenges for years to come.

"The funding I received through the Medical Research Foundation will be transformative for my research." Dr Myrsini Kaforou

But many of these scientists rely on the generosity and foresight of fellow members of the public – people like you, who understand the power of science and are willing to leave a gift to medical research in their Wills. At the Medical Research Foundation, over 90% of our voluntary income comes from individuals who choose to include a gift in their Will – they are crucial in the Foundation's ability to fund research that will enable the next generation of scientists to make real world discoveries in the future.

I firmly believe that a gift in your Will to the Medical Research Foundation is an excellent investment and will have a lasting impact on science and on the future of human health in the UK.

Please consider this very special gift today.

Professor Nick Lemoine MD PhD FMedSci
Chair of the Medical Research Foundation

Get your free guide to supporting research in your Will.

To request your free guide to gifts in Wills fill in this form and return to Freepost, MEDICAL RESEARCH FOUNDATION.
You don't need a stamp **OR** visit **medicalresearchfoundation.org.uk/support-us/wills**

Name _____

Address _____

_____ Postcode _____

Email address _____

Medical Research Foundation

Registered with FUNDRAISING REGULATOR

We would like to contact you from time to time with our latest news. Please tick here ☐ if you are happy for us to contact you via email. The Medical Research Foundation does not share your personal information. You can unsubscribe at any time. For further information on how we collect, store and process your personal data, please read our Privacy Notice medicalresearchfoundation.org.uk/privacy

Interview: Rosamund Kissi-Debrah

‘Ella’s law’ for clean air would honour her

Rosamund Kissi-Debrah, whose daughter Ella has become the first person in the UK to have air pollution listed as a cause of death, speaks to **Adam Vaughan**

A LANDMARK inquest has finally put a name and a face to the human cost of air pollution – estimated to kill up to 36,000 people in the UK and 7 million globally each year. On 16 December, a UK coroner found that the death in 2013 of 9-year-old Ella Kissi-Debrah was caused by asthma that was contributed to by exposure to “excessive air pollution” in London, the first

“I would want her to be remembered for how funny she was. How caring she was”

time this has been listed on a UK death certificate, which could have wide-ranging consequences (see “Legal action”, below).

The decision marks the end of a seven-year journey for her family. Her mother, Rosamund Kissi-Debrah, spoke to *New Scientist* shortly after the verdict.

Adam Vaughan: How are you feeling?
Rosamund Kissi-Debrah: Shock, really. It’s so enormous, you can’t really take it in. It will take a while, because I’m like that, I just don’t rush these things. I feel relief that it’s finally happened, but I didn’t wake up feeling like a different person. There was never going to be any big celebration. This was about getting justice and getting it on her death certificate. There was nothing to celebrate, but there was a sense of victory.

What is the significance of having it listed as a cause of death?
One of Ella’s doctors felt respiratory failure did not really do her justice. It does not say to us what she has been through. The filthy air she was breathing in was suffocating her, and ultimately she died, so that needs to be on her death certificate. I wasn’t really interested in people saying, “Oh, no one’s done this before”. This is my daughter, this is what happened to her and we have proved it, so this is what she should get. As a mother, you would want the real reason your child died on their death certificate.

What do you hope the wider impact of this verdict will be?
1952 was the last time we had a new clean air act. [A new act] might be too much to ask for, I don’t know. We will consider all sorts of things.

What do you think of the idea of an “Ella’s law”?
That would be a deep honour to her. If it would save lives, I would do everything I can to campaign for it. It’s all about saving lives. Anything I can do for no child to go through what she went through I’m more than happy to support.

Now the inquest is over, will you keep campaigning on air quality?
Now I can say what I truly want, you’re damn right I will. I need to talk to some people in parliament about WHO [World Health Organization] targets in the new environment bill. In order for me to take it seriously, they need to enshrine it in law.

HOLLIE ADAMS/AFP VIA GETTY IMAGES

Rosamund Kissi-Debrah is campaigning to raise awareness about asthma and air pollution

What would Ella have made of this?
She knew regarding her asthma she was going to be in the medical books. Her asthma was so severe and so rare. What was her response? Cool. What would she make of this? The type of person she was, if you showed it would save lives, she would like that. One other thing is she liked being popular with her siblings and friends. One of the things she used to worry about is they might forget her and move on. From that point of view, the fact people will remember her for something good, she will take that. The sad thing is she never got to live out her dream of flying.

How would you like Ella to be remembered?
I would want her to be remembered for how funny she was. How caring she was – she was always bothered about other people, she would help someone to read in her class. She loved her friends, she was incredibly loyal. How bright she was. Her sense of duty, she went to Beavers, Cubs, wanted to go to Air Cadets. Also, a very serious side to her. She used to play chess. She used to laugh, and that smile... To remember her as a happy child. As I said to her, sometimes bad things happen to good people. ▮

Legal action

The UK is divided into 43 areas for air quality monitoring purposes, and three-quarters of these areas breach annual mean legal limits of nitrogen dioxide, a toxic gas that comes mostly from diesel vehicles. Of these areas, only London has implemented a clean air zone (CAZ) so far, with charges to discourage the most polluting vehicles.

“It’s these zones that have been shown to be the most effective way of tackling the problem,” says Katie Nield at ClientEarth, an environment law group that has successfully challenged the UK government in court over the rate at which it is acting on toxic air. Cities including Leeds, Nottingham and Southampton rejected CAZs, while Oxford and Birmingham have used the covid-19 pandemic as justification for delays to theirs.

Nield says the verdict on Ella’s case should make the government take notice. “It is really quite momentous,” she says. Nield hopes the inquest’s conclusion will trigger renewed public and political pressure to stick within existing limits that the UK has breached for a decade – and to set targets to meet even tougher World Health Organization guidelines.

Tissue engineering

Growing cells on bread

Last year's home baking frenzy inspired a tissue scaffold for cultivating muscle

Michael Le Page

ALL that pandemic baking has produced more than just delicious bread. It also inspired a team of tissue engineers to try – and succeed at – using bread as a scaffold for growing cells. One potential use for such scaffolds could be for growing meat in factories for food.

Many groups around the world are working on ways of growing living tissues and organs outside the body for treating all kinds of disorders. For instance, in China, five children born with an underdeveloped ear have been given replacements grown from their own cells.

A common way of doing this is to "seed" a scaffold with cells. Such scaffolds are typically made from the protein collagen, which is a supportive material found in our bodies. But collagen scaffolds are expensive, as well as potentially problematic because they usually come from animals or cadavers.

Andrew Pelling at the University of Ottawa in Canada and his team have been experimenting with several plant-based alternatives. In 2016, they grew human ears using apples as scaffolds. These were carved into the shape of ears and all the living cells were removed, leaving cellulose scaffolds that were seeded with human cells.

Now, Pelling and his colleagues have used bread as a scaffold. They baked it, removed small portions, sterilised them by soaking them in alcohol and then seeded them with various cells from mice.

The first attempts resulted in a soggy mess, as did all the efforts with gluten-free recipes. Irish soda bread turned out to work the best, though the researchers did have to reinforce its structure by treating it chemically to create more cross-links between the bread's fibres.

The team found that several cell types, including skin, muscle and bone cells, can infiltrate the soda bread scaffolds and proliferate (bioRxiv, doi.org/fpck). "It's remarkable to me how human and animal cells have this capacity to grow in really odd, artificial environments," says Pelling.

He is now planning further studies to investigate whether these tissues can be safely implanted in animals and could therefore have medical uses.

"It is very interesting and innovative work," says Glenn Gaudette at Worcester Polytechnic Institute in Massachusetts. "While there are still many studies needed to determine if bread is a viable scaffold, this innovative thinking by Pelling can help push the field in new directions."

In addition to medical applications, the use of bread as a scaffold could have implications for cultured or lab-grown meat, says Gaudette. For industrial purposes, keeping costs down will be crucial, so a cheap, edible scaffold would help.

Irish soda bread works well as a scaffold for growing tissue

ALPAKSOY/GETTY IMAGES

While bread-based tissue engineering might sound rather implausible, an even more unlikely sounding project based on one of Pelling's plant materials is looking very promising: treating spinal injuries with asparagus. Pelling's team has shown that rats whose spinal cords have been completely severed can recover some movement after plant capillaries extracted from asparagus are implanted.

Pelling stresses that the asparagus method isn't a miracle cure and others have achieved similar results in rats. Yet the big advantage is that it doesn't require using living cells, making it much cheaper and simpler than many other approaches. In October 2020, the US Food and Drug Administration designated the implant as a "breakthrough device", which speeds up the process of starting human trials. ▮

Climate change

Fish are shrinking as they feel the heat of warmer waters

FISH are now smaller as adults after a rise in temperatures in the seas off the UK.

Idongesit Ikpewe at the University of Aberdeen in the UK and his colleagues have found that warming waters are linked to changes in fish size. They looked at trends in four commercially caught species of cod, haddock, whiting and saithe in the North Sea and off the west of Scotland.

The team analysed existing data for these fish between 1970 and 2017, looking specifically at the average length-at-age – a measure of the mean length of a species for each year between the ages of 1 and 7.

The four species spend most of their time near the sea floor, so the researchers compared the length-at-age with annual water temperatures at the seabed in the two areas that were studied. They found that as temperatures rose, average adult length fell (*Journal of Applied Ecology*, doi.org/fpc5).

The team also found that the length-at-age of juvenile fish – those younger than 4 years of age – had increased and was correlated with rising temperature.

Lab studies have found that ectotherms – animals, including fish, that rely on heat from their environments – develop faster at warmer temperatures and reach smaller maximum body sizes, so the findings are in line with expectations. The change is due to an increase in metabolic rate that means younger fish grow faster and reach maturity earlier. Most of their energy is then channelled from growth into reproduction.

"We would expect to see continued changes in fish size with further rises in sea temperature"

"We would expect to see continued changes in fish size and growth changes with further rises in sea temperature," says Ikpewe. The decrease in adult body size is likely to reduce yields for commercial fisheries and may have effects on predator-prey interactions, he says.

The researchers plan to look at whether faster-growing juveniles help compensate for this. ▮

Donna Lu

Archaeology

Stonehenge scuffle

Protecting prehistoric monuments will always involve trade-offs, but has the UK government got it right this time, asks **Michael Marshall**

A PUBLIC row has broken out among archaeologists over the UK government's decision to allow the building of a road tunnel close to Stonehenge, a protected prehistoric monument in Wiltshire. The tunnel is intended to replace a congested road that disrupts the landscape around the site, but some argue that the plans will cause irreparable damage to archaeological deposits. While digging near ancient history may seem like an obviously bad idea, the case isn't clear-cut.

Stonehenge is a ring of standing stones surrounded by an earth bank and ditch that was probably erected between 3000 and 2000 BC. It has long been protected by British law, and it was listed as a World Heritage Site by UNESCO in 1986, meaning it is protected by international treaty.

UNESCO forbids any sort of damage to the sites it protects, but Stonehenge has a problem. A major road, the A303, was built long before the 1986 listing and runs right past the monument, spoiling the uninterrupted landscape in which Stonehenge was originally situated. "It's just appalling," says Mike Pitts, an archaeologist and author of *Digging Up Britain*.

The UK government's solution is essentially a form of corrective surgery, replacing the road with a 3.3-kilometre tunnel under the World Heritage Site. It was approved by UK transport secretary Grant Shapps on 12 November 2020 against the recommendation of planning officials.

Like any kind of surgery, some damage is inevitable, which is why the plan takes precautions. Before the tunnel is dug, a consortium of archaeologists led by heritage company Wessex Archaeology in Meopham, UK, will conduct detailed surveys, sampling and excavations along the route, with the aim of ensuring that no significant sites or artefacts are destroyed. The team has already carried out surveys as part of the route's approval process.

PAUL CHAMBERS/ALAMY

The A303, a road running past Stonehenge in the UK, is often congested

3.3km

Length of the proposed tunnel under Stonehenge

"In an ideal world, the A303 would never have been built and we'd never have this problem," says Andy Crockett at Wessex Archaeology. "I genuinely do believe that this is the most appropriate, best scheme that's been prepared."

So if the tunnel will remove the problematic A303 from the Stonehenge area, restore the landscape and improve traffic flow, and a team of archaeologists will be on hand to oversee any artefacts that may be uncovered, why are other archaeologists mounting a legal challenge against the plans?

Critics argue that the tunnel isn't long enough to prevent damaging the World Heritage Site, and that the archaeological plan – while ambitious – doesn't offer enough protection.

"In all of its incarnations as the scheme has developed, the tunnel has never been adequate for the length of the World Heritage Site, which is just over 5 kilometres long," says Mike Parker Pearson at University College London. As a result, the entrances of the tunnel will be inside the site, meaning surface digging will have to take place within the boundaries.

There is no risk to Stonehenge itself, because the entrances will be well away from it. But the entire area within and surrounding the World Heritage Site is dotted with archaeological remains. Most criticism relates to the area around the western tunnel entrance.

One such site is Normanton

18+

WHAT IS AVAXHOME?

AVAXHOME-

the biggest Internet portal, providing you various content: brand new books, trending movies, fresh magazines, hot games, recent software, latest music releases.

Unlimited satisfaction one low price
Cheap constant access to piping hot media
Protect your downloadings from Big brother
Safer, than torrent-trackers

18 years of seamless operation and our users' satisfaction

All languages
Brand new content
One site

AVXLIVE.ICU

AvaxHome - Your End Place

We have everything for all of your needs. Just open https://avxlive.icu

Down, which hosts a set of burial mounds from the Bronze Age (2000 to 700 BC). There is a single long barrow, or burial mound, surrounded by 18 round barrows. "It's little known and visited, because it's such an unpleasant location because of the roads, but for archaeologists, it's an iconic location," says Pitts.

"Something like 90 per cent of the remains of the prehistoric people and their activities from the time of Stonehenge are actually in the very surface layers of soil," says Parker Pearson. But most of these artefacts will be fairly standard stone tools and only a small fraction can actually tell us anything we don't already know about this period. "Because 2 per cent of the sample is what's important to us, you have to have very high sampling proportions of that plough soil," he says. He adds that the planned sampling of the soil is insufficient.

Others argue that such meticulous sampling would be overkill. "The flint artefacts are useful only inasmuch as they tell you people were there at a particular time," says Pitts. "Actually, we know there were people in the landscape at Stonehenge in the Neolithic and Bronze Age. We don't need the arrowheads to tell us that."

Think of the future

Parker Pearson says we should consider future archaeologists along with the soil loss. "Once it's gone, it's gone for good," he says. "And it means no future researchers will ever have the opportunity to bring to bear new methods, new technologies, once that resource is removed."

Even in the east of the World Heritage Site, archaeologists are raising concerns. One place highlighted is Blick Mead: a hot spring that was inhabited for thousands of years in the late Stone Age. Since 2005, archaeologists led by David Jacques at the University of Buckingham in the UK have uncovered thousands of stone artefacts and bones there. "It looks as though we've got what's called

"In an ideal world, the A303 road would never have been built and we would never have had this issue"

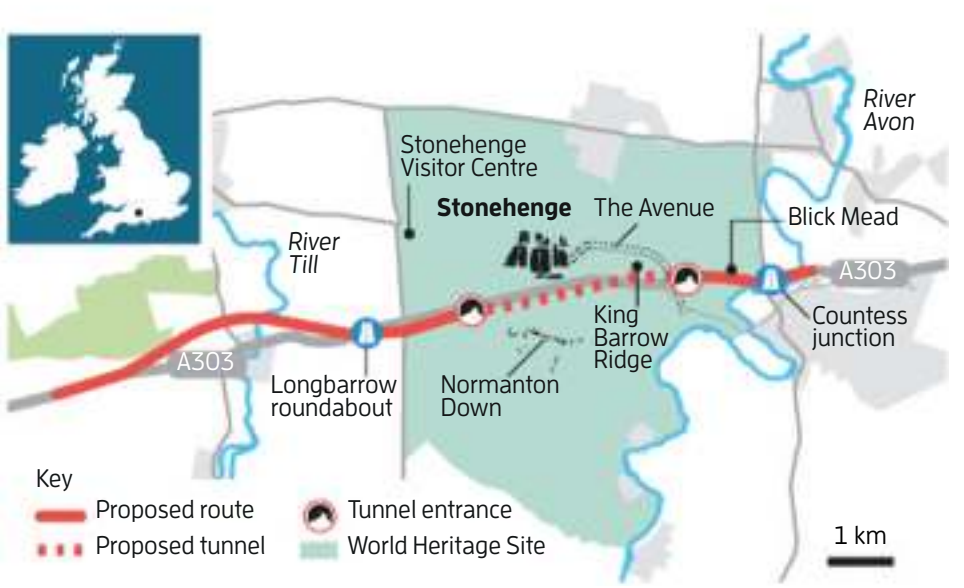
a home base," says Jacques. This is a place that people regularly visited for a long time. Radiocarbon dates indicate that people were there between 8000 and 3600 BC, a timespan longer than the existence of London.

