MARTIAN SHEEN
A sign of life from the Red Planet?

MY BIG FAT GEEK WEDDING
Tears, joy and oxytocin

BRAIN PARADOX
When a dementia gene makes you smarter

NewScientist

WEEKLY February 13 - 19, 2010

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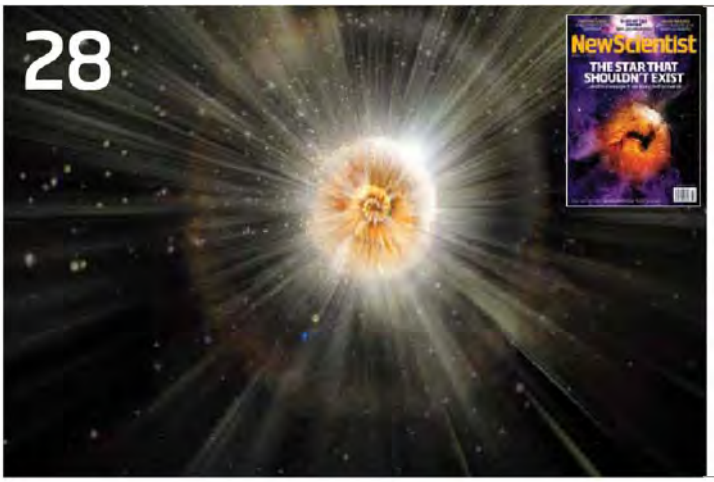

COVER STORY

The star that shouldn't be

An "impossible" stellar explosion opens a new window on the early cosmos

Cover image
Tim Gravestock

DAVID PLUKERT

Healing touch

The secret to growing new organs is to get all touchy-feely

JOE RCS ARBACH/AP/PRESS ASSOCIATION

Brain paradox

When a "dementia gene" makes you smarter

Coming next week

Message from the caves
Writing was invented long before civilisation

PLUS Jane Goodall on half a century saving the wilds

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Turning point for space exploration

The White House's plan for NASA may sound mundane, but it has far-reaching consequences

IN THE almost half century since Yuri Gagarin orbited the Earth, human space flight has been the preserve of state agencies – first Russian and American, and more recently Chinese too. That could be set to change, as the US charts a new course for its space agency, NASA.

The White House wants to scrap NASA's Constellation programme, which has been developing two new rockets to deliver astronauts to the moon and take over the task of ferrying people to the International Space Station after the space shuttles retire. President Barack Obama's proposed budget, which will implement this change, will likely face fierce opposition in Congress, but if it is approved, NASA will be able to shift the latter responsibility to private companies, leaving it free to spend its money on other activities.

Paying commercial enterprises to take astronauts aloft may not seem like such a big change. After all, NASA has always contracted with the private sector to provide its space hardware, and companies like Virgin Galactic have already announced plans to take paying customers into space. But if NASA can hand over to private "space taxis" the routine activities of delivering supplies and people into orbit, it will be able to concentrate its energies on truly revolutionary work. The possibilities range from demonstrating brand new technologies, such as ion engines and lunar mining (see page 8), to further developing robotics and other technologies at which it excels.

Strategic change along these lines could revitalise NASA and be the best possible riposte to those who have written off Constellation as an expensive attempt to clone the achievements of the Apollo programme in the 1960s. It will also do wonders in restoring the agency's fading glamour, and its ability to inspire the next generation of spacefarers.

"If NASA hands over routine tasks to private 'space taxis' it can focus its efforts on truly revolutionary work"

If private companies succeed in developing reliable vehicles for routine tasks, more adventurous space exploration will be the long-term winner. Private-sector companies already reckon that they will be able to launch astronauts for a fraction of the cost of a space shuttle flight – and they could even undercut Russia's Soyuz craft. Competition between them could drive down prices even further.

As time goes on, there will be new commercial opportunities for space tourism, contract research, even private exploration beyond low-Earth orbit for manufacturing, minerals and more. A few decades from now, human space flight could be supported more by commercial activities than government funding – and we'll look back in amazement to the days when cumbersome national agencies were allowed to monopolise our exploration of the final frontier. ■

A fair society is better for all of us

MANY rightly assume that the poor are relatively unhealthy. But the same goes for almost everyone, save the richest, according to a key review of the effects of health inequalities in England. As we report on page 11, the quest for social fairness should begin with child development.

