

Dark side of the sun Exotic matter lurks inside our star

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No candour, no trust

Without transparency it's impossible to have faith in climate science

IS CLIMATEGATE finally over? It ought to be, with the publication of the third UK report into the emails leaked from the University of East Anglia's Climatic Research Unit (CRU). Incredibly, none looked at the quality of the science itself.

The MPs' inquiry – rushed out before the UK general election on 6 May – ducked the science because the university said it was setting up an “independent scientific assessment panel” chaired by geologist Ron Oxburgh.

After publishing his five-page epistle, Oxburgh declared “the science was not the subject of our study”. Finally, last week came former civil servant Muir Russell's 150-page report. Like the others, he lambasted the CRU for its secrecy but upheld its integrity – despite declaring his study “was not about... the content or quality of [CRU's] scientific work” (see page 4).

Though the case for action to cut greenhouse gases remains strong, this omission matters. How can we know whether CRU researchers were properly exercising their judgment? Without dipping his toes into the science, how could Russell tell

whether they were misusing their power as peer reviewers to reject papers critical of their own research, or keep sceptical research out of reports for the Intergovernmental Panel on Climate Change?

Russell's report was much tougher on data secrecy, finding a “consistent pattern of failing to display the proper degree of openness”. Key data on matters of public importance – like CRU's assembly of 160 years of global thermometer data – cannot be

“Global thermometer data going back 160 years cannot be regarded as private property”

regarded as private property. Even so, he ought to have joined Oxburgh in calling for greater documentation of the “judgmental decisions” that turned raw data into the graphs of global average temperatures. Data manipulation is the stuff of science, but that manipulation has to be as open and transparent as the data itself.

Russell's team left other stones unturned. They decided against detailed analysis of all the emails in the public domain. They

examined just three instances of possible abuse of peer review, and just two cases when CRU researchers may have abused their roles as authors of IPCC reports. There were others. They have not studied hundreds of thousands more unpublished emails from the CRU. Surely openness would require their release.

All this, plus the failure to investigate whether emails were deleted to prevent their release under freedom of information laws, makes it harder to accept Russell's conclusion that the “rigour and honesty” of the scientists concerned “are not in doubt”.

Some will argue it is time to leave climategate behind. But it is difficult to justify the conclusion of Edward Acton, University of East Anglia vice-chancellor, that the CRU has been “completely exonerated”. Openness in sharing data, even with your critics, is a legal requirement.

But what happened to intellectual candour – especially in conceding the shortcomings of these inquiries and discussing the way that science is done. Without candour, public trust in climate science cannot be restored, nor should it be. ■

Why biology should inform policy

LEFT-LEANING politicians have traditionally blamed the structure of western society for the feckless and antisocial behaviour of its “underclass”. Now biologists are chiming in.

Animals that live shorter, riskier lives tend to reproduce early, and that applies to humans living in tough circumstances, too. So teenaged mothers and wayward fathers may be an

evolutionary response to deprivation, and many of the problem behaviours that plague western societies could be put down to a biological “die young, live fast” strategy (see page 40).

The solution is to improve the health and wellbeing of the poorest in society and give all young people the prospect of a good job and a stake in their future. But that looks unlikely,

given the economic downturn.

In recent years, though, we have gained considerable insights into the prerequisites for human fulfilment. Health and security may be top of the list, but we also thrive on community, fairness, bonding, altruism, playfulness and celebration. Hard-pressed politicians seeking inspiration would do well to look to these biological principles. ■



Climategate: time to move on

IT'S time to abandon the black-and-white fiction that human-induced climate change is fact or conspiracy. Instead, accept that the climate is changing and that there are shades of grey about how fast, how severe the impact will be and what we can do about it.

That's the message from leading scientists digesting the UK's official report into the "climategate" affair, in which private emails from the nation's Climatic Research Unit at the University of East Anglia in Norwich were made public in November 2009.

Muir Russell, a former civil servant who spent seven months investigating the affair, concluded in his official report, released on 7 July, that "the rigour and honesty of the

scientists involved are not in doubt". But he exhorted them to show more openness, to shed their "unhelpful and defensive" attitude when responding to requests to share their data and to make more effort to engage with climate sceptics who dispute their data and conclusions.

The scientists we contacted agreed with these suggestions. On sharing data, glaciologist Richard Alley at Pennsylvania State University in University Park says: "We're learning how to do this, and to make it more useful to the public and other scientists."

But overall, the scientists felt that the main legacy of the sorry saga will be the perpetuation of the myth that the world is split into climate-

change "sceptics" and "believers".

"It shouldn't be seen that scientists can't agree; that there's black and white," says Brian Hoskins of the Grantham Institute for Climate Change in London. "We're all on shades of grey and we have to be able to discuss those, and their implications."

"Within the scientific community, assessment bodies should strive for a diversity of viewpoints to be included, so that uncertainties and disputes are aired out in the open," says Roger Pielke Jr of the University of Colorado at Boulder.

Questioning climate science is what good scientists do, Hoskins adds. "As for people with a political agenda, will the report silence them? No."

Power struggle

WHAT do spacecraft and smoke alarms have in common? A material commonly used to detect smoke on Earth could soon power robotic missions to other planets.

Previous spacecraft travelling to the outer solar system have been powered by the decay of plutonium-238. The isotope is running out, though, so the European Space Agency now plans to build up an alternative supply of americium-241. In smoke detectors, the material's decay helps to make ions that trigger an alarm when smoke particles attach to them.

"We really don't know of any other way to have an electric power supply going into the deep solar system," says David Southwood, ESA's director of science and robotic exploration.

"We really don't know of any other way to have an electric power supply going into the deep solar system"

Americium-241 decays more slowly than plutonium-238, potentially allowing for longer missions, says Ralph McNutt of Johns Hopkins University in Baltimore, Maryland. On the downside, it takes more of the stuff to supply one unit of power.

Diabetes debate

A CONTROVERSIAL diabetes drug's days may be numbered. Regulators from the US Food and Drug Administration (FDA) will meet this week to decide whether or not to recommend that Avandia be pulled from the market over concerns that it may increase the risk of heart problems.

Concerns have hovered over the drug, made by GlaxoSmithKline, since an analysis in 2007 suggested that patients taking it were more likely to die of a heart attack than those on other diabetes medicines.

In an internal report dated 14 June but released last week,

FDA scientist Thomas Marciniak called into question a GSK-sponsored trial of Avandia. The trial, Marciniak claimed, included biases that led to the conclusion that Avandia was as safe as a competing drug.

Meanwhile, a study of more than 200,000 patients led by the FDA's David Graham and published last month concluded that Avandia increases the risk of heart failure and stroke by about 25 per cent compared with patients on competing drug pioglitazone (*The Journal of the American Medical Association*, DOI: 10.1001/jama.2010.920).

Cholesterol checks

HUNDREDS of premature deaths from coronary heart disease could be prevented each year in the US if every child had their cholesterol levels checked at age 11.

That's according to William Neal of West Virginia University in Morgantown, and colleagues, who say that current methods of only testing children if high cholesterol runs in the family misses a third of those who would benefit from treatment. Evidence suggests that treating children with elevated cholesterol reduces their risk of coronary heart disease later in life.

Neal used data from a screening scheme introduced for all state school pupils aged 10 or 11 in West Virginia in 2000. Of 20,266 children, 268 had cholesterol levels that merited consideration for cholesterol-lowering statins. One-third of these children would have been missed if current screening guidelines focusing on family history alone were applied (*Pediatrics*, DOI: 10.1542/peds.2009-2546).

But critics say this does not justify the cost: "More than 90 per cent of children in this study did not have high cholesterol, making [universal screening] difficult to justify," says Ellen Mason, a senior cardiac nurse at the British Heart Foundation.

Top hat cap

THE US Gulf coast was waiting on tenterhooks to find out if the Deepwater Horizon oil leak had finally been halted, as *New Scientist* went to press.

At 7 pm local time on Monday, BP fitted a new cap known as Top Hat 10 to its notorious well. It hopes that this cap will be strong enough to seal the leak, at least until the relief wells that are being drilled start working next month.

Top Hat has never been used at such depths and pressures before. BP began testing it on Tuesday to see if it could contain the oil, a

process that could take up to 48 hours. As oil builds up under the cap the pressure should rise; if it does not, that will suggest oil is still leaking. In a statement BP said that "its efficiency and ability to contain the oil and

"As oil builds up under the cap the pressure should rise; if it does not, that will suggest oil is still leaking"

gas cannot be assured".

Meanwhile, the US government has renewed a moratorium on deep-sea drilling in the Gulf of Mexico until 30 November.

No red herrings if you buy blue

NEXT time you spot the telltale blue label at your fishmonger's counter, you needn't worry about whether your supper of "sustainable Alaska salmon" actually came from depleted stocks in the Atlantic.

Several landmark studies have, over the past 20 years, highlighted the problem of mislabelled fish. One-third of fish on sale in the US is not the species it is sold as, and one-quarter of cod and haddock sold in Ireland is neither of these.

Now an exercise in eco-forensics has found that the certification scheme run by the Marine Stewardship Council (MSC), a global not-for-profit organisation, offers a way of ensuring you get what you think you're buying.

In a blind study, Rob Ogden of the Royal Zoological Society of Scotland tested 240 MSC-certified samples bought at supermarkets, restaurants and markets in the US, UK, Japan and Germany. He compared their DNA with validated reference samples. "Nothing came back as anything other than what it should have been," he says.

The study was able to differentiate between species such as farmed Atlantic salmon and the more expensive but sustainable Alaska salmon, and various populations of toothfish. This opens the possibility of telling apart sustainable and unsustainable fisheries of the same species. Ogden now plans to develop tests to distinguish between different populations of cod, herring and hoki.



A tick you can trust

60 SECONDS

Post-traumatic support

The US Veterans Affairs department published new rules on Monday that will give financial support to veterans seeking treatment for post-traumatic stress disorder. Veterans will be allowed to claim if a doctor confirms their symptoms and supports a diagnosis of PTSD.

Asteroid fly-by

The European Space Agency's Rosetta spacecraft captured its first close-up images of the asteroid Lutetia on 10 July. The hope is that the images will help astronomers classify the rock. It's unclear whether Lutetia is a primitive body left over from the solar system's birth, or a metal-rich fragment from the core of a much larger object.

Diet pill flop

Nine popular slimming supplements, including guarana seed powder and fibre pills, proved no better than placebos at helping consumers lose weight, says Thomas Ellrott at the University of Göttingen Medical School in the Netherlands. In a trial of 189 overweight volunteers, average weight loss over two months was 1 to 2 kilograms in the pill-takers, versus 1.2 kilograms in those receiving a placebo.

Smuggled pangolins

Chinese customs officers this week intercepted an illegal cache of dead scaly anteaters, or pangolins. The seizure, from a fishing vessel off Gaolan Island at the southern tip of China, included 2090 frozen pangolins and 1800 kilograms of pangolin scales, reports TRAFFIC, which monitors trade in threatened species. Two of the four species seized are endangered.

Hidden volcano

An undersea volcano that towers 3000 metres above the sea floor has been found off the coast of the island of Sulawesi, Indonesia. It is unclear whether the volcano, called Kawio Barat, is active.

The sun has a heart of darkness

The centre of our star may be made of dark matter, which could be cooling down the core

Eugenie Samuel Reich

IS DARK matter lurking at the centre of our bright sun? Yes, say two research groups who believe the elusive stuff is cooling the solar core.

The insight doesn't significantly affect the sun's overall temperature. Rather, a core chilled by dark matter would help explain the way heat is distributed and transported within the sun, a process that is poorly understood.

Dark matter doesn't interact with light and so is invisible. The only evidence for its existence is its gravitational effects on other

"Dark matter particles would absorb heat at the sun's centre and then carry it to the surface"

objects, including galaxies. These effects suggest dark matter makes up about 80 per cent of the total mass of the universe.

The idea that it might lurk at the heart of the sun goes back to the 1980s, when astronomers found that the number of ghostly subatomic neutrinos leaving the sun was only about a third of what computer simulations suggested it should be. Dark matter could have explained the low yield because it would absorb energy, reducing the rate of the fusion reactions that produce neutrinos.

However, the problem was solved another way when it was found that neutrinos oscillate between three kinds, only one of which was being detected on

Earth. As a result, the idea of solar dark matter was dropped.

Now it is being resurrected in the light of recent searches for dark matter, which have put limits on the mass of the particles that it is made of and shown that it interacts only very weakly with ordinary matter. These led Stephen West of Royal Holloway, University of London, and his colleagues to explore what would happen if particles that fell within these limits exist in the sun.

Their simulations show that gravity would pull such dark particles to the centre of the sun, where they would absorb heat. Some of these dark matter particles would then carry this heat from the core to the surface, decreasing the core temperature (www.arxiv.org/abs/1005.5102).

Similar, earlier work published this week by Mads Frandsen and Subir Sarkar of the University of Oxford also supports the idea that dark matter in the sun would cool the core (*Physical Review Letters*, DOI: 10.1103/physrevlett.105.011301). Their calculations used a dark matter particle with a mass of 5 gigaelectronvolts – lighter than the one in West's simulations.

Frandsen points out that this would make the dark matter particle about five times as heavy as a proton or neutron – which is consistent with the observation that there seems to be around five times as much dark matter as ordinary matter in the universe. "This is a very interesting dark matter candidate because it gives us a way to understand the ratio of matter to dark matter," he says.

Sarkar and Frandsen say that



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DARK STARS MIGHT MAKE BLACK HOLES

THE sun may not be the only star with a potentially dark heart. We could soon find out whether dark matter helped form the enormous stars that turned into the supermassive black holes at the centre of most galaxies.

The origin of such black holes is a mystery. One theory says they are the remnants of the universe's first stars, thought to have formed inside massive dark matter clouds. These stars may have had cores rich in dark matter particles of a type that would have annihilated one another in bursts of radiation. This extra power could have allowed these stars to grow larger than ordinary ones, resulting in the formation of supermassive black

holes when the stars died. But it was not clear whether there was any hope of detecting dark stars.

Then in June, a study led by Katherine Freese of the University of Michigan in Ann Arbor indicated that dark stars could attain up to 10 million times the sun's mass (*The Astrophysical Journal*, DOI: 10.1088/0004-637X/716/2/1397).

In a subsequent study, Erick Zackrisson of Stockholm University in Sweden and colleagues have worked out the apparent brightness of such stars. They conclude that they should be within sight of NASA's infrared James Webb Space Telescope, due to be launched in 2013 (www.arxiv.org/abs/1006.0481). David Shiga

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Dark within light

their solar dark matter particle also resolves another problem. Heat energy travels in the sun by conduction and radiation around the core, and by convection nearer the surface, but the position of the so-called convective boundary between these regions is disputed.

Simulations based on the sun's composition suggest that the boundary is further out than is indicated by sound waves detected on the surface of the sun, which are affected by the position of this boundary. Sarkar and Frandsen say that including their proposed dark matter particle in the simulations would bring this boundary inwards, resulting in closer agreement between simulations and observation.

Not everyone is convinced. Joyce

Guzik, West's collaborator at Los Alamos National Laboratory in New Mexico, points out that while there is a problem with current models of the sun, the difficulty is that these models already give a lower solar temperature than the one observed. Adding a chilling effect at the core only makes this discrepancy harder to resolve.

We may not have to wait long to find out whether there is dark matter in the sun. Both research groups agree that if there is core cooling, it should reduce the output of some kinds of solar neutrinos by around 10 per cent. It should be possible to check for this reduction when neutrino detectors in Canada and Italy become able to collect more sensitive data. ■

Want to get off to sleep? Ask your astrocytes nicely

IF YOU'RE feeling sleepy, it might be thanks to your astrocytes. This group of brain cells, long assumed to play a mere housekeeping role, may actually be responsible for controlling when we fall asleep, by releasing a chemical called adenosine.

"One of the leading theories of sleep generation comes from the observation that there is an accumulation of adenosine [in the brain] during waking, and that this adenosine decreases during subsequent sleep," says Tommaso Fellin at the Italian Institute of Technology in Genoa. Adenosine is thought to suppress neurons which usually stimulate the cortex and keep it, and so us, awake. However, he says, "the cellular source of this adenosine has long been overlooked".

Astrocytes play a key role in providing neurons with nutrients and aiding cell repair. In addition, unlike neurons that control immediate brain activity, astrocytes are thought to modulate longer-term activity by regulating communication between neurons. Because sleep pressure - the physiological mechanisms that result in the need to sleep - also builds up over a prolonged period of time, Fellin and Michael Halassa, now at the Massachusetts Institute of Technology, and colleagues, decided to investigate whether astrocytes might be the source of the adenosine

that may drive the urge to sleep.

They used mice which had been genetically engineered to stop releasing adenosine from their astrocytes in response to an antibiotic in their food. Suppressing levels of adenosine reduced the length of sleep the mice took after being deprived of shut-eye for 6 hours, and prevented some of the cognitive defects

"These brain cells are well suited to have a large, global influence on brain function"

associated with sleep loss (*Neuron*, DOI: 10.1016/j.neuron.2008.11.024).

"Our research suggests that these cells are responsible for adenosine accumulation" and the regulation of sleep, says Fellin, who presented the results at the Forum of European Neuroscience in Amsterdam, the Netherlands, last week.

"This is exactly the type of function that astrocytes would be expected to perform," says Douglas Fields at the US National Institutes of Health in Bethesda, Maryland. "Astrocytes communicate slowly and on larger spatial scales than neurons. They are well suited to have a more global influence on brain function."

The finding opens up new avenues for treating sleep disorders or keeping people awake longer. Linda Geddes ■



Succumbing to "sleep pressure"

Let there be night, for wildlife's sake

Peter Aldhous, Edmonton

IT IS time to take back the night for wildlife. That was the rallying call from a landmark session on light pollution at the Society for Conservation Biology on 4 July in Edmonton, Canada.

The disruptive effects on animals of our penchant for bright lights has rarely impinged on public consciousness. Notable exceptions are when turtle hatchlings head inland to the bright lights of a beach resort instead of the safety of the

"The glare of street lights diverts some pregnant bats from their usual commute to get food"

moonlit sea, or birds collide en masse with brightly lit buildings.

It is rapidly becoming clear, though, that light pollution subtly interferes with the growth, behaviour and survival of many nocturnal species – not just those that hit the headlines.

The threats posed by the humble street lamp do not rival the wholesale destruction of

tropical forests and other habitats, or indeed the threat of climate change. But participants in the session at the Edmonton meeting agreed that planners should spare a thought for wildlife when installing lighting. "We've taken away the night," warns Travis Longcore of the University of Southern California in Los Angeles, who chaired the session.

For instance, Emma Stone of the University of Bristol, UK, has shown that high-pressure sodium street lights can divert lesser horseshoe bats from their usual routes between roosts and foraging grounds. Such diversion may be energetically costly – all the more of a worry as the bats in the study were pregnant.

Many migratory birds also fly at night, and can be disoriented by brightly lit structures, circling them until they become exhausted, or collide with the buildings or each other. Surveys over 25 years at a single TV broadcasting tower in Florida recorded more than 42,000 casualties involving 189 species.

Alan Clark of Fordham University in New York City



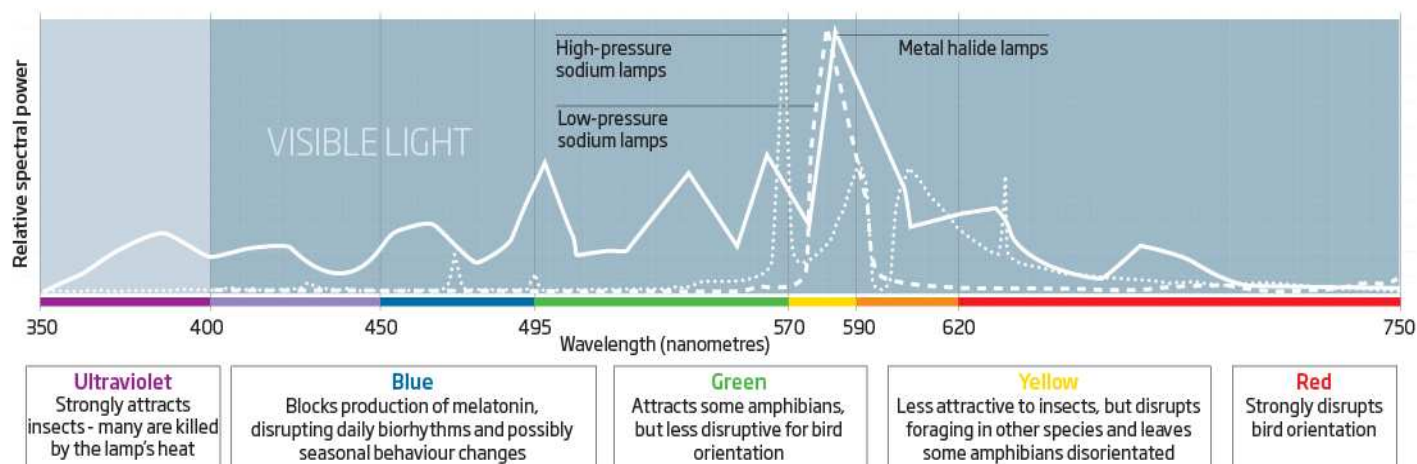
DIETER TELEMANS/PANOS

is now using microphones and radar to track birds through urban environments. He has found that more birds fly over darker and quieter sites like the Bronx Zoo and Central Park, and that those trying to navigate busy districts like Little Italy and East Harlem tend to call out much more, suggesting that they are disorientated.

Nor does it take New York City's bright lights to disrupt animals: recent studies on frogs have shown that lights barely brighter than a full moon can have profound effects. Bryant Buchanan of Utica College, New York, found that exposing the tadpoles of the South African clawed frog (*Xenopus laevis*) to 1 lux every night for 37 nights

Not all street lamps are the same

Common street lamps emit a mix of colours, with different effects on insects and other wildlife



SOURCE: LONGCORE UCL, M. ROBERTS, INDOOR LIGHT TECHNOLOGIES



Dim the lights

slowed their transformation into froglets. That's little brighter than a full moon, and typical of a light-polluted marsh in Utica. If native frogs are similarly affected, it could threaten their survival: delayed development can be fatal for frogs breeding in ponds that are susceptible to drying up.

Yet in some circumstances it may be possible to design wildlife-friendly lighting. Hanneke Poot of the Max Planck Institute for Ornithology in Seewiesen, Germany, has come up with a way of reducing the number of birds killed at offshore oil and gas rigs. Working on the Dutch island of Ameland in the North Sea, she shone lights of different colours at migrating birds flying south from Scandinavia.

White lights, generally used on rigs, caused more than 80 per cent of birds to change direction on overcast nights. Red lights were only a little less disorienting, but with green lights just 27 per cent shifted course when the skies were overcast, and only 5 per cent

were swayed by blue light.

Although humans don't see well in blue light, in tests on a Dutch gas rig, workers were happy with green light, finding that it gave good contrast. Preliminary results indicate that only half the normal number of migratory birds circled the green-lit rig.

Most commonly used lights have different effects on wildlife depending on their precise spectra (see diagram). Gerhard Eisenbeis of the University of Mainz, Germany, has found that different street lights attract and kill vastly varying numbers of insects. The least disruptive, he found, were those using LEDs, especially the "warm" variety that emit less blue light.

Still, Longcore warns that what's good for one species may be bad for another. "I don't think we're going to find a perfect light that will have a low effect on all wildlife," he admits. Ultimately, there is only one simple way to reclaim the night for wildlife: dim the lights. ■

Quantum entanglement shapes life's blueprint

THE most celebrated molecule in biology - the DNA double helix - might owe its shape to a mysterious quantum property called entanglement.

In recent years, animals have been shown to use quantum processes to their advantage. For example, some birds' eyes use quantum trickery to "see" the Earth's magnetic field, and light-harvesting molecules in algae and bacteria rely on quantum processes to transfer energy efficiently. Now it seems the blueprint of life could also owe its functioning to such phenomena.

DNA consists of two strands, each made of a chain of nucleotides, or bases. The bases in each strand link up like the rungs of a ladder, with each rung called a base pair, and the whole thing is twisted into a double helix. The helical shape is vital to DNA's stability, as it prevents it from disintegrating inside a cell.