The people at Blick Mead were hunter-gatherers, but the dates indicate that they lasted long enough to live alongside the first farmers, says Jacques. Furthermore, in unpublished results, the team has obtained DNA from the remains of plants preserved in the water of the spring. "We got 43 different plant species," says Jacques, which date to between 7500 and 4700 BC. This means Blick Mead preserves information about an earlier phase of the Stone Age, the Mesolithic, as opposed to the later Neolithic, making it the only site in the area known to do so.

Jacques is concerned that Blick Mead will be irreparably damaged by the project. "We are within 10 metres of where the flyover is going to be built," he says, describing it as "a real rough position". The water table in the area is only 8 centimetres deep, so large-scale digging nearby could disrupt it, he says. "We've got nationally important organic remains preserved by that water table, and they're going to be damaged and destroyed."

UNESCO condemned the proposed tunnel in July 2019 and considers the scheme a potential threat to the World Heritage Site. The International Council on Monuments & Sites UK condemned Shapps's decision to proceed in a statement issued on 16 November 2020. They noted that the government's own Planning Inspectorate, in a report published on 2 January 2020, recommended that the scheme not go ahead in its present form – but was overruled by Shapps. Opposition is being coordinated by the Stonehenge Alliance, a group of non-governmental organisations and individuals.

Many argue that the problems could be largely solved by extending the tunnel further west, so the western entrance is outside the World Heritage Site. Parker Pearson and Jacques both support that idea, yet Pitts argues there are problems with it, too. "There's no one point at which you would say, here we want to stop the tunnel because after that, there's no significant archaeology," he says. "You can carry on like this for miles and miles and miles."



A range of views

The tunnel entrance was chosen so it is on a slope, falling away from Stonehenge, says Duncan Wilson, chief executive of Historic England, a UK government body. "You won't see it from the stones themselves." Such sites are few and far between. Wilson notes that the current plan will move the Longbarrow Roundabout, which is unacceptably close to the Normanton Down burial mounds, to a less disruptive area.

For Pitts, the debate is too narrow. "All the focus is on the loss, and people are not recognising the gains," he says. He points out that in the eastern side of the World Heritage Site, the A303 currently runs right through the Avenue, a long earthworks construction that connects Stonehenge to the River Avon. This route could be restored if the tunnel is built. Removing the road will also improve the view from nearby King Barrow Ridge, which has its own burial mounds. "The amenity value, the visual, the atmospheric value of that group of burial mounds would be completely transformed," he says.

But here the UK's planning rules, which emphasise cost-benefit calculations, run up against UNESCO's no-damage approach. Ultimately, one side will have to budge. "There is no ideal solution," says Pitts.

New Scientist
Jobs

2021 STEM MARKET SURVEY HAVE YOUR SAY

New Scientist **in association with SRG is conducting an annual survey to provide you with insights into the STEM industry. We'll benchmark salary, as well as important issues including the impact of covid-19, discrimination and employment satisfaction. Take part in the survey to be part of the conversation!**

As a thank you for completing the survey you'll have a chance to win one of five £100 (or local currency equivalent) Amazon vouchers.

To take part visit
newscientist.com/stemsurvey

IN ASSOCIATION WITH

srg

Comment

A transport revolution

More than 100 cities already provide free public transport for their residents. Many other places should get on board, says **Richard Webb**

Richard Webb is executive editor at *New Scientist*

MICHELLE D'URBANO

ROUND where I live, heady pronouncements of a green transport revolution spurred on by the coronavirus pandemic have vanished in puffs of exhaust. In the London suburbs, the promised step change in provision for cyclists and pedestrians has amounted to authorities blocking off a few roads, to the vocal opposition of some.

Many people seem to be voting with their feet – on the gas pedal. According to data analysed by the Environmental Defense Fund Europe, traffic congestion in outer London rebounded to above 2019 levels soon after the first lockdown as people shied away from buses and trains for fear of infection.

Those shifts look to be global – and permanent, too. A survey run for the YouGov-Cambridge Globalism Project revealed that, in Great Britain, 23 per cent of people expect to be using their cars more after the pandemic. In Australia and the US, already more car-dependent than the UK, the figures are over 40 per cent, despite high levels of concern about climate change expressed in the same survey. Meanwhile, the pandemic has driven a coach and horses through the finances of public transport operators.

These fundamental changes to the transport landscape demand a far-reaching rethink, in particular of our attitude to public transport. It has never been a money-maker. Post-covid-19, it will be even less so. The question is whether it ever should be.

Within the European Union, transport contributes some 27 per cent of overall carbon dioxide emissions, almost half of that from private car use. It is the only sector that has seen CO_2 emissions rise over the past three decades, by over one-quarter.

Meanwhile, the Organisation for Economic Co-operation and Development reckons that, by 2060, air pollution will cause between 6 and 9 million premature deaths globally a year, and lop about 1 per cent off global GDP – around $2.6 trillion.

These huge "externalities" are insufficiently factored in to our thinking on transport. Wishing away the car isn't an option. Paying for top-notch public transport, particularly in high-density urban areas, is.

Besides accessibility, the problem of public transport is its high marginal cost. Once the fixed costs of owning a car are paid, the marginal cost of using it is typically low. Public-transport fares calibrated purely on the costs of provision, rather than the wider environmental and public health costs of not using it, provide little incentive to consider alternatives.

Some cities are already thinking radically. Worldwide, more than 100 provide free transport for residents, among them Dunkirk in France, Tallinn in Estonia and a sprinkling in the US, as well as the entire country of Luxembourg.

A perhaps more sustainable model for larger cities is provided by Vienna, Austria. Since 2012, a pass giving unlimited access to public transport there has been available for a modest annual flat fee of €365 – a euro a day. Nearly half the city's population of almost 2 million has one, and 38 per cent of all journeys are made by public transport – with walking pushing the car into third place, accounting for just 27 cent of trips.

Vienna's experience, now being eyed with envy by other European cities, shows how high-quality, affordable public transport provision can kick off a virtuous circle. Fewer cars on the road makes alternatives, including walking and cycling, more attractive, too. That improves health and quality of life and breaks down social barriers – socially disadvantaged groups are less likely to own a car and more likely to spend a higher proportion of their income on getting around.

Public transport is a public good, just like health and education are. The covid-19 pandemic provides an opportunity for enlightened authorities to start seeing it, and paying for it, that way. ▮

Field notes from space-time

The origins of galaxies

All galaxies started out as quantum fluctuations billions of years ago, but the forms they take today are incredibly diverse, writes **Chanda Prescod-Weinstein**

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

Chanda's week

What I'm reading
I am pretty excited about the Black Futures *collection of writing and art, edited by Kimberly Drew and Jenna Wortham.*

What I'm watching
I recently got into the horror show NOS4A2.

What I'm working on
My students did final presentations on the Hubble tension, and grading them has been a pleasure.

This column appears monthly. Up next week: Graham Lawton

IN THE early universe, there were constantly random quantum fluctuations, particles flickering in and out of existence. Some of them stuck around, and today we live with what those remainders have become, including galaxies.

All quantum fluctuations are essentially alike, and those that randomly occurred everywhere in the early universe were impossible to distinguish from one another. Yet, 14 billion years later, each galaxy is a structure with its own unique features and it is very easy to tell the difference between our home – the Milky Way – and, say, an elliptical galaxy. In other words, all galaxies have a shared origin in quantum fluctuations that occurred in the early universe, but the galaxies we see in the sky are incredibly diverse in the forms that they take.

Categorising galaxies based on their shape is a practice known as galaxy morphology. In 1926, Edwin Hubble (yes, of the Hubble constant!) introduced a classification scheme based on galaxies' appearances.

In his system, Hubble identified three kinds of galaxies. The two better known types are spirals like the Milky Way – which have a central bulge and spirals orbiting it – and ellipticals, which look like an ellipsoid or, more colloquially, a three-dimensional oval. The ones that you are perhaps least likely to have heard of are lenticular galaxies. These have a spheroidal bulge at their centre, with a visible disc around it.

To this day, astronomers still use a morphology classification scheme that was based on Hubble's: a system developed in the 1950s by Gérard de Vaucouleurs. One extension that de Vaucouleurs introduced was the "irregular" class of galaxies.

He also deepened the spiral category by identifying subcategories: bars, rings and those with different types of spiral arms. By looking for patterns and differences, astronomers have come to understand that galaxies are quite diverse, despite sharing humble origins in small fluctuations.

Of course, being able to see that galaxies have lots of different structures is one thing. Being able to explain why is something completely different.

Today, understanding how galaxies became so diverse is an active field of research.

"Knowing how galaxies got to be the way they are means understanding what dark matter is and how it behaves"

In the years since de Vaucouleurs came up with his system, Vera Rubin and Kent Ford provided the first substantial evidence for the existence of dark matter, adding another ingredient to the equation.

Measurements of cosmic microwave background radiation are the strongest signs we have of the existence of dark matter, and indicate that there is so much of it in the universe that it must play a major role in the formation of large-scale structures, such as galaxies. Therefore, knowing how galaxies got to be the way they are requires understanding what dark matter is and how it behaves.

As regular readers know, this particular question has captured my attention and it is one that I am currently devoting my career to answering. Yet, as elusive and fascinating as dark matter is, it is only one part of the conversation about structure formation – and the fact is, there is still much we don't know about luminous matter.

When we talk about luminous matter in the context of galaxies, we mean stars for the most part, since, at the end of the day, the visible part of a galaxy is a collection of stars and dust. To understand the evolution of a galaxy, therefore, is to understand, in part, the histories of its stellar populations. Our understanding of galaxy evolution is dependent on our models of stars.

One example of how the two types of work are entwined is a paper led by Lauren Porter that appeared in the December 2014 issue of the *Monthly Notices of the Royal Astronomical Society*. Porter – then a graduate student at the University of California, Santa Cruz – and her team of collaborators used computer simulations to study the formation history of elliptical galaxies by looking at the age and metallicity of their stellar populations.

Ellipticals, like lenticulars, tend to have older, redder stars, indicating that these galaxies are from an earlier time in the universe. Because it takes a generation or two of stars to make heavier elements (as discussed in an earlier iteration of this column), elliptical galaxies' stars are also likely to have lower metallicity – elements present that are heavier than hydrogen or helium.

In their paper, Porter and her colleagues find that there is a correlation between how fast stars are moving inside a galaxy and how long it took that galaxy to form. In other words, although galaxies have shared origins, where they end up depends greatly on the constituents that they begin with. ▮

Signal Boost

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

How outdoor learning encourages scientific enquiry

The Field Studies Council is an environmental education charity welcoming in the region of 150,000 learners a year to its network of 20 plus centres. Our aim is to inspire everyone to become curious, knowledgeable, passionate and caring about the environment through practical scientific learning.

There is no substitute for first-hand experiences. Spending time outdoors sparks understanding, enjoyment and curiosity in science subjects and scientific inquiry. Studying unpredictable nature develops practical, problem solving skills. Dealing with complex, messy data and adapting to the unexpected are essential to equip learners for the fourth industrial revolution. Whether it's defeating viruses or tackling climate change, early engagement with subjects through outdoor learning is vital.

Furthermore, learning outdoors in the field plays an important role in helping to develop personal and social skills, maintaining health and wellbeing and providing inspiration for creativity.

Each year, FSC's charitable activities connects people with nature and science and provides them with vital scientific skills through its programme of courses, residential trips and projects.

At FSC, we find that young people need the most support to access outdoor learning. Unfortunately, every year demand for FSC experiences far exceeds the charitable funds we receive from grants and fees.

As with many charities, the coronavirus pandemic has hit FSC hard. The crisis poses a real threat to funding and outdoor learning at a time when children and young people need it the most to support health and well-being.

There is widespread concern that outdoor learning opportunities for all children to do practical hands-on science may disappear as a result. This is particularly worrying for the more disadvantaged. We predict there will be an even greater need to support schools and families to access outdoor learning post-pandemic.

This is why we have set up a new online donation facility. Every pound donated will help FSC deliver high quality fieldwork in science and geography-related subjects across the UK and share our renowned educational resources and publications.

Money raised will help us support people every step of the way at our learning locations and where they live, study and work. It will help us to continue to inspire everyone to be curious, knowledgeable, passionate and caring about our environment.

Want to help?

For further information about FSC please visit the website field-studies-council.org

Editor's pick

A possible problem with festive virus strategies

12 December 2020, p 12

From Christine Duffill, Southampton, UK

Which of the different approaches to coronavirus for the festive season in Europe will have worked best? The most important factor at play will have been psychology.

The first wave of the virus was governed by fear, trust in science and broad compliance with the rules. Yet after a year of lockdowns and restrictions for most people in Europe and North America, the pent-up desire to see loved ones and friends was huge, while failed promises and wrong predictions caused public trust in governments following "the science" to suffer.

There may have been little difference between countries over Christmas because people were largely making and following their own rules by then.

Cashing in on fossils has long been a problem

28 November 2020, p 23

From Geoffrey Cox, Rotorua, New Zealand

The sale of valuable fossils to the highest bidder is unfortunate, but not new. In 1861, when the first largely complete *Archaeopteryx* fossil was discovered, it was quickly acquired by collector Karl Haberlein, who made his fortune a year later when he sold it to the British Museum, with the rest of his collection, for £700 – a lot of money at the time.

About 15 years later, his son acquired the next *Archaeopteryx* fossil and made a packet selling it to a musuem in Berlin.

Empathy isn't necessarily always a good thing

5 December 2020, p 34

From Matthew Tucker, Sydney, Australia

To lead a country, large business or institution, you need people skills, often in a Machiavellian way. This means you must be good at understanding other people's minds – in other words, you need a high degree of empathic ability.

So, if Simon Baron-Cohen is right and there is a biological trade-off between empathy and systemising ability, the best innovators and problem-solvers aren't the people who have climbed the corporate or political ladders, but the people who are literally unable to do so.

From John Davnall, Manchester, UK

The assertion that the bone flute was "the beginnings of music" cannot go unchallenged. Humans can make music through their vocal cords, so no instrument is needed at all.

More views on the population debate

14 November 2020, p 34

From Ronald Gibson, Irvine, California, US

Your article on overpopulation is too little and definitely too late. I once had the chance to ask M. King Hubbert, he of peak oil theory fame, if he thought we had enough time to salvage our future, considering overpopulation and its effects on the planet's diminishing geologic resources and increasing environmental problems. His reply: oh no, to dock a large ocean liner, you must start slowing down far from shore, not when you see the dock.

From Tony Osborn, Downham Market, Norfolk, UK

We, the deist gods, widely believed to have existed since before time began and ever constantly watching over our cosmic creation, have recently become very interested, even concerned.

Our worries are centred on the tiny planet Earth, currently suffering from a potentially serious infection of humanitis. The cause seems to be a relatively recently evolved bipedal organism named *Garmentcladia infestans*. It threatens, parasitically, to become more widely – even cosmically – infectious. Now it is disrupting the local ecosystem that has given us much pleasure to watch.

Cosmic events – asteroidal or a sufficiently near supernova, say – could intervene and allow Earth to recover, perhaps with another dominant species, maybe of a different genus, class or phylum.

The trolley problem: how to stay out of jail

31 October 2020, p 23

From Geoff Vaughan, Lowton, Greater Manchester, UK

Sylvia Terbeck presents two versions of the trolley problem: one in which you divert a trolley that will kill five people so it only kills one other person, and another in which you push someone into the path of the trolley to stop it. This addresses the problem as a moral issue, with differences between the two cases.

However, people may also consider a legal question in their decision: am I guilty of murder? In the second case, almost certainly; in the former case, probably not. Also, doing nothing wouldn't be considered a crime.

I wish more people would think like Kari Leibowitz

5 December 2020, p 40

From Sam Edge, Ringwood, Hampshire, UK

Thanks for the early Christmas present of the Kari Leibowitz interview on positive mindsets. What a refreshing article. I wish more doctors and therapists, not to mention friends and relatives, were more like Leibowitz. I wonder how much of the damage of, say, being "clinically obese" can be traced to the overt and subliminal disapproval of doctors, media, colleagues, friends and family?