The implications are radical. Based on the knowledge that people with degrees have lower mortality rates than those without, Michael Marmot's team asked what would happen if everybody in England, aged 30 and over, had the mortality rate of graduates. The answer was there would be 202,000 fewer premature deaths each year, accounting for 40 per cent of all deaths. Levelling health disparities in rich nations will have a much bigger impact than focusing on the worst off. ■

Saying 'I do' to science

IN OUR celebrity-obsessed culture, weddings can sometimes turn out to be little more than publicity stunts. So some may think the decision by one of our reporters to measure hormone levels during her own vows is just another gimmick (see page 32). In fact, researchers rushed to help, as her wedding offered a rare opportunity to study a real-life situation, rather than a stage-managed lab test. They were rewarded with plenty of insights into a little-appreciated mystery: why so many of us want to say "I do" in public. ■

What's hot on NewScientist.com

PHYSICS Found: cosmic graffiti
Stephen Hawking's initials are written into the cosmic microwave background. Find more in our interactive graphic

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Our dossier of some of the UK's most sensitive government sites, from the erstwhile venue of gruesome human experiments to eavesdropping stations

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TECH Intelligence in your pocket Our reporter spends a week with an "artificially intelligent" assistant installed on his phone. Could he trust it with the important stuff?

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It's a bird that thinks it's a bat. The split personality of the echolocating, cave-dwelling oilbird makes it a particularly slippery specimen

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MOHAMED DAHIR/AFP/GETTY

Scourge of the Indian Ocean

Science held to ransom

SOMALI pirates terrorising the Indian Ocean are a hazard to more than shipping and tourists. They are also killing important scientific research and may be indirectly damaging the ocean's ecosystem.

Fishing boats in the Indian Ocean routinely carry scientists who gather data about fish stocks and threatened species while ensuring that boats comply with fishing rules. The piracy threat has put a stop to that. "We can't monitor and we can't do experiments because of the pirates," says Laurent Dagorn of France's Research Institute for Development (IRD).

Boats now carry guards and no longer have room for scientists, who have had to confine their own research vessels to port. IRD has cancelled all of its cruises in the last nine months.

By eliminating scientific observers, piracy may be indirectly increasing by-catch. It could also be encouraging the use of damaging fishing methods like "fish-attracting devices" – bamboo rafts held together with netting that are left at sea for days or weeks. Fish such as tuna congregate under FADs, making them easier to catch, but FADs also snag and kill turtles and sharks. Michel Goujon, director of the French tuna-boat owners' association, Orthongel, has evidence that their use is on the rise.

Regional governments accept the need to resume research. But, "I don't see any sign that piracy is going to decrease", says Goujon. "In fact, every time a ransom is paid it's an incentive for new attacks."

Gene patent spat

DOCTORS providing diagnostic gene tests in the US should no longer face the threat of litigation by companies owning patents on those genes. So says a committee advising the US health secretary, Kathleen Sebelius, adding that researchers developing improved tests should be exempt too.

Jim Evans of the Secretary's Advisory Committee on Genetics, Health and Society says when the panel examined the availability of gene tests, it found more for conditions such as Huntington's disease, cystic fibrosis and colorectal cancer, which don't involve patented genes, than for diseases such as breast cancer, which do. More tests increase

"There was greater availability of tests that don't involve patented genes than those that do"

choice and offer the option of a second opinion, says Evans.

The Biotechnology Industry Organization has vehemently objected to the recommendations. By undermining firms' ability to sue violators of their intellectual property, they will deter investors from funding development of new tests and therapies, it warns. The committee counters that this is an overreaction as the recommendations apply only to tests, not to gene-based therapies.

If Sebelius does alter the law, it would affect companies such as Myriad Genetics of Salt Lake City, Utah, which owns patents on two key breast cancer gene variants and is currently engaged in a court case on the patentability of these genes.

Depressing news?

AS IF women with both breast cancer and depression don't have enough to worry about, it now seems some treatments for the two conditions may not mix.

To work, the common breast cancer drug tamoxifen must be converted into its active form by a liver enzyme, but there are hints that a class of antidepressants called selective serotonin reuptake inhibitors (SSRIs) inhibit this enzyme. So David Juurlink of Sunnybrook Health Sciences Centre in Toronto, Canada, and colleagues looked at the medical records of 2430 women aged 66 or over who received tamoxifen between 1993 and 2005. When tamoxifen treatment overlapped with the use of the SSRI paroxetine, the long-term risk of death from breast cancer was higher (*BMJ*, DOI: 10.1136/bmj.c693).