To see if quantum processes play a role in determining the shape of DNA, Elisabeth Rieper of the National University of Singapore and colleagues modelled each base pair as a cloud of electrons that oscillates around a positively charged nucleus. The team found that

with each other, an essential prerequisite for entanglement to occur. Each cloud has the largest effect on its neighbours, with its influence dropping with distance.

When the researchers analysed the DNA without its helical structure, they found that the electron clouds were not entangled. But when they incorporated DNA's helical structure into the model, they saw that the electron clouds of each base pair became entangled with those of its neighbours (arxiv.org/abs/1006.4053v1). "If you didn't have entanglement, then DNA would have a simple flat structure, and you would never get the twist that seems to be important to the functioning of DNA," says team member Vlatko Vedral of the University of Oxford.

"It's a very nice step forward, a new way of looking at DNA," says Sandu Popescu, who studies entanglement in biological systems at the University of Bristol, UK. But whether the entanglement has any biological relevance remains to be proven, he adds.

However, Aleksei Aksimentiev of the University of Illinois at Urbana-Champaign is sceptical that quantum effects are the sole reason for the helical structure. He points out that the way the helical structure shields the hydrophobic bases from water inside a cell is already considered a viable explanation for DNA's shape.

To better understand the significance of entanglement to DNA's stability, the quantum effect "should be compared to other factors that are known to stabilise DNA structure and give the molecule its functionality", Aksimentiev says.

It's also unclear whether entanglement affects the information content of DNA. Could it hinder how information is read or lead to faster information processing, as has been demonstrated in quantum computing? "At this stage I don't think we can answer either of these questions," Vedral says. Anil Ananthaswamy ■

"If you didn't have entanglement you would not get the twist that is vital to DNA's functioning"

quantum entanglement between these clouds helped DNA to maintain its helical structure.

Entanglement is a quantum property where two or more objects are linked and in "superposition" - existing in many possible states at once. When this happens, it is impossible to describe the state of each object individually - the entangled objects must be considered as a whole.

In their model, electrostatic forces caused the electron clouds of adjacent base pairs to interact

Archimedes and the solar steam cannon

Jo Marchant

DID the ancient Greek inventor Archimedes build a solar-powered steam cannon that fired flaming projectiles? Perhaps, if the latest design for such a weapon is anything to go by.

Archimedes is said to have built fantastic machines of war, ranging from catapults to giant claws, that were used against the Romans during their siege of Syracuse, Sicily, in the 3rd century BC. One of the most controversial stories is that Archimedes set fire to Roman ships by focusing the sun's rays onto them with concave mirrors. Sceptics say it would be impossible to use mirrors to keep the sun's rays focused on a moving ship. What's more, they say, any fires would start slowly and could easily be put out by those on board.

Now Cesare Rossi of the University of Naples Federico II in Italy has suggested an alternative scenario. He points out that according to several scholars, including Petrarch and Leonardo da Vinci, Archimedes invented

a cannon which used pressurised steam to force a projectile out of the barrel at high speed. In 2006 a team at the Massachusetts Institute of Technology successfully tested a steam cannon built to their own design.

In a chapter in the book *The Genius of Archimedes* (Eds: S. A. Paipetis and Marco Ceccarelli,

Springer), Rossi argues that a steam cannon might explain the mirror legend. He has worked out a possible design for the cannon that uses sun-focusing mirrors to heat a chamber within. Water fed into the chamber vapourises, causing a rapid increase in pressure that can propel a cannonball (see diagram).

Although using mirrors in this way might seem impractical, Rossi says it would have made sense for the Syracusans to avoid using open fires as the cannons would have been sited on the city walls, on platforms made of wood.

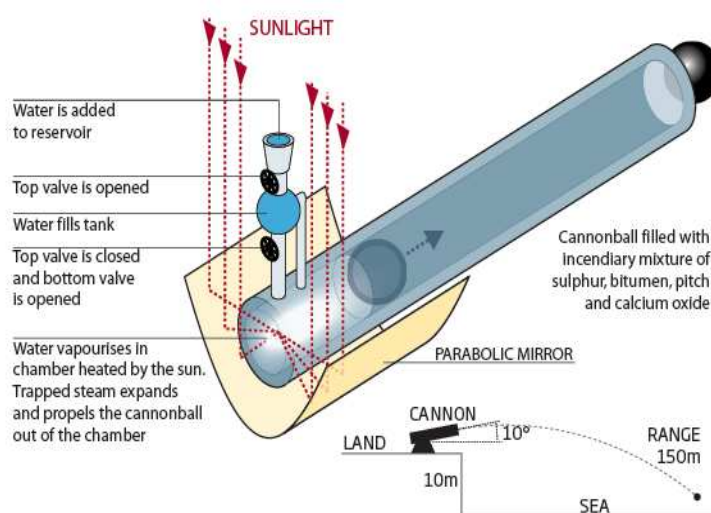
The projectiles fired by the cannon could have been made of clay, Rossi says, and filled with an incendiary fluid – perhaps a mixture of sulphur, bitumen, pitch and calcium oxide. He calculates that a cannonball measuring 20 centimetres across and weighing around 6 kilograms could have been fired at 60 metres per second. With this firing speed, a gun 10 metres above sea level and angled up at 10 degrees to the horizontal would have had a range of around 150 metres.

Historians who specialise in ancient technology say Rossi's design is entertaining but doubt that anything like it was ever built. Serafina Cuomo of Imperial College London says there is no convincing evidence that Archimedes used steam cannon. She says that Archimedes's fame in medieval times led da Vinci and other scholars to attribute any impressive inventions they heard about to him. "Archimedes became a quasi-mythical icon of the scientist capable of constructing incredible weapons," she says.

Tracey Rihll at Swansea University, UK, says that Rossi doesn't explain why the hollow clay cannonballs didn't break apart when they were fired. Catapults would be a more practical way of hurling flaming projectiles, she says. ■

Getting up steam

Archimedes is said to have used mirrors as weapons of war, but perhaps he used a parabolic mirror to generate heat, for a steam cannon



'Cuddle chemical' promises to ease schizophrenia

NASAL sprays containing the hormone oxytocin, nicknamed the "cuddle chemical" because it helps mothers bond with their babies, have helped people with schizophrenia.

Although the 15 participants used the sprays for three weeks only, most reported measurable improvements in their symptoms in this the first trial to test oxytocin in schizophrenia. "It's proof of concept that there's therapeutic potential

here," says David Feifel at the University of California in San Diego, head of the team running the trial.

Each participant received oxytocin or a placebo for three weeks, then the opposite treatment for three weeks with a week break in between.

On the basis of two standard tests for schizophrenia, taken before and after each block of treatment, participants averaged improvements of around 8 per cent when taking the oxytocin compared with the placebo (*Biological Psychiatry*, DOI: 10.1016/j.biopsych.2010.04.039).

The effects didn't kick in until the final week, suggesting that it takes a while for the hormone to begin

acting. "Standard antipsychotic drugs increase their efficacy several weeks later too, so oxytocin fits that profile," says Feifel.

Feifel thinks that oxytocin is dampening down the excessive production of the neurotransmitter dopamine, which can trigger schizophrenic symptoms such as hallucinations. He says the rationale for treating people came from his own team's studies showing that oxytocin could relieve a form of

psychosis in mice, and research showing that people who sniffed nasal sprays of oxytocin became more trusting, which could ease paranoia symptoms in schizophrenia.

Feifel is seeking approval from the US National Institutes of Health for a larger trial testing oxytocin at a range of doses, and over a longer time.

"This work provides compelling data on the utility of oxytocin as a treatment for schizophrenia," says Heather Caldwell of Kent State University in Ohio, co-author of a study in 2008 showing that "knockout" mice unable to make oxytocin were more prone to a form of psychosis. Andy Coghlan ■

"Most participants reported measurable improvements in the first ever trial to test oxytocin in schizophrenia"

Bit of a crybaby? Blame those serotonin blues

NEXT time a sentimental movie makes you cry, blame your serotonin levels. Differences in the neurotransmitter might explain why some people are more prone to crying in emotional situations than others.

Frederick van der Veen's team at the Erasmus Medical Centre in Rotterdam, the Netherlands, gave 25 female volunteers a single dose of either paroxetine – a selective serotonin reuptake inhibitor (SSRI) which briefly increases serotonin levels – or a placebo. Four hours later they were asked to watch one of two emotional movies: *Brian's Song*, in which the hero dies of cancer, or *Once Were Warriors*, about domestic violence, and

to indicate if, and to what extent certain scenes had made them cry.

On another day, the women watched the second film with their treatments swapped over. "It didn't matter which movie they saw, we saw a strong and consistent effect of paroxetine," says van der Veen, who presented the results at the Forum of European Neuroscience in Amsterdam last week. "Higher serotonin levels lead to less crying."

Although SSRIs are used to treat depression, their mood-boosting effects do not normally show up for around six weeks. The women reported no change in mood in the current study. "We're looking at the direct effect of a



FRANÇOIS DELAERIERE/WILLENIUM

Enough to make you weep

single dose of paroxetine," says van der Veen, who adds that the findings might help explain why some people report blunted emotions when taking SSRIs.

"Our understanding of the neurobiology of crying is fairly limited," says Christopher Lowry,

a serotonin researcher at the University of Boulder in Colorado. "It makes sense that it is tapping into circuitry involving serotonin."

Van der Veen now wants to find out whether genetic differences in serotonin production affect the tendency to cry. **Linda Geddes** ■

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A primal habit

I cook, therefore I am... human

Catherine Brahic, Portland, Oregon

THE French have elevated it to an art form, and even the British have got better at it – but chimps can't cook at all. According to one controversial evolutionary theory, early humans developed a taste for cooked food around 2 million years ago, and this set in motion a series of changes that made us utterly different from any other animal.

Now the proponents of the cooked-food hypothesis are presenting fresh evidence in support of the idea – and it all comes down to how you chew.

The theory, championed by Richard Wrangham at Harvard University, has divided palaeoanthropologists. In an attempt to convince the doubters, Wrangham and his colleagues have been amassing empirical evidence, including evolutionary adaptations consistent with a diet

of heated food, such as the small size of our guts.

At the Evolution 2010 conference in Portland, Oregon, at the end of June, Christopher Organ of Harvard and Brown University in Providence, Rhode Island, presented what he and Wrangham say is the best evidence yet that we are adapted to eating cooked food, and that this is the result of events that occurred early on in human evolution.

Organ and Charles Nunn, also of Harvard, had predicted that if humans are uniquely adapted to eating cooked food, then we should spend far less time chewing than other primates, as cooked food tends to be softer than raw food. To test this, they gathered data from various primate species and looked at the correlation between chewing time and body size, taking into account how the different species

were related to each other.

A primate species of our size should, in theory, spend 48 per cent of the waking day chewing, they found. Yet on average we chew for less than 10 per cent of the day, says Organ.

The pair then did a comparison of molar size and found that humans fall well outside the normal range for primates: we have small molars for our body size. When they included teeth from fossils of extinct hominins, the analysis revealed that *Homo*

"Humans fall well outside the normal range for primates: we have small molars for our body size"

habilis and its contemporary *H. rudolfensis* fit well with the average for similarly sized primates. But Neanderthals and our direct ancestor, *H. erectus*, had small teeth for their body size.

This confirms what palaeoanthropologists have long known, says Leslie Aiello, president of the Wenner Gren Foundation for Anthropological Research in New York. "In *H.*

erectus the molars are considerably smaller than in the earlier hominids," she says. "It's something that nobody has been able to explain."

For Wrangham, cooking is the explanation. Around 1.8 to 2 million years ago, he says, *H. erectus* or perhaps an immediate ancestor acquired a taste for food that had accidentally fallen into a fire. These early humans then learned to use fire for cooking, unwittingly getting more nourishment as a result.

Because the cell walls in cooked food are already partially broken down, it needs less chewing and is easier to digest. Wrangham argues the additional energy humans gained allowed them to evolve bigger brains and build complex social relationships. He points out that the fossil record suggests the size of hominin brains grew rapidly around this time.

Still, other explanations cannot be ruled out, such as a transition to meat-eating 1.5 to 2 million years ago. Although raw meat is hard to digest, early humans may have been able to extract more energy with less chewing if they had pounded the meat or focused on eating softer, richer tissues like the liver and heart.

The key stumbling block for the theory that our early ancestors cooked their food is that as yet there is no convincing evidence that hominins could control fire more than a million years ago. The oldest direct evidence for fire at a site of human habitation only goes back to 790,000 years ago at Gesher Benot Ya'agov in Israel, where charred flints, seeds and stone tools have been found, says Richard Potts of the Smithsonian Institution in Washington DC.

Aiello says that if Wrangham is right, cooking hearths would have had to be widespread around 1.5 to 2 million years ago, otherwise "it would have been an 'oh shi't' moment when the fire went out and our ancestors had to wait 10,000 years to get fire again," she says. ■



The simple law of hurricanes decrees a stormy future

THE intensity of hurricanes follows a simple mathematical law – a finding that could help predict how the storms will respond to climate change.

Álvaro Corral of the Centre for Mathematical Research in Barcelona, Spain, and colleagues looked at records of hurricanes from four ocean basins around the world between 1966 and 2007. They calculated how much energy each recorded hurricane released, based on its wind speeds and how long it lasted.

The researchers found that the proportion of rarer, strong hurricanes to commoner, weaker ones was always

the same. Only the very weakest and the very strongest hurricanes did not fit the pattern, called a power law.

The team also looked at the effect of sea surface temperatures on hurricanes. The proportion of weak to strong hurricanes in each year was similar whether the sea was warm or cold that year, but more of the most powerful hurricanes were observed in warm years (*Nature Physics*, DOI: 10.1038/nphys1725).

Corral says that the finding hints that rising temperatures due to climate change will bring more of the most powerful hurricanes, but cautions it is difficult to say for sure. James Elsner of Florida State University in Tallahassee is less sanguine, however. “Their results show that you get more powerful hurricanes if the sea surface temperatures are higher,” he says.

Vaccines that came in from the cold

GENES borrowed from Arctic bacteria could generate safer vaccines against diseases like tuberculosis. The genes enable researchers to make temperature-sensitive bacteria that prime the immune system before dying back.

So say Francis Nano and colleagues at the University of Victoria in British Columbia, Canada. They replaced genes in *Francisella tularensis* bacteria

with versions from different species of bacteria found in the Arctic. The Arctic genes evolved in freezing temperatures and stop functioning at the higher temperatures inside animals.

The team chose genes indispensable for survival, such as those that repair DNA, so that their engineered bacteria would die when the genes stopped working.

The team successfully

vaccinated mice against normally fatal doses of *F. tularensis* by first injecting their tails with the temperature-sensitive version (*Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.1004119107).

The bacteria managed to survive within the lower temperatures of the skin, allowing it to prime the immune system, but was not present in internal organs, so posed no threat of disease. “TB is our big target now,” says Nano.

Single star count ups odds of aliens

SOLITARY suns like ours are not as rare as we once thought, boosting the likelihood that there are other planets on which life has evolved.

Surveys had suggested that most systems containing a star the same mass as our sun have two or more stars orbiting each other. But when Deepak Raghavan of Georgia State University in Atlanta and colleagues looked at 454 such stars, they found that 56 per cent were single like our sun and just 44 per cent had a stellar companion (arxiv.org/abs/1007.0414). Their study will be published in *The Astrophysical Journal*.

Single stars provide a stable planetary system where life is more likely to evolve. Planets can form in multiple star systems, but the gravity of the additional stars can hurl planets into their parent star, says John Chambers of the Carnegie Institution for Science, based in Washington DC.

Tyrannosaurs not above scavenging

THE tyrant lizards were not above scavenging for a free lunch.

Tooth marks found on the fossilised humerus of a plant-eating dinosaur found in Mongolia show that a large tyrannosaur removed the meat from the bone, yet the rest of the skeleton showed no sign it had been attacked.

David Hone at the Institute of Vertebrate Palaeontology and Palaeoanthropology in Beijing, China, and Mahito Watabe of the Hayashibara Museum of Natural Sciences in Okayama, Japan, report that tooth marks on the 70-million-year-old bone match the pattern and shape of the teeth of *Tarbosaurus*, an Asian tyrannosaur nearly as big as *T. rex* (*Acta Palaeontologica Polonica*, DOI: 10.4202/app.2009.0133).

Self-taught synaesthesia

A FORM of synaesthesia in which people experience letters or numbers in colour could be learned. The discovery could shed new light on how such traits develop.

Synaesthesia is thought to have a genetic component, but some people have reported synaesthetic experiences following hypnosis, so Olympia Colizoli at the University of Amsterdam in the Netherlands, and colleagues, wondered if it might also be possible to acquire synaesthesia through training.

To test the idea, they gave seven volunteers a novel to read in which certain letters were always written in red, green, blue or orange (as below). Before and after reading the book, the volunteers took a "synaesthetic crowding" test, in which they identified the middle letter of a grid of black letters which were quickly flashed onto a screen. Synaesthetes perform better on the test when a letter they experience in colour is the target letter.

The volunteers performed significantly better on this test after training compared with people who read the novel in black and white.

The findings suggest that natural synaesthesia may develop as a result of childhood experiences as well as genetics, says Colizoli, who presented the findings at the Forum of European Neuroscience in Amsterdam last week.

Synaesthesia is thought to have a genetic component, since it often runs in families and is more common in women

Depression makes the world look dull

FOR people with depression the world really does look dull. That's because their ability to perceive contrast is impaired.

To investigate links between mood disorders and vision, Emanuel Bubl at the University of Freiburg, Germany, and colleagues ran an electrode along one eye in each of 40 people with depression, and 40 people without. The electrodes measured activity in the nerves connecting photoreceptors – which detect different aspects of light – to the optic nerve, but not the brain.

Participants sat in a dimly lit room and watched a black and white chequered screen which became greyer in six distinct stages, reducing the contrast between each square. Each stage was presented for 10 seconds, and the experiment was repeated over an hour.

The team found that electrical signals to the optic nerve were lower in people with depression. For example, when viewing the stage containing black and white squares, healthy volunteers had three times the nerve activity of

those with depression, indicating that depression diminishes the ability to detect contrast. The more severe a person's depression, the worse their perception of contrast (*Biological Psychiatry*, DOI: 10.1016/j.biopsych.2010.02.009).

Mathew Martin-Iverson at the University of Western Australia in Perth says this could be because the neurotransmitters which regulate nerve activity in vision could also be involved in emotion.

Bubl believes that a similar technique could be used to aid diagnosis of clinical depression.

Climate warning from Arctic history

WITH carbon dioxide levels close to our own, the Arctic of the Pliocene epoch may have warmed much more than previously thought – and the modern Arctic could go the same way.

Ashley Ballantyne at the University of Colorado, Boulder, and colleagues analysed 4-million-year-old Pliocene peat samples from Ellesmere Island in the Arctic archipelago to find out what the climate was like when the peat formed. At that time, CO₂ levels are thought to have been close to current levels – around 390 parts per million – but global temperatures were warmer.

Ballantyne's team estimated the temperature of the period at which the peat formed by measuring various things that are affected by temperature, including isotopes in tree rings and the amount of fossilised vegetation. The analysis suggests the samples formed when average local temperatures were about -0.5 °C. That is 19 °C warmer than temperatures today – more than computer models had estimated (*Geology*, DOI: 10.1130/g30815.1).

We can expect the Arctic to warm much more than the rest of the planet, says Ballantyne.



CORSIN MÜLLER

Mongoose who can, teach

CAN animals teach? Not quite, but mongooses have provided the first definitive evidence that young animals learn the ropes by imitation.

Biologists have long debated whether animals learn skills from each other, as they could also be inherited genetically or shaped by the environment. Now a study of wild banded mongooses (*Mungos mungo*) shows that pups copy skills from "teenage" males who act as escorts.

Mongooses have two ways of breaking bird eggs: by holding and biting, or by smashing them against rocks. Corsin Müller and Michael Cant

of the University of Exeter, UK, gave an artificial egg containing food to smasher and biter escorts as their respective pup companions watched.

Two to four months later, the pair gave eggs to the pups. They almost exclusively used the same technique as their escort (*Current Biology*, DOI: 10.1016/j.cub.2010.04.037).

Since the two skills co-exist in the same population, environmental and genetic explanations could be ruled out, says Michael Krützen of the University of Zurich in Switzerland, proving "beyond reasonable doubt" that imitation occurs in the wild.



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HUNG-KUO CHU



Can you spot the hidden animals?

Child's puzzle foils computers

A WAY to create children's picture puzzles could be used to improve online authentication, as it involves spotting images within images.

There are three animals hidden in the accompanying picture. To obscure them, Hung-Kuo Chu of National Cheng Kung University in Tainan, Taiwan, developed a tool that first simplifies the animal image, creating a pattern of lighter and darker regions. The image is then overlaid on the base picture so that the background texture shows through. Any gaps are filled with texture that approximates the background. "Our model can generate camouflage images at different difficulty levels," Chu says.

The technique works best with natural backgrounds that have plenty of detail, such as cliff faces, forests and cloudy skies, Chu says. Large blocks of solid colour, or regular

patterns like those of brick walls, are more difficult to hide images in.

Though it is not always easy for humans to pick out the images, we can do it. However, it is almost impossible for computers, Chu says. That means as well as generating photo puzzles, the system could be

"The system could make Captcha images, which ensure website users are people rather than bots"

used to make Captcha images, which websites employ to ensure that users signing up for accounts are genuinely people, rather than software bots. The work will be presented at the Siggraph conference in Los Angeles later this month.

Can't see the animals? Go to NewScientist.com at bit.ly/c1A3v8

Why would you be interested in that?

A NOVEL search-engine tool could disarm would-be hackers by using their own queries against them.

When hackers learn about a new method of attacking websites, they search the web for code sequences that reveal which sites are vulnerable. John John at the University of Washington in Seattle and colleagues have developed SearchAudit, a system that identifies who has searched for such sequences and finds what else they've looked for.

Set loose on three months' worth of Microsoft Bing's search logs with 500 known malicious terms, SearchAudit detected 4 million malicious queries – identifying some threats even before they had been circulated on hacker websites. The work is to be presented at the Usenix security symposium in Washington DC in August.

5bn

cellphones are now in use across the world, according to UK-based analysts Wireless Intelligence

Implants evolved to use less energy

MIMICKING natural selection could boost the efficiency of brain implants and mean their batteries need to be replaced less often.

Implants that stimulate nerve clusters deep within the brain can help control epilepsy and Parkinson's disease. The shape, or waveform, of the electrical pulse used is crucial. Warren Grill and colleagues at Duke University in Durham, North Carolina, wanted to find the optimum waveform that would both target the desired nerves and use the least possible energy.

They started with random

pulses and selected those able to excite neurons in a simulation. They then mutated the "fittest" waveforms – those associated with the lowest energy use – and "interbred" the results to make new "offspring".

After 10,000 generations, the optimum waveform emerged: a bell curve with the lower parts of each side cut short by a vertical line. Tests with implants in cats showed the waveforms were beneficial and minimised energy use. Grill says an implant using this waveform would need its batteries replaced five or six times over 30 years instead of eight to 10 times (*Journal of Neural Engineering*, DOI: 10.1088/1741-2560/7/4/046009).



"I just flew for 26 hours without using a drop of fuel"

André Borschberg reflects on his long journey piloting Solar Impulse, which flew for more than a day using engines powered only by its 12,000 solar panels. The craft paves the way for carbon-free aviation, Borschberg says (ft.com, 8 July)

Ecobot III – the power and the poop

It's not the most glamorous, or even sanitary, of advances in robotics, but the most basic of bodily functions could give robots the freedom to roam

Duncan Graham-Rowe

HOT on the heels of the first synthetic cell comes a slightly lower-brow advance: a synthetic gut. The basic function that it provides could be the key to freedom for self-sustaining robots.

In the bid to create such autonomous robots, researchers turned to biomass as an energy source. By being able to feed themselves, robots could be set to work for long periods without human intervention.

Such food-munching robots have been demonstrated in the past, often generating power with the help of microbial fuel cells (MFCs) – bio-electrochemical devices that enlist cultures of bacteria to break down food to generate power. Until now, though, no one had tackled the messy but inevitable issue of finding a way to evacuate the waste these bugs produce.