From Jim Ainsworth, Kingsland, Herefordshire, UK

The interview with Leibowitz was full of sage advice. Of particular interest must be the fact that we have some control over our own mindset and can change it for the better, just by thinking positively. It would seem that the arts and sciences may be at one on this. John Milton summed up the whole thing in two lines some 350 years ago: "The mind is its own place, and in itself / Can make a Heav'n of Hell, a Hell of Heav'n."

We need AIs that are good at folding of another kind

5 December 2020, p 15

From James Weatherly, Scappoose, Oregon, US

Michael Le Page writes about the exciting news that an AI system has learned how to predict how proteins fold. That is all well and good and I am sure it will help the human condition immeasurably, but when will the great scientific minds teach a robot to fold the clothing after a wash and dry?

You're twistin' my melon man

28 November 2020, p 34

From Mike Bell, Woolacombe, Devon, UK

After reading about efforts to put a quantum twist on Einstein's theories of space and time, I think I am getting a torsion headache.

For the record

Bureau of Land Management and American Wild Horse Campaign birth control programmes for wild horses in the US are separate entities (19/26 December 2020, p 12).

Want to get in touch?

Send letters to letters@newscientist.com; see terms at newscientist.com/letters

Letters sent to New Scientist, 25 Bedford Street, London WC2E 9ES will be delayed

New Scientist Academy

Q: FASCINATED BY THE COSMOS BUT DON'T KNOW WHERE TO BEGIN?

A: NEW SCIENTIST ACADEMY

Valerie Jamieson
CREATIVE DIRECTOR

Throughout all human history, people have looked up at the night sky and wondered about the universe and how it came to be. Now, thanks to the ingenuity of today's physicists and astronomers, we essentially know what we're looking at.

THE BIGGEST MYSTERIES OF THE COSMOS, our expert-led online course, will introduce you to what we know about the sweep of cosmic history from the big bang to hundreds of billions of years into the future. But as we find answers, more questions emerge.

Join us as we explore these cosmic mysteries and prepare to expand your mind.

THE BIGGEST MYSTERIES OF THE COSMOS TOPICS COVERED INCLUDE:

WHAT WE KNOW ABOUT THE UNIVERSE
Explore the story of its evolution from the big bang to present day

THE ANTIMATTER MYSTERY
Find out what makes it different from matter, and why matter's dominance in today's universe is so puzzling

DARK MATTER
Investigate the role of dark matter in the universe and why cosmologists think the universe is filled with a type of matter we can't see

DARK ENERGY
Get up to speed on this mysterious energy that fills space, and its role in determining the ultimate fate of the universe

INFLATION
Understand and explain why inflation is a defining moment in cosmic history and why it suggests our universe could be just one of many

NOW ON SALE Introductory rate just £149 for a limited time only

Start your course today, visit newscientist.com/courses

A rising tide of optimism

The forces fighting climate science haven't been defeated, they have just changed tactics. But a key figure in the fightback is hopeful, says **Richard Schiffman**

Book

The New Climate War: The fight to take back our planet
Michael E. Mann
Scribe UK

ALEX PLAVEVSKI/EPA-EFE/SHUTTERSTOCK

A wind, solar and fishing base in Dongtai, Jiangsu province in China

MOST people accept that climate change is happening, but that doesn't mean the war against climate science is over. The denialists have just changed their tactics, argues Michael Mann in his book *The New Climate War*.

Mann should know. A climatologist at Penn State University, he has been a target since his "hockey stick" graph was published in 1999. The graph shows the rapid rise in temperature globally since industrialisation caused heat-trapping carbon dioxide to spew into the atmosphere.

This dramatic visual, featured in Al Gore's film *An Inconvenient Truth,* earned Mann decades of harassment and death threats. This was part of a war against climate research that has been waged since the 1970s, first to cover up and then to contest the growing evidence that shows our planet is warming.

However, as data about rising sea levels, higher temperatures and megafires mounted, the climate sceptics shifted to "a kinder, gentler form of denialism", says Mann. They now mostly concede that, yes, there is some warming and human activity plays some role, but it's not nearly as bad as those "alarmist" scientists say.

This new effort (bankrolled by the same polluting interests that funded the old one) no longer disputes climate change, but tries to block the action needed to move towards a low-carbon future. It is being fought by the successors to climate change denialists, who Mann calls the "inactivists". They lobby against effective carbon pricing programmes and subsidies for renewable energy that would imperil big energy's bottom lines.

According to Mann, central to this strategy is a campaign to shift culpability for climate change from the corporations selling fossil fuels to those who use them. Fossil fuel companies aren't to blame, "it's the way people are living their lives", Chevron argued in court in 2018.

"Doomism and the loss of hope can lead people down the very same path of inaction as outright denial"

Some environmentalists have bought into this argument. While Mann agrees it is good to eat less meat, travel less and recycle more, such actions alone aren't enough. We need to decarbonise the economy, he says. Focusing on personal responsibility takes our eyes off that prize.

Another thing inactivists do, Mann says, is to support divisive films like Michael Moore's recent documentary *Planet of the Humans* that purported to show that renewable energy is ineffective and polluting.

The film was condemned by environmental activists and climate scientists. But the pro-fossil fuel American Energy Alliance spent thousands to promote a film it hoped would take the wind out of the sails of the push for clean energy.

"Doomism and the loss of hope," writes Mann "can lead people down the very same path of inaction as outright denial. And Michael Moore plays right into it." Despair is counterproductive.

Fossil fuel interests also cynically push "non-solution solutions" like natural gas, carbon capture and geoengineering, whose inadequacies Mann details. Again, the effort is to distract from the real task of weaning the world off fossil fuels.

But in the end, Mann says he is optimistic, heartened by the upswell of youth activism and the rapid development of green technologies. Even investors are beginning to flee from fossil fuels. Moreover, botched responses to covid-19 underline the peril of ignoring science and failing to act.

With the major COP26 UN climate summit due to be held later this year in Glasgow, UK, Mann's call to get serious about climate change couldn't be more timely. Let's hope he is right that the tide is finally about to turn. ▮

Richard Schiffman is an environmental journalist and poet based in New York City

Consider the future now

Emerging technology comes with both upsides and downsides that we need to understand, says **Vijaysree Venkatraman**

Podcast

Brave New Planet
Eric Lander
All podcast providers

"IN THE face of overwhelming odds, I'm left with only one option. I'm going to have to science the shit out of this," says Matt Damon's character in *The Martian*, when he realises he is stranded on Mars and no one is rushing to his rescue.

Eric Lander, a key scientist on the Human Genome Project and director of the Broad Institute, a biomedical and genomic research centre in Massachusetts, quotes the lines in the prologue to his podcast, *Brave New Planet*, that explores how technology may shape the future.

We may not be alone on our planet, but we do face an existential threat from climate change. The question is, how much should we rely on technology to get us out of trouble? Should we, for example, attempt to pump the stratosphere with chemicals to reflect some solar radiation back into space? Lander, who acknowledges that society's relationship with science has frayed in recent times, says such important decisions cannot be left to scientists and politicians alone.

As host, Lander encourages listeners to grapple with these complex topics and to mull over the technologies that could dramatically improve our future or leave us worse off unless we put the right checks and balances in place.

In seven engaging episodes, he spotlights videos created by artificial intelligence called deepfakes, geoengineering, lethal autonomous weapons, bias in predictive algorithms and "gene drives" that might allow us to restore ecosystems or reduce malaria deaths.

The first and last episodes give mathematician and geneticist Lander the opportunity to discuss the importance of decisions we make now and what it will take to build common ground globally.

Throughout, he interviews a lively bunch of experts – academics, law professionals, policy-makers, activists and the like – to illuminate the workings, and the imaginable impacts, of each technology.

The second episode, "Deepfakes and the Future of Truth", starts with a moving elegy to the crew of the 1969 moon landing in Richard Nixon's voice. Thankfully, the US president never needed to give this speech: "In Event of Moon Disaster" was filed away in the archives. Last year, a team at MIT showed deepfake's potential by taking this text and using AI to create a hyperrealistic video of Nixon saying the words.

When seeing is no longer believing, can truth prevail, the show asks. Synthetic media, which can be easily shared on social media, threatens to swing elections and cause international conflicts – not to mention affect the lives of ordinary people.

Lander speaks to a woman in Australia who, as a teenager, discovered doctored images of herself on pornographic sites. She now campaigns to reform laws around image-based abuse, deepfakes and cyberbullying.

Given Lander knows many of the scientists he interviews, they slip naturally into jargon-free conversation. Overall, the experts appear to take their work, and not themselves, seriously. The bonhomie makes the podcast easy to listen to.

Lander avoids the temptation of advocating a single solution to any of the big questions the show poses. With the arrival of a new US president this month, the well-timed podcast gives us, as stewards of the planet, a heads-up on some pressing tasks ahead. ▮

Vijaysree Venkatraman is a science journalist based in Boston

Deepfakes are doctored videos created by artificial intelligence

ALEXANDRA ROBINSON/AFP VIA GETTY IMAGES

Don't miss

Read

Bear Head is a sequel to *Dogs of War* by prolific science fiction author Adrian Tchaikovsky. It follows the adventures of Honey, a genetically engineered bear that appears to have infiltrated Jimmy the Martian's head.

Watch

Where are the Women in STEM? is the question put to an audience of 10 to 14-year-olds on 13 January in an interactive lecture from Newcastle University in the UK. The YouTube event explores the forgotten roles of women in STEM fields.

Read

We Alone is conservationist David Western's account of humankind's management of the planet, from Masai herders battling droughts in East Africa to the technological frontiers of California.

MIDDLE: JEFF GILBERT/ALAMY

The film column

Of gods and monsters

Documentary *iHuman* is thoroughly committed to an apocalyptic view of society in which we are in thrall to artificially intelligent machines. That is its strength – and its weakness, says **Simon Ings**

Simon Ings is a novelist and science writer. Follow him on Instagram @simon_ings

COSMIC CAT

***iHuman* explores our relationship with technology**

Film

iHuman

Tonje Hessen Schei

Screening for eight weeks at modernfilms.com/ihuman

Simon also recommends...

Film

Colossus: The Forbin project

Joseph Sargent

An advanced US defence system joins forces with its Soviet counterpart to take control of the world in this understated slice of cold war paranoia from James Bridges, writer and director of The China Syndrome.

Book

Destination: Void

Frank Herbert

When a ship's artificial brain fails, its crew must rebuild it from scraps in this techno-theological thriller by the author of Dune.

IN 2010, she made *Play Again*, a film about digital media addiction among children. In 2014, she won awards for *Drone*, which explored the CIA's secret role in drone warfare. Now, with *iHuman*, Norwegian documentary-maker Tonje Hessen Schei tackles – well, what, exactly?

iHuman is a weird, portmanteau diatribe against computation – specifically, the branch of it that allows machines to learn about learning. Artificial intelligence, in other words.

Incisive in parts, often overzealous and wholly lacking in scepticism, *iHuman* is an apocalyptic vision of humanity already in thrall to the thinking machine. It is put together from intellectual celebrity soundbites and illustrated with a lot of upside-down drone footage and digital effects. As such, the whole film resembles nothing so much as a particularly lengthy and drug-fuelled opening credits sequence to the US crime drama *Bosch*.

The film opens with the famous Stephen Hawking quote: "Success in creating [AI] would be the biggest event in human history. Unfortunately, it might also be the last." If that seems heated, go visit Xinjiang, a region of China seen in the film in which 13 million Turkic Muslims (Uighurs and others) live under AI surveillance and predictive policing.

Nor are the film's speculations particularly wrong-headed. It is hard, for example, to fault the reasoning that leads Robert Work, former US deputy secretary of defence, to fear autonomous killing machines, since "an authoritarian regime will have less problem delegating authority to a machine to make lethal decisions".

> **"*iHuman* is a profoundly fetishistic film, worshipping at the altar of a god it has itself manufactured"**

iHuman's great strength is its commitment to the bleak idea that it only takes one bad actor to weaponise artificial intelligence before everyone else has to follow suit in self-defence, killing, spying and brainwashing whole populations as they go.

Yet its great weakness lies in its attempt to throw everything into the argument: social media, prejudice bubbles, election manipulation, deep fakes, face recognition, social credit scores, autonomous killing machines and more. Of all the threats Hessen Schei identifies, hype is conspicuously missing. For instance, we still await convincing evidence that propaganda campaigns on social media really can tip an election.

Much of the current AI furore looks jolly small and silly once you recognise the role of advertising in AI development. Most assertions about how our feelings and opinions can be shaped by social media are retreads of claims made in the 1910s for the billboard and the radio. All new forms of media are terrifyingly powerful, and all age very quickly indeed.

So there I was, watching *iHuman* through my fingers – the score is terrifying, and artist Theodor Groeneboom's animation of what the internet sees when it looks in the mirror is the stuff of nightmares – when it occurred to me to look up the definition of "fetish". In one sense, it means an inanimate object worshipped for its supposed magical powers or because it is considered to be inhabited by a spirit. *iHuman* is a profoundly fetishistic film, worshipping at the altar of a god it has itself manufactured. Nowhere does it mention the work being done to normalise, domesticate and defang our latest creations.

How can we stand up to our new robot overlords? Trying politics would be my humble suggestion. ▮

New Scientist Events

EARLY BOOKING TICKET PRICE £13

HEALTH SERIES

HERMAN PONTZER

THE MISUNDERSTOOD SCIENCE OF METABOLISM

Thursday 25 February 2021 6-7pm GMT and on-demand

How many calories do you burn each day? Does exercise help lose weight? What is the "natural" human diet?

In this talk, we'll share the surprising new research investigating our metabolism – the way we burn energy. Pontzer will discuss his ground-breaking work with hunter-gatherers, with our great ape cousins, and with populations around the globe, exploring the way our bodies use energy, and how our evolutionary past shapes our lives and our health today.

For more information and to book your place visit:

newscientist.com/metabolism

HEALTH SERIES
HERMAN PONTZER

JUERGEN FREUND

Reviving the Great Barrier Reef

"I RECOMMEND getting inside the net. It's very good for you," jokes marine ecologist Peter Harrison. "It's good for your skin, it's good for your clothes."

The net in question is a giant, slimy thing, with a fine mesh at its base that contains a precious cargo: coral larvae that have been incubating in the ocean for five days. Some white sun shirts have already fallen casualty to the net, getting coated in a greenish algal stain on contact.

It is early December and we are on Wistari Reef, which forms part of the southern end of the Great Barrier Reef off the east coast of Australia. I'm with 17 others on three research boats, on a field trip to reseed reefs with coral larvae in the hope that they will eventually grow into new coral.

Harrison, who is leading the expedition, is the founding director of the Marine Ecology Research Centre at Southern Cross University in New South Wales. He was one of a group of researchers who first discovered the mass spawning of corals on the Great Barrier Reef in the early 1980s, and has spent the intervening four decades researching coral reproduction and restoration.

Coral spawning occurs once a year. On the outer reefs off the east coast of Australia, the action begins a few nights after a spring full moon in late November or early December. Various coral species release sperm and eggs en masse, in trillions of small balls that rise to the surface and open, resulting in fertilised larvae known as planulae.

These larvae form slicks of vivid pink or orange on the ocean surface, and drift for days or weeks until eventually attaching themselves to hard surfaces underwater to form new colonies. As they mature and become ready to settle, they fade to a greyish hue.

Harrison estimates that only one in a million coral larvae will become an adult coral: some die naturally, some are eaten by plankton or fish, and others are carried by currents into waters that are too cold for the coral to grow. This is why the researchers have come to Wistari. By increasing the number of larvae that settle on reef systems, they are hoping to speed up the reef regeneration process – particularly crucial given that the Great Barrier Reef ›

has suffered three mass bleaching events due to warm ocean temperatures in the past five years.

The team has been based on Heron Island, a coral cay where there is a permanent research station, since the end of November. When spawning occurred in the first week of December, the researchers collected millions of larvae from some of the slicks.

The task on the boats today is to collect larvae from three floating nursery pools in Wistari Reef, where they have been maturing, and seed them onto damaged sections of reef that no longer have live corals. The net of each pool hangs from a square pontoon that is roughly 3 by 3 metres in size.

Researchers gather around the perimeter of each pontoon and lift each net out of the water in sync, concentrating the larvae at the bottom, while Harrison hoses the sides to wash down any larvae caught on the fine

"Coral species release sperm and eggs en masse, in trillions of small balls that rise to the surface and open"

mesh. The process is laborious: each net contains about 80 kilograms of water, which takes time to drain out.