It is known that antidepressants can reduce the severity of some side effects of chemotherapy, so women may not want to ditch their pills just yet. Other studies suggest that other SSRIs inhibit the enzyme less strongly, so these might be a safer alternative.


AFP PHOTO DDP / AXEL SCHMIDT/GETTY

Mixed messages from President Ahmadinejad

Iran's uranium

IRAN announced this week that it will produce uranium enriched to contain 20 per cent of the fissile isotope uranium-235. It says this is to refuel a reactor in Tehran that makes medical isotopes, after talks aimed at acquiring the fuel abroad stalled.

Iran already makes 3.5 per cent low enriched uranium (LEU). Enriching that to 20 per cent is allowed under international rules, and Iran has asked for the process

to be supervised. But the Institute for Science and International Security (ISIS), a Washington DC-based think tank, says it will be hard for Iran to safely turn the uranium into reactor fuel elements. Some western governments say they fear the move is a prelude to producing weapons-grade uranium, enriched to 80 percent or more.

According to ISIS, by enriching natural uranium to 20 percent the Iranians will already have done almost all of the work needed to get it to 80 per cent. Less "separative work" is needed as concentrations of uranium-235 increase.

Anti-HIV gel hope

VAGINAL gels to protect women against HIV have failed to work, but new insights into how the virus is transmitted could change this.

HIV in semen takes two forms: as DNA in white blood cells and free-floating RNA in seminal fluid. The two are genetically distinct.

To find out which transmits the disease, Davey Smith and colleagues at the University of California, San Diego, took samples from six pairs of homosexual men in which HIV had been transferred from one to the other. When they compared the virus found in the recipient to the DNA and RNA versions in the semen of the man who infected him, it was most closely related to the RNA, which suggests RNA is the culprit (*Science Translational Medicine*, vol 3, p 1).

"Vaginal gels could help women whose male partners refuse to wear a condom"

Gels, which could help women whose male partners won't wear condoms, have been focused on physically blocking HIV. Newer ones could target RNA, says Smith.

Half-power ahead

NEXT week, engineers at the Large Hadron Collider will prepare the particle-smasher to run at 7 teraelectronvolts (TeV) – half the energy it was designed for. So what will it find?

Greg Landsberg, a member of the CMS collaboration, which operates one of the four experiments at the LHC, says the first few months should generate accurate measurements of the properties of particles like the W and Z bosons and the top quark.

Particles that hint at extra dimensions or supersymmetry could also be discovered during the run, provided they are light enough – although probably not until at least the latter half of 2010, he says. Higgs particles in the lighter predicted range could be produced, but they may be hidden by background signals.

After two years at 7 TeV, the collider will be shut down for the whole of 2012 to check the splices between the superconducting magnets, one of which failed disastrously in 2008. In 2013 the energy will be ramped up to its maximum of 14 TeV. The LHC's operators are being cautious, "but given what happened in 2008, who can blame them?" says Jon Butterworth of the UK ATLAS collaboration, another experiment.

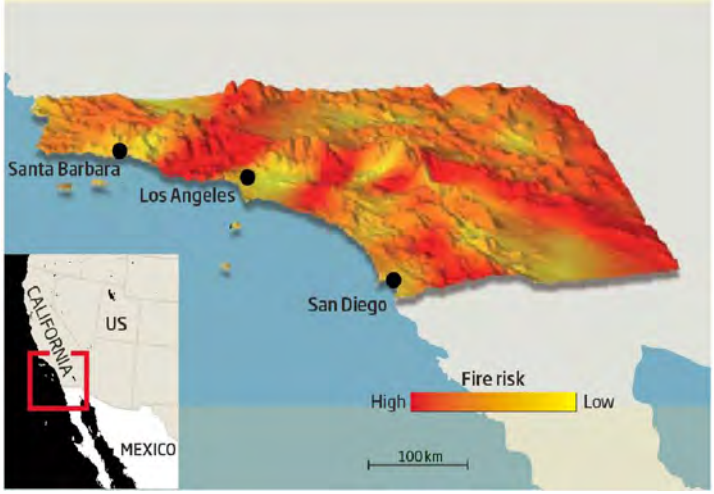
Where the worst fires will be

THIS year, southern California will burn – you can count on it. But we may now be able to predict which areas will be worst hit, thanks to this map. It was compiled by Max Moritz's team at the University of California, Berkeley, and is the first to take into account fire-friendly weather.