What was needed was an

artificial gut, says Chris Melhuish, director of the Bristol Robotics Lab in the UK. He has spent three years with Ioannis Ieropoulos and colleagues working up the concept. The result: Ecobot III.

"Diarrhoea-bot would be more appropriate," Melhuish admits. "It's not exactly knocking out rabbit pellets." Even so, he says, it marks the first demonstration of a biomass-powered robot that can operate unaided for some time.

Previous incarnations of Ecobot showed that it is possible to generate enough power for the robot to exhibit certain basic, yet intelligent behaviours, such as moving towards a light source. Human intervention was needed to clean up after meals, though.

Now, by redesigning the robot to include a digestive tract, Ecobot III has shown that it can survive for up to seven days, feeding and "watering" itself unaided. It obediently expels its waste into a litter tray once every 24 hours.

The key to getting this gut to work, says Ieropoulos, is a recycling system that relies on a gravity-fed peristaltic pump which, like the human colon, applies waves of pressure to squeeze unwanted matter out of a tube.

At the start of the digestive process the robot feeds itself by moving into contact with a dispenser. This pumps a nutrient-rich solution of partially processed sewage into its "mouth" where it is distributed into 48 separate MFCs within the robot. This fluid is a concoction of minerals, salts, yeast extracts and other nutrients. As unappetising as this mixture

sounds, for the culture of microbes in the robot's stomach it is ambrosia itself.

At the heart of the process is a reduction-oxidation reaction that takes place in the anode chambers of each of the robot's MFCs. As the bacteria metabolise the organic matter, hydrogen atoms are given off. The hydrogen's electrons migrate to the electrode, generating a current, while hydrogen ions pass through a proton-exchange membrane into the cathode chamber of the cell, which contains water. Here, oxygen dissolved in that water

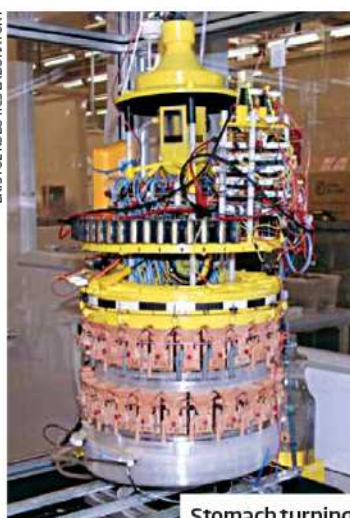
combines with the protons to produce additional water. Because this supply of water gradually evaporates, the robot also needs regular drinks, which it gets from a separate spout.

The cells are arranged in a stack of two tiers of 24 (see picture, below left), designed to allow gravity to direct any heavy undigested matter to accumulate in a central trough. The contents are repeatedly re-circulated from the trough into the robot's feeder tanks to extract as much energy as possible, before being excreted.

Getting rid of this waste not only prevents fuel cells from filling up and becoming clogged, but also removes any acidic waste products from the digester that might poison the bacteria, says Ieropoulos.

As things stand, the fuel cells are capable of extracting a mere 1 per cent of the chemical energy available in its food, despite the recycling process. The system uses off-the-shelf components, so modifying the anodes to have

BRISTOL ROBOTICS LABORATORY



Stomach turning



a larger surface area upon which bacteria can attach themselves, should help extract far more energy, says Ieropoulos.

Robert Finkelstein who is heading the Energetically Autonomous Tactile Robot (EATR) project at the US's military research agency DARPA, thinks MFC technology is the wrong choice. It is inefficient and too

slow to convert energy, he says.

EATR will derive its energy from burning biomass rather than eating it. Using a novel combustion engine, developed by Cyclone Power Technology of Pompano Beach, Florida, the hope is that when EATR is assembled and tested later this month it will generate enough energy to roll 160 kilometres on 60 kilograms of biomass. In terms of the calorific value of the fuel, that's better than the average car, says Finkelstein.

One of the advantages of MFCs, though, is that they can consume almost anything, including waste water, a substance that isn't easily burned, says Ieropoulos. The bacteria in Ecobot III's gut are made up of hundreds of different species, allowing it to adapt to different foodstuffs. One of the ideas the group is playing with, and the reason they are using waste water as food, is to see if these fuel cells could be used as part of a filtration system to clean up sewage water.

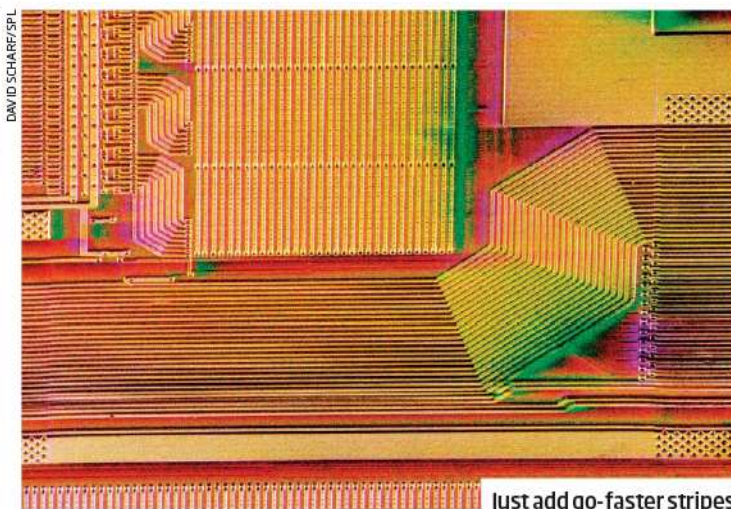
The work will be presented at the Artificial Life conference in Odense, Denmark, next month. The next step is to explore how the robot will cope with a heartier meal, namely flies.

The carnivorous-robot fearing public need not worry, says Melhuish. Much of the energy generated from flies will go into powering the robot's digestive system. With an average speed of about 21 centimetres a day, it is unlikely to catch you, he says. ■

"Diarrhoea-bot would be more appropriate... It's not exactly knocking out rabbit pellets"

slow to convert energy, he says.

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DAVID SCHARF/SPL Just add go-faster stripes

Silicon speed limit broken on a lead-coated racetrack

A "RACETRACK" capable of shuttling electrons around at high speed has set a new record for silicon chips, the cornerstone of computing.

Electrical resistance imposes a strict speed limit on electrons travelling through silicon. To break this limit, computer scientists are considering replacing silicon with carbon, as atom-thick sheets of carbon, or graphene, conduct electricity better than any other substance at room temperature.

Graphene owes this property to an unusual interaction between its hexagonal lattice structure and the electronic structure of its atoms. This effectively brings the mass of its free electrons down to zero. That apparent weightlessness allows them to zip across graphene like photons, reaching speeds of up to 0.003 of the speed of light in a vacuum.

The snag is that graphene is difficult to make in bulk. Now Han Woong Yeom and his team at the Pohang University of Science and Technology in South Korea believe they can mimic its conductivity in silicon. They have clocked electrons travelling 20 times faster than usual in their silicon chips.

Yeom's team added an atom-thick layer of lead to the surface of a silicon block. Because the lead layer is so thin, the arrangement of its atoms is influenced by the silicon atoms

underneath. The team suspected that the lead's electrons would, in turn, influence the electronic structure of the silicon at the interface.

To investigate, they fired high-energy photons at the material to knock electrons out of it, and measured their momentum and energy. By subtracting the energy the photons contributed to the displaced electrons, they calculated that some of the electrons at the silicon-lead interface had an apparent mass 1/20th of that of the electrons in typical silicon chips (*Physical Review Letters*, DOI: 10.1103/PhysRevLett.104.246803). "This indicates the possibility of 20-times-faster electrons," says Yeom.

"Adding a thin layer of lead to a silicon semiconductor could speed up the chip by 20 times"

That's still just one-third of the speed of electrons in graphene, but in principle the electron mass can be further reduced - and their speed increased - if different metals are used to coat the silicon, he adds.

"It's fantastic progress," says Zahid Hasan of Princeton University. Speedy silicon could easily outrace graphene to the shelves as the manufacturing infrastructure is already in place, Hasan says. Kate McAlpine ■



FRAZER HUDSON

Laser scanning reconstructs the gory details of murder

RECONSTRUCTING the sequence of events leading up to a murder could become easier and more precise thanks to a new system for producing a high-resolution 3D map of a crime scene.

A post-mortem can shed some light on the circumstances surrounding a murder, and vital clues can also be gleaned from an analysis of bloodstains at the scene of the crime. Among other things, this can reveal if the victim was standing, sitting or lying down when they were attacked.

Bloodstain pattern analysis involves studying blood spatters on walls, floors and furniture, using the length and width of elliptical stains to estimate their angle of impact. As seen in TV crime dramas like *Dexter*, elasticated string is then pinned to each bloodstain, projecting from it at the estimated impact angle. The point in 3D space at which most strings converge is taken to be the position from which the blood was spattered.

The method is both time-

consuming and prone to error: a spatter of blood does not travel in a straight line as the strings suggest, but follows a ballistic curve that depends on its velocity. So Ursula Buck and colleagues Silvio Näther and Beat Kneubuehl at the University of Bern, Switzerland, have developed a system that more realistically

reconstructs the ballistics of blood droplets at a crime scene.

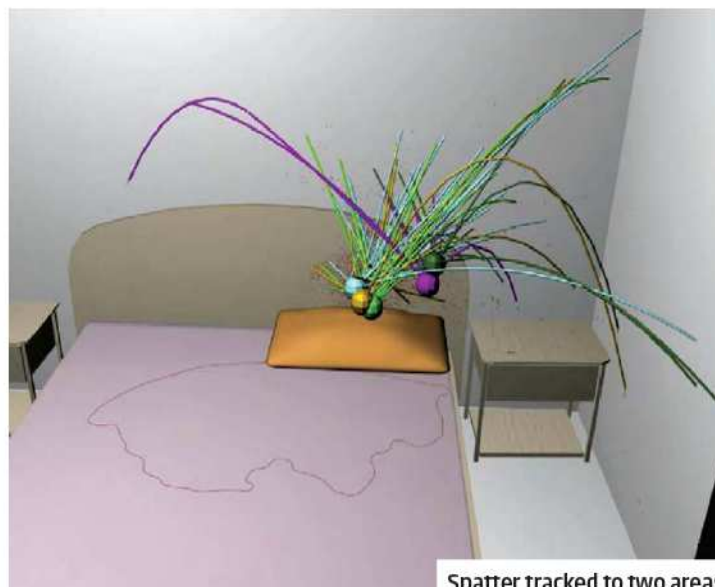
The first step is to use a laser scanner to make a 3D digital map of every object in the crime scene. This does not include much surface detail, so the team also uses a digital camera to capture the shape of bloodstains. They then use another laser ranging device called a tachymeter to obtain a precise location for each blood spot in the 3D model.

Next, they calculate the mass of each drop from the size of its

stain, and use this to calculate its maximum potential velocity – air drag would rip apart a droplet if it travelled faster than this limit. With that information, and an angle of impact estimated from the shape of the stain, their software projects a realistic trajectory backwards in time to locate the origin of the blood spatter (*Forensic Science International*, DOI: 10.1016/j.forsciint.2010.06.010).

“The 3D results give us good clues about the area of origin, the number of blows, the positioning of the victim and the sequence of events,” says Buck. The system has already helped in two murder inquiries, revealing in one that a woman killed by her husband was lying in bed rather than sitting up when attacked.

“This seems a useful way to capture 3D blood pattern information,” says Gillian Leak, a blood pattern analyst with the UK Forensic Science Service in Birmingham. But she adds that there is no substitute for human expertise at the scene of a crime: “You still need a scientist to go into the crime scene to interpret which blood stains are the most important.” Paul Marks ■



Spatter tracked to two areas

Cheap drones could replace search-and-rescue helicopters

THE US military's uncrewed aerial vehicles are a critical component of its search-and-destroy missions in warring regions. But could UAVs instead be used to save lives by flying search-and-rescue (SAR) missions in the nation's large national parks?

Michael Goodrich, Lanny Lin and colleagues at Brigham Young University in Provo, Utah, took a commercially available propeller-driven plane with a 1.2-metre wingspan, optimised for low-speed flight, and adapted it to both fly and search autonomously. Their idea is to provide SAR teams with a cheap alternative to helicopters, and one

that can be used even in the perilous weather conditions that can ground helicopter-led rescue missions.

Without any piloting experience, an SAR operator can direct the plane to an area they want to search by clicking way-points on a computerised map, Goodrich says. The craft can also work autonomously to conduct search missions even if it is fed less specific information, such as a missing person's last known position. To do so it uses computerised maps of the area to analyse the terrain and relies on probabilistic models to work out the missing person's most likely routes.

The mistakes hikers make and the

routes they take when lost are less random than you might think, says Goodrich. Topographical and environmental factors play a big role in determining where someone ends up. For example, once lost, people often stick to the easiest available ground rather than attempting to descend precipices or climb cliffs.

Experienced SAR team leaders

“The craft took between 35 minutes and 2½ hours to find a dummy dumped in the wilderness”

already read the landscape to determine in which areas to focus the search effort and in what order of priority, says Ron Zeeman, a seasoned member of Utah County Sheriff Search and Rescue. Zeeman helped Goodrich's

team develop the algorithms that allow their autonomous UAV to do the same.

In trials, operators using the craft have taken between 35 and 150 minutes to find a dummy dumped in the wilderness – fast enough to impress Zeeman. “If we could use it right now, I would,” he says.

Although the system can predict where the dummy might be, the algorithms for detecting it within the images taken by the on-board camera still need work, says Goodrich. At the moment it's usually the operator that spots the dummy first. With improved image-analysis software, the UAV could work entirely independently to locate missing people, he says.

The work will be presented at the AAAI Conference on Artificial Intelligence in Atlanta, Georgia, this week. Duncan Graham-Rowe ■

inbox (you have new knowledge)



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An evil atmosphere

The right-wing think tanks that deny climate change is even happening are advocating geoengineering to fix it. Don't heed them, warns **Clive Hamilton**

IN 1892 Edvard Munch witnessed a blood-red sunset over Oslo, Norway. Shaken by it, he wrote in his diary that he felt "a great, unending scream piercing through nature". The incident inspired him to create his most famous painting, *The Scream*.

The striking sunset was probably caused by the eruption of Krakatoa, which sent a massive plume of ash and gas into the upper atmosphere, turning sunsets red around the globe and cooling the Earth by more than a degree.

Now a powerful group of scientists, venture capitalists and conservative think tanks is coalescing around the idea of reproducing this cooling effect by injecting sulphur dioxide into the stratosphere to counter climate change. Despite the enormity of what is being proposed – nothing less than seizing control of the climate – the public has been almost entirely excluded from the planning.

Up to now, governments have been reluctant to talk about geoengineering. The reason is simple: apart from its unknown side effects, it would weaken resolve to reduce emissions.

But it may soon prove an irresistible fix. This form of geoengineering is extremely attractive because its costs are estimated to be trivial compared to those of cutting carbon. It also gets powerful lobbies off governments' backs, gives the green light to burning more coal, avoids the need to raise petrol taxes, permits yet more unrestrained growth and



is no threat to consumer lifestyles.

No government is yet willing to lend support to geoengineering, but the day when a major nation backs it cannot be far off. It is even possible that a single nation suffering the effects of climate disruption may decide to act alone.

Indeed, Russia has already begun testing. Yuri Izrael, a scientist who is both a global-warming sceptic and a senior adviser to Prime Minister Putin, has tested the effects of aerosol spraying from a helicopter. He now plans a large-scale trial.

Izrael is the latest in a long line of scientists who have advocated planetary engineering. Two of the earliest and most aggressive were

Edward Teller and Lowell Wood. Teller, who died in 2003, is often described as the "father of the hydrogen bomb" and was the inspiration for Dr Strangelove, the eponymous mad scientist of Stanley Kubrick's 1964 film. Wood was one of the Pentagon's foremost weaponeers, which led his critics to dub him "Dr Evil". He led Ronald Reagan's ill-fated Star Wars project.

Wood and Teller began promoting aerosol spraying in 1998. Reflecting the dominant

"If we start manipulating the atmosphere, we could become forever dependent on sulphur injections"

opinion of the 1950s, they saw it as our duty to exert supremacy over nature. Both have long been associated with conservative think tanks that deny the existence of human-induced global warming.

A number of right-wing think tanks actively denying climate change are also promoting geoengineering, an irony that seems to escape them.

Of course, geoengineering protects their funders in the fossil fuel industries because it can be a substitute for carbon reductions and justify delay, but a deeper explanation lies in beliefs about the relationship of humans to the natural world.

While emissions reductions are an admission that industrial society has harmed nature, engineering the climate would be confirmation of our mastery over it, final proof that human ingenuity will always triumph.

Wood believes that climate engineering is inevitable. In a statement that could serve as Earth's epitaph, he declared: "We've engineered every other environment we live in, why not the planet?"

Advocates of geoengineering also court the super-rich. Wood is doubtful that governments can reach a consensus, but he sees no need for that, instead speculating about going ahead with support from a billionaire. "As far as I can determine, there is no law that prohibits doing something like this". He is right.

Perhaps the billionaire he has in mind is Bill Gates, who has been funding geoengineering research

for three years. Gates is also an investor in a firm named Intellectual Ventures that is promoting a scheme called StratoShield, which would pump sulphur dioxide into the upper atmosphere through a hose held aloft by blimps.

Richard Branson has also set up his own "war room" to do battle with global warming using "market-driven solutions", including geoengineering.

The Carbon War Room website promotes a paper co-authored by Lee Lane of the American Enterprise Institute, well known for its climate scepticism. It argues that the benefits of geoengineering vastly outweigh the costs. The authors worry that ethical objections from environmental groups may block deployment, before noting with relief that "in reality, important economies remain largely beyond the influence of environmental advocacy groups".

Geoengineering is not something we should enter into lightly or without proper public consultation. If we resort to it, then the concentration of carbon dioxide will continue to rise. It would then become impossible to call a halt to sulphur injections, even for a year or two, without an immediate jump in temperature.

It's estimated that if whoever controls the scheme decided to stop, the greenhouse gases that would have built up could cause warming to rebound at a rate 10 to 20 times that of the recent past – a phenomenon referred to, apparently without irony, as the "termination problem". Once we start engineering the atmosphere we could be trapped, forever dependent on sulphur injections. More than a painting, *The Scream* would become a prophecy. ■

Clive Hamilton is Charles Sturt Professor of Public Ethics in the Centre for Applied Philosophy and Public Ethics at the Australian National University. His new book, *Requiem for a Species*, is published by Earthscan

One minute with... Brian Shiro

The president of Astronauts4Hire on how the commercial space race is changing what it means to be an astronaut

What's the idea behind Astronauts4Hire?

Our aim is to train a highly qualified group to become the first scientist-astronauts for hire by researchers wanting to fly experiments in space. People will be able to go to our website and search for astronauts with the type of scientific and flight expertise they want.

Why is now the right time for this service?

Since 2004, when SpaceShipOne became the first commercial spacecraft to take a person up into space, there has been a mad dash to develop sub-orbital spacecraft. Their flights will be geared towards space tourism, but there is also a massive opportunity for scientists to send their experiments up on these flights. A group of colleagues and I walked away from the Next-Generation Suborbital Researchers Conference in February this year saying, "We have to seize this."

Are commercial space flights really such a big deal for science?

Even if you had just one science experiment in each craft, that's a lot of data, especially because these flights will be going up frequently, perhaps daily. There is also the cost factor. Some people estimate that the cost of space flight will drop tenfold or even 100-fold compared with today.

What kind of science does sub-orbital flight allow you to do?

Fundamental physics and chemistry studies in microgravity, astronomy, planetary science. It's a unique vantage point that we haven't explored yet, as it's much lower than the space station but much higher than the altitude reached by most sub-orbital uncrewed rockets. There could be medical studies too. With thousands of space tourists, you could also do physiological studies on how different people react to space flight.

You co-founded Astronauts4Hire in April. How's it doing so far?

Right now we are reliant on sponsors and donors to help fund our training. In the meantime we've had our first request for



PROFILE

As a child, Brian Shiro spent his summers at space camp. Now he is a geophysicist at the Pacific Tsunami Warning Center in Hawaii and president of the group Astronauts4Hire

one of our members to conduct an experiment aboard an upcoming zero-g flight.

Being an astronaut is one of the pinnacles of human achievement today, but will it become a lot more like a regular job in future?

I hope so. Commercial space companies are commoditising the sub-orbital and the low-Earth orbit realms, just like what happened a century ago with aviation. Today, only 500 or so people have flown to an altitude of 100 kilometres, most of them highly qualified test pilots or scientists. With this new revolution, if you have the money, or if you have the funding for an experiment, you can go. Or, as we are hoping, you have the experiment and you hire us and we will do it for you.

If I were a scientist, I'd want to go myself. Why would anyone pay to send you?

Maybe they need to be on the ground to monitor the experiment. Maybe the person doesn't want to go on what is considered an experimental aircraft and be one of the guinea pigs in this new industry.

Interview by Celeste Biever

BRIAN SHIRO

Dream on

From Kevin Wallace

For people with narcolepsy, the lucid dreaming for which Jessica Hamzelou strives can be an undesirable and sometimes frightening intrusion into normal daily life (12 June, p 36).

The hallucinations often experienced at the onset of narcolepsy can take the dream-within-a-dream form Hamzelou describes. For a narcoleptic, these dreams are frequently nightmares in which the dreamer awakes with great relief at the end of the dream only to discover that he or she is still asleep. This nesting of dreams within dreams can be several layers deep, and is frightening.

During a daytime sleep attack, a narcoleptic may begin to dream while fully engaged in conversation. This can be confusing for both the narcoleptic and the other party, as the narcoleptic shifts from the topic in hand to incorporating elements of the dream into the conversation. There are documented cases of people with narcolepsy being misdiagnosed with schizophrenia, due in large part to their appearing to

hear voices while in a lucid dream state.

Let's hope that the search for techniques to initiate lucid dreaming may also lead to associated techniques for those of us who desire the opposite – making it stop.
Montreal, Canada

From Richard Horton

I spontaneously started experiencing lucid dreams in the 1990s. I thought the phenomenon was entirely subjective until I read Hamzelou's references to the use of PET scans and EEG to demonstrate measurable effects during this state of consciousness.

A particularly interesting aspect of lucid dreaming is the ability to create and manipulate 3D images of previously unencountered objects – certainly not something I can do when awake. On several occasions I have come across a piece of complex electronic apparatus in a lucid dream. On inspection of the equipment, the dials and switches are consistent when I walk all the way around the object.

When awake I cannot create a 3D image in this way, so how do I have this ability while dreaming? In contrast, if I read

printed text in a lucid dream and then look away, when I look at the text again it is always different.

Harrogate, North Yorkshire, UK

From John Wellbelove

I recently discovered that my dream states are completely different from the "normal" dreams described in your article.

My dreams are never vivid, let alone lucid – they are more akin to daydreams or visualised memories: fuzzy and indistinct, like watching a bad TV picture. Yet I am fully aware of the fact that I am dreaming, and can usually direct and restage parts of my dream when I don't like the way the story is going.

Having discovered the unusual nature of my dreams, and the experiences one could have with lucid dreaming, I find myself disappointed at what I have missed out on all these years.
Southampton, UK

Public science

From Guy Cox

Tom Wakeford and Jackie Haq discuss the dangers of keeping private the debate into the consequences of artificial life research (26 June, p 26).

Their article is well-intended but a little naive. Over the course of my scientific career I have encountered both big-business funded activism and pressure groups who could hold their meetings in a telephone booth, and I know from bitter experience that both are equally capable of stifling rational debate. Any meaningful discussion has to go beyond this, but Wakeford and Haq offer no solution.

Taking a sample of the population using well-developed market research techniques is an idea, but the real problem lies in informing the wider population. Scientific research should be much more widely available to the general public. In these

times, when science has so much hold over our lives, it is a real failure of our education system that students can leave school without a sound grasp of scientific method.

Sydney, Australia



Autism activism

From Nuraini Arsad

In reference to Brian Barry's letter, I am quite surprised to discover that the spectrum of autism does not just include savants, but also X-Men and the next stage in human evolution (29 May, p 28).

I donate annually to the local autism society: one of the reasons I do so is that I might have an autistic child myself some day. Also, autistic charities are not often prioritised above causes that are more likely to affect the general populace on a personal level. In some countries, there may be no recourse available to parents of autistic children, except facilities provided by volunteers and charities.