All the larvae are collected by 9.30 am, and decanted into tubs in preparation for seeding. Concentrated, the larvae float in a cloudy brown suspension. "It looks like miso soup," someone remarks. The smell is less appetising: like the fishy saltiness of seafood, but more pungent.

We have been on the boats since 7 am, and will spend at least another 5 hours out on the water. Wistari Reef has a central lagoon edged by a wall of coral. At low tide, the tips of the coral jut out of the water and it becomes impossible for boats to pass. The water level will only be high enough for us to return to Heron Island in the mid-afternoon. But low tide, at 10.40 am today, is perfect for coral seeding – there are fewer currents that will disperse the larvae away from the targets.

We weave the boats around the corals for more than an hour, searching for suitable sites: the researchers are after flat reefs that aren't too shallow, which might limit the future growth of corals. Four sites are chosen. At each, 30 small, square tiles made from crushed coral skeletons are laid down. These will be used to measure the rate at which coral larvae have settled.

We take a quick break for lunch, but the food is all aboard one boat. This poses little problem: our sandwiches are delivered by Floatyboat, a small, remote-controlled robotic boat developed by Matthew Dunbabin at the Queensland University of Technology and his colleagues.

Floatyboat serves a greater purpose than just aquatic deliveries: at two of the chosen release sites, the team uses it to disperse larvae from two thin pipes that dangle beneath it. Snorkelling behind as it gets to work, I watch the jets of larvae shooting out. At two other sites, larvae are manually dispersed via a larger pipe.

The team won't be able to see the results of its handiwork for several years. The larvae have been captured from corals that have survived recent mass bleaching events, so the idea is that their offspring may also be more heat tolerant. The researchers hope to upscale the restoration across more sites in the future, using robots to disperse larvae more efficiently.

But climate change is an existential threat. The ideal temperature for larvae along the Great Barrier Reef is between 26°C and 28°C. At warmer temperatures – the same that result in adult coral bleaching – the larvae won't settle.

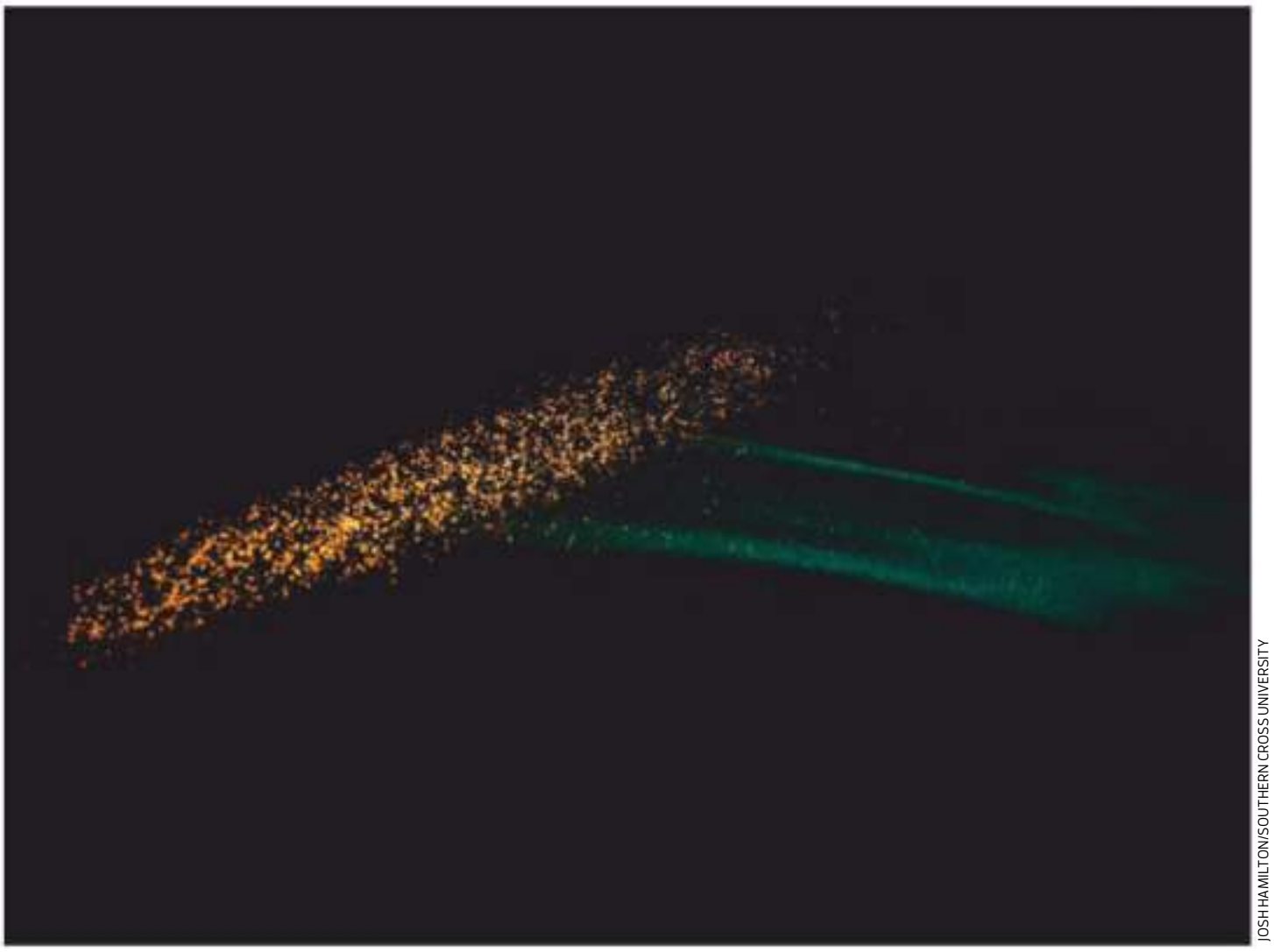
The coral restoration programme is one of a range of tools to help boost the resilience of the reef, says Anna Marsden, managing director of the Great Barrier Reef Foundation, a charity dedicated to protecting the reef.

The research under way is a race against time. "We've got 30 years to solve this, otherwise we will not have coral reefs on this planet," says Marsden. ▮

Donna Lu

GREAT BARRIER REEF FOUNDATION

JOSH HAMILTON/SOUTHERN CROSS UNIVERSITY



JOSH HAMILTON/SOUTHERN CROSS UNIVERSITY

Previous page: A 13-metre octagonal floating nursery pool on the Great Barrier Reef filled with millions of coral sperm and eggs collected after an annual mass spawning

This page, clockwise from above: A close-up image of coral spawning; the coral restoration team preparing to deploy larvae on sections of Wistari Reef; headlamps worn by the research team reveal a spawn slick on the ocean surface

Breaking with bread

Are low-carbohydrate diets an easy route to weight loss or a recipe for a heart attack? **Clare Wilson** investigates

JASON FORD

COUNTLESS fad diets come and go, but these days there is one we never stop hearing about. Whether you call it low-carbing, Atkins, keto or paleo, the principle is the same: cutting down on starchy food and filling up on fat and protein.

Low-carbohydrate diets are increasingly being endorsed by obesity and diabetes specialists, and a growing number of trials show that the approach helps people lose weight at least as much as traditional low-fat, low-calorie regimes. More and more people are eating this way, not to lose weight, but because they see it as healthier.

Yet many doctors warn that low-carbing is dangerous. They point to large-scale population studies linking low-carb diets to increased risk of heart attack, stroke and premature death.

The puzzling thing is, those warnings don't seem to square with findings from clinical trials, generally a better kind of medical evidence than population studies. Several have now shown that low-carb diets generally don't raise the levels of "bad cholesterol", long seen as a major risk factor for heart attack and stroke. Even in people who do see a rise, other markers of heart health usually improve.

It is so confusing that some wonder if we have got the causes of heart disease all wrong. "This has led me to question whether I believe in the cholesterol hypothesis at all," says Eric Westman, an obesity specialist at Duke University in North Carolina.

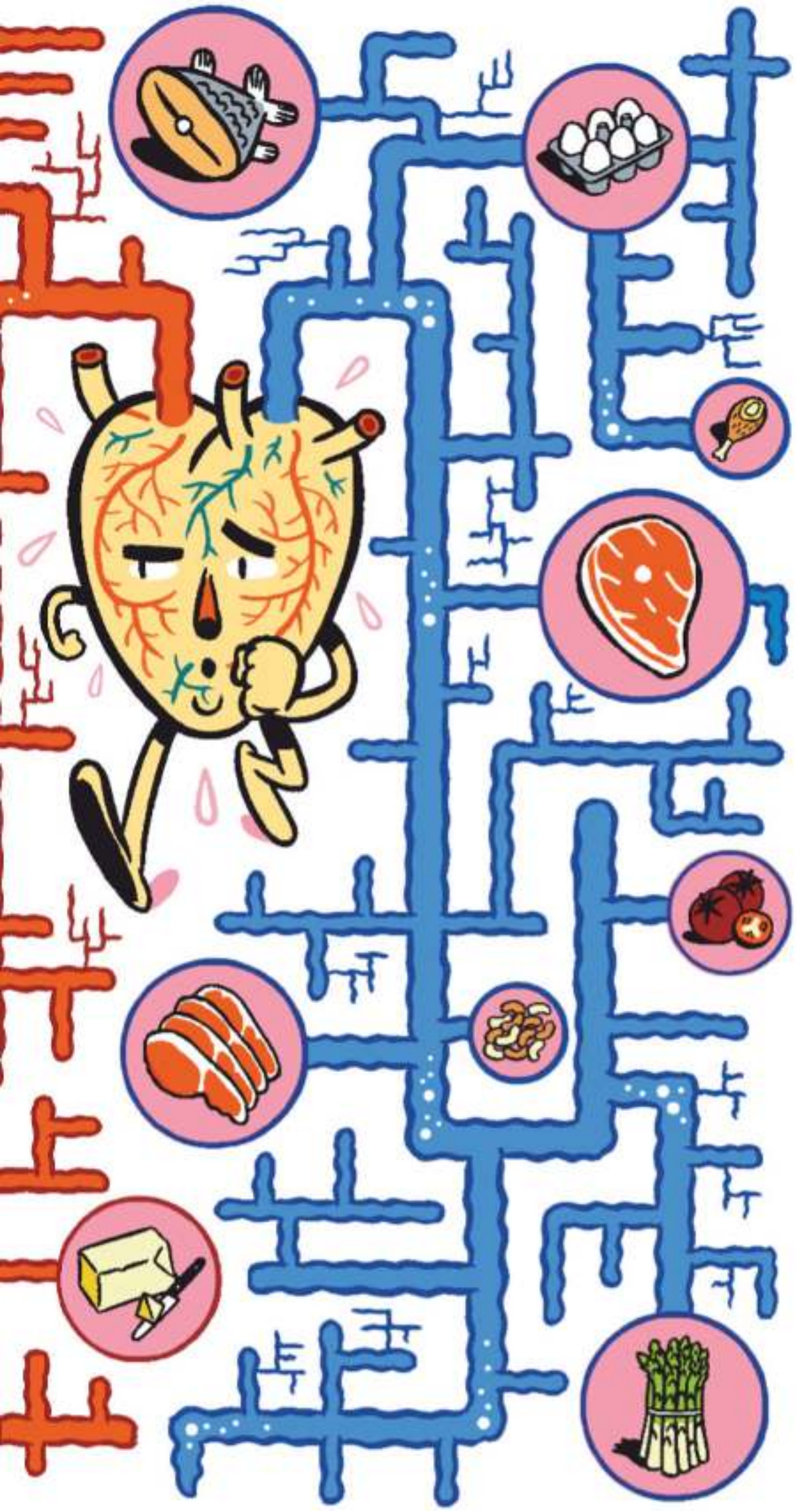
As rising rates of obesity and diabetes threaten public health, the questions around the safety of low-carb diets are becoming increasingly urgent. So, is ditching carbs a safe way to lose weight and stay healthy – or a recipe for heart attack?

Low-carb diets first came to fame in the 1970s through New York cardiologist Robert Atkins, who lost weight himself this way and recommended it in diet and cookery books. His advice to fill up on steaks, cream and butter, while shunning most fruit and vegetables, made him a medical pariah. Critics said people wouldn't be able to stick to it, and if they did, it would kill them, says Westman, who studied under Atkins.

Pass the butter

For many people, however, low-carb diets clearly work. By the early 1990s, randomised trials were showing that such diets are at least as good as low-fat ones for weight loss, often a little better. In one trial, people on a low-carb diet lost an average of 4.4 per cent of their body weight after a year, compared with 2.5 per cent among those in a low-fat group. And contrary to the warnings, people's cholesterol levels, and results from other blood tests, generally moved in the right direction. "That was a big moment," says Westman, who led some of those studies.

What's the explanation? The central idea is that weight control requires more than just



“Calories from fat make us feel fuller than those from carbs”

calorie counting. For a start, the same amount of calories from fat or protein makes people feel fuller than if they come from carbs, which explains why people on low-carb diets report less hunger than those on low-fat ones. Westman’s studies helped show that, although most people on low-carb diets don’t calorie count, they tend to consume just 1200 to 1500 calories a day, much less than the recommended 2000 calories per day for women and 2500 for men. “They eat less because they’re not hungry,” says Westman.

The other key insight is about what happens when we change the body’s main energy source. Usually, our cells are fuelled by glucose, a simple sugar that all other forms of sugar or starch are converted into. Glucose is highly reactive, so our bodies normally keep the amount in the blood within a narrow range to avoid damage to blood vessels and cell structures. When glucose levels rise after eating, we quickly release the hormone insulin, which tells cells to start taking up glucose, and using and storing it.

Insulin has a host of other effects, but they can be summarised as signalling to our bodies we have had an influx of calories and we need to stash them away. Crucially, insulin makes fat cells turn glucose into fat and store it. But in the absence of glucose, the body has an alternative fuel source: fat. Depending on the cell type, stored fat may be turned into fatty acids or into molecules called ketones, which can be used for energy. This normally happens a little overnight, when we go for ›

several hours without eating any carbohydrates.

The raison d'etre of low-carbing is to minimise insulin release and be fuelled as much as possible by ketones. For most people, a shift into what is known as ketosis happens within a few days of dramatically cutting carbs. Eating very low levels of carbs is also known as a ketogenic diet.

As well as people trying to lose weight, many others have adopted low-carbing or the keto diet because they see it as a way of living healthily and prolonging lifespan. Some adherents believe entering ketosis has a range of metabolic benefits, including warding off cancer and Alzheimer's disease, although there isn't good evidence for this. Neurologists use very low-carb diets to induce ketosis as a treatment for certain forms of epilepsy and it is being investigated in other conditions (see "The keto diet in medicine", page 36).

Matters of the heart

What has recently granted low-carbing more legitimacy, though, is its effects on type 2 diabetes. This condition occurs when the body's cells become less sensitive to insulin – a state known as insulin resistance – which leads to dangerous rises in blood sugar after meals. Long term, these sugar surges contribute to the many health consequences of diabetes, including nerve damage and kidney and heart disease.

The medical orthodoxy is that, because diabetes raises the risk of heart disease, it is even more important that those affected avoid saturated fats, found mainly in red meat and dairy products, because these are thought to raise blood cholesterol and lead to blocked arteries. The UK National Health Service advice for type 2 diabetes is that people should keep fat to a minimum and eat starchy foods like pasta, for instance.

Yet this ignores the fact that people with diabetes may see two benefits from low-carbing. As well as weight loss improving their insulin sensitivity, avoiding starch and sugar reduces those harmful blood sugar spikes. Remember that starch is basically long chains of sugar molecules. People with diabetes often measure their blood sugar at home, and can see for themselves that starting the day with bacon and eggs gives less of a sugar surge than toast or cereal do.

Sceptics might say that while a few days of low-carbing leads to lower blood sugar levels, it is hard to stick to this way of eating. There is mixed evidence on the issue. For instance, a review of 10 randomised trials found that low-carb diets were more effective than low-fat diets at improving blood sugar control in people with diabetes over the first year, but the differences disappeared after that. But there is evidence that for those who keep it up, the health benefits can be longer term, such as a study of 128 people with type 2 diabetes who went to low-carb counselling sessions run by David Unwin, a family doctor in Southport, UK. After an average follow-up of two years, about half had been able to stop taking all their diabetes drugs.