Wild fires cause millions of dollars of damage each year in California and elsewhere. Fire researchers typically identify risk areas by looking for flammable vegetation and features like canyons that can funnel fires. There is a third factor, however, that stokes many of the worst infernos: hot, dry winds, like the Santa Ana winds of southern California and the sirocco around the Mediterranean.

Moritz and his colleagues used a computer model of fine-scale weather patterns to predict temperature, wind speed and humidity at 6-kilometre intervals across southern California during Santa Ana wind events, then calculated the fire risk at each point. When they compared their map with historical fire records, the researchers found that the areas they had identified as being at high and low risk were equally as likely to burn, but the impact of fire was greatest in a high-risk area (*Geophysical Review Letters*, DOI: 10.1029/2009GL041735).

Moritz's map may help planners guide housing development away from the riskiest areas. The approach could also be used in other fire-prone regions like South Africa and western Australia, he says.



60 SECONDS

Staring at the sun

NASA's Solar Dynamics Observatory was scheduled to launch this week. The probe will watch the sun for the evolving magnetic fields and interior pressure waves that are the prelude to solar storms, and could provide better forecasting of the events. A severe storm could cripple power grids and telecommunications.

Neural comeback?

For the first time, a drug has shown signs of reversing cognitive decline in people with Huntington's disease, an inherited neurodegenerative condition. The 45 recipients of dimebon – also active against Alzheimer's disease – averaged a 1-point increase in cognitive scores on a standard 30-point scale after three months (*Archives of Neurology*, vol 67, p 154).

Stammering enzyme

The discovery of gene mutations in some unrelated people with a stutter suggests an enzyme may contribute to the condition. The gene in question produces an enzyme involved in recycling cell contents. Enzyme replacement might help some stutterers (*The New England Journal of Medicine*, DOI: 10.1056/NEJMoa0902630).

Ancient genome

A 4000-year-old, brown-eyed man from Greenland has become the first ancient human to have his genome sequenced (*Nature*, vol 463, p 757). Analysis of DNA collected from once-frozen tufts of hair shows the man had A+ blood, dark skin and, possibly, dry earwax. His ancestors migrated out of Siberia about 5500 years ago.

All the farms in China

China's farms generate more water pollution than its factories, according to a government-commissioned report. It shows that agriculture is dumping most of the phosphorus and nitrogen found in rivers and lakes. Both pollutants are responsible for aquatic dead zones.

A new era for space exploration

Big changes are afoot in the US space programme. What will it look like a decade from now?

David Shiga and Rachel Courtland

ASTRONAUTS digging into an asteroid for samples to send back to Earth. Experimental robots on the moon, paving the way for extraterrestrial refuelling stations and for astronauts "living off the land". Commercial space taxis ferrying crew members to and from the International Space Station, while a "plasma thruster" – a precursor to engines that will eventually send astronauts to Mars – undergoes tests in space.

All this could be happening a decade from now, following a change of direction for NASA signalled by the White House last week. The Obama administration has said it wants NASA to scrap the Constellation programme, which would have taken astronauts to the moon and Mars. The decision could mark one of the most significant shifts since the agency was set up in 1958.

"The focus has turned to technologies that can take us further, faster and more affordably into space"

Though NASA has not yet been set formal new goals, the agency's administrator, Charles Bolden, is betting that the billions of dollars freed up by the change will buy big advances in the technology needed for new ways to explore the solar system. He also reckons that commercial space companies are finally ready to take the strain when it comes to transporting NASA astronauts.

The lack of any firm objectives is raising fears that the agency will drift. "It's basically a prescription for tail-chasing," says Paul Spudis of the Lunar and Planetary Institute in Houston, Texas. "NASA as an agency does not do well when it is given money and no direction."

However, Bolden said last week that the agency is working on a new schedule for reaching destinations beyond low-Earth orbit. The moon, Mars and asteroids "naturally come to mind", he said, though he did not indicate which would come first. Although NASA intends to abandon Constellation, a return to the moon is not off the table, according to Bolden's deputy, Lori Garver. But the focus is now on "technologies that can take us further, faster and more affordably into space", she says.