As Joanna Baron mentions on the same page, hype about the prodigies can threaten the provision of assistance for those who are less able to cope. Hype would not deter me from donating, but it seems that even high-functioning autistic individuals could benefit from a greater understanding of social dynamics, and balancing the benefits of their activism against the risk that help will be denied others who are not as self-sufficient as they are.
Kajang, Malaysia

Enigma Number 1604

From primes to squares

RICHARD ENGLAND

Harry has been looking for 5-digit perfect squares that can be read (in any order) as a 1-digit prime and two 2-digit primes. He knows that 1 is not a prime. 31329 (177²) qualifies in two ways, since the primes could be 3, 13, 29 or 31, 3, 29. Harry hasn't found that example, but he has found three squares that each qualify in one way; they use nine different primes. What are those three 5-digit squares?

WIN £15 will be awarded to the sender of the first correct answer opened on Wednesday 18 August. The Editor's decision is final. Please send entries to Enigma 1604, New Scientist, Lacon House, 84 Theobald's Road, London WC1X 8NS, or to enigma@newscientist.com (please include your postal address).

Answer to 1598 Twin squares: TAIDOWEN is 83421096

The winner Dave Kirkham of Frenchs Forest, New South Wales, Australia

Medical empiricism

From John Hastings

When discussing the measures to which some people will resort in searching for a cure for autism, Jim Giles inadvertently highlights a widespread problem in wealthy, developed nations (26 June, p 42): we believe that everything can be cured by medical intervention.

Good health depends on clean water, a balanced diet, hygienic sewage disposal, good housing, exercise and health education. Medicine's major contribution lies in antibiotics and immunisation. The main burden of ill health in nations with advanced healthcare systems comes from chronic, incurable and often poorly understood diseases, for which medicine can offer palliative treatment at best.

I was interested to see that oxygen chambers figure in the list of treatments for autism, because hyperbaric oxygen therapy has been recommended to my wife, who has multiple sclerosis. Michael Bennett and Robert Heard carried out a review of nine randomised, controlled trials of HBOT for MS and found no evidence of beneficial effect



(Cochrane Database of Systematic Reviews, 2004).

Perhaps health education programmes in our schools should include information about chronic diseases, and how to spot a quack remedy. Perhaps too, our medical professionals should come clean in public about what they cannot do, instead of

quietly allowing us to think they can cure anything.

Whittlesey, Cambridgeshire, UK

Mitochondrial link

From David Taub

While reading Andy Coghlan's article on how reawakened mitochondria can help fight cancer (15 May, p 6), it occurred to me that mitochondria might be a key factor behind the link tying exercise and obesity to the disease.

A number of studies have linked obesity to an increased risk of cancer. Exercise has been shown to reduce the risk of cancer, and it is also known that vigorous exercise increases the number of mitochondria in our cells. Could it be, therefore, that a fit person's increased number of mitochondria are more resistant to being shut down? Or that exercise turns on a chemical pathway to produce more mitochondria, and this pathway in turn helps block cancer?

If so, an optimal treatment for cancer might include both a drug to boost mitochondrial activity and a regime of physical exercise. Karlstad, Sweden

Dark matters

From Julian Mann

Kate McAlpine clearly explained the issues surrounding the standard model of particle physics (22 May, p 40).

However, in view of the considerable successes it has already achieved, it is more likely that the model needs to be extended rather than demolished. Also, it is likely that such an extension would unify and explain all the major unresolved questions in cosmology and quantum mechanics: gravity, mass, dark matter and dark energy.

The proposed Higgs boson seems to have little credibility

as an explanation for mass, given that most of the energy range where it is supposed to reside has already been tested.

Only the existence of a substantial amount of antimatter, locked in an alternate quantum phase (as dark matter) can possibly satisfy all these unresolved questions.

London, UK

Practical art

From Ian Barr, Healthcare and Bioscience iNet

In your special report on collaborations between art and science, David S. Berman writes that "a successful art-science work... should impact on people in a direct way, with a sensory component that moves them" (8 May, p 43).

Towards what should it move these people? To a greater understanding of a scientific concept? To marvel at the skill of the artist? No, the true value of art-science collaborations is that they bring about innovation which will result in new products and services.

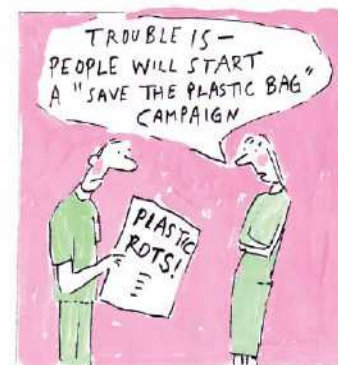
In the field of healthcare, this has already been happening: Healthcare and Bioscience iNet runs an annual "Where Art Meets Science" competition across the UK's East Midlands, and the entries have sparked discussions between academics, innovators and charity representatives. Crucially, the real collaborations begin when the exhibits have been taken down. Nottingham, UK

Plastic fantastic

From Steve Hibbert

James Mitchell Crow's article on decaying plastics seemed to only stress the downside of this phenomenon (19 June, p 42).

Has no one thought of the positive side? Plastic rots! It is like finding out that living next to a



nuclear power plant boosts fertility, or that whales enjoy the cut and thrust of being chased by whalers.

I hope I can now take a plastic bag from the supermarket without getting sneered at, secure in the knowledge that in 100 years the bag will crumble to dust.

London, UK

Quantum geography

From Paul G. Ellis

By implying a truly macroscopic "superposition" of the Austrian Erwin Schrödinger with the German Werner Heisenberg, Michael Brooks's "Rise of the quantum machines" (26 June, p 34) seems to promise success far beyond his article's own foresight.

This reader's "measurement" resulted in the *New Scientist* wave function collapsing to yield "Austrian, Heisenberg" (p 37). This confusion, by a process of elimination, must be an entangled state, given that the pure state is Würzburg, Heisenberg. Würzburg, Heisenberg's birthplace, is, of course, in Germany.

London, UK

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We are all from Alpha Centauri

In a fast-paced world that needs nimble brains and sophisticated thinking, we must junk stereotypes about gender differences once and for all, says **Lise Eliot**

IN 2010 we need to ask afresh just how deep the rabbit hole goes when it comes to gender politics – and how far we are from digging ourselves out. Our beliefs about differences between the sexes have an impact on society vastly out of proportion to the magnitude of those differences, from female scientists defending their mathematical and technical expertise to boys accused of lacking the communication and emotional skills to succeed at school.

In truth, women are doing well in science: since 1970, the number of doctorates awarded to women in the US has increased five-fold in physics, nine-fold in computer science and 24-fold in engineering, according to the US Department of Education. And yet just last month we heard John Tierney of *The New York Times* appearing to echo former Harvard University president Larry Summers's claim that women may be intrinsically incapable of performing at the highest level in such fields.

At the same time, boys are stepping away from pursuits like creative writing, foreign languages, art and singing in choirs as they hear they are not "hard-wired" for words or feelings. While young women get the message they can do anything, young men are put off careers in journalism, design, teaching, veterinary practice and psychotherapy, where they were once quite successful.

When I set out to write my book *Pink Brain, Blue Brain*, I had little sense of the controversy surrounding gender differences. I was just a neuroscientist with a daughter and two sons, curious about how their brains might differ and how best to raise them. Now I see how little the science of gender differences has penetrated popular culture and am hoping to set the record straight on behalf of both sexes.

Yes, boys and girls, men and women, are

different. But most of those differences are far smaller than the *Men are from Mars, Women are from Venus* stereotypes suggest. Nor are the reasoning, speaking, computing, empathising, navigating and other cognitive differences fixed in the genetic architecture of our brains. All such skills are learned, and neuro-plasticity – the modification of neurons and their connections in response to experience – trumps hard-wiring every time. If men and women tend towards different strengths and interests, it is due to a complex developmental dance between nature and nurture that leaves ample room to promote non-traditional skills in both sexes.

"There is almost nothing we do with our brains that is hard-wired"

The obvious place to start looking for behavioural differences between the sexes is infancy. Yet even here they are often in the eye of the beholder. In a classic experiment, researchers cross-dress babies to fool people that they are interacting with a child of the opposite sex. Volunteers tend to comment more on the physical strength and negative emotions of babies they believe to be boys, and on the beauty and positive emotions of babies they believe to be girls.

In reality, baby boys and girls begin to smile, crawl and walk at the same time. Their vision and hearing are more or less the same, and they make equal eye contact with adults, at least when they are newborns. This changes when they hit 4 months, however: girls lock eyes with adults significantly more than boys. Also, by 4 or 5 months, boys outperform girls at the ability to rotate objects mentally –



a spatial ability that differs dramatically between men and women but which only recently was found to differ in infancy.

Between 9 and 12 months, boys and girls start diverging in their preference for toys. While younger boys and girls prefer dolls over other playthings (they have faces, which all babies are drawn to from birth), older boys prefer trucks and balls over dolls and pink beauty sets – one of the largest sex differences that has been identified. Wheeled toys, in particular, are highly attractive to boys, probably because of their higher activity level.

And yes, boys really are more active than girls, a difference that grows as they get older. By around 8 or 9, the average boy is more active than about two-thirds of girls, meaning that a third of girls are more active than the average boy. Such early differences appear innate, though evidence linking them to the



Boys and girls differ far more in play preferences than in their academic skills and emotions

difference that grows more marked as they go through school. In fact, this gap is larger and more universal than the gap in mathematics, which girls have largely closed in recent years. Yet there is no evidence that boys' brains are any less prepared to learn how to read than girls' brains. Rather, it seems the small advantage girls have from talking earlier encourages more conversation and wordplay with parents and peers, more time with books and earlier development of the skills crucial for reading.

Once they have learned to read and write, girls simply use these skills for pleasure more than boys. Since fMRI studies have found little difference in the way male and female brains process the written word, it is likely that this amount of experience rather than any hard-wiring accounts for the literacy gap. Similarly, boys' spatial abilities grow as they spend more time building, playing fast-paced video games and actively exploring the world around them. Such skills are important in geometry, calculus and physics, where boys tend to pull ahead of girls towards the end of secondary education.

So should we abandon our search for the "real" differences between the sexes? Yes. There is almost nothing we do with our brains that is hard-wired: every skill, attribute, and personality trait is moulded by experience. At no time are children's brains more malleable than in early life – the time when parents are so eager to learn the baby's sex, project it to others and unconsciously express stereotyped impressions of their child.

Increasingly, biologists appreciate the role of epigenetics in shaping body, brain, mental traits and propensity to disease. Why should sex differences be any different? We know that baby rats that are licked and groomed more by their mothers show a host of neurochemical changes, beginning with DNA modification, that permanently alter their stress response and memory. No one has yet investigated what this means for behavioural sex differences, even though mothers of most species interact differently with male and female offspring.

Gender roles will continue to evolve as our brains adapt to the new opportunities and expectations each generation faces. A fuller understanding of the real magnitude and multiple causes of gender differences can help us avoid stereotyping and better cultivate the unique talents of every child. Considering our fast-changing world, with its need for nimble, sophisticated thinking skills, surely our children deserve no less. ■

prime suspect – the surge of testosterone in boys before birth – remains shaky. Whatever the initial cause, most behavioural differences between the sexes are amplified with age, as children's initial biases hit our gendered culture and they learn what it means to be a boy or girl. Toy preferences, say, grow more disparate: a male toddler shows only a slight preference for trucks, but by 5 years of age he won't be caught dead near anything pink.

Generally, boys avoid girls' toys, clothes and activities much more than girls avoid boys' things, mostly because of social taboos, but also because parents have seen the benefit of girls playing sports, building things and taking part in traditionally male pastimes. So while prenatal testosterone exposure may fuel boys' initial preference for more active toys, social influences considerably magnify this difference throughout childhood, a period

when levels of oestrogen and testosterone do not actually differ between boys and girls.

In spite of their passion for guns or Barbie dolls, boys and girls differ much less in their cognitive and emotional skills than toy preferences suggest. Girls talk earlier, but the difference is small – about a month, on average – and sex has been found to account for a mere 3 per cent of the variation in young children's verbal development.

Girls read and write better than boys, a

PROFILE

Lise Eliot is associate professor of neuroscience at the Chicago Medical School, part of Rosalind Franklin University. This essay draws on her book *Pink Brain, Blue Brain: How small differences grow into troublesome gaps – and what we can do about it* (OneWorld, 2009)

What's the beef with meat?

Some claim that the only way to save our planet from disaster is for everyone to stop eating meat. Is it really that simple, asks **Bob Holmes**

IF YOU'RE a typical westerner, you ate nearly 100 kilograms of meat last year. This was almost certainly the costliest part of your diet, especially in environmental terms. The clamour for people to eat less meat to save the planet is growing ever louder. "Less meat = less heat", proclaimed Paul McCartney in the run-up to last December's conference on global warming in Copenhagen. And this magazine recently recommended eating less meat as a way to reduce our environmental footprint.

If less is good, wouldn't none be better? You might think so. "In the developed world, the most effective way to reduce the environmental impact of diet, on a personal basis, is to become vegetarian or vegan," says Annette Pinner, chief executive of the Vegetarian Society in the UK.

It seems like a no-brainer, but is it really that simple? To find out, let's imagine what would happen if the whole world decided to eliminate meat, milk and eggs from its diet, then trace the effects as they ripple throughout agriculture, the environment and society. The result may surprise you.

In 2008 the world consumed about 280 million tonnes of meat, 700 million tonnes of milk and 1.2 billion eggs, according to the UN Food and Agriculture Organization (FAO). Environmentally speaking, this came at an enormous cost.

All agriculture damages the environment – think of all those felled forests and ploughed-up prairies, all the irrigation water, manure, tractor fuel, pesticides and fertiliser. Agriculture produces more greenhouse gases than all methods of transport put together, and contributes to a host of other problems, from nitrogen pollution to soil erosion.

Livestock farming does the most damage.

In part, that is because most livestock eat grain that could be used to feed people. As little as 10 per cent of that grain gets converted into meat, milk or eggs, so livestock amplify the environmental impact of farming by forcing us to grow more grain than we would otherwise need.

As a rough measure of how much more, consider that livestock consume about a third of the world's grain crop. So as a first approximation, a vegan world would need only two-thirds of the cropland used today. That's only part of the story, of course: meat and milk make up about 15 per cent of calories eaten by humans, so we would need to eat more grain to compensate for their loss. Altogether, switching to a vegan diet would reduce the amount of land used for crops by 21 per cent – about 3.4 million square

kilometres, roughly the size of India.

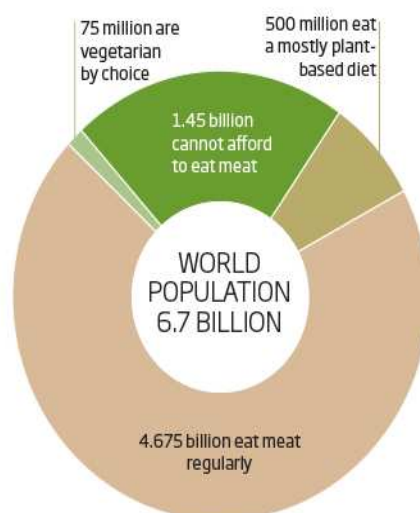
Such a reduction would have a huge effect on the environmental impact of farming. Take nitrogen pollution, which can lead to eutrophication in lakes. As a small-scale illustration, environmental scientist Allison Leach of the University of Virginia in Charlottesville calculated that if everyone at her university cut out meat from their diet, it would reduce the university's nitrogen footprint – the amount of nitrogen released to the environment from all activities – by 27 per cent. This is largely because of reductions in fertiliser use and the amount of nitrogen leaching from manure. If everyone went a step further and eliminated dairy products and eggs as well, Leach found that the university's nitrogen footprint would fall by 60 per cent.

It's not just in terms of nitrogen that livestock impact the environment. Global statistics are hard to come by, but in the US at least, livestock account for 55 per cent of soil erosion and 37 per cent of pesticide use. As well as that, half of all antibiotics manufactured are fed to livestock, often as part of their normal diet, a practice that is leading to antibiotic resistance in bacteria.

That's not all. Livestock are also a major source of greenhouse gases. Much of this comes in the form of methane – an especially potent greenhouse gas – produced by microbes in the guts of grazers such as cattle and sheep, and eventually belched out to the atmosphere. Livestock farming also accounts for a lot of carbon dioxide, mostly from forests being cut down for pasture, or when overgrazing and the resulting soil erosion causes a net loss of carbon from soils. When you add all this together, livestock account for a whopping 18 per cent of all greenhouse

Veggie world

About 20% of the world's population is vegetarian





"You give your leftovers to the pigs, they deal with your rubbish and you get meat"

gas emissions as measured in CO₂ equivalents, according to *Livestock's Long Shadow*, a 2006 FAO report. Eliminating livestock would certainly make a big difference in efforts to control global warming.

Just how big a difference depends on what replaces the livestock and the land it grazes. Certainly, where pastures revert to forests – particularly in areas like the Amazon basin, for example, where 70 per cent of deforested land is now pasture – the regrowing forest will sequester huge amounts of carbon. The American plains, too, would accumulate carbon in their soil if grazing stopped. But in sub-Saharan Africa, any reduction in methane from domestic grazers is likely to be at least partially offset by increased emissions from wild grazers and termites, which compete with livestock for food. "It's certainly worth someone spending some time to look at that," says Philip Thornton, an agricultural systems scientist with the International Livestock Research Institute.

Hidden costs

A meat-free world, then, would be greener in many ways: less cropland, more forest and, presumably, more biodiversity; lower greenhouse gas emissions; less agricultural pollution; less demand for fresh water – the list goes on. Clearly, if meat, milk and eggs were on trial for crimes against the environment, the prosecution would have an easy ride. And that says nothing of animal-welfare issues.

But wait. If everyone opted to give up meat there would be significant costs, too. It is true that most livestock today are fed grain that people could otherwise eat, but it doesn't have to be so. For most of human history, cattle, sheep and goats grazed on land that wasn't suitable for ploughing, and in doing so they

converted inedible grass into edible meat and milk. Even today, a flock of sheep or goats can be the most efficient way to get food from marginal land. In a world where more than a billion people don't have enough to eat, taking such land out of production would only contribute to food insecurity. Moreover, for semi-arid or hilly land, modest levels of grazing may cause much less ecological damage than growing crops.

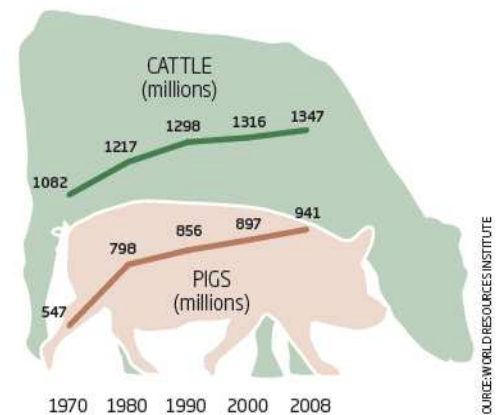
Even pigs and chickens, which lack the digestive machinery to eat grass, don't need grain. Instead they can subsist on leftovers and whatever they forage. "Your household pig was your useful dustbin," says Tara Garnett, who heads the Food Climate Research Network at the University of Surrey in Guildford, UK. "You give your leftovers to the pigs, they deal with your rubbish, and you get meat." Fed in this way, livestock represent a net gain of calories and protein in the human diet while dealing with some of the estimated 30 to 50 per cent of food that goes to waste – a benefit that a meat-free world would have to do without. Most pig and chicken farms are missing a trick here, since the animals eat commercial, grain-based feeds.

Another downside would be the disappearance of animal by-products. A meat-free world would have to replace the 11 million tonnes of leather and 2 million tonnes of wool that come from livestock farming every year. Not only that, many farmers would miss the manure, though the use of animal fertiliser is less important than it once was. "Manure has become a minor source of nitrogen in all major agricultural countries. It's not unimportant, but it accounts for probably less than 15 per cent of total nitrogen," says Vaclav Smil, an environmental scientist at the University of Manitoba in Winnipeg, Canada.

Even ardent vegetarians acknowledge that dairy products and even meat may be a good

Livestock census

The number of cows and pigs being farmed for food has increased rapidly since 1970



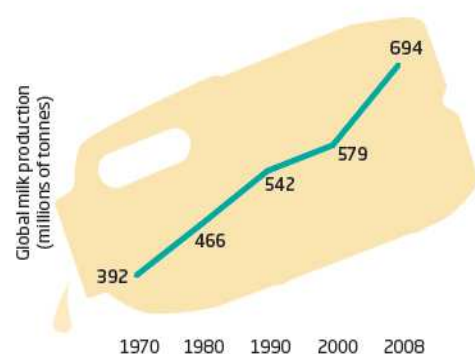
thing in poorer countries. "Whilst there's no doubt that considerable reduction of meat consumption would have an environmental benefit, we do have to be careful about saying it would be the best solution if the whole world went vegetarian," says Pinner. For as many as a billion of the world's poorest rural residents, an animal or two may represent their only realistic hope for a little extra income, and a little bit of animal protein can make a big difference to a marginal diet.

What if we decided on a vegetarian, rather than vegan diet? After all, milk and eggs are very efficient ways of producing animal calories, second only to factory-reared broiler chickens. Unfortunately, an exclusively lacto-ovo livestock system simply doesn't work well in practice.

"It's difficult to switch to a no-meat but milk diet, because you cannot produce milk without meat," says Helmut Haberl, a social ecologist at the Institute of Social Ecology in Vienna, Austria. Dairy cows must calve every year to keep producing milk, and only half

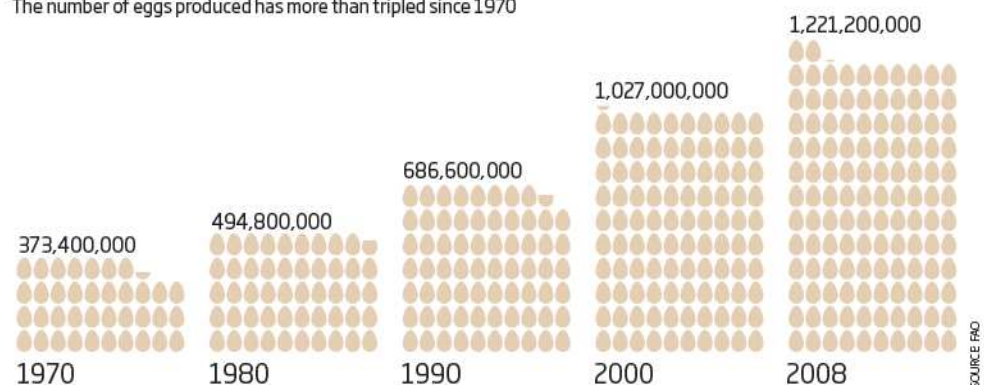
A thirst for milk

Milk production has almost doubled since 1970



Global egg production

The number of eggs produced has more than tripled since 1970



their offspring will be female. While many vegetarians see moral reasons not to kill and eat the males – or retired dairy cows – there is surely no practical reason to waste so much meat. Similar arguments apply to chickens kept for eggs.

So even though a meat-free world sounds good on paper, it is likely that a utopian future will still have some animal products in it. And we are talking meat, not just milk and eggs. The real questions, then, are how much meat do we want, and how will we produce it?

The answers depends on how you approach the question. The most straightforward is to assume that the world will continue to demand ever more meat. That is certainly how things are going at the moment (see “Wealth = meat”, below right).

Under this scenario, the goal will have to be producing the most meat at the lowest environmental cost. That means fewer free-range cattle and sheep grazing in bucolic pastures and more animals, especially chickens, packed into feedlots or high-density enclosures. “If you’re going to keep some livestock systems, I think the ones you’ll want to keep are the intensive ones,” says Walter Falcon, an agricultural economist at Stanford University in California.