Because of results like these, diabetes doctors and patient support groups have started questioning the low-fat orthodoxy too. Bodies such as Diabetes UK and Diabetes Australia now say low-carbing is a valid option for weight loss. Ten years ago, that

"Many are starting to question whether 'bad cholesterol' really is a risk to heart health"

GOJAK/GETTY IMAGES

would have been unheard of. The American Diabetes Association went a step further last year and said out of all dietary strategies, low-carbing has the most supporting evidence for improving blood sugar control.

Yet, as more and more people have adopted this way of eating, there have been renewed questions over its safety. In some cases, low-carb diets can lead to an alarming change in people's cholesterol levels.

The idea that certain kinds of cholesterol can cause a build-up of dangerous plaques within our blood vessels is a pillar of mainstream medicine. There are several different types of cholesterol particles in the blood. One type, called high-density lipoprotein (HDL), is linked with a lower risk of heart attacks – this is sometimes known as good cholesterol. Bad cholesterol is a type called low-density lipoprotein, or LDL. Another kind of fatty particles, called triglycerides, are also thought to be harmful.

Some people on low-carb diets see their bad cholesterol levels rise significantly. Although they seem to be in the minority, the number of these "hyper-responders", as they are coming to be termed, is unclear. Westman estimates that only a tiny fraction of people who try such diets will be hyper-responders. In one of his trials, from 2004, two people out of 59 randomised to low-carbing dropped out because their bad cholesterol levels rose.

Westman and others say they most often learn of this response in people who are slim and relatively muscular. He believes he may now be hearing about more of these cases because low-carbing is increasingly being adopted as a longer-term approach to healthy eating, not simply a short-term strategy for weight loss.

You don't have to be slim and muscular to be a hyper-responder, though. Vipan Bhardwaj, a family doctor in Wokingham, UK, saw bad cholesterol rise in two out of 38 of his patients who began low-carbing for diabetes. "It scared the bejesus out of us," says Bhardwaj.

What is strange about hyper-responders is that while their LDL level goes up, their other health markers tend to move in the right direction. These include their HDL, triglycerides, blood pressure and several other measures linked with glucose and insulin response. This was the case for Bhardwaj's two hyper-responders. He got further reassurance by scanning the arteries to their heart to check for any plaques. "You see what's really going on underneath the bonnet," he says. "They were absolutely fine."

Some elite athletes and other people not looking to lose weight are adopting low-carb diets as part of a "healthy" lifestyle

ANDREAS SOLARO/AFP VIA GETTY IMAGES

Guilt by association

The fact that some people see a rise in their bad cholesterol levels on a low-carb diet while other measures improve is now leading some to question whether LDL really is a key determinant of the risk to our hearts. Much of the case against this form of cholesterol has been built on population studies done in the past few decades, which found that people with higher LDL levels were more likely to have heart attacks.

But these kinds of studies can only find correlations between blood markers and health outcomes, not prove that one leads to the other. It could be that something else is the root cause of heart disease, which increases LDL levels as a side effect.

The chief suspect for that something else is insulin resistance, says Gary Taubes, a US science journalist, who has long been a proponent of low-carbing and has just written a book called *The Case for Keto*.

This idea isn't drastically at odds with our current understanding of the root causes of heart disease. Doctors already recognise that type 2 diabetes, obesity and heart disease frequently co-occur – so much so that the triad has its own name, "metabolic syndrome". Yet, rather than heart disease being a disorder of "faulty plumbing" in which our arteries get blocked up because we consume too much fat, the real problem could be a predisposition towards insulin resistance, which in turn promotes higher insulin levels, fat storage and heart disease. "If that is true, the medical research community made a terrible mistake, and we've yet to fix it," says Taubes.

Another important strand of evidence that made us believe LDL is important was the success of LDL-lowering drugs called statins, which reduce heart attack rates, according to multiple randomised trials, the most respected kind of medical study. But several other drugs that lower LDL levels don't protect against heart attacks, and statins have many effects on the body, including ›

The keto diet in medicine

Low-carbohydrate diets may be controversial as a way to lose weight, but they have been used for decades to treat severe epilepsy in children and are being explored for other conditions.

For epilepsy, avoiding carbohydrates so the body enters a state called ketosis, when cells have to switch to using fat for energy, causes several metabolic changes within brain cells. It may work by making brain cells less "excitable" or prone to uncontrolled firing, or by reducing the damage to brain cells caused when seizures do happen.

Ketogenic diets can be very helpful for children whose seizures can't be controlled by epilepsy drugs, says Bahee Van de Bor, a spokesperson for the British Dietetic Association, who has helped children on this diet at Great Ormond Street Hospital in London.

A keto diet is also being investigated as an add-on to standard cancer treatments. It seems to make tumour cells more sensitive to the effects of chemotherapy and radiotherapy because they have often mutated to become more dependent on glucose for energy.

The metabolic changes the diet induces in brain cells may also be protective against neurological conditions such as Alzheimer's and Parkinson's disease, and there have been some promising individual case studies. But, in these conditions, research is still at a very early stage.

dampening low-level systemic inflammation. It may be that statins actually protect the heart through their anti-inflammatory effects.

Some say it was the arrival of statins that got us so fixated on LDL levels. "Doctors only have 5 or 10 minutes with a patient. It's convenient to write a prescription and follow the LDL," says Bret Scher, a US cardiologist and medical director for the website, Diet Doctor, which promotes low-carb eating.

While practising physicians focus on their patients' LDL levels, these days, cardiologists who study biomarkers of heart health debate whether LDL levels really are the most important indicator, or whether things like the ratio of total cholesterol to HDL, or that of triglycerides to HDL, would be more useful. Hyper-responders would be fine if judged by either of those metrics: generally their HDL levels rise and their triglyceride levels fall.

One trial often used to underscore the dangers of low-carb diets found that people with type 2 diabetes saw their LDL levels rise by about 10 per cent on average after a year on the regimen. However, there was improvement in most of the other 25 health markers tracked, such as weight, blood pressure and HDL. Participants' overall risk score for heart disease fell by 12 per cent.

As an illustration of how confusing this is for the public, this particular trial is cited both as evidence against low-carbing – because LDL went up – and in favour of it, because overall risk went down. Scher acknowledges that we don't yet know how risky it is if people on low-carb diets experience their LDL levels rising while other health markers improve. What we need are more studies that follow hyper-responders over time to see if they are developing heart disease.

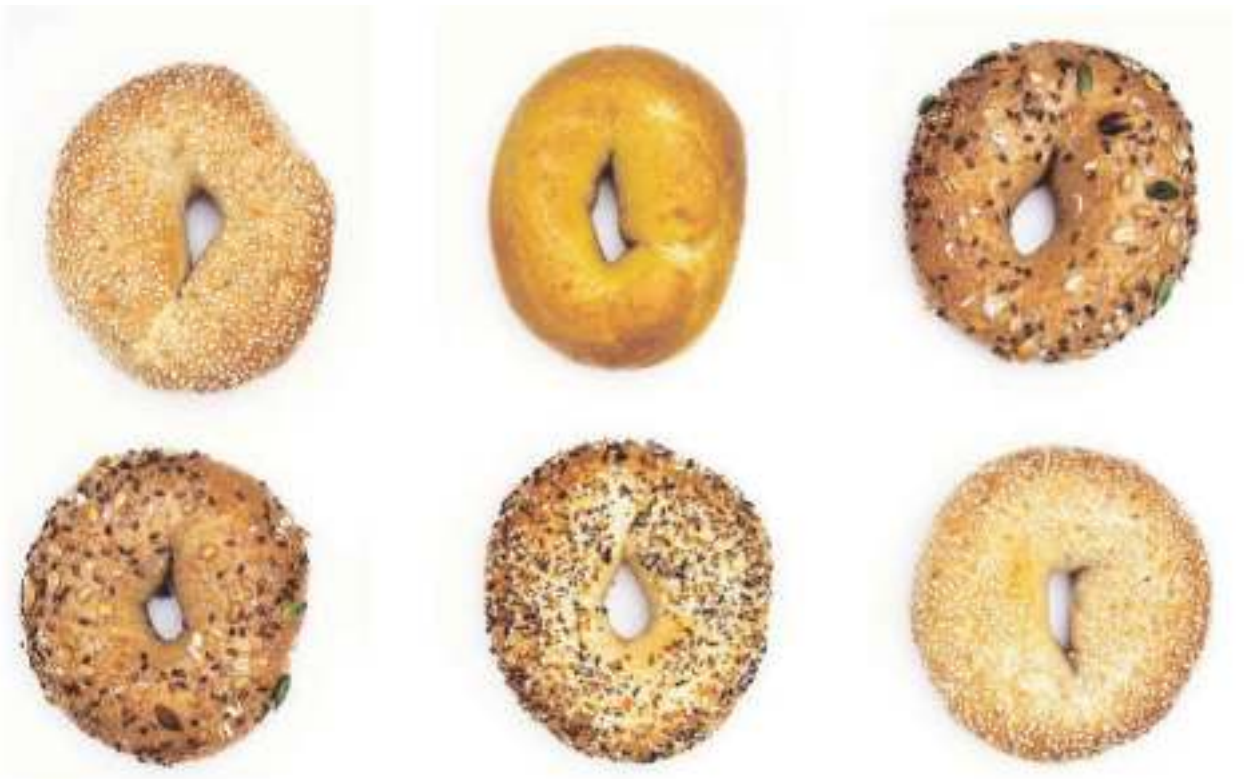
In the meantime, where does the uncertainty leave the average person who wants to lose a few pounds? The emergence of hyper-responders shouldn't stop people from trying low-carbing, says Westman. "That would be crazy, like telling someone not to take a useful drug because it sometimes has a side effect."

On the other hand, unlike with most medicines, we don't know how common this side effect is. Trials tend to report only average LDL changes for the whole group assigned to low-carbing.

Despite the new enthusiasm for these diets among diabetes and obesity specialists, many heart specialists and dietitians remain critical. A 2019 joint report on the prevention of heart disease from two US cardiology bodies said low-carb diets are linked with

AAMULYA/GETTY IMAGES

A diet rich in protein and fat, but low in carbohydrates, can lead you to burn more body fat to produce energy



KAREN BEARD/GETTY IMAGES

higher death rates. "The evidence is still weak about the long-term cardiovascular safety of the ketogenic diet," says Donna Arnett at the University of Kentucky, one of the guideline authors.

"There is conflicting evidence," says Tracy Parker, a dietitian for the British Heart Foundation. "We know saturated fat does increase your blood cholesterol." Parker says that if people are determined to reduce their carb intake, the safest bet is to replace carbohydrates with oils from plants and fish. However, she admits that would make what is already a restrictive diet even more so, because people would have to avoid not only all starchy and sugary foods, but also meat and dairy products.

It isn't as though low-carbing is the only way to lose weight, says Roy Taylor, a diabetes specialist at Newcastle University in the UK. Taylor has pioneered the use of meal-replacement shakes to help people quickly slim down on a low-calorie, low-fat diet, and has shown that if people with type 2 diabetes can lose about 15 kilograms this way, they can also put their disease into remission.

Unfortunately, none of the trials that have compared low-carbing with low-fat diets have lasted long enough to know which approach helps people keep weight off long term. Indeed, a recent review of many different kinds of diet – including low-carbing, low-fat and Mediterranean – concluded that most people put nearly all their lost weight back 12 months after they started anyway.

"Despite enthusiasm for these diets, many heart specialists remain critical"

Whatever works

Of course, not everyone can stick to a low-carb diet; some find they miss their bread, rice and pasta. Mike Lean at the University of Glasgow, UK, who worked with Taylor on the meal replacement diet strategy, says his obesity clinic now offers advice on both low-fat and low-carb diets. "People can use whatever they are better able to lose weight with, low-fat or low-carb," he says. "We have found no difference in weight loss."

The idea that different people might do better on different foods is supported by more recent research suggesting that there is no such thing as a single healthy diet that works for everyone. Instead, our individual genetics, habits and gut microbiomes may all influence how our bodies deal with the nutrients in our diet.

Yet even if the most we can say in favour of low-carb diets is that they work for weight loss and are safe for most of the population, that would still be a marked change from the previous orthodoxy that saturated fat is an inevitable route to a heart attack.

At the moment, there are more questions than answers. But even before low-carbing came along, there were growing concerns that the cholesterol theory of heart disease was on shaky ground. Now hyper-responders are making it look even wobblier. "There's a chance that this subset of patients could upend the philosophy that LDL is the most important risk factor for heart disease," says Scher. "I'm cautiously optimistic." ▮

Clare Wilson is biomedical reporter at *New Scientist* and author of the Health Check newsletter. Follow her @ClareWilsonMed

A pandemic like no other

Why has covid-19 been so problematic compared with past pandemics, wonders biologist **Jonathan R. Goodman**

WAS "unprecedented" the most overused word of 2020? There is no doubt that covid-19 has had an extraordinary range of consequences, from turning toilet paper into a treasured commodity and making handshakes taboo to closing schools and putting whole countries in lockdown. But humans have always had to face diseases. Is this one really so different from the others?

As vaccines come into use and we start to see light at the end of the tunnel, it is worth considering this question. There is no doubt that governments, institutions and individuals have made mistakes when trying to deal with covid-19. But perhaps we can be forgiven for some of those failings, because over the past year it has become clear that this disease has unusual attributes. These, combined with certain features of the modern world, may have created the perfect pandemic storm. Whether in our judgements about lockdown and personal risk or in questions about where the virus came from and is going, we really have faced some unprecedented challenges.

The lockdown dilemma

In January 2020, as news emerged that a lockdown had been imposed in Wuhan, China, in an attempt to stop the spread of a new disease, few citizens of other countries could have imagined that their lives would soon be similarly restricted.

Quarantine has long been used as a weapon against infectious diseases, from the English village of Eyam's response to plague in 1665 to action taken in West Africa to curb Ebola outbreaks in the 21st century. However, a year ago, the idea that democratically elected governments would forcibly curtail the freedoms of whole nations seemed unthinkable to many.

A key difference between covid-19 and past outbreaks of infectious diseases is its relatively low mortality rate. No country shuts down its economy when faced with seasonal flu – which is responsible for as many as half a million deaths worldwide every year – but where do you draw the line? SARS-CoV-2, the virus responsible for the

HOSSEIN FATEMI/PANOS PICTURES

Unprecedented: Streets in New York, "the city that never sleeps", were deserted during lockdown

covid-19 pandemic, certainly kills a higher percentage of people who contract it than flu does. Most estimates suggest a mortality rate of about 1 in 100 people, although it has been difficult to pin down, with estimates ranging from 0.5 to 3.5 per cent. Covid-19 is definitely far less deadly than Ebola, though, which without medical intervention kills more than 80 per cent of people who get it. As a result, policymakers haven't always known how to act.

"It's very tricky for governments," says Devi Sridhar, a public health scientist at the University of Edinburgh, UK. "If it were like the MERS or SARS outbreaks of the early 2000s, which killed about 33 per cent and 10 per cent of infected patients respectively, everyone would have pulled out the hammer and shut down. But governments think they're being judged on their economies, not covid."

The dilemma is exacerbated by our ability to create models showing what percentage of the population is likely to die if a lockdown isn't implemented. The question for policymakers then becomes what to do with that information, knowing there will be consequences either way.

"Modelling can be really helpful, but it has no value judgements in it, and the key decisions are political ones, not scientific," says Sridhar. "New Zealand, under Prime Minister Jacinda Ardern, reacted immediately to treat this like a SARS event. Compare this with Sweden, which attempted to achieve herd immunity by treating coronavirus like flu."

Worldwide, governments that acted early and decisively have generally experienced lower death rates, but the picture isn't straightforward. Ultimately, we won't know which strategies worked best until this pandemic is over.

Varied personal risk

We can usually identify who might be most at risk from a particular disease and uncover the underlying reasons why. Take the 1918 flu pandemic. Unlike most annual flu outbreaks, it tended to be more deadly in people aged between 20 and 40 than in older people. Two likely reasons have been identified: ›

CARLOS SPOTTORNO/PANOS PICTURES

crowded living conditions of young soldiers in the trenches of the first world war, and a level of immunity among older people as a result of contact with previous influenza viruses. The variable severity of covid-19, by contrast, continues to confound us.

Taking a novel approach that uses health analytics to interpret huge English patient data sets, a group called OpenSAFELY has shown that no demographic is at zero risk of dying from covid-19. Many factors have been associated with a higher mortality rates, though. For example, people older than 65 are at a much greater risk than are younger people, men are more likely to die of covid-19 than women and members of ethnic minority groups tend to have more severe cases. We don't know why this happens. We also aren't sure why various underlying conditions, such as lung disorders, coronary heart disease and diabetes, increase an individual's likelihood of dying from covid-19. And we don't know why some people get the lasting symptoms of long covid.