Louis Friedman, executive director of space advocacy group the Planetary Society in Pasadena, California, shares this optimism. Bolden's plan could "get astronauts beyond the moon and maybe also to the moon's surface more quickly than with Constellation", he says.

In the panel opposite, we offer a prediction of the ways NASA's activities could be transformed a decade from now.

Whether NASA's shift in direction actually takes place will depend on Congress, which must agree to the funding for any plans before they can take effect. Fierce opposition is expected from representatives of areas where jobs are tied to the Constellation programme. How many of their colleagues will side with them remains to be seen. ■

RICHARD T. NOWITZ/CORBIS

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TRIP TO AN ASTEROID

Eat your heart out Bruce Willis. A decade from now, astronauts could be perching on one of the rocks that occasionally strike our planet.

Asteroids are made of material left over from the formation of the planets, so studying them close up should provide clues about how bodies like Earth came into being. As well as collecting samples, astronauts might install seismometers to detect vibrations set off by small explosive charges, to reveal the asteroid's interior.

Findings from a mission like this could prove vital if we ever need to deflect an asteroid from a collision course with Earth. Many of these bodies are simply loose collections of rubble, and an ill-thought-out attempt at deflecting one could break it up into a dangerous shower of fragments.

A visit by 2020 might just be possible, says Louis Friedman of the Planetary Society, though a major review of NASA space flight last year – the Augustine report – points to the mid 2020s.

A prerequisite will be finding ways to shield astronauts from radiation. "There is a very real chance you could lose a crew because of that," says Daniel Durda of the Southwest Research Institute in Boulder, Colorado.

SPACE TAXIS

NASA's Florida space hub could look a lot different 10 years from now. It may still be the departure point for trips to the International Space Station, but the space shuttle will be long gone. A handful of astronauts could still hitch rides on Russia's dependable Soyuz spacecraft, but US government support for commercial space taxis should have helped drive down the cost of rocket trips, and groups of two or three astronauts may be squeezing into capsules atop small rockets run by private companies.

These newcomers will be beginning to draw enough interest in space tourism and microgravity research to launch several private trips to low-Earth orbit each year. Access to space for all will be well on the way – as long as some key hurdles have been overcome by then. "Making this work for NASA means being able to do this safely and reliably," says Bretton Alexander of the Commercial Spaceflight Federation.

Rules will be needed for how private spacecraft are evaluated and certified. The first step – a draft of NASA's human rating requirements – may be released as early as March, Alexander says.

FUELLING IN SPACE

If missions could refuel after leaving Earth, astronauts could revisit the moon without the need for expensive new rocket systems.

The technology to build orbiting fuel depots – such as sunshades to keep fuel cool – could be on the way by the end of the 2010s. And the first American visitors to the moon in decades could also be part of the plan: not astronauts, but robots that will manufacture rocket fuel. "Like exploring way out west, you send the scouts out in front of you," says NASA engineer Patrick Troutman.

Test plants could use the sun's heat to release oxygen from lunar soil, while microwaves could extract traces of water as a source of hydrogen and oxygen. Storage technology will need tightening up though. "Hydrogen leaks from everything," says Troutman.

$7.8bn

The sum NASA hopes to spend on exploration technologies in the next five years

ION ENGINES

Today's rockets work by ejecting hot gases generated by chemical combustion – a technology dating back to Germany's second world war V2s and beyond. Soon they could be replaced by radically different engines, setting the stage for journeys to Mars that could be completed in a matter of weeks.

Ion and plasma thrusters use electric and magnetic fields to accelerate a propellant. They need much less fuel than chemical rockets, and can boost spacecraft to much higher speeds. In 2013, a plasma thruster called the Variable Specific Impulse Magnetoplasma Rocket (VASIMR) – developed by the Ad-Astra rocket company of Houston, Texas, headed by former astronaut Franklin Chang Díaz – will be sent to the ISS. If tests go well, it could be used to give the station the regular boost it needs to maintain its position in orbit.

To carry humans to Mars, such engines will need a huge power supply that does not add too much mass. Ultra-lightweight solar arrays or space-hardy nuclear reactors would need to be developed for the job, says John Schilling of Silverbird Astronautics in Lancaster, California.