Indigestible grass

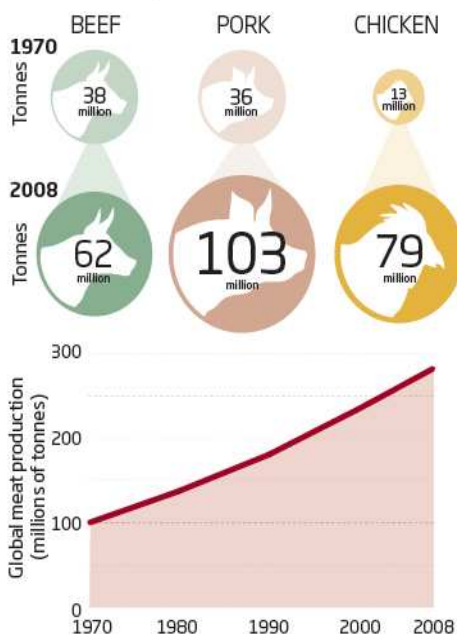
That’s because pasture grazing is inherently inefficient. Animals burn large amounts of energy roaming about the landscape feeding on relatively indigestible grasses. They grow more slowly than feedlot animals and, as a result, emit more methane over their lifetime. A beef cow in a US pasture, for example, emits 50 kilograms of methane per year, compared with just 26 kilograms in a feedlot, according to *Livestock’s Long Shadow*.

But even a feedlot cow is a much less efficient meat producer than an industrial pig or chicken. While these eat a largely grain-based diet and thus compete directly with humans for food, they are relatively good at converting feed into flesh while producing little or no methane. This keeps their environmental cost down: a kilogram of industrial chicken meat represents greenhouse gas emissions equivalent to just 3.6 kilograms of CO₂; a kilogram of pork, 11.2 kilograms; and a kilogram of beef, 28.1 kilograms, according to an analysis by Bo Weidema of sustainable development consultancy 2.-O LCA based in Aalborg, Denmark.

Of course, such intensive operations cause other problems as well, notably the

Rise in global meat production

Chicken has seen the biggest rise in production, with six times as much produced in 2008 as in 1970



disposal of large amounts of manure. In theory – and increasingly in practice – much of this manure could be used to generate biogas and subsequently electricity. If all US livestock manure were processed in this way, it could reduce greenhouse gas emissions by about 100 million tonnes annually, equivalent to 4 per cent of the emissions from electricity generation (*Environmental Research Letters*, vol 3, p 034002). With the right incentives, intensive livestock farms could cause much less environmental damage than they do today.

There is another alternative, though: treat livestock as part of the ecosystem. Garnett envisions returning animals to their original role as waste-disposal units, eating food leftovers and grazing on land not suitable for crops. “In that context,” she says, “methane

WEALTH = MEAT

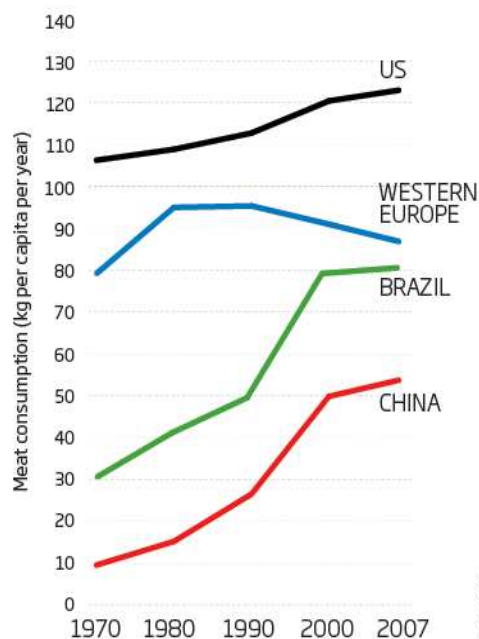
Persuading the world to eat less meat looks like a tough task. In country after country, as people become wealthier they eat more meat. Between 1980 and 2002, per capita meat consumption in developing countries doubled to 28 kilograms per year, and is projected to rise to 37 kilograms per year by 2030.

That is still less than half what the average person in the developed world eats today, and demand is still rising. In the west, people ate nearly 8 per cent more meat per capita in 2002 than they did in 1992.

When you add this to the growing population, the United Nations’ best guess is that by 2050, the world will need to more than double its production of meat – an increase that would be environmentally disastrous.

A growing taste for meat

As people get richer, they tend to eat more meat



emissions per animal will be higher, but overall emissions would be less because there would be fewer animals.”

Fewer animals means less meat of course. Just how much less, no one really knows. As a first approximation, Garnett notes that about half of global meat production comes from intensive animal-only farms, and none of these would be allowed under the ecological approach. What is left would be those ranches where animals graze on marginal land and are not fed grain – about 10 per cent of the total today – and a larger number of mixed farms where the livestock feed off crop residues, milling wastes and other leftovers.

Such a future would require a major adjustment in food preferences. People would need to eat less meat, especially in the meat-hungry west. Not only that, but we would also have to change the kind of meat we eat. “You are not going to get your fat, heavy-breasted chickens by feeding them household scraps and letting them peck for worms. You are going to get a much scrawnier animal,” says Garnett.

Would people really accept pricey free-range beef and scrawny barnyard chickens perhaps once or twice a week? Certainly most do not today, opting for price and abundance over environmental impact. But change happens. Given the deforestation, soil erosion, water pollution and greenhouse gas emissions that will result if worldwide meat production continues to rise, some people are already choosing to eat less meat. And the message is definitely less, not none. For best results, meat should be medium-rare. ■

Bob Holmes is a consultant for *New Scientist* based in Edmonton, Canada

Laughter, the best medicine

We all like a good laugh. But how many of us know why? Humour, schadenfreude, tickling, nerves – all can trigger a ho-ho-ho or a heh-heh-heh. What does that tell us about laughter? Is laughing a uniquely human state, and why, if we hear someone laughing, do we want to join in?

On the coming pages, **Kate Douglas** and **David Robson** put on a straight face and look for the answers. Meanwhile on page 36, acoustician **Trevor Cox** invites you to participate in an online experiment to answer another burning question: can we make a computer laugh convincingly?

WHAT ARE YOU LAUGHING AT?

Ignoring any aggressive intent in the above question, the answer is obvious: I am laughing because something you said amused me.

Right? Wrong. According to a classic study of laughter by Robert Provine of the University of Maryland, Baltimore County, and his colleagues, laughter is an unexpectedly serious business. Observing the human animal in its natural habitat – the shopping mall – they documented 1200 instances of laughter, and found that only 10 to 20 per cent of them were responses to anything remotely resembling a joke. Most laughter was in fact either triggered by a banal comment or used to punctuate everyday speech. Furthermore, says Provine in his book *Laughter: A scientific investigation*, we are 50 per cent more likely to laugh when speaking than when listening, and 30 times gigglier in a social setting than when alone without a social surrogate such as a television.

Provine's conclusion was that the essential ingredient for laughter is not a joke but another person. Laughter is far more general than just a response to humour: it is a social glue that we use in all sorts of ways to bind ourselves together.

As such, it comes in many guises. Our first laughs occur at between 2 and 6 months of age – even in deaf babies. They are triggered by surprise in a safe situation (think peek-a-boo), and don't

just endear babies to their parents. Since laughter is associated with activity in the brain's dopamine reward circuitry, it encourages babies to explore the world by making them feel happy and safe. When infants begin to engage in rough-and-tumble play, laughter signals that the intentions are not serious, allowing children to test physical and social boundaries without serious jeopardy.

The conversational laughter Provine observed essentially acts as a social lubricant. It engages listeners and dispels tension, aggression and competition by putting people at ease. Nervous laughter can make light of a stressful or psychologically difficult situation. And, through its catching nature (see "Why is laughter contagious?", page 36), laughter can unify the mood and behaviour of a group, promoting coordinated activity for the greater good (*The Quarterly Review of Biology*, vol 80, p 395).

Laughter also has a darker side. "You can influence the behaviour of others through laughter," says Michael Owren, a psychologist at Georgia State University in Atlanta. He believes that as we master the subtle cues of laughter, so we begin to use it to manipulate those around us. An "in" joke can exclude outsiders from a clique, for example. Laughter can be used to show who is boss and malicious laughter is an effective weapon of intimidation. **Kate Douglas**



MOUSE or RAT

PARP!



SPENNERWILSON

"Most people identified chimp laughter as a dog panting, a few had it down as noisy sex and some even heard sawing or sanding"

TICKLING A RAT...?

"Man is distinguished from all other creatures by his faculty of laughter," wrote the English essayist Joseph Addison in 1712. Modern science has a different take – up to a point.

We're pretty sure that no other animal laughs quite like we do. That's down to our unique status as an ape that has learned to stand on its own two feet. "Bipedalism was the breakthrough," says Robert Provine, the doyen of laughter research. Four-legged mammals must synchronise their breath with their stride. By taking pressure off the thorax, bipedalism gave us the breath control needed for speaking and the ability to chop up our exhalations, giving the characteristic ha-ha-ha sound of human laughter.

If laughter really is just a social lubricant (see "What are you laughing at?", p 32), you might expect our equally social great-ape cousins to do something similar. "Laughter is literally the sound of rough-and-tumble

play," says Provine – and great apes at play do indeed produce something akin to a laugh. But their playful pants are not as musical as ours and instead of being made up of extended exhalations, they are produced by breathing in and out. As a result, ape laughter doesn't sound much like our own. When Provine played a recording of chimp laughter to his students, most of them thought it was a dog panting, a few had it down as noisy sex and some even heard sawing or sanding.

This is probably about as close as we are going to get to human laughter. Last year Marina Davila-Ross from the University of Portsmouth, UK, and colleagues tickled three babies and 21 orang-utans, gorillas, chimps and bonobos, measured various acoustical features of the sounds they produced and used these to create a family tree of laughter. It was remarkably similar to the evolutionary tree (*Current Biology*, vol 19, p 1106). "The strongest acoustical

differences were between humans and great apes," says Davila-Ross. But the laughs of the African great apes – the chimps and gorillas that are our closest genetic cousins – were acoustically more similar to ours than the squeaks produced by orang-utans.

So where should we draw the line? Should we define a laugh simply as any vocalisation made during play? Opinion is divided.

One researcher who advocates a liberal definition is Jaak Panksepp of Washington State University in Pullman. By making recordings of rats using bat detectors, he discovered that they produce characteristic ultrasonic chirps at a frequency of 50 kilohertz when tickled. Not only does he consider this to be laughter, he argues that studies on rats could help us understand the neurobiology of human laughter (*Behavioural Brain Research*, vol 182, p 231). *Kate Douglas*



JAMES CARMEN/GETTY

IS IT A SEX THING?

Sense of humour varies enormously from person to person, but while much is learned and culturally influenced, there is no evidence of systematic differences in the things that men and women find funny (*Journal of Pragmatics*, vol 38, p 1). Neither does recent research back an early finding that women laugh more than men overall.

There is one scenario, though, in which differences between women and men begin to show – in their interactions with each other. Right from the start, boys are the laugh-getters, the buffoons and the school clowns who entertain the giggling girls, according to laughter researcher Robert Provine. He has found this same pattern in *Lonely Hearts* columns, where men tend to advertise their sense of humour and women seek a funny man. Provine believes this shows the behaviours have evolved by sexual selection and has controversially suggested that female laughter in the presence of men is a signal of submission.

Another possibility is that this difference is culturally rather than biologically determined. Many studies have shown that dominant individuals, from tribal elders to workplace bosses, are more likely to orchestrate laughter than their subordinates, using it as a means of



wielding power either to bond their followers or to divide and rule. The excess of female laughter in mixed-gender gatherings might simply reflect the fact that men generally hold more power in society than women.

Or perhaps women are manipulating men in this case, as Michael Owren, a psychologist at Georgia State University in Atlanta and his colleague Jo-Anne Bachorowski from Vanderbilt University in Nashville, Tennessee, believe. They find that laughter influences listeners in two ways. First, like any sudden, loud, rising sound, it is stimulating and puts us on high alert. Secondly, laughter also makes listeners feel better by association with positive emotions from earliest childhood. "Men and women can take advantage of these effects in different circumstances," Owren says. Women, he notes, are likely to be vigilant and wary with an unfamiliar man, but by laughing nervously they can influence his mood and put the encounter on a more positive footing. The same trick doesn't work for men, according to Owren, because laughter would increase the woman's already heightened state of alertness and make the situation tenser. Kate Douglas

IS LAUGHTER THE BEST MEDICINE?

"No pain, no gain" is a mantra often used to motivate those hard slogs at the gym. But could a daily dose of rib-tickling comedy reap some of the benefits of a gruelling workout? Lee Berk at Loma Linda University in California thinks so.

To assess the health benefits of laughter, Berk showed 14 volunteers 20-minute clips from humorous television programmes such as *Saturday Night Live*, measuring their blood pressure and cholesterol levels before and afterwards. The results, which he presented at the 2009 Association for Psychological Science meeting in San Francisco, should bring a smile to all lovers of levity. During the "laughercise" both cholesterol levels and systolic blood pressure fell. Direct comparison with exercise is difficult, but Berk estimates the physiological benefits were equivalent to those of a moderate 20-minute workout. Watching sombre scenes from *Saving Private Ryan* had no such effect.

That's not all: laughter may also help fight off infection. Other studies have found that it boosts the performance of the immune system by increasing the production of antibodies and the activity of natural-killer cells. A mother's laughter can even improve the quality of her breast milk, making it more effective at fighting skin allergies in newborn babies (*New Scientist*, 16 June 2007, p 23).

All this might suggest that you can laugh your way to a longer life. Unfortunately, what little evidence there is suggests quite the opposite. When Leslie Martin at La Sierra University in Riverside, California, compared data about the life history of 1215 Americans with their psychological profiles at age 10, she found that the most cheerful were also more likely to die young. In fact, a cheerfulness rating in the top quarter of the population increased the risk of death at any point in their life by 21 per cent over the risk for those who fell in the bottom quarter (*Personality and Social Psychology Bulletin*, vol 28, p 1155).

No one knows why this should be so, though the study did find that the sunnier children were also more likely to drink and smoke in later life. Perhaps misery guts take more care of themselves and so ultimately have the last laugh. **David Robson**

WHY IS LAUGHTER CONTAGIOUS?

"It is a fair, even-handed, noble adjustment of things, that while there is infection in disease and sorrow, there is nothing in the world so irresistibly contagious as laughter and good-humour," wrote Charles Dickens in *A Christmas Carol*. More than 160 years later, we still don't know exactly why laughter is so catching, though a recent study offers some tentative clues.

Sophie Scott at University College London measured the brain activity of 20 volunteers in a functional MRI scanner while she played them laughter, squeals of triumph and moans of fear and disgust. She also played a neutral, artificial sound that would have no specific meaning to the subjects.

The result? All the emotive sounds triggered a response in the

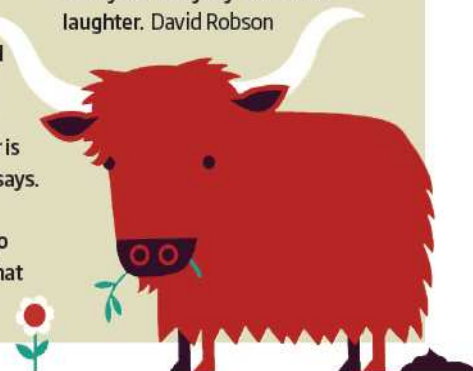
brain's premotor cortical, the area that controls the movement of facial muscles. Inside the brain scanners, though, the subjects were not actually using these muscles. To Scott, that indicates the brain is wired with "mirror circuits" that prime us to copy another's behaviour when we recognise their emotions. The brain response was more pronounced for the sounds of laughter and triumph than the vocalisations of negative emotions, suggesting that the urge to copy is greatest when we hear another's delight or amusement (*Journal of Neuroscience*, vol 26, p 13067).

That may explain how laughter is contagious, but why should it be so? One explanation stems from its evolutionary origins in rough-and-tumble play, where laughter sends

out a clear message that the fighting is not for real (see "What are you laughing at?", page 32). "It might be important to have the whole group safely signal this so that a play fight does not turn ugly because someone 'didn't get the memo'," says Christian Hempelmann at Purdue University in West Lafayette, Indiana. Scott has an alternative suggestion. She believes that mirroring another's emotional state might ease communication and interaction. Laughing at the same joke would help us to show affiliation with others, and this may be why it is especially contagious. "Laughter is an incredibly binding thing," she says.

There is another type of contagious laughter that is not so pleasant or playful. In 1962 in what is now Tanzania, a "laughing

epidemic" broke out in a girls' school, spreading across the whole country for several months. On closer inspection, though, it looks as if the laughter was a single symptom of a more complex disorder known as "mass psychogenic illness" or mass hysteria, that emerged as a result of building political and social pressures in the region (*Humor*, vol 20, p 49) - so it probably had little to do with your everyday infectious laughter. David Robson



CAN WE MAKE A COMPUTER LAUGH?

It would be fun to have a robot throw its head back and guffaw convulsively. Acousticians like me, however, simply want to synthesise a convincing sound. That's a tough task, given how much our laughs and giggles can vary.

For one thing, humans can change the vowel sound of their laughs - from "tee-hee" to "ho ho ho", though "ha ha ha" is the most common (*Journal of the Acoustical Society of America*, vol 110, p 1581). We also vary the prosody - the stresses, rhythm and intonation - within and between laughs, helping us to convey different

characteristics such as joy and ridicule (*Emotion*, vol 9, p 397). Shrieks of laughter, in which the vocal folds vibrate to give a distinctive pitch to the sound (see diagram below), differ from snorts, grunts and pants, where the vocal folds do not vibrate. These "unvoiced" sounds seem less popular with listeners (*Psychological Science*, vol 12, p 252).

We want you to help us test the best in laughter synthesis in an experiment that pits examples from leading researchers against one another. Each bionic chuckle was produced

using a different technique, but the goal is the same: to add laughter to synthesised speech to make it sound more natural.

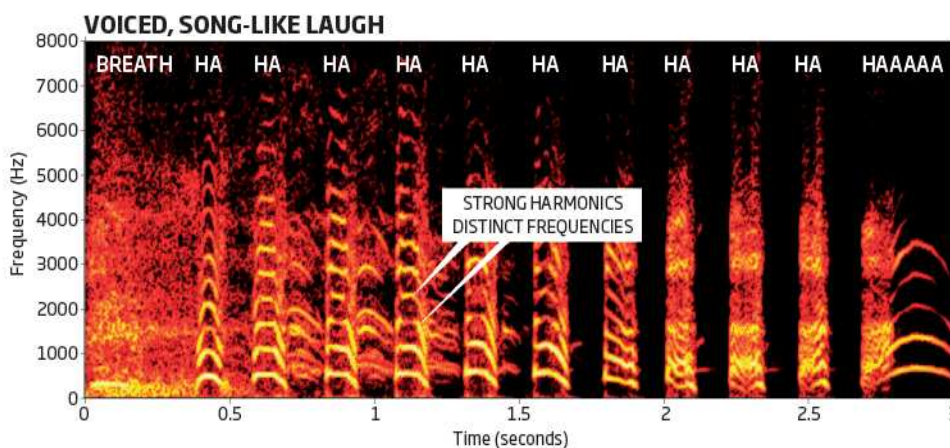
Jürgen Trouvain and colleagues from the University of Saarland in Saarbrücken, Germany, for example, model the movements of the vocal tract and air flow. Grégory Beller at the Pierre and Marie Curie University in Paris, France, on the other hand, takes an algorithm that turns text into speech and then alters the prosody to try and convey different emotions.

Meanwhile Shiva Sundaram at Deutsche Telekom in Berlin, Germany, uses a technique called linear predictive speech coding to generate individual laughs ("ha"), and a simple algorithm to work out their timing. Jérôme Urbain from the University of Mons, Belgium, mixes and manipulates single laughs drawn from real laughter.

Which technique is most effective? You decide. Our online experiment, found at www.soundsfunny.org/turing/, is very simple to use. Just audition a set of sounds, and after each one say whether it was a computer or a human laughing. Can you spot the fakes? **Trevor Cox** ■

Laughter lines

The complex patterns of frequencies in a human laugh make it hard for a computer to reproduce



SOURCE: TREVOR COX, UNIVERSITY OF SALFORD

Kate Douglas and David Robson are feature editors for *New Scientist*. Trevor Cox is professor of acoustic engineering at the University of Salford, UK, and president of the UK Institute of Acoustics

The idea that oxygen levels are falling is just a myth – or is it?
Stephen Battersby investigates

Breathe deep

HAVE been feeling a little short of breath on mountain paths lately, and it took me ages to light the barbecue last week. I wonder why? Perhaps it's something to do with a lack of exercise, an excess of beer, some damp charcoal... But wait, there is a much simpler explanation: these days, there isn't enough oxygen in the air.

So say many websites – sites that just happen, by wild coincidence, to sell solutions to this atmospheric catastrophe in the form of “liquid oxygen” supplements, personal oxygen generators, even oxygen-laden skin-creams. As *New Scientist's* Feedback column has noted over the years, these snake-oil salesmen exploit a bafflingly persistent myth, that industrial activity has sucked much of the oxygen out of the air.

Some claim that a couple of hundred years ago the “natural” level of oxygen in the atmosphere was 38 per cent, others that large cities such as Tokyo, Japan, now have oxygen levels as low as 5 per cent. In fact, the oxygen content of the air worldwide is about 21 per cent, the same as it was for the Victorians, the Romans and the Neanderthals. All those claims that the sky is falling are utter nonsense. Well, almost.

It is true that human activity is causing a steady, measurable decline in the oxygen content of the world's air, although as yet this

decline is negligible. But if we continue to burn fossil fuels for centuries more, levels could fall much further. Should we be worried?

Since 1989, Ralph Keeling has been monitoring oxygen levels around the globe. As well as continuous measurements at permanent monitoring stations, flasks of air are captured in some of the wilder parts of the planet, such as Cold Bay in Alaska and Cape Grim in Tasmania, and sent to Keeling's lab at the University of California, San Diego, for analysis.

Originally, Keeling measured the speed of light in the air samples with a laser beam. Because light moves faster in oxygen than nitrogen, this reveals the oxygen content. Now he and his collaborators use several methods, including mass spectroscopy and ultraviolet probes. Some of these techniques are being ➤





In the future will we need extra oxygen to stay healthy?

used on board a plane that is zigzagging from pole to pole. All the methods give the same result: the concentration of oxygen is declining everywhere at the same rate, about 20 parts per million (ppm) per year. In other words, for every million molecules of O_2 in the air in 1989, there are now only about 999,600.

This fall comes as no surprise. When you burn a hydrocarbon fuel such as oil, its hydrogen and carbon atoms combine with oxygen from the atmosphere to create water and carbon dioxide. As we drive up levels of CO_2 by burning fossil fuels, we also deplete oxygen.

In fact, Keeling's measurements have shown that oxygen is declining less rapidly than expected, probably because plants are enjoying a brief bonanza. As they have exploited the higher levels of CO_2 , the total amount of biomass on the planet has increased, and in the process extra oxygen has been pumped out.

This probably won't last. Studies of Earth's past suggest that the total biomass will soon stabilise – or more likely start to decline. That means the drop in oxygen will depend largely on how much more fossil fuel we burn.

Say we guzzle all the easily accessible fuels – all the coal, oil and gas that can be economically hacked or pumped from the Earth today. In total, that is estimated to be roughly 1200 billion tonnes of carbon, mostly in the form of coal. Burning the lot would



SUFFOCATING SAURIANS

Three hundred million years ago, dragonflies and millipedes grew to frankly disturbing sizes – thanks in part to levels of oxygen in the atmosphere as high as 30 per cent. What created this abundance, and what brought oxygen back down to today's less heady levels?

It is all to do with the fate of plants. Plants emit oxygen while they are photosynthesising, but the same amount of oxygen is used up if the carbon compounds they make are broken down. To boost oxygen in the long term, organic matter must be buried beyond the reach of hungry bugs and beasts. Most of the oxygen in our air came from plants whose remains – or those of the animals that fed on them – became entombed in sedimentary rocks.

As the crust shifts, however, it can bring sediments containing ancient corpses back to the surface, where they decompose, removing oxygen from the

atmosphere once more. Gases from organic material buried deep in the Earth can also escape to the surface, where they react with oxygen. So oxygen levels can go down as well as up, depending on the balance between burial and exhumation.

When plants conquered the land they found new places to grow and new ways to be buried, gradually boosting atmospheric oxygen. This eventually resulted in the oxygen-rich atmosphere of the Carboniferous period around 340 to 280 million years ago. "The Carboniferous had lush swampy forests, perfect for burying carbon" says Tim Lenton of the University of East Anglia in Norwich, UK.