There are numerous hypotheses to explain the observed patterns and inconsistencies, but, as an article in *Nature* put it, covid-19 poses a "riddle for the immune system". We know enough to help us prioritise vaccinations, but despite months of intensive research, we still don't know why one person infected with SARS-CoV-2 becomes severely ill while another has no symptoms at all.

Hidden transmission

In 2012, a new disease, caused by a coronavirus, emerged in Saudi Arabia. That disease, MERS, is far deadlier than covid-19, but also less contagious. This is in large part because people catch MERS from camels, an animal most of us rarely encounter. The new coronavirus, SARS-CoV-2, by contrast, spreads from person to person. The density of human populations and our fondness for intercontinental travel explain why covid-19 swept across the world within months of emerging in China.

There are still uncertainties about how the virus is transmitted, however. The main route is via airborne particles. We know people are more likely to be exposed to these in confined indoor spaces than in wide-open, outdoor ones. But we don't know how far these aerosols travel, or for how long the virus remains infectious when airborne. There is, furthermore, inconclusive evidence about how great the infection risk is from viral particles on surfaces. Some studies suggest that coronaviruses can remain potentially infectious on plastic for over a week. Others suggest that, even when viral particles are present, surfaces are unlikely to infect someone who interacts with them.

"The variable severity of covid-19 continues to confound us"

Early on in the pandemic, members of the medical community were divided about whether face masks do any good. Now, we know that wearing one protects both you and others nearby, particularly in indoor spaces. In large part, that is because of another anomalous characteristic of covid-19: you can catch it from someone who has no symptoms.

Research from early on in the pandemic found that up to 75 per cent of infected people show no symptoms. A study from December 2020 suggests that the figure may be far lower. Nevertheless, with other contagious

REUTERS/CARLOS OSORIO

BJOERN STEINZ/PANOS PICTURES

Extraordinary: 2020 saw some very strange scenes in nursing homes (left) and exercise classes (right) – while misinformation flourished (below right)

diseases, such as flu, most people become at least a bit sick when infected. Moreover, people who don't become sick with flu usually transmit it at a much lower rate. People with infectious diseases also tend to self-isolate, either by choice or because they are too unwell to go anywhere, giving the pathogen less opportunity to pass on.

Asymptomatic and pre-symptomatic transmission make it easy for the coronavirus to transmit itself and hard for us to track it, says Sridhar. "Test and trace relies on people coming forward with symptoms."

Mysterious evolution

There is no doubt that this pandemic began in or near Wuhan, China. However, misinformation, conspiracy theories and political agendas are preventing us from determining how the virus first infected people. We do know that local bats carry genetically ancestral forms of SARS-CoV-2. One idea is that someone involved in the wildlife trade or deforestation contracted the virus and brought it into the city. Another is that crowded conditions at Wuhan's enormous Huanan Seafood Wholesale Market – where both wild and domestic animals are traded – created the perfect evolutionary environment for the virus to adapt to new hosts, including humans.

What happened next is puzzling, too. Evolutionary theory predicts that pathogens transmitted from person to person often become less deadly with time because a disease that kills too rapidly will soon run out of hosts to infect and so peter out. The SARS-CoV-2 genome contains 30,000 bases – the letters of the genetic code – and there have been just a handful of pervasive mutations since the pandemic began, according to Nextstrain, an open-source project tracking genetic changes in the virus as it moves through human populations.

Although SARS-CoV-2 has been exceptionally stable until now, that may be changing. Two recent mutations – one increasingly dominant in the UK, one known as the South African variant – are raising concerns. In addition to those two new variants, a few purported cases of reinfection among humans indicate that people had encountered mutant versions of the virus that were sufficiently different to evade their immune memory. What's more, the discovery of mutations in SARS-CoV-2 viruses circulating among farmed mink in Denmark – which, in November, resulted in the culling of some 17 million animals – seems to support the hypothesis that the virus evolved because of overcrowded conditions in the market in Wuhan. But we don't yet have a firm grip on how the various mutations are affecting how transmissible and virulent the virus is, or whether they will influence the efficacy of vaccines – although experts agree the risk of mutation shouldn't dissuade people from getting vaccinated.

Information overload

In past pandemics, there have always been huge knowledge gaps about the origins and spread of the disease. That is true this time, too. We also face another, paradoxical, problem: information overload. Academic journals have published tens of thousands of papers on the covid-19 pandemic. You would need to read several hundred a day to keep up with the output. Coupled with the biological peculiarities of SARS-CoV-2, this surfeit of research makes the science hard to interpret.

When even the scientists disagree, it is easy for people to peddle misinformation – and hard for governments to create coherent public health plans. No wonder conspiracy theories abound and many governments have failed to communicate effectively with their citizens. As a result, it falls on the public to be discerning about the information they take in, and wary of political motivations behind scientific proclamations. Even as vaccines enter mainstream circulation, we must learn to deal with risk and uncertainty if we are to overcome this very peculiar pandemic. ▮

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

MARTIN O'NEILL

How to grow metal

Mining is a dirty, damaging business. Can we get the metals we need from farms instead? **Michael Allen** investigates

WHEN you cut into a branch of *Phyllanthus rufuschaneyi*, the sap runs an intensely bright blue-green. That's the sort of thing that makes plant hunter Anthony van der Ent sit up and take notice. So when he came across this unusual woody shrub at a national park ranger's station in Malaysian Borneo, he knew he had to investigate further. It turned out that the sap was chock-full of nickel.

Van der Ent, based at the University of Queensland, Australia, is one of several scientists who think plants like this might be a solution to one of the most pressing problems of our age. Demand for many metals has been creeping upwards for years because they are essential ingredients in everyday tech like phones and computers. Our appetite for these metals will soon become even more voracious because they are also needed for green technologies such as wind turbines and the rechargeable batteries in electric cars. Yet mining them is difficult, environmentally damaging and sometimes extremely dangerous.

Could those problems be addressed by growing metals instead? That is what van der Ent believes. We will soon see if he is right as the first metal farms are now springing up in China, Europe and Malaysia. On the face of it, these farms are all-round winners: the profits are tidy, the environmental credentials excellent. So steel yourself for the latest disruptive mining technology: the plant.

The nickel colouring the blue-green sap of the shrub van der Ent discovered is just one of the metals we depend on. Nickel has long been a crucial ingredient in stainless steel. It is also used in many lithium-ion batteries in electric vehicles, phones and other consumer electronics.

Demand is expected to surge over the next decade as electric vehicles become more widespread. A leading resource consultancy has forecast that the amount of nickel needed for use in electric vehicles in 2025 will be 256,000 tonnes, roughly double the demand in 2019. Other crucial technologies, from wind turbines to magnets to lasers, also require a witches' brew of metallic elements.

Like many metals, nickel is usually obtained by strip-mining. Vegetation is removed from the ground and explosives are used to reveal the mineral seams beneath. It is a destructive practice. The French territory of New Caledonia in the Pacific holds some of Earth's largest nickel deposits and it has been ravaged by mining. With fewer trees to slow water flowing off the land, streams of pollution from mines run into the sea, killing fish and coral. The ore is often shipped for smelting, a process that produces toxic fumes and mountains of waste.

> "One relative of cabbage contains 2000 times as much nickel as a typical plant"

It is no surprise that plants contain some metal. Their roots take in minerals from the soil that provide elements like iron, zinc and more. What is surprising is that some plants contain truly massive quantities of metal.

This first came to light in 1948, when botanist Ornella Vergnano discovered a plant called *Alyssum bertolonii* in Tuscany, Italy. This relative of kale and cabbages contained 10 milligrams of nickel in every gram of its dried tissue. That's an astonishing 2000 times as much as a typical plant.

Hundreds more of these so-called hyperaccumulator plants have since been discovered. No one knows why they do it. Our best guess is that it serves as a defence against pests, because the high concentrations of metal make the plant tissue toxic.

These plants don't grow just anywhere because it takes a special type of soil to supply such huge amounts of metal. Back in our planet's early years, when its surface was still molten, metals tended to sink. They ended up in what is now the mantle, just below the crust. This means the mantle is made of softened ultramafic rock, which is high in iron, magnesium and other metals. In areas that had lots of tectonic activity long ago, this ultramafic rock was pushed to the surface, resulting in soil that today is rich with metals. It is in these areas that hyperaccumulators are found. ›

For decades, these plants were regarded as mere curiosities. Then in 1997, Rufus Chaney, an agronomist at the US Department of Agriculture, and his colleagues demonstrated that they could harvest the plants and extract a nickel-rich "bio-ore". The idea of metal farming was born – but it would be a while before it got serious attention.

One incident that helped draw that attention was van der Ent's discovery in Borneo. The plant's sap turned out to contain a whopping 25 per cent nickel by weight. "It is the best candidate metal crop we have ever found," he says.

The first thing he did on seeing this plant was ask the park ranger where it came from. He couldn't remember. So van der Ent offered local people a reward if they could tell him – to no avail. It wasn't until 2015, a few years after the initial discovery, that he chanced upon a clump of the plants growing on a nearby hillside. From there, he began experimenting with farming metal, otherwise known as agromining or phytomining, as an environmentally friendly alternative to mining. He even named his shrub *Phyllanthus rufuschaneyi* in homage to the inventor of agromining.

If you go to the state of Sabah in Borneo these days, you can find what van der Ent calls the "first tropical metal farm". There, he and his colleagues are growing that nickel-loving woody shrub. Each year, they coppice the plants, pulp them and extract the metal. In 2019, they reported a yield of 250 kilograms of nickel a year – currently worth almost $4000 – from each hectare of land.

Guillaume Echevarria at the University of Lorraine in France is a long-time collaborator of van der Ent's, and wanted to start his own metal farms in Europe. *Phyllanthus rufuschaneyi* wasn't the obvious choice, being at home in tropical conditions. So Echevarria and his team set up a series of agromining plots, mostly on ultramafic land in Albania, that grow a different hyperaccumulator that resembles kale. Local farmers use tractors to sow and harvest the crop. It is then baled and transported to Echevarria in France. There, the plants are burned to yield nickel-rich ash from which the metal is extracted using a chemical process.

Although these European farms can't quite match the yields of those in Borneo, the team still gets up to 200 kilograms of the metal per hectare of crop. That amount of nickel is worth around $3000 at today's prices, which makes it look like a sustainable business. For comparison, British farmers can sell a hectare's worth of wheat for about $2100.

Metal farming can also claim good marks when it comes to carbon emissions. Plants suck in carbon dioxide as they grow. Burning them releases it and so do the tractors, trucks and machinery used to plant, harvest and transport the crops. However, in Echevarria's project, the burning of the plants doubles as a heat source for nearby buildings and so the whole process ends up being carbon neutral, according to a life-cycle analysis he did.

These farms are small though. Could they provide a scalable alternative to mining? "There are very large areas around the world where phytomining could take place," says van der Ent. The island of Sulawesi in Indonesia alone has over 15,000 square kilometres of ultramafic soils, he points out.

Healing the land

Echevarria is more cautious. He says that much of Earth's ultramafic land sits within protected areas and biodiversity hotspots. If an agromining rush led to monocultures of hyperaccumulators replacing natural vegetation, that could be a biodiversity disaster. However, he still thinks agromining could meet a few per cent of global nickel requirements. That's not to be sniffed at, given how demand for the metal is expected to skyrocket. "My understanding of the market for metals is that any source will be important," says Echevarria.

Planting hyperaccumulators could even heal some of the damage wrought by strip-mining in places like New Caledonia. The plants won't significantly reduce the natural nickel content of soils, but they could help revegetate and stabilise them.

71%

The portion of the world's mined cobalt that came from the Democratic Republic of the Congo in 2019

Source: US Geological Survey

$240,000

The cost of a tonne of dysprosium, a rare earth metal required in many technologies

Source: US Geological Survey

256,000

The amount of nickel, in tonnes, forecast to be required in electric car batteries in 2025

Source: Wood Mackenzie

The shrub *Phyllanthus balgooyi* oozes a brightly coloured sap that is full of nickel

ANTONY VAN DER ENT

Farming vaccines

Hopes of an end to the covid-19 pandemic are pinned on developing vaccines and producing them in massive quantities. Plants could help.

Those vaccines that are based on proteins are usually cultured in animal cells. Flu vaccines are cultured in chicken eggs, for instance. This requires special lab equipment. But we have long toyed with the idea of producing proteins using plants instead, an idea called molecular farming.

It works by giving plants the biological instructions for making a particular viral protein, so that their cells become factories pumping it out. Then you harvest the leaves or other tissues and extract the goodies. This technology is less developed than using animal cells, but far easier and cheaper. "All you need is greenhouses", says Helga Schinkel at the Fraunhofer Institute for Molecular Biology and Applied Ecology in Germany.

Canadian company Medicago has already produced a candidate covid-19 vaccine through this method. It uses plants to make virus-like particles that mimic the coronavirus's outer structure, complete with the spike protein it uses to enter human cells. Such proteins can provoke our immune system to make antibodies to the virus and protect us.

Molecular farming may still be too immature to have a big impact on the current pandemic. But in future, it should be a great way to produce vaccines, says Schinkel, especially in low-income nations. "This is the perfect way for developing countries to make their own medications because they don't need all this expensive equipment," she says.

DEAGOSTINI/GETTY IMAGES

Mining has stripped vegetation from the French territory of New Caledonia, a group of Pacific islands

Agromining could also give farmers in ultramafic areas a financial boost, says Ángeles Prieto Fernández, a soil scientist at the Spanish National Research Council. "These soils really are quite poor for other agricultural applications," she says. "It is a way to use them and get an extra income." Echevarria agrees, saying that many farms on such land in Greece, Albania and Bulgaria are being abandoned.

Agromining isn't the only way we can grow our way out of trouble. Plants and microorganisms are sometimes used to soak up pollutants like heavy metals or chemicals from the soil after natural disasters. There is even talk of using plants in the fight against covid-19 (see "Farming vaccines", left).

Meanwhile, metal farmers are looking beyond nickel. Plants that accumulate arsenic, cobalt, manganese, zinc and rare earth elements have been discovered. Farming rare earth elements would be especially interesting, says Fernández. These are critical for many modern technologies and demand is increasing. "We really need these and it is expensive and difficult to get them," she says. "Even in mines they are in very low concentrations."

A team led by Marie-Odile Simonnot, also at the University of Lorraine, has been assessing a fern called *Dicranopteris dichotoma* that grows naturally on waste heaps near rare earth mines in China's Jiangxi province. Field surveys suggest it is possible to harvest about 300 kilograms of mixed rare earth elements per hectare of this crop, with lanthanum, cerium, praseodymium and neodymium chief among them. This could be a lucrative operation: the ore praseodymium oxide fetches around $49,000 per tonne. The team is now optimising the techniques for extracting these elements and working with scientists in China to run field trials at old mining sites.

For his part, van der Ent is out there doing what he does best: plant hunting. He and Echevarria reckon there are many more hyperaccumulators waiting to be discovered – and they have a better way of finding them than hoping for chance encounters in Borneo.

These days, they spend a good chunk of their time pacing the world's herbariums with a handheld instrument called an X-ray fluorescence spectroscope. Point one of these at a sample of pressed plant tissue in a catalogue and it will give you an instant read-out of the elements it contains. They have discovered hundreds of new hyperaccumulators this way. If they can be cultivated, then all of them will have sap running with metals. ▮

Michael Allen is a science journalist based in Somerset, UK

GOVERNMENT OF INDIA

Ministry of Education
Department of Higher Education
Technical Section - I

Appointment of Director, IIT Indore and IIT Mandi

Applications are invited for appointment to the post of Director of Indian Institute of Technology (IIT) at Indore and Mandi. The Director of an IIT is the academic and administrative head of the Institution. He/she is expected to have a minimum of 5 years' administrative experience and leadership qualities to head an Institute of National importance. The candidate/person should be a Ph.D. with first class or equivalent at the preceding degree, preferably in a branch of Engineering. In exceptional cases, candidates with Science, Mathematics or Management degrees may be considered. He/she should have an outstanding academic record throughout and a minimum of 10 years teaching experience as a Professor in a reputed Engineering or Technology Institute or University and should have guided Ph.D. students. The applicant should preferably be less than 60 years of age on the last date of receipt of the applications. The post carries a fixed pay of Rs. 2,25,000/- (Revised) per month, with allowances as per rules.