Entangled photons love a bumpy ride

Colin Barras

ATMOSPHERIC turbulence can be a pain for plane passengers, but for entangled photons it could prove something of a boon. The particles used in quantum cryptography communication travel like a dream through a turbulent atmosphere.

In 2007, Anton Zeilinger's team at the University of Vienna, Austria, created entangled pairs of photons on a mountain top in La Palma, one of the Canary Islands, and beamed one of each pair 144 kilometres through the air to Tenerife, establishing the longest ever quantum communications channel.

We have yet to tease out all of the conditions favouring the transmission of fragile entangled photons through air, but Andrew Semenov at the Institute of Physics in Kiev, Ukraine, and Werner Vogel at the University of Rostock, Germany, think they might have found one of entanglement's allies.

They analysed the Zeilinger team's data, which included information on atmospheric conditions and the strength of the quantum link. The link strength is established by comparing the number of entangled photons that make it to their respective receiver with the number of non-entangled photons – for instance, in background light – that also reach the detector. Semenov and Vogel found that whenever the signal was particularly strong, the prevailing atmospheric conditions were turbulent (arxiv.org/abs/0909.2492). This contrasts with standard satellite-based optical communication, which can be disrupted by atmospheric turbulence.

Turbulent airflow leads to random fluctuations in atmospheric temperature, and those make the atmosphere more or less easy for photons to traverse, says Semenov. The fluctuations will sometimes produce a "more transparent" atmosphere through which more entangled photons can travel without being scattered.

"The turbulent atmosphere is by no means [always] a better channel," says Vogel, because the random fluctuations are just as likely to make the atmosphere more opaque to the photons. But because the receivers automatically reject data if the signal is too weak and establish a connection using a strong signal only, "the fluctuations may improve the situation". "Increasing turbulence from the zero value can be useful," Vogel says.

Alessandro Fedrizzi, formerly of Zeilinger's team and now at the University of Queensland in St Lucia, Australia, says it is an "amazing result" and encouraging for the prospect of eventually setting up satellite-based quantum communication networks. ■

MIKE THIESS/NATIONAL GEOGRAPHIC/GETTY

Good weather for quantum communication

Chromosome caps presage brain's decline

A SIGN of a cell's age could help predict the onset of dementia. Elderly people are more likely to develop cognitive problems if their telomeres – the stretches of DNA that cap the ends of chromosomes – are shorter than those of their peers.

The shortening of telomeres is linked to reduced lifespan, heart disease and osteoarthritis. Telomeres naturally shorten with age as cells divide, but also contract when cells experience oxidative damage linked to metabolism. Such damage is associated with cognitive problems like dementia. Thomas von Zglinicki at Newcastle University, UK, showed in 2000 that people with dementia not caused by Alzheimer's tended to have shorter telomeres than people without dementia.

To see if healthy individuals with short telomeres are at risk of developing dementia, Kristine Yaffe at the University of California, San Francisco, and colleagues, followed 2734 physically fit adults with an average age of 74.

Yaffe's team tracked them for seven years and periodically assessed memory, language, concentration, attention, motor and other skills. At the start, the researchers measured the length of telomeres in blood cells and grouped each person according to short, medium or long telomeres.

After accounting for differences in age, race, sex and education, the researchers found that those with long telomeres experienced less cognitive decline compared to those with short or medium-length telomeres (*Neurobiology of Aging*, DOI: 10.1016/j.neurobiolaging.2009.12.006).

"Longer telomere length will become one ingredient in a recipe for successful mental and bodily ageing"

Von Zglinicki calls the work a "carefully done, large study", but notes that short telomeres by themselves are not enough to predict whether an individual will get dementia.

The key, says Ian Deary at the University of Edinburgh, UK, will be to combine telomere length with other biomarkers. "Most likely, longer telomere length will become one ingredient in a recipe for successful mental and bodily ageing." Anil Ananthaswamy ■

INSIGHT

Act early in life to bridge the health gaps that blight society

THAT a lack of wealth all too often translates into poor health may seem painfully obvious. But now a review of health inequalities in England reveals that such disparities don't just disadvantage the least well-off. The review also suggests some strategies to tackle the inequalities. These remedies should apply the world over, including in the US, where health and wealth inequalities can be especially stark.

Commissioned by the UK government, the review was headed by Michael Marmot of University College London, who most famously showed that British civil servants at the bottom of the organisational pile were much more likely to suffer coronary heart disease than those at the very top. In his latest work, Marmot uses census data from across England to show that these health inequalities don't just exist between the richest and the poorest.