Later, the continents moved together to create large, dry supercontinents much less hospitable to verdant plant life. The balance swung against burial, and oxygen levels fell.

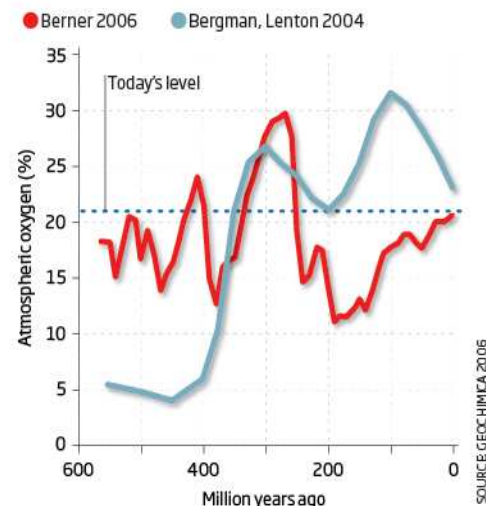
What happened next, during

the age of the dinosaurs from 230 to 60 million years ago, is more controversial. According to Lenton and his colleagues, oxygen levels increased once more before falling to present day levels. However Robert Berner of Yale University thinks oxygen levels plummeted after the Carboniferous before slowly rising to present day levels (see graph, right). Both conclusions are based on models that are broadly similar, but involve on somewhat different assumptions.

So did the dinosaurs have to breathe heavily despite their efficient bird-like lungs, or could they take leisurely sniffs of the air? The jury is still out, though fossil charcoal shows that forest fires were common at the time. This would be difficult to explain if oxygen levels fell below 15 per cent, as Berner's model suggests, because fires should not occur below this level.

Past oxygen

Estimates of past levels vary, but it is clear that there have been big swings



mean we lose 3600 ppm of our oxygen, so the level would fall from today's 20.95 per cent of the atmosphere down to 20.87 per cent.

Hardly suffocating, then, but that may not be the end of the story. The Earth holds other, less-accessible fuels, such as tar sands, and a more exotic possibility in the form of icy methane hydrates. In the pessimistic "A2 scenario" looked at by the Intergovernmental Panel on Climate Change, a world undergoing slow technological change but high population growth burns 3700 billion tonnes of carbon over the next two centuries. This would translate to a loss of about 1.1 per cent of our present stock of oxygen – down to 20.7 per cent of the atmosphere.

Natural lows

To get a feel for what this would mean, bear in mind that the amount of oxygen in a given volume of air changes with atmospheric pressure, and the local pressure changes with the weather. When it is raining, one lungful of air will often have a few per cent less oxygen than on an average day – a larger reduction than in our pessimistic scenario above. Or you could get much the same reduction by climbing from sea level up a hill just 100 metres high. In other words, a fall to 20.7 per cent would make hardly any difference.

Estimating fuel reserves is far from a precise science, however. In fact, there is undoubtedly

much, much more buried carbon than any estimates of fossil fuel reserves suggest – more than enough to consume every last bit of oxygen in the atmosphere if it was burned (see "Suffocating saurians", page 38). Perhaps fortunately, the vast majority of this carbon is spread very thinly, forming only a very minor ingredient in rocks. It is useless as fuel, because it would take more energy to extract than would be gained by burning it.

Still, according to some analyses as much as 25,000 billion tonnes of carbon might be recoverable. These estimates are based largely on old figures for the total amount of methane hydrates that are now thought to be too high, but let's be extremely pessimistic, and assume that they are right – and that we are ingenious enough and unwise enough to extract and burn all this carbon, or trigger its release. That would consume nearly 8 per cent of our oxygen, causing levels to drop to just 19.4 per cent of the atmosphere. Surely that would cause serious problems?

Probably not, says physiologist Mike Grocott of University College London, who studies the effects of hypoxia on hospital patients and mountain climbers. "I'd be very surprised if there was any widespread medical effect – although I'd expect patients who already have low blood oxygen levels due to severe cardiac or respiratory conditions to be at greater risk of complications."

Athletes would find it harder to break

"When it rains, each lungful of air contains less oxygen than normal"

records, says Grocott, and climbing high mountains will become a little more difficult. "Everest is already on the threshold of what's possible without supplemental oxygen. It might become impossible for most people."

Somewhat more seriously, people living in parts of the high Andes and the Himalayas would find life even tougher. Physical labour would become harder, for instance, and infant mortality would increase. That would be worrying – if it weren't for the vastly greater peril of extreme climate change caused by burning all that carbon. With the ice caps rapidly melting, today's coasts being inundated and the tropics turning into desert, the least of the world's worries will be a few wheezing yaks.

While there is far more reason to worry about rising CO₂ than falling O₂, we could still create a real oxygen crisis – not on land, but in the oceans. As atmospheric oxygen levels fall, less oxygen will dissolve in seawater, depleting levels slightly. Worse still, the warmer seawater gets, the less oxygen it can hold.

The effect of both these processes has been modelled by Gary Shaffer and his colleagues at the Danish Centre for Earth System Science in Humlebaek. In their worst case, based on the A2 scenario, oxygen levels in the top 500 metres of the oceans could drop by more than 20 per cent by the year 4000 (*Nature Geoscience*, vol 2, p 105).

"Dead zones" with almost no oxygen already make up around 2 per cent of the oceans by area, and they could expand seven-fold. "Fish can swim away, but the area of ocean they inhabit will become smaller," says Shaffer. Some species are more tolerant to low oxygen levels, and of course marine mammals and seabirds get their supply from the atmosphere, but they would all fall victim to an indirect menace. Low oxygen levels encourage the growth of bacteria that destroy nitrate – a vital nutrient for the ocean's microscopic plants, or phytoplankton. The phytoplankton are the base of the main marine food chain, eaten by zooplankton, which are eaten by fish, and so on. Take them away and the whole ecosystem collapses.

As if that weren't bad enough, the bacteria that thrive in low oxygen conditions emit a powerful greenhouse gas, nitrous oxide. If we suffocate the sea, it might take its revenge. ■

With less oxygen, breaking records will be tougher for athletes



BEN CURTIS/AP/PA

Stephen Battersby is a consultant for *New Scientist* based in London

FROM feckless fathers and teenaged mothers to so-called feral kids, the media seems to take a voyeuristic pleasure in documenting the lives of the “underclass”. Whether they are inclined to condemn or sympathise, commentators regularly ask how society got to be this way. There is seldom agreement, but one explanation you are unlikely to hear is that this kind of “delinquent” behaviour is a sensible response to the circumstances of a life constrained by poverty. Yet that is exactly what some evolutionary biologists are now proposing.

There is no reason to view the poor as stupid or in any way different from anyone else, says Daniel Nettle of the University of Newcastle in the UK. All of us are simply human beings, making the best of the hand life has dealt us. If we understand this, it won't just change the way we view the lives of the poorest in society, it will also show how misguided many current efforts to tackle society's problems are – and it will suggest better solutions.

Evolutionary theory predicts that if you are a mammal growing up in a harsh, unpredictable environment where you are susceptible to disease and might die young, then you should follow a “fast” reproductive strategy – grow up quickly, and have offspring early and close together so you can ensure leaving some viable progeny before you become ill or die. For a range of animal species there is evidence that this does happen. Now research suggests that humans are no exception.

Certainly the theory holds up in comparisons between people in rich and poor countries. Bobbi Low and her colleagues at the University of Michigan at Ann Arbor compared information from nations across the world to see if the age at which women have children changes according to their life expectancy (*Cross-Cultural Research*, vol 42, p 201). “We found that the human data fit the general mammalian pattern,” says Low. “The shorter life expectancy was, the earlier women had their first child.”

But can the same biological principles explain the difference in behaviour between



Could many of the problems in modern societies actually be evolved strategies to deal with dire circumstances? Mairi Macleod investigates



When life expectancy is short, it makes sense to have babies early

rich and poor within a developed, post-industrialised country? Nettle, for one, believes it can. In a study of over 8000 families, he found that in the most deprived parts of England people can barely expect 50 years of healthy life, nearly two decades less than in affluent areas. And sure enough, women from poor neighbourhoods are likely to have their babies at an early age and in quick succession. They have smaller babies and they breastfeed less, both of which make it easier to get pregnant again sooner (*Behavioral Ecology*, DOI: 10.1093/beheco/arp202).

"If you've only got two-thirds as much time in your life as someone in a different neighbourhood, then all of your decisions about when to start having babies, when to become a grandparent and so on have to be foreshortened by a third," says Nettle. "So it shouldn't really surprise us that women in the poorest areas are having their babies at around 20 compared to 30 in the richest ones. That's exactly what you would expect."

Consciously or subconsciously, women do seem to take their future prospects into account when deciding when to start having children. At a meeting last year, Sarah Johns at the University of Kent in Canterbury, UK, reported that in her study of young women from a range of socioeconomic backgrounds in Gloucestershire, UK, those who perceived their environment as risky or dangerous, and those that thought they might die at a relatively young age, were more likely to become mothers while they were in their teens. "If your dad died of a heart attack at 45, your 40-year-old mum has got chronic diabetes and you've had one boyfriend who has been stabbed, you know you've got to get on with it," she says.

It's the same story in the US. The latest figures, from 2005, reveal that teenage motherhood accounts for 34 per cent of first births among African Americans – who are more likely to live in deprived areas – and 19 per cent among whites. Arline Geronimus of the University of Michigan at Ann Arbor, who has studied health inequalities and



"In the most deprived parts of England, people can barely expect 50 years of healthy life – two decades less than in affluent areas"



BELOW: "THE CHILD" LES FILMS DU FLEUVE/ARTE FRANCE CINEMA/CANAL+/EURIMAGES/LOTTERIE NATIONALE DE BELGIQUE/CNC/RONALD GRANT ROBIN NELSON/ZUMA

"No amount of money poured into sex education and parenting classes will change the situation if young people don't see a decent future for themselves"

reproductive patterns, points out that healthy life expectancy is short for African Americans and women depend on extended family networks for support. This means it is in their interests to have children while they still have relatives in good physical shape to help out.

The shockingly rapid deterioration in health experienced by women in poor black neighbourhoods also directly affects mothers. Even women in their 20s have an increased risk of conditions such as hypertension that would reduce the chance of a healthy pregnancy and birth. In research carried out in the late 1990s, Geronimus and her colleagues found that in Harlem, a poor neighbourhood in New York City, the infant mortality rate for babies born to mothers in their 20s was twice that of the babies of teenage mums (*Political Science Quarterly*, vol 112, p 405). Geronimus thinks the situation may be even worse now, given that the rate of health deterioration in black women has increased in the past decade.

It is not simply a case of teenage girls from deprived backgrounds accidentally becoming pregnant. Evidence from many sources suggests that teen pregnancy rates are similar in poor and affluent communities. However, motherhood is a choice, as both Geronimus and Johns are keen to point out. Teenage girls from affluent backgrounds are more likely to have abortions than their less-privileged peers. In terms of reproduction, the more affluent girls are best off concentrating on their own career and development so that they can invest more in the children they have at a later stage. "It seems that girls are assessing their life chances on a number of fronts and making conscious decisions about reproduction," says Johns.

Another important issue is whether or not a girl's father is around when they are growing up. Developmental psychologist Bruce Ellis, of the University of Arizona in Tucson, has studied extensively the effects of girls' relationships with their fathers. His research shows that the less involved a father is with his daughter from an early age, and the less warm the relationship, the earlier she starts having sex and, potentially, babies (*New Scientist*, 14 February 2007, p 38).

Fathers in deprived neighbourhoods are more likely to be absent, which could be because they are following "fast" strategies of their own. These include risky activities designed to increase their wealth, prestige and dominance, allowing them to compete more successfully with other men for sexual

opportunities. These needn't necessarily be antisocial, but often they are. "I'm thinking about crime here, I'm thinking about gambling," says Nettle, and other risky or violent behaviours that we know are typical of men in rough environments. A fast strategy also means a father is less likely to stick with one woman for the long term, reducing his involvement with his children.

Paternal benefits

That is unfortunate, since a father's involvement not only delays his daughter's reproduction but also has a big impact generally on the life chances of his children. In a study of 17,000 people in the UK born in a single week in March 1958, Nettle found that where father involvement was greater, children had higher IQ scores at age 11 and increased upward social mobility through adulthood (*Evolution and Human Behavior*, vol 29, p 416).

Lower investment in children, whether it be through the absence of dad, less breastfeeding from mum, or less parental attention generally because there are more children in the family, comes at a high cost to the children themselves. For one thing, Nettle's large-scale study of families in England found that babies born

in the poorest areas have slower cognitive development, which compromises their education and prospects later in life.

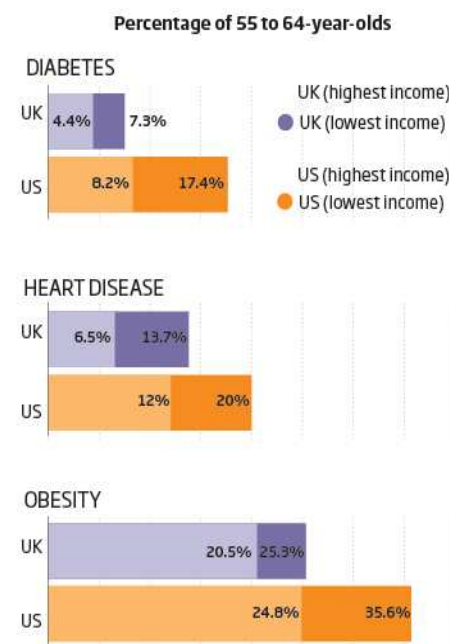
To all this you might ask the question, aren't poor people bringing their problems on themselves? If only they would wait a while before starting to have babies they might be able to invest more in each one, providing a better diet and healthier lifestyle. It is not so simple. "Children of low income, low education families don't do well regardless of what their parents' age is," says Johns. What's more, youngsters who delay parenthood may actually be worse off. "In a US study looking at pairs of low-income sisters, the ones that became mothers in their teens quite often did better [in terms of employment and earnings] because they had something to focus their energy into and create a better life for."

Nettle agrees: "Overwhelmingly the poverty into which a baby is born is going to be a big influence, whatever the age of the mother. It may be that there's not much pay-off for waiting and doing other, more middle-class behaviours that public health people want to encourage the poor to do."

People in deprived areas face two kinds of hazard, Nettle says. First, there are constraints on what they are able to do to mitigate their situation. Diet is a prime example: "It's much more expensive to get 2000 calories a day from fresh fruit and vegetables compared with eating junk food," Nettle says. Then the environment is often physically more dangerous and unhealthy. "People are doing more dangerous jobs. There is probably more air pollution, more car accidents, a higher crime rate, poorer

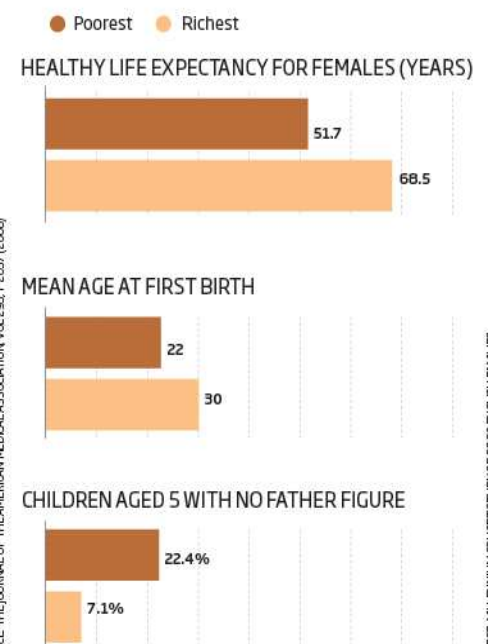
In sickness and in wealth

The poorest people in society suffer higher rates of major diseases than the richest



Living in the moment

Teenaged mothers and absent fathers may be evolution's answer to a shorter life expectancy



SOURCE: THE JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION VOL 295, P 2107 (2006)

SOURCE: MILLENNIUM COHORT STUDY OF 8650 ENGLISH FAMILIES

Young men without prospects are more likely to behave badly



housing – things you cannot really do much about, which trigger a downward spiral of faster living and less attention to health.”

Once you are in a situation where the expected healthy lifetime is short whatever you do, then there is less incentive to look after yourself. Investing a lot in your health in a bad environment is like spending a fortune on maintaining a car in a place where most cars get stolen anyway, says Nettle. It makes more sense to live in the moment and put your energies into reproduction now.

Evolutionary theory can explain these behavioural responses to poverty, but it doesn't make them desirable. So what is the answer? What can be done to help people escape from the slippery slope of poor health, poor education and deprivation?

Governments are very good at being concerned about rates of teenage pregnancy and violence among young men, but Nettle argues that no amount of money poured into sex education and parenting classes will change the situation if young people don't see a decent future for themselves. To change behaviour we have to change the environment, which means that actually reducing poverty in the most deprived areas is likely to do a much better job than education schemes or handing out morning-after pills.

Perhaps the most compelling evidence for this comes from real-life situations. In the mid-1990s, the residents of one poor, mainly Native American district in North Carolina each received a windfall in the form of royalties from a casino that had been built on their land. After the windfall, the researchers recorded a significant reduction in conduct

disorder – the psychologist's term for antisocial behaviour – among the poorest children (*The Journal of the American Medical Association*, vol 290, p 2023).

On a larger scale, during the 1990s there was a dramatic decline in teenage birth rates in the US, especially among African Americans. In 1993, 6.4 per cent of black girls aged between 15 and 17 became first-time mothers but by 2000 this had dropped to 4.5 per cent (*Social Science and Medicine*, vol 63, p 1531). Geronimus puts this down in part to the strong economic expansion and increase in employment rates during this time, which offered young black women job opportunities they were unlikely to have had before. Teen births among African Americans are now rising again, predictably, given the recent economic nosedive.

It's all relative

Still, reducing poverty alone probably isn't the answer. In their book *The Spirit Level* (Allen Lane, 2009), epidemiologists Richard Wilkinson and Kate Pickett, of the universities of Nottingham and York, UK, respectively, emphasise the degree of income inequality in a society rather than poverty per se as being a major factor in issues such as death and disease rates, teenage motherhood and levels of violence. They show that nations such as the US and UK, which have the greatest inequality in income levels of all developed nations, also have the lowest life expectancy among those nations, the highest levels of teenage motherhood (see diagrams, left) and a range of social problems.

The effects are felt right across society, not just among poor people. “Inequality seems

to change the quality of social relations in society,” says Wilkinson, “and people become more influenced by status competition.” Anxiety about status leads to high levels of stress, which in turn leads to health problems, he says. In unequal societies trust drops away, community life weakens and society becomes more punitive because of fear up and down the social hierarchy.

“Really dealing with economic inequalities is difficult because it involves unpopular things like raising tax,” says Nettle. “So rather than fighting the fire, people have been trying to disperse the smoke.” Politically it is much easier to pump money into education programmes even if the evidence suggests that these are, on the whole, pretty ineffective at reducing the effects of poverty.

There are two quite different ways that societies can be made more equal, Wilkinson says. Some countries, like Sweden, do it by redistribution, with high taxes and welfare benefits. In others, earnings are less unequal in the first place. Japan is one such country, and it has one of the highest average life expectancies and lowest levels of social problems among developed nations. Other important factors, says Wilkinson, are strong unions and economic democracy.

The bottom line, if young people are to avoid being channelled into a fast reproductive strategy with the disadvantages that this entails, is that they should have the chance to develop a longer view – through better availability of jobs and health support. They need reasons to believe they have a stake in the future. ■

Mairi Macleod is a journalist based in Edinburgh, UK

The killer that won't go away

Malaria changed the course of history, as this book reminds us. We mustn't let that happen today

The Fever: How malaria has ruled humankind for 500,000 years by Sonia Shah, Sarah Crichton Books, \$26
Reviewed by Martin de Smet



FIFTEEN years ago when, as a doctor, I treated people in Rwanda, we relied on presumptive diagnosis – anyone with a fever was treated for malaria.

A great deal of progress has been made since then on the complex issues of diagnosing malaria, drug resistance and access to care. Nonetheless, in this raw and vivid account, Sonia Shah gives an alarmingly accurate picture of how basic practices like presumptive diagnosis still

endure. In too many countries malaria is viewed with little more seriousness than the common cold, not as a public health crisis that kills close to a million people each year.

Malaria has been around for centuries, and Shah presents a fascinating history of how it played a major role in significant historical turning points, from the collapse of the Roman Empire to the Vietnam war, when the disease sometimes put more soldiers out of action than the enemy did. Shah's lucid account of how malaria spreads will give non-experts a fascinating glimpse into parasite biology and what drug resistance means in practice.

Sadly, nearly all the challenges that malaria posed in the past are still recognisable today. Malaria

leads to poverty and poverty leads to malaria. The logical conclusion, that malaria treatment should be free, is still absent in many countries where the disease is endemic.

Shah examines the resistance to insecticides and antimalarial drugs that continues to impede progress, including today's horrific situation in which resistance is emerging to the most powerful weapon we have – artemisinin combination therapies. As Shah explains, treatment based on combination therapies can avoid a rapid surge in drug resistance, yet their efficacy is being threatened by profit-driven sales of artemisinin on its own,

Sierra Leone's children are especially vulnerable to malaria

and by substandard drugs.

We do, however, have a number of other resources at our disposal, including insecticide-treated bed nets that retain their efficacy after 30 to 40 washes, and rapid diagnostic kits that remove the need for presumptive diagnosis. What is needed is to raise awareness in regions where

"Resistance is emerging to the most powerful weapon we have - artemisinin combination therapies"

malaria is endemic, rather than simply assuming that people will sleep under a bed net because it is dropped on their doorstep.

Critically, *The Fever* exposes the growing threat posed by donors who want to see immediate results. The issue is all too familiar to field workers, who see aid flooding into countries where success is more or less guaranteed, but poor investment in chaotic post-conflict countries where the burden of the disease is often heaviest.

Everyone – politicians, donors, research institutes, lobby groups and the pharmaceutical industry – has their own agenda when it comes to malaria. Shah's examination explores them all.

The Fever is a mine of information, drawing on diverse accounts from medical experts and field workers. This is an important book on the historical lessons we must not forget and the mistakes we are still making today in the battle against what remains a formidable killer. ■

Martin de Smet is the leader of the malaria working group at Médecins Sans Frontières



WILLIAM DANIELS/PANOS

Inside the mind of a suicide bomber

Certain personality types are more likely to become martyrs, Ariel Merari tells Michael Bond



AMMAR AWAD/REUTERS

It has been thought that suicide terrorists are not psychologically different from other terrorists, but your latest research on Palestinian would-be bombers who failed to blow themselves up suggests otherwise. What did you find? They seem to have certain personality characteristics that make them more likely to be recruited to or to volunteer for suicide-bombing missions. None of the 15 would-be suicide bombers we interviewed suffered from a psychosis, but they had one of two personality types. Two-thirds were dependent-avoidant:

such people find it hard to say no to authority figures and are more likely to cooperate to carry out tasks against their own judgement. They are also greatly influenced by public opinion. The rest were impulsive and emotionally unstable. These types are likely to volunteer, but in many cases their enthusiasm will not last long enough for them to see it through.

Were they militantly ideological?

None were any more militant than the average Palestinian. For many, the suicide mission was their first involvement in

Posters proclaim 18-year-old suicide bomber Sami Salim Hamad as a martyr

terrorism. Ideological motivation was not what made them suicide bombers. Two-thirds hesitated somewhere along the line, though this was caused by fear of death and worry about their families.

How are they able to see the operation through to the end?

Some of them apparently enter a psychological state known as a dissociation, in which they shut themselves off to disturbing thoughts. One bomber, who tried to blow himself up on a bus, told us he was afraid from the moment he was recruited, and that his fear grew as the operation drew near. But he says he does not remember anything from the moment he stepped onto the bus. I believe him. We know what happened from the passengers. He walked to the middle of the bus and tried to activate the explosive charge but it didn't work. He pressed it again and again. People were all over him, he was kicking and fighting and shouting. But he remembers nothing. He had shut himself off because he was in a terrible conflict.