2. Interested individuals may apply giving their detailed resume in the prescribed format clearly bringing out research, teaching, industry-academia collaborations and administrative achievements, alongwith a two-page justification in support of their candidature, a two-page vision statement for the institution and contact details of at least two distinguished individuals well acquainted with their work. The application typed in the prescribed format along with enclosures may be sent by Registered/Speed Post to **The Under Secretary (TS.1), Department of Higher Education, Ministry of Education, Room No. 428 "C" Wing, Shastri Bhawan, New Delhi -110 001** so as to reach the Ministry **on or before 31st December, 2020.** The detailed advertisement and the format of application is available on the website (**www.education.gov.in**).

Positions for research in synchrotron and neutron imaging in hard materials and life sciences – in Denmark

Why us?

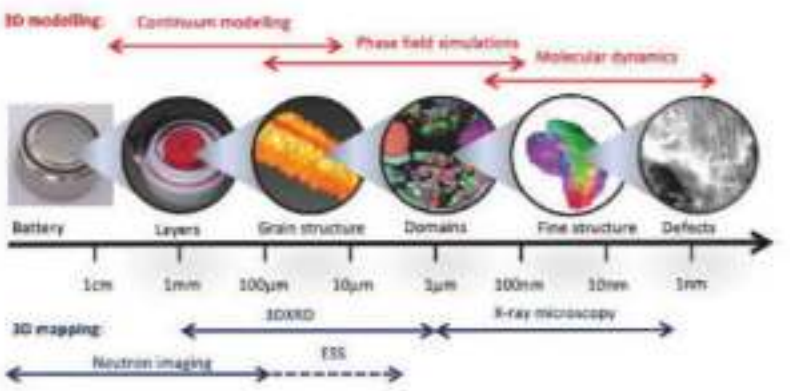
SOLID is a Danish Centre of Excellence with more than 40 scientists and engineers, who couple materials and health science research with developments in 3D synchrotron and neutron imaging. We work together in a dynamic, friendly team, to solve questions of relevance for energy, health and climate.

We are interdisciplinary, international and inclusive. Our environment is diverse, and dynamic. Motivated candidates are encouraged to apply, regardless of background.

Read more about SOLID at **www.solid.dtu.dk**

Our vision

We aim to visualize the internal structure of all sorts of solid materials, their creation and change during use – in 3D, on all the relevant length and time scales. This means we can generate and apply a new generation of more realistic multiscale material models. This would be a fundamental "game changer" in materials science, because effective models are the door to the dream of computational materials design. Multiscale 3D description is the key to understanding the basics of bone and tooth biology and thus for the development of new drugs and diagnostic methods, e.g. for osteoporosis. Similarly, our new high throughput 3D imaging methods will facilitate massive digitization of fossils and museum specimens, to facilitate progress in understanding human evolution and climate change



Why Denmark?

English is spoken widely and is the working language in the university. Denmark offers an attractive work-life balance, with work hard/play hard expectations. Research benefits from a deep culture of teamwork, creativity and enthusiasm in solving problems together, where students work side by side with senior scientists.

Denmark has a thriving food scene, excellent museums and infrastructure, beautiful natural scenery and friendly people. All of the SOLID partner institutions are in student rich cities. A young population means many cultural and athletic activities and music festivals.

The positions

As a cross disciplinary centre, we seek candidates with a background in physics, chemistry, biology, mathematics, materials science, geology or engineering. For the PhD positions, no specific experience is required in the topic of the research but keen interest and a drive for solving problems are essential. We also expect you to be strong in physics, chemistry and mathematics.

Our expectations about you, as a person

You are excited about fundamental science and applying the results to solve practical problems of importance to society. We expect that you enjoy being part of a team, that you have a sense of humour, you are a good problem solver, enjoy helping others and that you are also able to work effectively and independently.

We hope to receive your application

We plan to hire 7 PhDs and 3 postdoctoral fellows within the next half year. The openings are listed below but we are open to letters of interest at any time and for future positions. To learn more about the materials, projects and people, and to start your application, we refer to the homepage: **www.solid.dtu.dk**

PhD: High pressure neutron and x-ray studies of liquid structure
PhD: Semi-supervised learning (artificial intelligence) for volumetric segmentation
PhD: Visualization of self organization of dislocations using an x-ray microscope
Post doc: Dark field x-ray microscopy
PhD: Phase contrast imaging with neutrons
PhD: Diffraction imaging with neutrons

New Scientist
Shop

JANUARY SALE

50% OFF

MANY MORE SALE ITEMS AVAILABLE ONLINE

shop.newscientist.com

worldwide shipping available

50% discount applies to selected items whilst stocks last

The back pages

Citizen science

Counting penguins

How are penguin populations responding to climate change? You can help researchers to find out, says **Layal Liverpool**

Layal Liverpool is a digital journalist at *New Scientist*. She believes everyone can be a scientist, including you. @layallivs

What you need

A computer
A web browser open to penguinwatch.org
A keen eye for penguins

NEXT time you are struggling to fall asleep, try counting penguins instead of sheep. Doing so could help us see how the birds are being affected by threats like climate change.

Tom Hart at the University of Oxford and his colleagues are constantly capturing photographs of penguins through a network of about 140 remote cameras planted across Antarctica. There are far more images than the researchers can process on their own, so Hart and his team set up a project called Penguin Watch.

Through penguinwatch.org, you can join more than 1 million citizen scientists who have participated so far and help the team by flicking through photographs online and clicking wherever you spot a penguin. You will be asked to mark adult penguins, chicks and eggs in the images, by clicking on the centre of each one.

I found it surprisingly addictive. You can also keep an eye out for other seabirds that might appear and mark these for researchers to identify later. In addition to providing clues about how these animals are behaving and interacting with their changing environment, your work will also help the team to train artificial intelligence, which is increasingly allowing the group to automate picture assessing. "We now automate about half of it," says Hart. The team still relies heavily on volunteers, though, especially to help spot unusual things, such as new species, he says.

FIONA M JONES

Hart and his colleagues also regularly visit Antarctica and other penguin breeding sites in the southern hemisphere to take images with flying drones and to collect penguin faeces, which they then analyse in the laboratory to gain further insights.

Early results from the project are revealing some of the challenges that various penguin populations are facing as their environment changes. Nest flooding, for example, may reduce survival of eggs and chicks. In a recent study, Hart and his team found that heavy snow events overlapped with declines in numbers of gentoo chicks.

Melting ice in Antarctica also poses a threat. "On the Antarctic peninsula, Adélies are doing very badly and now chinstrap penguins are doing very badly," says Hart. Populations of ice-loving penguins like Adélies and chinstraps are likely to continue to decline, he says, whereas gentoo penguins (pictured), which tend to prefer an environment with less sea ice and more exposed rock, may fare better.

Penguin Watch and other research efforts should help to give a clearer picture of how individual colonies are responding to climate change, as well as to other pressures such as krill fishing in the Southern Ocean. "It's only now that we're starting to answer these big questions," says Hart. ▮

These articles are posted each week at newscientist.com/maker

Citizen science appears every four weeks

Next week

Stargazing at home

Thinking about exploring the world again?

While travel is still just a dream for many at the moment, we know that some of you are now eager to pencil in your next adventure for later this year.

- Over 40 departures
- Transferable deposits and deposit refunds should covid-19 impact departure dates
- Small group sizes and safe touring protocols
- Increased flexibility so you can book with confidence including reduced deposits, removing amendment fees and pushing final payment dates back on many of the tours

Whether you're ready to book or just want to carry on dreaming for a little longer, we hope you enjoy browsing some of the new tours we've created. For more information on all our new tours for 2021, visit **newscientist.com/tours**

CZECH REPUBLIC ❱

Kepler's Prague: Astronomy and the music of the spheres

6 days

14 April and 14 Septemper 2021

Discover the legacy of Kepler and Brahe where astronomy, maths, music and art connect in the city of a hundred spires. Our tour with author and broadcaster Jane Green will journey to the heart of early science and Prague's medieval marvels.

MALTA ❱

Megalithic Malta: Temples, fortifications and archaeology

6 days

17 May and 1 November 2021

Malta and Gozo are small islands with a long and fascinating history including exceptional archaeological sites. From the ancient and mysterious temples believed to be some of the world's oldest structures, to the fortifications of the Knights of St John. Discover over 7000 years of history.

MONGOLIA ❱

Dinosaur hunting in the Gobi Desert

15 days

28 August and 11 Sept 2021

Join *New Scientist* on a thrilling and unique expedition to find dinosaur remains in the wilderness of the Gobi desert with professional palaeontologists from the Mongolian Institute. Fully participate in live prospecting and fossil digging across keys sites.

❰ GREECE

Learn to dig Mycenaean archaeology

7 days

14 May and 4 June 2021

An interactive tour of the key Mycenaean sites including a unique 'behind the ropes' 3-day experience at Mycenae where you will be taught how to explore, map and excavate with their resident archaeologists. Followed by visits to the hidden gems and famous sites of the ancient Peloponnese.

❰ ITALY

The science of the Renaissance

8 days

7 June and 1 November 2021

Embark on a cultural adventure to the great science cities of Florence, Pisa and Bologna, as architecture expert Andrew Spira and science historian Professor David Wootton guide you through the great discoveries and minds of the Renaissance.

New Scientist Discovery Tours

Want to know more?
For more information on all our new tours for 2021, visit newscientist.com/tours

RUSSIA

Saint Petersburg: The history of Russian science

8 days

27 August and 8 October 2021

Explore the history of Russian science, from the creation of the Academy of Sciences, through to the fraught years of Soviet transformation in this stunning and vibrant city. A plethora of museums, cathedrals and cultural treasures.

VIETNAM

Caves, Conservation, Culture

11 days

4 September 2021

Discover a different side of Vietnam in this wide-ranging tour that covers geology, stunning landscapes, animal conservation, culture and history. Experience tropical jungles, limestone caves, blissful villages and amazing feats of underground engineering.

DENMARK

Bohr's Copenhagen: Physics past and future

6 days

1 September and Nov 2021

Discover the scientific heritage of Denmark through this city tour of Copenhagen. Accompanied by author and journalist Philip Ball, learn about the science of Niels Bohr, Tycho Brahe, and Ole Romer as you explore observatories, museums, and research centres, as well as delving into Denmark's Viking past in Roskilde.

ITALY

Hidden science of the Dolomite Mountains

8 days

6 September 2021

A gentle outdoors tour through the stunning Dolomite Mountains that investigates several scientific phenomena including glacial recession, archaeology, geology, ecology, deep time, astronomy and the 'White War'.

FRANCE

The birth of modern medicine: Paris and Montpellier

6 days

1 September 2021

Discover the foundations of the modern science of medicine in two French cities: Paris, where the 'Paris School' of hygiene and hospital teaching flourished and Montpellier, home to the world's oldest university medical faculty. Accompanied by *New Scientist* writer Linda Geddes.

USA

Space: The history and future of space exploration

12 days

September 2021

A comprehensive tour visiting key sites in the history and future of space exploration. From the first rockets, to the iconic missions, space stations and developing space tourism industry. Including three NASA space centers and Virgin Galactic Spaceport America.

SWEDEN

Nobel's Stockholm: Celebrating science through space and time

6 days

16 August 2021

Explore the beautiful city of Stockholm as you learn about Alfred Nobel and the Nobel prizes. Explore the scientific heritage of Stockholm, past and present, meet experts and learn about Sweden's contribution to botany, astronomy, physics, chemistry and medicine.

JAPAN

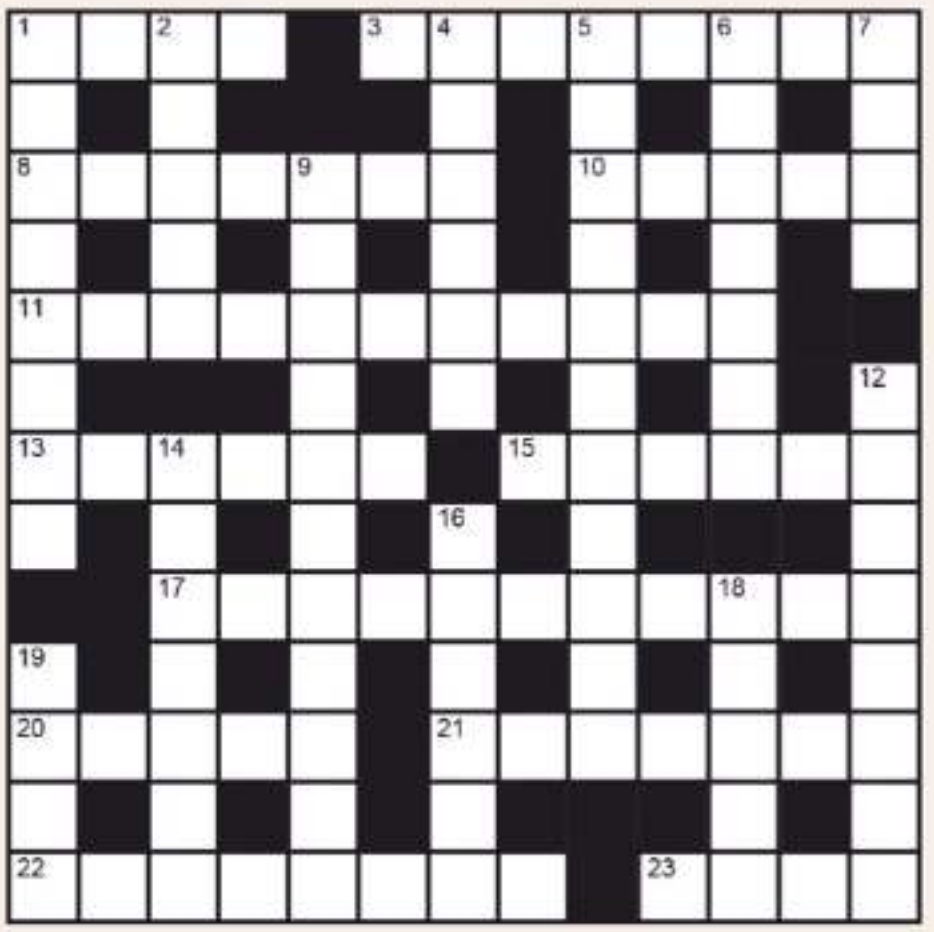
Nature, culture, science: Tokyo to Kagoshima

12 days

17 October 2021

Traverse the length of Japan in a journey that encompasses its must-see technology and nature, from the buzzing metropolis of Tokyo with New Scientist's Rowan Hooper to hot springs, volcanic islands and snowy mountains.

Cryptic crossword #48 *Set by Rasa*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Bypass captain (4)
3 Force accepts awful din when people ring in the New Year (8)
8 Auk with no tail? Call working ornithologist (7)
10 Taste created by university mosque leader from the east (5)
11 Empty ideas and backward nonsense written in strange cipher from long ago (11)
13 Geronimo, for instance, quickly corrals horse (6)
15 Uneasy with a dagger, oddly (2,4)
17 Promises made to self with respect to tea and coffee, say (11)
20 Laughing one brief laugh about desire (5)
21 Extraction tool to be used with porcini mushrooms (7)
22 Twitter embraces faux embroidery (8)
23 By the way, I see retro fastener (4)

DOWN

1 Vegetables from tin almost satisfy (4,4)
2 Admitted with pass for non-studio film (5)
4 Hotel had present from the start (6)
5 Sequel to *Supernova* non-starter surprisingly grabs you in the end (7,4)
6 Made a surgical incision after head of geriatrics took a quick look (7)
7 Time to fix maths course (4)
9 Genius (bachelor) restores public garden (6,5)
12 Anyhow, seems UPS makes mistakes (6,2)
14 Sign off on a welcome video, finally (5,2)
16 Maypole finial features polypropylene, for example (6)
18 Returning stone set in a ring, last of a series (5)
19 What 18 Down represents: houses for cockneys, we hear (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #83

1 When was the BCG vaccine first used?
.
2 What does CRISPR stand for?

3 To the nearest whole number, how many parsecs are there in a light year?

4 Chess-playing computer Deep Blue first took on Garry Kasparov in 1996. What was the final score in that match?

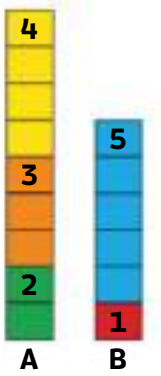
5 Chytridiomycosis infects what group of animals?