For example, even if you exclude the richest and poorest 5 per cent of people in England, the richest remainder can expect to live 6 years longer than the poorest, and enjoy an extra 13 years free of disability.

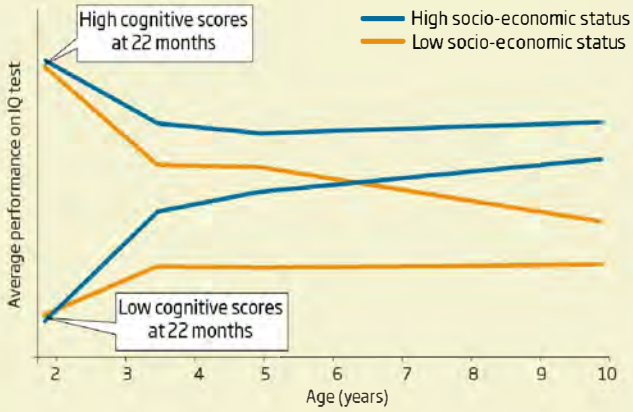
Marmot says action to reduce health inequalities should take place right across society, not focus solely on the poor. "It's not rich versus poor, because it's a social gradient," he says.

What's more, the most productive time to intervene to create a healthier society is childhood, Marmot says. That children who start out with well-off, well-educated parents are likely to be healthier would seem to be something of a no-brainer. But the fates of 17,200 UK babies monitored since they were born in the same week in April 1970, and highlighted in Marmot's review, make compelling evidence.

It turns out that babies who had low IQs at 22 months and were born to richer, better educated parents caught up by the age of 6 with children who started with high IQs but whose parents were poorer and less educated. By age 10, the children in the higher socio-economic group were forging ahead on intelligence tests while those in the lower socio-economic group fell further and further behind (see diagram, above). "It shows that the social is trumping the biological," says Marmot. "We can change that, and that's why I'm optimistic."

When social factors trump biology

A study based on 17,200 babies born in the UK in one week in April 1970 reveals the extent to which social status can influence cognitive performance



SOURCE: 1970 BRITISH COHORT STUDY

He also finds that children in poorer families miss out on pre-school reading, socialising and physical exercise. This disadvantage leaves them trailing far behind when they start school and they seldom recover.

Such inequalities are not confined to the UK. A report in April 2009 by the US-based Robert Wood Johnson Foundation concluded that interventions most likely to improve the health of all Americans were "programs that promote early childhood development and that support children and families". A report from Brazil recommended prioritising "actions related to health promotion of children and adolescents".

"We look forward to assessing how to adapt the policy recommendations for England to the rest of the world," says Rüdiger Krech, director of the WHO's department of ethics, equity, trade and human rights. He agrees that giving every child the best start in life "is critical in setting the foundation for a lifetime of health and successful contribution to society".

What can be done to ensure this? One option is to extend maternity or paternity leave, suggests Marmot. Another is to help struggling parents by providing extra services and information. **Andy Coghlan** ■

Keep me warm and I'll be sweet to you

SYMBIOSIS comes in many flavours. Lots of animals trade protection or food in a mutually beneficial relationship. Now there is a flower that offers yeast its sugary nectar in exchange for warmth.

A European herb, the stinking hellebore, is the only plant discovered so far that relies on another organism to generate heat for it. Other plants, like the famous "corpse flower" whose blooms smell of rotting flesh, warm up by breaking down salicylic acid, or by tracking the sun's movement.

Yeasts are common in a wide range of flower nectars, says Carlos Herrera of the Doñana Biological Station in Seville, Spain. It is deposited there by pollinating bumblebees, who pick it up from other flowers. Herrera and his colleagues took a sample of yeast from a local bumblebee in the Spanish mountains of Sierra de Cazorla. They injected the yeast into 37 "virginal" specimens of *Helleborus foetidus*, which had been covered in netting to keep pollinators away.

The team then compared the temperature of these flowers to the temperature of flowers with yeast-free nectaries. Flowers with yeasty nectar turned out to be 2 °C warmer on average, and up to 7 °C warmer when yeast densities were high. (*Proceedings of the Royal Society B*, DOI: 10.1098/rspb.2009.2252).