You also interviewed 14 organisers of suicide attacks, all of them senior commanders of Palestinian militant groups. How does their psychology compare?

Their psychology is very different. They are not dependent – they are manipulative. They are much more intelligent than the bombers and are also older – 27 on average in our study, compared with 19 for the bombers. Some had university education. They

were not psychopathic. They were very pragmatic, they believed they were doing it for their nation and that it was the right thing to do. They did not express any moral doubts about it.

How did you feel talking to them?

The would-be bombers did not look how you would imagine typical murderers. They looked like pitiable young boys. There is no air of malice around them. In interviews they were usually kind and polite. I saw them as people who were manipulated.

With the organisers it was different. I knew these were the people who sent youngsters to kill innocent civilians, though I could still relate to them as human beings. In a way I was dissociated from them. If you want to really understand what motivates people, you cannot be judgemental when you talk to them. I could not think about the terrible human aspect of what they did. ■



PROFILE

Ariel Merari is retired professor of psychology at Tel Aviv University in Israel. His latest book, *Driven to Death: Psychological and social aspects of suicide terrorism*, is published by Oxford University Press

Elusive stuff

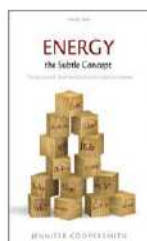
The concept of energy is explained through this intriguing history of its discovery



THEO ALLOES/CORBIS

Energy, the Subtle Concept: The discovery of Feynman's blocks from Leibniz to Einstein by Jennifer Coopersmith, Oxford University Press, £29.95

Reviewed by Manjit Kumar



MOST of us have a vague idea of what energy is, if only because we have to pay for it. We know that it is the *E* in Einstein's famous equation, $E=mc^2$,

and all of us have an opinion about the pros and cons of nuclear energy. For William Blake's devil in *The Marriage of Heaven and Hell*, energy was "eternal delight", yet Newton never fully appreciated the importance of a concept that was rarely used until the 19th century.

So, what is energy? Easy to ask the question but, as Jennifer Coopersmith shows in *Energy, the Subtle Concept*, finding the answer was a messy and tangled affair,

involving plenty of argument and controversy. It's a tale of persecuted genius, of royal patronage, of social climbers and dreamers, of rich men and poor men, a founding, entrepreneurs and industrialists, lawyers, engineers, a taxman, a spy and a brewer. Some were showered with honours, others neglected until long after death.

The concept of energy is hard to grasp because it is something that cannot be directly observed. It was only in the early 19th century that it was even recognised as a distinct physical quantity. Since then it has played a vital role in the development of science and technology. Its importance lies in the fact that it possesses the very rare property of being preserved. Energy cannot be created or destroyed; it can only be converted from one form to another. So fundamental is this property to nature that it is enshrined, in more sober scientific terms, as the first

law of thermodynamics.

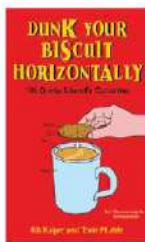
The first step on the long road to understanding the true nature of this relationship had been taken in the 1800s by Benjamin Thompson, an Anglo-American physicist, inventor and soldier of fortune. While supervising the boring of new cannons Thompson realised that heat might be a form of motion rather than a special weightless substance called "caloric". Most remained unconvinced, largely because Thompson was a notorious opportunist and spy. The turning point came in the form of experiments performed, in the 1840s, by English brewer and amateur scientist James Prescott Joule, who introduced the term thermodynamics.

The conservation of energy is arguably the most important law in physics. But what exactly is being conserved? Are some forms of energy more fundamental than others? You will have to read the book to find out. Coopersmith sets out to answer such questions and to explain the concept of energy through the history of its discovery. This is neither a straightforward narrative nor one for the faint-hearted. Those not put off by the odd bit of mathematics, will be well-rewarded by dipping into this book.

Wacky findings

Dunk Your Biscuit Horizontally: 106 strange scientific facts by Rik Kuiper and Tonie Mudde, Summersdale, £7.99

Reviewed by Bill Parry



SOME books were never written for the shelves of bookshops, but rather to adorn counter space by the cash registers of card shops for those looking to find something more substantial – quirky but witty, and occasionally enlightening. This quick read fulfils that role very well.

The authors have trawled through decades of published research, from arcane theses to papers in top scientific journals, to bring us a smattering of the fairly obvious to the curiously intriguing and amusing.

An article from the near-aply named *Annals of Emergency Medicine* describes how a rectal massage has proved the only cure for persistent hiccups. Another prescribes slicing pizza on the toilet seat cover rather than your cutting board if you're concerned about nasty bacteria. And 104 more.

A digestible compendium of amusing facts, definitely.

Meltdown

The Flooded Earth: Our Future in a World without Ice Caps by Peter D. Ward, Basic Books, £15.99

Reviewed by Jon Turney



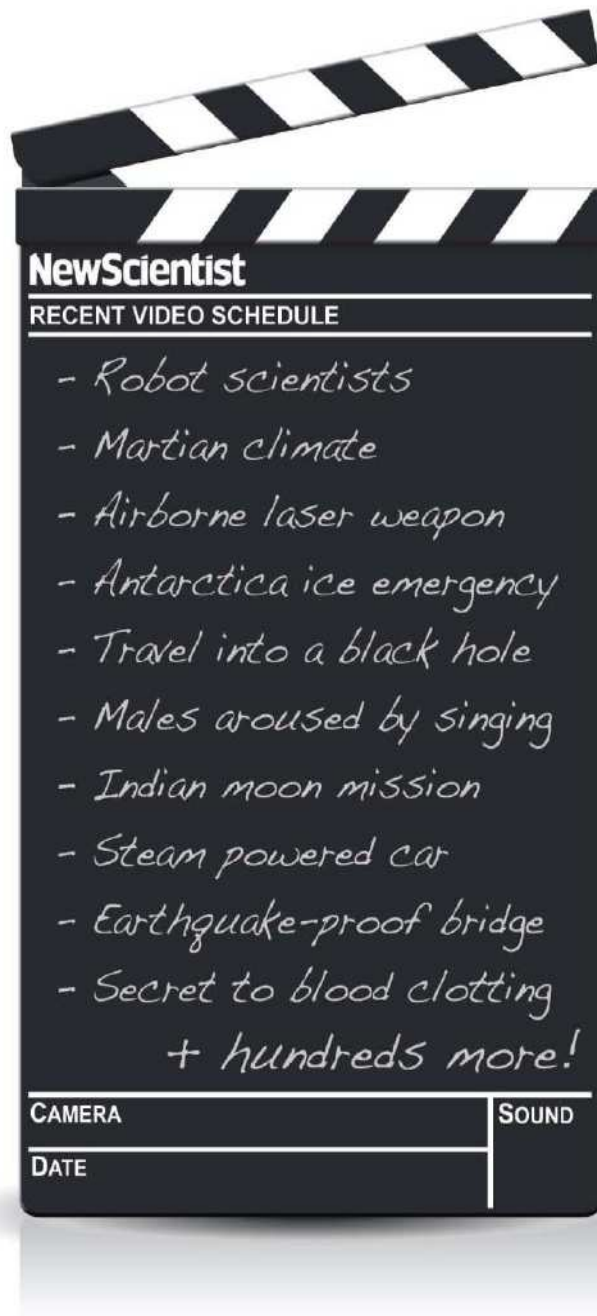
AS THE Earth warms, so its surface ice melts into the sea: true in the past, and true in the future. How far, and how fast, the melting goes

will affect millions who live in low-lying cities or rely on crops from coastal plains.

Peter Ward, prolific writer on Earth history, is a sure-footed guide to the state of play. He relates how projections of this century's sea-level rise are going up, but still nowhere near the 60-metre leap that would follow if the Greenland and Antarctic ice sheets go. And he highlights geological evidence which suggests the sheets could melt faster than the centuries or millennia often assumed.

The science is leavened by glimpses from his own travels – of bleached corals and the new sea defences of countries such as Belgium. In the end, uncertainty remains, but he convinces us that it would be foolhardy to risk a global meltdown.

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Fax 415 543 6789

BIOLOGY

Americas Commercial Finance Lead (001SH)

Monsanto
CA - California
Americas Commercial Finance Lead for Oxnard, CA agricultural/biotechnology company to oversee financial planning/analysis for Americas region's vegetable seeds business; lead analyst & credit teams; provide financial support for product management & sales/marketing decisions

For more information visit
NewScientistJobs.com Job ID:
1400844796

Bean Breeder - (Vegetables Division) (001MJ)

Monsanto
ID - Idaho
Monsanto is seeking a highly motivated individual to become an integral member of a multidisciplinary, bean breeding team. This is a superb opportunity to manage a breeding program in collaboration with a multidisciplinary global research team to obtain successful new products.

For more information visit
NewScientistJobs.com Job ID:
1400846301

Key Account Manager - Nebraska East (001RI)

Monsanto
NE - Nebraska
We currently have an opportunity for a Key Account Manager to support strategic national affiliated accounts. In this position, you will be responsible for developing significant working relationships with multiple management units such as general managers, CEO's, Crops managers, Seed and Chemical Managers as well as Regional and Key location Managers.

For more information visit
NewScientistJobs.com Job ID:
1400850175

Lab Analyst (001T3)

Monsanto
IA - Iowa
Monsanto Company is a leading global provider of technology-based solutions and agricultural products that improve farm productivity and food quality. Our Muscatine, IA plant, a leading producer of Roundup, is seeking qualified individuals for laboratory analyst positions.

For more information visit
NewScientistJobs.com Job ID:
1400850723

Line Development Breeder (001MT)

Monsanto
NE - Nebraska
The breeder's primary responsibility is to conduct a corn inbred line development breeding program utilizing the latest in breeding technologies to develop superior corn products for irrigated and dryland markets in the western Corn Belt.

For more information visit
NewScientistJobs.com Job ID:
1400845042

Molecular Breeder - Cotton (001E7)

Monsanto
MO - Missouri
The Molecular Breeder is responsible for the discovering and implementation of high throughput DNA markers in cotton with a focus on agronomic traits such as yield, fiber quality and disease tolerance as appropriate.

For more information visit
NewScientistJobs.com Job ID:
1400850189

Operations Clerk (Vegetables Division) (001N7)

Monsanto
ID - Idaho
We currently have an opportunity available in Nampa, ID for an Inventory/Receiving Clerk within our Vegetables Division at Monsanto. The Inventory Clerk position is

responsible for providing accurate and timely data entry on all crops received at site facility.

For more information visit
NewScientistJobs.com Job ID:
1400853017

Research Assistant - Trait Integration (001EX)

Monsanto
IL - Illinois
In this role you will in the daily operations associated with a comprehensive Trait Integration corn breeding program consisting of field operations and equipment operation for planting, harvesting, and seed processing.

For more information visit
NewScientistJobs.com Job ID:
1400841279

Research Assistant - Woodland, CA (001JY)

Monsanto
CA - California
The Field Research Assistant will assist in all phases of a comprehensive breeding and testing program aimed at germplasm development and the introgression of new traits into elite cultivars.

For more information visit
NewScientistJobs.com Job ID:
1400850178

Seed Technician I (001T7)

Monsanto
IA - Iowa
We currently have an opening for a Seed Technician position. Seed Technicians are involved in all facets of seed production within a location. This may include crop production, harvest, conditioning, maintenance, packaging, or warehousing.

For more information visit
NewScientistJobs.com Job ID:
1400853859

Associate Research Scientist

Pfizer US
NY - New York
Monitors complements, human

serum controls and clinical samples (workboxes) used for the SBA throughput tests, organize the throughput freezer to secure all clinical workboxes and samples are in the signed places all the time and continue to update the freezer's contents weekly.

For more information visit
NewScientistJobs.com Job ID:
1400849771

Bioinformatics Post-Doc

Roche
NJ - New Jersey
The laboratory of Dr. Dennis Vitkup (Columbia University, Center for Computational Biology and Bioinformatics) and Roche Pharmaceuticals In Silico Sciences group are jointly seeking to fill an exciting Postdoctoral Research Scientist position.

For more information visit
NewScientistJobs.com Job ID:
1400853966

Biomarker Bioanalytical Senior Principal Scientist (R6-R8) - Flow Cytometry

Pfizer US
CT - Connecticut
The successful candidate will have experience developing partnerships in a matrix environment, influencing project strategies, and leadership in technology development and implementation.

For more information visit
NewScientistJobs.com Job ID:
1400859433

Biotech Affairs & Regulatory Lead

Pioneer Hi-Bred Production LP
IA - Iowa
The Biotech Affairs and Regulatory (BA&R) Lead will have sole authority and accountability to develop, own, deploy and maintain the global BA&R strategy for assigned traits and/or products.

For more information visit
NewScientistJobs.com Job ID:
1400857740

Clinical Statistical Programmer - CPW (D3-Manager / D4-Associate Director)

Pfizer US
CT - Connecticut

Role is primarily responsible for the project management of statistical programming activities in the Clinical Programming & Writing (CPW) group. SAS programming is a core skill, but main focus of the position is oversight of external providers performing programming.

For more information visit
NewScientistJobs.com Job ID:
1400845052

Director / Sr. Director of Medical Genetics, Rare Diseases Research Unit

Pfizer US
MA - Massachusetts

This Research Unit will focus on developing pharmacologic assets for diseases which are both orphan per the FDA, and have a known genetic basis as their respective etiologies.

For more information visit
NewScientistJobs.com Job ID:
1400853127

FULL PROFESSOR in BIOLOGICAL INORGANIC CHEMISTRY

University of Toronto
ON - Ontario

The successful candidate will also have demonstrated a high level of excellence in teaching at both the undergraduate and graduate levels. The position will have undergraduate and graduate teaching responsibilities in inorganic chemistry.

For more information visit
NewScientistJobs.com Job ID:
1400846446

GENERAL CHEMISTRY - TENURE TRACK POSITION

California Polytechnic State University, San Luis Obispo
CA - California

Teaching assignments will primarily be in general chemistry for majors and non majors as well as occasional assignments in advanced courses. The successful candidate will be expected to play a central role

in coordination and pedagogy development for our extensive general chemistry offerings.

For more information visit
NewScientistJobs.com Job ID:
1400850613

Manager - Energy Nanomaterials Organization

Sandia National Laboratories,
California

CA - California

We are a world-class team of scientists, engineers, technologists, post docs, and visiting researchers all focused on cutting-edge technology, ranging from homeland defense, global security, biotechnology, and environmental preservation to energy and combustion research, computer security, and nuclear defense.

For more information visit
NewScientistJobs.com Job ID:
1400852378

Manager of ABSL-3 Laboratory - Memphis, TN - Medical Research

St. Jude Children's Research Hospital
TN - Tennessee

The Manager of ABSL-3 Laboratory serves as a specialist in laboratory animal management and animal bio-safety that supports the institutions select agent registration.

For more information visit
NewScientistJobs.com Job ID:
1400843059

Manager, Global CMC, Biologics

Pfizer US

MA - Massachusetts

The individual will provide input and expertise in the development and execution of Global Regulatory CMC strategies for lifecycle management of commercially marketed biopharmaceutical products.

For more information visit
NewScientistJobs.com Job ID:
1400851185

PDM NBE Principal Investigator (PI)

Pfizer US

MA - Massachusetts



University of Michigan

HEMATOLOGY/ONCOLOGY FACULTY POSITIONS

The Division of Hematology/Oncology of the Department of Internal Medicine and the University of Michigan Comprehensive Cancer Center invite applications for faculty positions in two areas.

The first position is for candidates with an interest in genitourinary cancer clinical research. The desired candidates should have documented expertise in the design and execution of Phase I and II clinical trials to test novel therapeutic agents targeting genitourinary cancers. The selected candidate will join an established Program in Genitourinary Oncology at the University of Michigan Comprehensive Cancer Center which includes over 30 faculty from 10 departments with annual direct funding of \$6M. The Program has a robust translational research focus in all GU cancers for which there are specific multi-disciplinary clinics and tumor boards. Other areas of research interest include characterization of GU cancer stem cells, and development of novel combined modality therapies of GU cancers involving immunotherapy, chemotherapy, and radiotherapy.

The second position has a focus on clinical research in hematopoietic cell transplantation as a treatment modality for hematologic malignancies. Candidates should have documented expertise in the evaluation and management of patients with malignant hematopoietic disorders and hematopoietic stem cell transplantation. Selected candidates will be members of an established clinical and translational research program in hematologic malignancies within the University of Michigan Comprehensive Cancer Center, which includes 34 faculty members with \$6.3M in research funding.

Applicants (who must be either U.S. citizens or permanent residents) must be board certified or eligible in internal medicine and hematology and/or medical oncology. Faculty track and rank will depend upon prior experience.

Candidates should submit a curriculum vitae, a list of three references, a concise statement of research goals, and a letter of application to Kathleen A. Cooney, MD, Chief of the Division of Hematology/Oncology, Department of Internal Medicine and Associate Director for Faculty Affairs, University of Michigan Comprehensive Cancer Center, 7216 CC, 1500 E. Medical Center Drive, Ann Arbor, MI 48109-5948; e-mail: kcooney@umich.edu

The University of Michigan is an equal opportunity/affirmative action employer and encourages nominations and applications from women and minority candidates.

Responsible for the oversight of a number of projects within an RU or BTU groups providing leadership and strategic direction to assigned projects from idea to POC.

For more information visit
NewScientistJobs.com Job ID:
1400840911

PDM Principle Investigator

Pfizer US

MA - Massachusetts

The candidate will also advance the science and strategies for prosecuting biotherapeutic projects and influence external scientific and regulatory practices through publication and other interactions.

For more information visit
NewScientistJobs.com Job ID:
1400842440

PhD Biochemist- Post Doctoral Fellow

Pfizer US

CA - California

The ideal candidate will develop screening methods that will overcome the limitation of current phage display method on peptide discovery (low affinity and poor serum stability).

For more information visit
NewScientistJobs.com Job ID:
1400845050

PhD Biologist-Post Doctoral Fellow

Pfizer US

CA - California

The individual possesses basic and molecular biology techniques and animal handling experience with a good track record of productivity in previous research. Specific expertise in immunohistochemistry is desired.

For more information visit
NewScientistJobs.com Job ID:
1400840900

PhD Cell Biologist- Post Doctoral Fellow

Pfizer US

NY - New York

The ideal candidate will design and execute experiments to understand how epigenetic modifications cancer stem cells. The individual will demonstrate a high level of initiative in interpreting data and trouble

shooting experiments.

For more information visit
NewScientistJobs.com Job ID:
1400851241

PHYSICAL POLYMER CHEMISTRY - TENURE TRACK POSITION

California Polytechnic State University, San Luis Obispo
CA - California

Primary teaching assignments will be courses in the Polymers and Coatings Program, and in other courses in applicable areas, specifically physical chemistry and possibly general chemistry.

For more information visit
NewScientistJobs.com Job ID:
1400850615

Post Doctoral Fellow - Organic Chemist

Pfizer US

MA - Massachusetts

Develop viable and scalable synthetic routes to nucleotides capable of undergoing oligomerization using ring opening metathesis. Collaborate with computational chemists to design optimal model oligonucleotides for duplexing with natural RNA.

For more information visit
NewScientistJobs.com Job ID:
1400843813

Post Doctoral Fellow - Protein Engineering

Pfizer US

CA - California

At Rinat, we are dedicated to developing new protein-based therapeutics to improve human life. We use the latest scientific knowledge and apply novel approaches to discover new ways of treating disease.

For more information visit
NewScientistJobs.com Job ID:
1400842520

Post Doctoral Fellow, Therapeutic Protein Immunogenicity

Pfizer US

CA - California

The ideal candidate for this position needs to be able to: perform literature searches;

rapidly and efficiently implement computational models of biological systems and evaluate them against data; design, analyze and interpret experiments in order to prepare internal and external presentations and peer-reviewed publications.

For more information visit
NewScientistJobs.com Job ID:
1400845049

POSTDOCTORAL FELLOW

Barrow Neurological Institute

AZ - Arizona

Successful candidates will have skill sets in molecular biology, histopathology, biochemistry, tissue culture assays, and mouse models to characterize stem and progenitor cells.

For more information visit
NewScientistJobs.com Job ID:
1400846498

Postdoctoral Fellow - Protein Solution Biophysics

Pfizer US

MO - Missouri

The Pharmaceutical Research & Development (PhRD) at Pfizer Biotherapeutic R&D in St. Louis, MO has an opening for a highly motivated Postdoctoral Fellow to work on protein stability & aggregation aspect related to therapeutic protein development.

For more information visit
NewScientistJobs.com Job ID:
1400849718

Postdoctoral Position in Tissue Repair

Pfizer US

MA - Massachusetts

Develop complex model systems to identify and characterize novel pathways that regulate tissue repair/regeneration; Explore the roles of microRNAs in the regulation of cell differentiation and metabolism in connective tissues

For more information visit
NewScientistJobs.com Job ID:
1400840930

Postdoctoral researcher positions

The Ohio State University,
Center for RNA Biology
OH - Ohio

Postdoctoral researcher positions - The Ohio State University Center for RNA Biology Several NIH-funded postdoctoral positions are available in the Schoenberg lab to study fundamental aspects of mRNA metabolism and translational control.

For more information visit
NewScientistJobs.com Job ID:
1400843275

Principal Scientist - Biomedical Informatics

Roche

NJ - New Jersey

The Disease and Translational Informatics Department at Roche Pharmaceuticals in Nutley, NJ is seeking a biomedical informatics scientist who will be part of a group in building intelligent scientific systems integrating various genomics and text data in the research and early development environment.

For more information visit
NewScientistJobs.com Job ID:
1400843279

Protein Formulation Scientist

Pfizer US

MI - Michigan

The position will involve the use of innovative and modern techniques to develop and characterize viable dosage forms of candidate molecules. The position will also design and conduct studies required for CMC regulatory documents.

For more information visit
NewScientistJobs.com Job ID:
1400842456

Research Assistant

Pioneer Hi-Bred Production LP
HI - Hawaii

Assists with tasks including, but not limited to planting, weeding, pollinating, and harvesting by following standard operation procedures. Makes detailed observations and records data.

For more information visit
NewScientistJobs.com Job ID:
1400850705

Research Associate - Kansas State University - Cancer



Faculty Position

University of Pittsburgh Cancer Institute and Department of Pharmacology & Chemical Biology

Applications are invited for two tenured faculty positions at the level of full Professor at the University of Pittsburgh Cancer Institute (UPCI). Candidates who have a Ph.D., M.D. or equivalent graduate degree are being recruited to expand expertise in women's malignancies at UPCI. The incumbents will have primary appointment in the Department of Pharmacology & Chemical Biology, University of Pittsburgh School of Medicine (UPSOM).

The UPCI has consistently been among the top NCI-funded and NCI-designated Comprehensive Cancer Centers located within the academic environment of the University of Pittsburgh and University of Pittsburgh Medical Center and has an active and highly interactive community of basic, translational and clinical research scientists. The institution has several state-of-the-art facilities with varied capabilities including cell and tissue imaging, high-throughput drug discovery and a cancer biomarkers facility with mass spectrometry, genomics and proteomics platforms.

The UPCI is executing an exciting plan for the development of a women's cancer program and envisions expansion of its capabilities to translate research findings to clinical applications with integration of basic research, clinical investigation, and patient care missions of the UPCI. We are interested in the recruitment of candidates with a strong interest in translational breast cancer research, particularly as it applies to mechanisms of hormone action, therapeutic resistance, growth factor action and its implication for therapeutic application. Understanding and expertise in molecular and cell biology, breast cancer cell lines, breast genetics and animal models will be an advantage. In order to develop an outstanding, extramurally-supported research program, the applicants must have excellent communication skills, publications in high-impact journals and a proven track record of extramural funding in breast cancer research.

The incumbent will have the opportunity to mentor graduate students through the Department of Pharmacology and Chemical Biology and UPSOM Integrated Biomedical Graduate Program and will have progressive involvement in the teaching of graduate and medical students. Salary and benefits will be commensurate with experience.

Interested candidates should send curriculum vitae, brief description of research interests and contact information for three references to:

UPCI Search Committee/Pharmacology

C/O Vijaya C. Gandhi, PhD, MBA

Associate Director for Administration and Strategic Planning, UPCI

5150 Centre Avenue, Suite 532, Pittsburgh, PA 15232

Email: gandhivc@upmc.edu

The University of Pittsburgh is an Affirmative Action, Equal Opportunity Employer.