Answers on page 55

Puzzle

set by Rob Eastaway

#95 Catch up



Catch Up 5 is a two-player game using five stacks of toy bricks of height 1, 2, 3, 4 and 5. The aim is to end with a taller tower than your opponent. Player A starts by taking a single stack of any height – in the example above, they chose the "2" stack. B then takes as many stacks as they want, piling them up until their tower is the same height or taller than A's, which ends B's turn. Here, B took the "1" stack, then the "5". A now does the same, stacking until their tower is at least as tall as B's. Here, A took the "3" stack, then the "4". The players take turns until all of the stacks of bricks have been used up, so Player A won this game.

Imagine you are going first in a game against a Catch Up 5 expert who always plays the optimal move when it is their turn. Which piece should you choose?

Answer next week

Fifty shades of green

Why are tree leaves so many different shades of (mainly) green?

Chris Daniel
Glan Conwy, Conwy, UK
Leaves have a number of pigments, including chlorophylls, that are involved to a greater or lesser extent in photosynthesis: using light energy to make sugars.

Chlorophylls appear green because they absorb light at the blue and red ends of the visible spectrum. Chlorophyll a is the most abundant form in leaves and has a light green colour. Chlorophyll b absorbs more of the shorter, blue wavelengths of sunlight, giving it a darker shade of green. It is known as an accessory pigment because its role is to pass light energy to chlorophyll a to complete the photosynthesis. Other accessory pigments have different light-absorbing properties and are antioxidants, protecting leaves from excessive exposure to sunlight. These include carotenes, which have orange colours, while xanthophylls are yellow and anthocyanins red, purple or blue.

"As the leaf's green disappears, the red, yellow and orange pigments become prominent, giving the colours of autumn"

Plants that grow well in low-light conditions have darker green leaves because they have more chlorophyll b, as do older leaves. New leaves in the spring mostly have light green chlorophyll a.

When the strength of sunlight decreases in late summer, photosynthesis slows and the chlorophyll molecules are broken down for the tree to absorb as nutrients. As the green disappears, the red, yellow and orange pigments become more prominent, giving the warm colours of autumn.

OLEKSIY BOYKO/ALAMY

This week's new questions

Digital print **Do other animals have "fingerprints"?**
***John Cleveland**, Bloomington, Indiana, US*

Dropping off **How do our brains stop us from falling out of bed while asleep?** ***Ian Cairns**, Seaford, East Sussex, UK*

Satellite limits

To what extent can satellites have satellites? Could our moon have its own moon with its own moon, for example? Is there a limit?

Spencer Weart
Hastings-on-Hudson, New York, US
The moon not only can have satellites, but has had many, some of them inhabited. They are the Apollo lunar orbiters, which circled the moon while the landing craft, well, landed.

The interesting question is how long such sub-satellites can keep circling before tidal forces tear them loose. If we think of Earth as a satellite of the sun, then, for the moon, the answer is billions of years. On the other hand, a satellite launched to circle the moon at about half the distance from the moon to Earth wouldn't even complete one orbit. It all depends on the relative masses and distances.

Peter Borrows
Amersham, Buckinghamshire, UK
The force of attraction between various bodies can be calculated using Isaac Newton's equation of universal gravitation. These calculations show that the sun attracts the moon with roughly double the force that Earth does. So, strictly speaking, "our" moon isn't a satellite of Earth, but of the sun, albeit with a rather distorted orbit due to the proximity of the relatively massive Earth.

What about the International Space Station (ISS)? Earth attracts the ISS more strongly than does the sun, so there is no doubt it is a satellite of Earth.

What about the Apollo 11 command module Columbia, which orbited the moon while Neil Armstrong and Buzz Aldrin were on the surface?

In this case, the sun attracted Columbia about twice as strongly as Earth did, but the moon attracted Columbia far more strongly than either of them. So Columbia was a true satellite of the moon.

Anthony Woodward
Portland, Oregon, US
The mass of a primary moon and therefore the strength of its gravitational field has to be less than that of the planet it orbits, otherwise the planet would become the satellite. The mass of any secondary moon imagined to orbit the primary moon must have a mass (and gravitational attraction) less than that of the primary moon. So, the planet's gravitational force will capture any proposed secondary moon.

Albert Einstein's theory of gravity is often depicted as a massive object such as a planet causing a hemispherical dent in an elastic sheet of space-time. A primary moon orbits the planet some distance up the wall of that hemisphere. Imagine a secondary moon trying to orbit the primary moon. It will "fall down" the slope of the indentation to orbit the planet.

Mike Follows
Sutton Coldfield, West Midlands, UK
There is no pretending that Einstein's general theory of relativity is simple, but the three spatial dimensions and the time dimension it depicts can be represented as a flat sheet known as the fabric of space-time

Celestial bodies create depressions on this fabric in much the same way as we create an impression on a mattress in our beds. This "gravitational potential well" is deeper and wider for more massive bodies. Towards the outside of the well the sides

Do other animals have the equivalent of our fingerprints?

Want to send us a question or answer?
Email us at lastword@newscientist.com
Questions should be about everyday science phenomena
Full terms and conditions at newscientist.com/lw-terms

Tom Gauld
for New Scientist

are more gently sloping.

Our solar system orbits within the potential well of the Milky Way, with a supermassive black hole possibly tearing a hole in the fabric of space-time at its centre. Earth is far enough away from the sun that it orbits on the relatively flat part of the sun's potential well. Our moon is trapped inside Earth's potential well because it doesn't have enough mechanical energy to escape this. The moon would have escaped if Earth were less massive or much closer to the sun.

"The Mercury-crossing asteroid 66391 Moshup is just 1.3 kilometres wide, but is orbited by a moon called Squannit every 16 hours"

One remarkable example of a tiny moon is that of the Mercury-crossing asteroid 66391 Moshup. The asteroid is 1.3 kilometres wide, and is orbited by a 360-metre diameter moon called Squannit every 16 hours.

Patchy cabbage

Why do cabbages exist? What is the point of having a tight bundle of leaves that don't attract pollinators and shield each other from the sun? Does its structure affect its ability to photosynthesise? (continued)

Markus Eymann
Edmonton, Alberta, Canada
The previous responses implied that the cabbage head serves no survival value to the plant. This makes sense if you view the cabbage as a passive recipient of selective breeding, but if you look at this process as just another evolutionary force in the plant's long history, things look different.

Cabbages and humans have co-evolved in a mutually beneficial relationship, where humans look after the cabbage's reproduction by breeding it and distributing its seed, and help it compete with other plant species by weeding and applying herbicides. In return, the cabbage provides us with food. Viewed this way, the cabbage's enlarged terminal bud is highly adaptive, because it manipulates us into being its hands and brain.

Celia Berrell
Cairns, Queensland, Australia
The humble wild cabbage
named *Brassica o*
looks more like a weed
than the veggies we know.

Through breeding (like dogs)
to enhance special traits,
there's more than one
Brassica o on our plates.

Selecting big leaves gives us
kale and collard greens,
while breeding big buds
grows the cabbage we've seen.

Exaggerate flowers and
what have we got?
Some huge heads of broccoli
served steaming hot.

Those cream cauliflowers
are brassicas too.
One plant; many veggies
And so good for you! ▮

Answers

Quick quiz #83
Answers

1 1921

2 Clustered regularly interspaced short palindromic repeats

3 Three

4 It was 4–2 to Kasparov

5 Amphibians

Quick crossword #73
Answers

ACROSS 1 Tube, **3** Stop, **6** Miner, **10** Illogical, **11** Mamba, **12** Trypsin, **14** Echo, **16**/**25D** Squash court, **18** Ohm, **21** Hal, **22** Acetyl, **23** Vein, **25** Clearer, **27** Malaria, **29** Upped, **30** Detergent, **31** Thyme, **32** Oryx, **33** X-Men

DOWN 1 Thirtieth, **2** Bilby, **4** Technique, **5** Polyp, **6** Mammoths, **7** Number one, **8** React, **9** Egest, **15** Half-empty, **17** Asymmetry, **19**/**13** Manhattan project, **20** Oak Ridge, **24** Flora, **26** Radio, **28** Rheum

#94 Fastest fingers first
Solution

All three contestants got the same number correct in the same position, meaning two, one or zero letters are in the right place. All combinations with one or two correct lead to contradictions, so all four got every position wrong. From that we deduce that the third in the list isn't B, D or C so must be A, meaning the second must be C, and the correct order is BCAD. Hence a Sentonium has more legs than a Fettlepod.

Stocks and sleighs

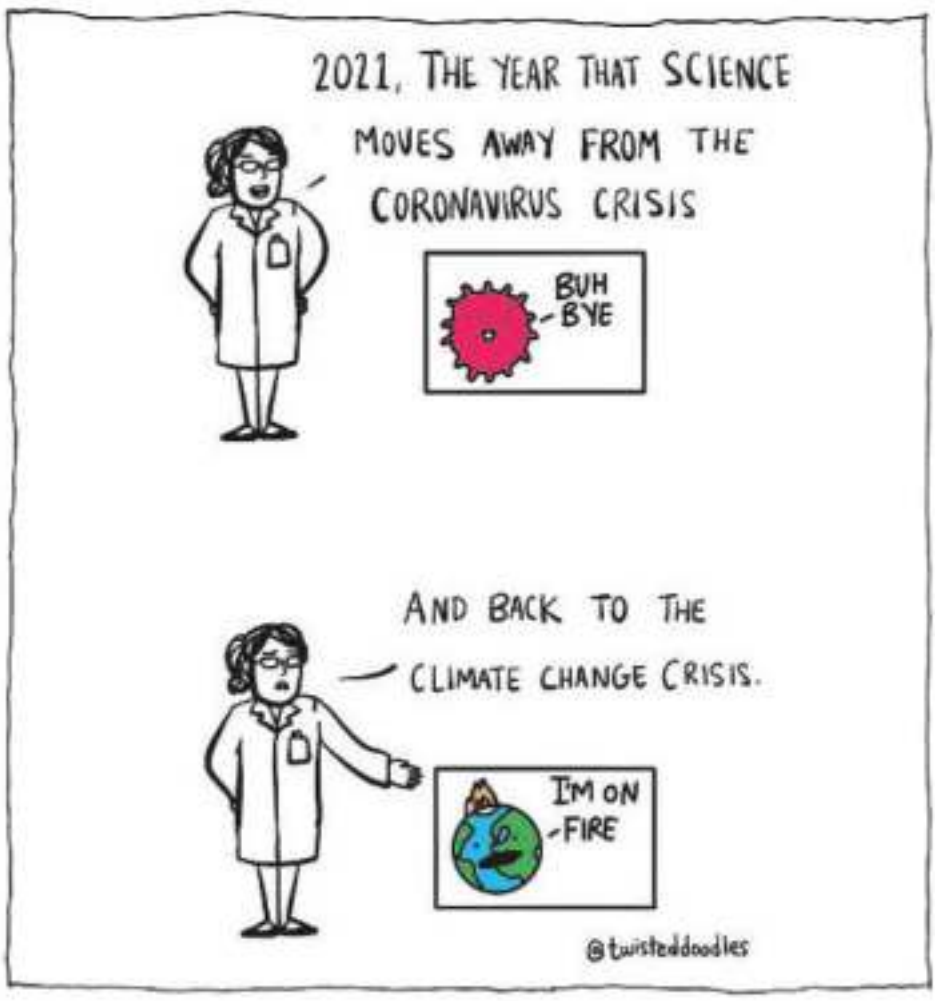
In this year of all years, Feedback doesn't intend to join the chorus of naysayers saying you should have taken your Christmas decorations down by now. That's not least since we learned that Dolly Parton – surely one of the heroes of 2020 for her appearance as a philanthropic sponsor of coronavirus vaccine research – doesn't dispose of hers until after her birthday on 19 January.

Accordingly, on this 16th day of Christmas, we bring you the seasonal silly news that if you haven't been investing in vaccine research, then you haven't been paying enough attention to your financial adviser. You know, the one with the antlers and the very shiny nose.

Economist Bruce Sacerdote at Dartmouth University in New Hampshire and his colleagues encouraged a team of 10 reindeer at a Christmas-themed amusement park in the state – Dasher, Dancer, Prancer, Vixen, Comet, Cupid, Donner, Blitzen, Rudolph and Boris (a trainee) – to choose securities by making hoofprints on the stock pages of *The Wall Street Journal*. During a dire year for stock markets, their heavily covid-19-skewed strategy, favouring life science, pharma, tech, entertainment and media stocks, outperformed the US S&P 500 index by a statistically significant 4.9 per cent.

Some of the picks are controversial – the researchers highlight the appearance of oil company Chevron on the list, a contrarian choice for an Arctic species threatened by global warming. Overall, however, the cervids' selections did better than the stock trades by US senators and representatives – the subject of repeated accusations of cashing in during the pandemic – investigated by the same researchers earlier in the year, which led them to conclude that these politicians were "as feckless as the rest of us at stock picking". Unsurprising, perhaps, that Santa's sleigh team should have a better high-level global view.

Twisteddoodles *for New Scientist*



Got a story for Feedback?

Send it to feedback@newscientist.com or New Scientist, 25 Bedford Street, London WC2E 9ES
Consideration of items sent in the post will be delayed

Lunar units

Richard Gillingwater makes the dangerous admission of reading our competitor *Popular Science,* in particular, an article on the discovery last year of dark shadowy pockets on the surface of the moon that might hold frozen water.

You could have read it in these pages, Richard (31 October 2020, p 14). But then you wouldn't have gained the startling insight that "these small spots, known as 'cold traps,' range in size from about the diameter of a belly button to much larger craters that could take 10 minutes to walk across". Musing with Richard about the wisdom of leaving a belly button exposed on the moon, we also invite estimations as to how many belly buttons there are in a 10-minute walk.

1.2-metred friend

In a similar vein, reader Tim Hall "needed to measure [his] dog correctly for his Christmas present", and found the advice online was to ensure the dog was standing "with all 4 feet (1.2m) on the floor".

We suspect the leaden hand of algorithmic proofreading here. Certainly, it is something *New Scientist*'s all-too-terrifyingly flesh-and-blood subeditors would never have let pass. They wouldn't have had a non-metric dog in the house in the first place.

Totes breblicious

Those looking for late grounds for festive family arguments could do worse than suggesting a game of "BLABRECS: the wordgame that hates you". The brainchild of artificial intelligence researcher and game designer Max Kreminski, it is "a rules modification for SCRABBLE that swaps out the dictionary for a capricious AI", he explains on Twitter. Real words aren't allowed. Rather, you can only play nonsense words, that, through statistical analysis of letter sequences in English words, sound real to an AI.

Testing our chops at mkremins.github.io/blabrecs/ we find we are pretty aptious at blabrecs, genging frungibles with facilibandon. Feedback has avoided Scrabble since we were forced some years ago to disown an elderly aunt following a ferocious argument about the admissibility of the word "yive". It's scratback time.

Steaming romance

Douglas Ormrod writes in, charmingly, from Auckland, New Zealand, with a late addition to our items last year on the worst jobs in science (10 and 17 October). He reports beginning his research career in 1967 at the Royal (Dick) School of Veterinary Studies at the University of Edinburgh, UK, on a programme that aimed to prevent colibacillosis in calves by the oral administration of serum-derived immunoglobulins.

The less-than-glamorous reality was that, while his female colleague, Dale, bottle-fed the calves at the front end, Douglas fingered their rear ends – without gloves – to extract liquid faecal samples for testing. They then divided the samples into cup-cake cases, weighed them and dried them in the lab oven to determine dry matter ("we always removed the pies first", says Douglas).

But besides a front and back, this story has a happy end for the pair. "The smell lingering about our persons made it difficult for us to get dates outside the lab, so we got married," Douglas reports. "Still are 50 years later." Congratulations to you both. At least you can be sure you'll be there for each other when the... readers do please complete.

New Scientist Podcast

> **"Very well informed... delivered in an unfussy, well presented and accessible way... Definitely news you can use."**
> Press Gazette

The New Scientist Weekly podcast

Episode 49 out Friday 8 January

Our weekly podcast has become the must-listen science show, bringing you the most important, surprising or just plain weird events and discoveries of the week. If you missed the earlier episodes you can still listen in to hear about:

Episode 48
Must-know science of 2021: covid, climate and microplastics. Plus culture picks for the new year

Episode 47
Christmas special quiz of the year

Episode 46
Stardust hunting, the illusion of the self and space rocks return to Earth

Episode 45
Vaccine roll out in UK and China, Chris Packham on connectedness and AlphaFold breakthrough

Hosted by *New Scientist*'s Rowan Hooper, new episodes are out each Friday.
Follow us on Twitter **@newscientistpod**

Apple Podcasts · Spotify · Google Podcasts · Stitcher