Research

Kansas State University,
Biochemistry Department
KS - Kansas

Research Associate position is available at Kansas State University to study the role of ADAM proteases in breast cancer. The successful candidate will be a highly motivated, enthusiastic researcher, with excellent oral/written communication skills.

For more information visit
NewScientistJobs.com Job ID:
1400841631

Research Associate- Microbiologist

Reckitt Benckiser
NJ - New Jersey
Conduct required tests (e.g. AOAC, ASTM, CEN) to evaluate the antimicrobial efficacy of disinfectant and personal care products for the purpose of product registration. Perform appropriate practices and procedures and maintain laboratory records in compliance with Good Laboratory Practice standards.
For more information visit

NewScientistJobs.com Job ID:
1400850406

Research Scientist II / Technology Engineer III

Pfizer US
MA - Massachusetts
The Manufacturing Sciences and Technology group of Pfizer Biomanufacturing Sciences Group is looking for a highly motivated, versatile process development scientist or engineer to help develop and characterize late stage or second generation microbial fermentation and/or cell culture processes.

For more information visit
NewScientistJobs.com Job ID:
1400849798

Research Worker

Pioneer Hi-Bred Production LP
IA - Iowa
The Pioneer Insectary is in need of a temporary employee to help with everyday tasks and sanitation processes. This individual will be in close contact with beetles, moths,



UNIVERSITY OF
TORONTO
SCARBOROUGH

FULL PROFESSOR in BIOLOGICAL INORGANIC CHEMISTRY

The Department of Physical & Environmental Sciences at the University of Toronto Scarborough invites applications for a tenured position in the area of bioinorganic chemistry at the rank of Professor commencing January 1, 2011, subject to negotiation. The successful candidate will already hold a position at the rank of full professor at an internationally recognized university and have a strong, externally funded research program in the area of biological inorganic chemistry. The successful candidate will also have demonstrated a high level of excellence in teaching at both the undergraduate and graduate levels. The position will have undergraduate and graduate teaching responsibilities in inorganic chemistry. The successful candidate will also be appointed to U of T's Graduate Department of Chemistry.

We are particularly interested in applicants with interdisciplinary research interests that complement and enhance the existing strengths in the Department in the areas of biological chemistry and environmental science.

Information about the Department can be found at:

<http://www.uts.utoronto.ca/~physsci/>

The Department is at an exciting stage in its history. New space and funding growth is making it possible for unprecedented growth in faculty complement and program initiatives. The department has a newly established, state-of-the-art instrument facility, houses the Environmental NMR Centre and offers the opportunity for research collaboration with faculty in the physical, environmental, biological and medical sciences. The successful candidate will work with our existing faculty to reshape and strengthen our growing undergraduate programs in chemistry, and to continue to grow their own creative, high-impact research program based on external funding. Salary will be commensurate with qualifications and experience.

Applications will be accepted until **September 15, 2010**. Applicants should refer to the department's website for details about the application process.

The University of Toronto is strongly committed to diversity within its community and especially welcomes applications from visible minority group members, women, aboriginal persons, persons with disabilities, members of sexual minority groups, and others who may contribute to the further diversification of ideas. All qualified candidates are encouraged to apply; however, Canadians and permanent residents of Canada will be given priority.

and larvae and will need to be comfortable around large quantities of insects.

For more information visit
NewScientistJobs.com Job ID:
1400846454

Scientific Associate II / Scientist I

Novartis Institutes for BioMedical Research (US)
 CA - California

This individual must be proficient in mammalian cell culture and recombinant DNA techniques. Additionally, the successful candidate will be able to design and execute studies that reveal the effects of our therapeutic leads on multiple cellular properties (including cell proliferation and apoptosis, signal transduction, cell cycle progression, migration and invasion).

For more information visit
NewScientistJobs.com Job ID:
1400860381

Senior Bioinformatics Support Consultant

Pioneer Hi-Bred Production LP
 IA - Iowa

The successful candidate will be responsible for providing proactive bioinformatics support, scientific consultation, data analysis capabilities, and application support to sequencing lab PIs and researchers actively engaged in utilizing Next Generation Sequencing technologies.

For more information visit
NewScientistJobs.com Job ID:
1400857755

Sr Director, Clinical Research (Nutrition)

Pfizer US
 PA - Pennsylvania

We are looking for expertise and talent wishing to contribute to dynamic, science-based department. -Develop and execute a portfolio of clinical research studies to support nutrition products -Drive scientific research agenda studies across several nutrition related platforms and specific clinical sites

For more information visit
NewScientistJobs.com Job ID:
1400849758

Team Lead - Collections

Pfizer US
 TN - Tennessee
 Supervises a team of Credit Analysts, providing all training, development, and counsel to effectively manage their defined area of responsibility. Position reports directly to the GFS Americas Collections Manager.

For more information visit
NewScientistJobs.com Job ID:
1400851204

CHEMISTRY

Area Technology Development Manager - Iowa/Minnesota (001QF)

Monsanto
 IA - Iowa
 The Area Technology Development Manager will operate as a field team leader creating a team platform that ensures innovation for agricultural science.

For more information visit
NewScientistJobs.com Job ID:
1400850183

Technology Development Representative - Evansville, Indiana (001QD)

Monsanto
 IN - Indiana
 We currently have an opportunity for a Technology Development Representative with expertise in applied field research, and agronomic sciences to provide technical leadership and conduct field research within their assigned geography.

For more information visit
NewScientistJobs.com Job ID:
1400850179

Research Scientist I (Postdoctoral Fellow)

South Dakota School of Mines and Technology
 SD - South Dakota
 Research Scientist I (Postdoctoral Fellow) Exempt Position
 Announcement South Dakota School of Mines and Technology (SDSM&T) is seeking a Research

Scientist I (Postdoctoral Fellow) under the supervision of Professor Hao Fong in the Department of Chemistry.

For more information visit
NewScientistJobs.com Job ID:
1400853935

CLINICAL

Research Associate - Trait Integration (001SI)

Monsanto
 IA - Iowa
 Monsanto is seeking a highly motivated individual with the ability to work as a member of the Corn Trait Integration programs based in Williamsburg, IA. You will be responsible for supporting the activities of the Breeder and Testing Manager in all phases of a comprehensive trait integration process aimed at the introgression of new traits into elite corn cultivars.

For more information visit
NewScientistJobs.com Job ID:
1400844795

Research Scientist - Seed Production (001NH)

Monsanto
 MI - Michigan
 This is a unique opportunity to lead all aspects of production research to advance corn and soybean production practices by improving seed quality, reducing costs, and maximizing land productivity.

For more information visit
NewScientistJobs.com Job ID:
1400853019

Research Associate

Pioneer Hi-Bred Production LP
 HI - Hawaii
 The Waimea Research Center Associate Training Program Research Associate will be assigned to one of four areas in order to learn and support the daily operations of the assigned project.

For more information visit
NewScientistJobs.com Job ID:
1400850702

Research Scientist

Pioneer Hi-Bred Production LP
 IA - Iowa

Develop and lead a research team to develop elite soybean varieties in maturity groups III and IV. This would include building and leading a strong research team at the research center.

For more information visit
NewScientistJobs.com Job ID:
1400845054

Senior Research Associate

Pioneer Hi-Bred Production LP
 IA - Iowa
 Provide hands-on support, training, and troubleshooting of technical solutions for research clients who use DuPont and Pioneer proprietary research information management systems and IT point solutions.

For more information visit
NewScientistJobs.com Job ID:
1400841541

Tenure/Tenure-Track Position in Viral Disease Immunology

National Institute of Allergy & Infectious Diseases (NIAID), National Institute of Health (NIH)
 MT - Montana
 LV conducts high-impact, innovative scientific research on viral agents requiring high or maximum containment, including arenaviruses, bunyaviruses, filoviruses, flaviviruses, and paramyxoviruses, with the goal of developing diagnostics, vaccines, and therapeutics.

For more information visit
NewScientistJobs.com Job ID:
1400850237

ENGINEERING

Electrical Maintenance Engineer (001RN)

Monsanto
 LA - Louisiana
 Requires Bachelor's degree in Electrical Engineering. Must have demonstrated skills gained through education or employment in designing/analyzing power systems, investigating commercial lighting system characteristics, working with automatic/digital control systems, electronic devices, energy conversion & high voltage

PROFESSOR OF AEROSPACE ENGINEERING & DISCIPLINE HEAD, AEROSPACE and AVIATION

- Based in Melbourne, Australia
- Academic/Research Leadership Opportunity in Aerospace Engineering
- AUD\$151,633 plus 17% superannuation per annum

RMIT is a global university of technology based in Melbourne, with a commitment to and reputation for high quality professional and vocational education and research engaged with industry and community.

The School of Aerospace, Mechanical and Manufacturing Engineering is nationally and internationally renowned in the Aerospace and Automotive Engineering fields for its industry relevant high impact research and globally competitive graduates. It is also widely recognised for its work-relevant education programs, supreme research facilities, creative real-world project work and robust relations with local and international industry leaders.

The School is now seeking to appoint a leader with a distinguished record of academic and/or professional achievements to lead and manage the Aerospace and Aviation discipline.

Applicants must be able to demonstrate a strong ability to develop and lead the Discipline team in an inclusive manner within a collegial school environment, and to maintain and grow engagement in the Aerospace and Aviation industry sectors. The Discipline is focussed on achieving high quality research outcomes and excellent student experiences within a collaborative School environment. To be considered for this position, candidates will possess a PhD qualification in Aerospace Engineering or an associated field.

> Applications close 30th August 2010

For more information and confidential discussion

please contact the Head of School, Professor Aleksandar Subic, on

+61 3 9925 6000

To apply go to:

www.rmit.edu.au/yourcareer



engineering.

**For more information visit
NewScientistJobs.com Job ID:
1400841281**

Facilities Maintenance Manager (00156)

Monsanto
CA - California

Requires Bachelor's degree in Mechanical Engineering; 5 yrs progressive post-Bachelor's experience with ISO-9001 manufacturing facility providing mechanical design/installation, mechanical estimates/equipment specifications; reviewing/approving vendor drawings/construction bids; qualifying/maintaining equipment utilizing SAP maintenance & TQM

**For more information visit
NewScientistJobs.com Job ID:
1400842695**

Research Director

Pioneer Hi-Bred Production LP
DE - Delaware
Pioneer is seeking a Research

Leader for protein engineering and directed evolution. The group leader will be responsible for building a group with world class capabilities in protein engineering and protein evolution.

**For more information visit
NewScientistJobs.com Job ID:
1400860239**

Senior Scientist, Formulations R&D

Celgene

NJ - New Jersey

This senior scientist position is responsible for providing the scientific leadership and conducting laboratory research for formulation development of Celgene drug candidates starting from lead candidate optimization to enable preclinical and clinical studies.

**For more information visit
NewScientistJobs.com Job ID:
1400858499**

MATHS&IT

Testing Operations Manager

- Olivia, Minnesota (001SN)

Monsanto

MN - Minnesota

Monsanto is seeking a highly motivated individual with the ability to work as a member of a multidisciplinary breeding team. The Testing Operations Manager partners with the on site Breeders to support individual program needs and work priorities to ensure that they are accomplished.

**For more information visit
NewScientistJobs.com Job ID:
1400850187**

Trade and Compliance Specialist NAFTA (001JB)

Monsanto

CA - California

Oversight of all import and export compliance procedures and practices associated with the Monsanto Vegetable North America supply chain

**For more information visit
NewScientistJobs.com Job ID:
1400853030**

Area IMPACT Field Testing Lead - Northeast Business Unit

Pioneer Hi-Bred Production LP
OH - Ohio

This testing is a collaboration between Pioneer customers, Area Agronomists, Business Unit tech teams and research and includes planning, execution, data quality and process improvement.

**For more information visit
NewScientistJobs.com Job ID:
1400845119**

Maize Product Development Intern

Pioneer Hi-Bred Production LP
HI - Hawaii

Different areas of focus may include one or more of the following: seed production and nursery management, pest management, GPS mapping, database applications, and health and safety compliance.

**For more information visit
NewScientistJobs.com Job ID:
1400847208**

Wadsworth Center

New York State Department of Health

The Wadsworth Center, a research-intensive public health laboratory affiliated with the New York State Department of Health, provides a unique and dynamic postdoctoral training environment. Basic and applied research programs at Wadsworth focus on infectious disease and immunology, molecular genetics, neuroscience, structural and cell biology, and environmental health sciences among others. Supplementing this training environment are state-of-the-art core facilities; an NIH-supported national biotechnical Resource for the Visualization of Biological Complexity; broad-based graduate programs in the biomedical and environmental sciences with University at Albany, State University of New York; and initiatives in biodefense and emerging infections, genomics, and structural and computational biology.

Wadsworth also sponsors a number of events and activities specifically designed to enhance the overall postdoctoral training experience. These include an active seminar program, annual postdoc retreat, annual postdoctoral research appreciation day, grantsmanship course, training in oral and written communication, career workshops, and instructorship appointments at U Albany for those who want to teach. In addition, the institute provides memberships for its fellows in regional and national organizations that focus on issues of interest to postdocs, particularly career development. The Center strongly supports the Wadsworth Postdoctoral Association (PDA), which serves the informational and logistical needs of its fellows. Wadsworth has consistently been named by The Scientist Magazine as one of the Best Places to Work for Postdocs or Best Places to Work in Academia.

The Center is located in upstate New York in Albany, a mid-sized city about 3 hours by car or train from New York City and Boston. Surrounded by rivers, lakes, and mountains, Albany is an ideal location for outdoor activities year round.

For additional information and a list of positions currently available, please go to: www.wadsworth.org/educate/postdocs.htm

To apply, contact:

Donal Murphy, PhD

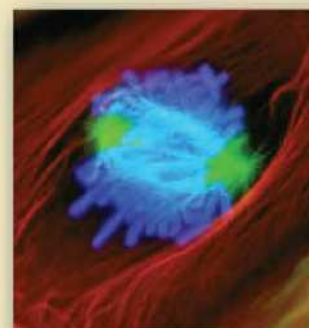
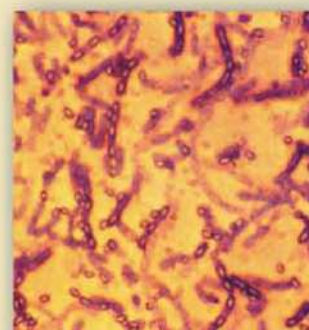
Office of Research & Technology, Wadsworth Center

New York State Department of Health

PO Box 509, Albany, NY, 12201-0509

Email: murphy@wadsworth.org

AA/EOE



Postdoctoral researcher positions – The Ohio State University Center for RNA Biology



Several NIH-funded postdoctoral positions are available in the Schoenberg lab to study fundamental aspects of mRNA metabolism and translational control.

- One position will study the relationship between signal transduction, mRNA decay and cell motility (Mol. Cell 25: 779-787, 2007; RNA 15:576-587, 2009). This research will integrate protein:protein and protein:RNA interactions with signaling events that activate the decay process.
- One position will investigate the relationship of cytoplasmic capping to translation and the re-activation of microRNA-silenced mRNAs (MCB 29: 2155-2167, 2009; Trends Biochem. Sci. 34: 435-442, 2009).
- One position will investigate the role of mRNA endonucleases in nonsense-mediated mRNA decay (PNAS 99: 12741-12746; RNA 9: 1157-1167, 2003).

Candidates for each of these positions should have experience with RNA molecular biology, mammalian cell culture, and protein biochemistry as evidenced by publications in major journals. Preference will be given to individuals with experience and interest in proteomics, bioinformatics and transcriptome-wide approaches to studying gene expression.

Send a CV and names and contact information for 3 references to:

Daniel R. Schoenberg, Ph.D. | Department of Molecular & Cellular Biochemistry
The Ohio State University | Columbus, OH 43210-1218 | schoenberg.3@osu.edu

OTHERS

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Monsanto

PA - Pennsylvania

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Monsanto

SD - South Dakota

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QUITE why David Kemmish was looking for studies on the medical effects of prayer we do not know, but we are as delighted as he was to be reminded of the nine-year-old paper "Effects of remote, retroactive intercessory prayer on outcomes in patients with bloodstream infection: randomised controlled trial" by Leonard Leibovici, then at the Rabin Medical Center at Petah-Tiqva, Israel.

It seems surprising that this paper, published in the prestigious *British Medical Journal* in December 2001 (vol 323, p 1450), didn't create more of a stir at the time. It appears to show that prayer is associated with shorter stays in hospital and quicker recoveries from fever. However, as David points out, "the keyword is 'retroactive' – the patients were treated between 1990 and 1996 but the prayers were said in July 2000. Apparently this works because God is 'not limited by linear time'."

We are bound to point out here that any result reported with, say, a 95 per cent confidence level (the standard for social science studies) has, by definition, a 1 in 20 chance of being utter nonsense. On the other hand, what if the effect were real? Do we have to convert before we pray for, say, Mary Wollstonecraft (Mary Shelley's mother) to have recovered from her septicaemia in 1797? If we succeeded, would we risk un-writing *Frankenstein*?

Might prayer work for outcomes other than length of stay in hospital? What if we pray, most faithfully, for Abraham to have said "no way, Yahweh" and we thereby manage to un-found an entire family of religions?

READERS continue to assist with retro-proofreading our quote from an article in the UK consumer-issues magazine *Which?* We reproduced, accurately, their assertion that "The average bacon packet was

nearly 15 grams and we [in the UK] eat about 50 million packets of bacon a year. That's 7500 tonnes of packets, the equivalent of 50 blue whales" (15 May). Readers quickly pointed out that we had failed to spot that 50 million times 15 grams is only 750 tonnes, the equivalent of a mere five blue whales (19 June).

Since then, several readers and colleagues have commented that 15 grams is a miserly serving of bacon, even by the fabled standards of British seaside guesthouses. True enough, but we're obliged to point out that the weight in question is that of the packaging, not the rashers of pork product therein. We accept it is possible to wrap a decent breakfast in 15 grams of packet – though we have to admit that, as we share accommodation with a vegetarian, we don't actually bring home the bacon ourselves, but meet it only in its natural café habitat, where it is packetless.

Jim Grozier, meanwhile, took the trouble to check our suggestion that perhaps *Which?*'s numbers work in whale arithmetic, as opposed to the human kind. He has come up with an equation showing not only that the sums are wrong in base 10 arithmetic but also that they cannot be correct for any base.

Then, however, he undercuts his argument by asking whether whales, having zero fingers, count in base zero, in which all equations are true. Perhaps that settles it – unless any whales reading this disagree.

WONDERING what a friend meant when she said on Facebook that she had been for a 4D scan of her baby, Luke Gibbons tracked down an explanation on babyscan.co.uk: "3D scans are still pictures of the baby, whereas 4D scans are moving 3D images. These videos show the outside of your unborn baby in amazing detail and are a world apart from the traditional black & white 2D ultrasound images most people are familiar with."

That's the great thing about promotional writing. If

copywriters don't like or don't understand what a technical term means, they can simply make up a new meaning for it.

THE pair of socks Karen Hamshaw-Hart bought for her baby daughter came with the instruction to "Wash and dry separately". This led to a domestic disagreement, with Karen arguing that it meant the socks should not be washed and dried at the same time, as if such a thing



were possible, and with her husband believing it meant each sock should be individually laundered. Or did it mean, as Feedback guesses, that the socks should be washed and dried separately from other garments? Karen does not tell us if any of these views prevailed, or if she simply decided to ignore the instruction.

FINALLY, continuing the theme of strange notices (12 June), Malcolm Moore reports one in a men's restroom near Lake Rotorua, New Zealand. It says: "LAKE FLIES DO NOT OPEN WINDOWS".

"That," says Malcolm, "is good news."

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

Rod Heard read in the magazine of the Queensland Writers Centre, Australia, that entries for the Place and Experience Poetry Prize 2010 "must be typed on single-sided A4 paper"

Eyes down

How do bifocal contact lenses work? Specifically, how is the reading part of the lens held in the correct position?

■ There are at least three kinds of bifocal contact lens: “translating”, concentric and aspheric. The question relates mainly to the translating type, because these are the only ones that have to be positioned correctly all the time. A translating bifocal lens is in two halves, with the part that corrects for short-sightedness at the top and that for long-sightedness at the bottom, pretty much the same design as for bifocal glasses.

Such lenses are relatively small, covering only the centre part of the eye, and they are made of a more rigid material than the more usual soft lenses.

“The brain has to sort out conflicting information from the two different parts of the bifocal lens”

In addition, a small segment of the lens is cut away at the bottom leaving a flat edge. The flat edge ensures that the lens stays correctly aligned when you blink. Its small size and rigidity allow the eyelid to hold the lens centrally while the eyeball translates – slithering up and down between far and near vision.

In concentric lenses, the centre is made up of concentric bands of material that alternate between correction for short sight and long

sight. This design exploits the adaptability of the human brain, which can keep a mixture of both near and distant objects in focus at the same time.

The wearers “train” their brains to “see” either close-up objects or distant ones as required, because in effect the eye is registering both at the same time. Such lenses move with the eyeball and it doesn’t matter if they rotate on the surface of the eye because they are symmetrical.

Finally, aspheric lenses are similar to the progressive lenses in glasses: correction for short-sight is in the centre of the lens, and it progressively changes to correction for long sight towards the outside. Once again the brain has to sort out conflicting information from the two parts of the lens.

People who wear progressive lenses will remember the first time they tried them, when head movements produced a wildly oscillating, completely disorientating visual field. Somehow the brain sorts this out and, after a few hours, everything returns to normal and perfect vision ensues.

*Terence Hollingworth
Blagnac, France*

■ I wear toric contact lenses, which correct for my astigmatism as well as my short-sightedness. Because these lenses are not symmetrical they have a heavier portion at the bottom designed to “drag” the lens into the correct position after insertion. The lens

itself also has a small mark at the six o’clock position so I can insert it the correct way up when I start wearing them. This mark is invisible to the wearer once the lens is on the eye.

*Rhian Chapman
Luton, Bedfordshire, UK*

This week’s questions

POOLING RESOURCES

When I open a new jar of marmalade the contents are a nice, semi-solid, homogenous mass with a smooth surface, however old the jar is. Yet when I make a spoonful-sized hole in the flat surface to remove some marmalade, the next time I open the jar a couple of days later, the hole has started to fill with a syrupy liquid. What is it about breaking the surface of the marmalade that sets this process in motion? It continues until the jar is empty.

*Kenneth Crowther
Derby, UK*

MALT TEASER

In my kitchen cupboard I have olives in brine and pickled onions in vinegar. There is no doubt that when I go to remove an olive or onion with my fingers (I know I should use a fork) the vinegar feels warmer than the brine. I even filled a jar with water and left it overnight in the cupboard to check. It felt colder than the vinegar. And friends have verified my finding. Surely the vinegar should be at cupboard temperature? Has anybody any idea what’s going on?

*Bill Brinkley
Exeter, Devon, UK*

DUCKING THE ISSUE

I have never seen a duck stand as erect as the one shown in the centre of the attached photo (below) which I took at Rowsley, Derbyshire. Does anyone know if there is an explanation for this posture or is it just an unexpectedly tall duck?

*Vince Sellars
Sheffield, South Yorkshire, UK*



Questions and answers should be concise. We reserve the right to edit items for clarity and style. Include a daytime telephone number and email address if you have one. Restrict questions to scientific enquiries about everyday phenomena. The writers of published answers will receive a cheque for £25 (or US\$ equivalent). Reed Business Information Ltd reserves all rights to reuse question and answer material submitted by readers in any medium or format.

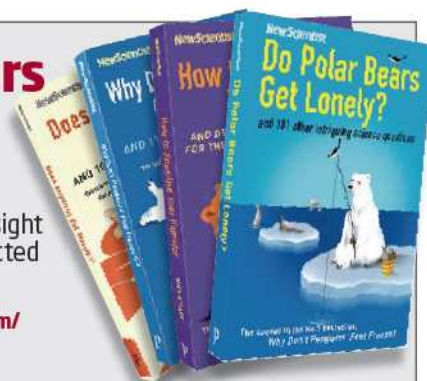
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For a list of all unanswered questions send an SAE to LWQlist at the above address.

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