It's a significant spike in temperature for the plant, says Herrera. "But unless you have ultrasensitive fingertips, you won't notice it by touch." The yeast generates heat when it breaks down nectar sugars to grow.

What is in it for the plant? "The temperature rise may cause the flower to release a volatile which attracts more pollinators to the flower," says Sarah Gurr of the department of plant sciences at the University of Oxford. That is certainly what happens in another hot flower. The voodoo lily, a cousin of the corpse flower, has a temperature spike the day it blooms. As with the corpse flower, "this releases putrid amines, which smell like dead carcasses and attract pollinators to the flower, boosting its reproductive success", says Gurr. Shanta Barley ■

"The stinking hellebore is the only plant discovered so far that relies on another organism for heat"

Alzheimer's gene makes you smart

Ewen Callaway

A GENE variant that ups your risk of developing Alzheimer's disease in old age may not be all bad. It seems that young people with the variant tend to be smarter, more educated and have better memories than their peers.

The discovery may improve the variant's negative image (see "Yes or no", below). It also suggests why the variant is common despite its debilitating effects in old age. Carriers of the variant may have an advantage earlier in life, allowing them to reproduce and pass on the variant before its negative effects kick in. "From an evolutionary perspective it makes sense," says Duke Han at Rush University Medical Center in Chicago.

The "allele" in question is epsilon 4, a version of the apolipoprotein E gene (*APOE*). Having one copy increases the risk of developing Alzheimer's at least fourfold compared with people who have other forms of the gene. A person with two copies has up to 20 times the risk.

One big clue that epsilon 4 might be beneficial emerged several years ago, when Han's team scanned the *APOE* genes of 78 American soldiers. All had suffered traumatic brain injuries, many while serving in Iraq. Sixteen had at least one copy of epsilon 4. Han's team expected to find that these carriers would be in worse cognitive shape than their counterparts with different versions of *APOE*, given previous studies that showed elderly people with epsilon 4 fare worse after head injury. But the opposite was true: soldiers with the epsilon 4 allele had better memory and attention spans (*Journal of Neurology, Neurosurgery & Psychiatry*, DOI: 10.1136/jnnp.2006.108183).

It wasn't the first study to suggest that epsilon 4 may be beneficial to the young. Back in 2000, researchers showed that young women with epsilon 4 have IQs a few points higher than those with no copies of the variant and score 7 points higher on the non-verbal portion of a common intelligence test (*Neuroscience Letters*, vol 294, p 179). Then in the Czech Republic in 2001, researchers showed that 87 per cent of epsilon 4 carriers go on to university, compared with 55 per cent of people with another version of *APOE*. The last group were also more likely to drop out of school (*Neuropsychobiology*,

JOERG SARBACH/AP/PRESS ASSOCIATION

YES OR NO TO KNOWING IF YOU HAVE EPSILON 4?

When DNA co-discoverer James Watson published his genome in 2007, he left one tiny bit out: the piece that would have told him which version of the *APOE* gene he has. He opted not to know whether he was carrying the epsilon 4 version, which can vastly increase the odds of developing Alzheimer's disease.

He's not the only one to make an exception for *APOE*: Harvard University psychologist Steven Pinker, one of several high-profile scientists planning to make his genome freely available as part of the Personal Genome Project, will follow Watson's lead and keep his *APOE* sequence a mystery.

In contrast, genome pioneer Craig Venter has let the world know that he has one copy of epsilon 4, which also increases the odds of developing heart disease – and has started taking a cholesterol-lowering drug that he hopes may also delay Alzheimer's.

Scientific celebrities aren't the only ones who agonise over their *APOE* status. Anyone who has forked out a few hundred dollars to have their genome scanned can decide whether to find out if their *APOE* gene puts them at increased risk of Alzheimer's.

Knowing your status may not be all bad, says Robert Green of Boston University in Massachusetts, who over two years monitored how people reacted to finding out which version of the gene they have (*The New England Journal of Medicine*, vol 361, p 245). "By and large there were no catastrophic reactions," he says.

DAVID DEAL/REDUX/EYEVINE

Craig Venter has come clean about his copy of epsilon 4

The only people whose mood changed much were those relieved to discover they didn't have the risky variant.

If epsilon 4 does improve cognition in young adults (see main story) does that strengthen the case for knowing whether you carry that version?

Clare MacKay, who studies the effect of epsilon 4 on cognition at Oxford University, thinks not. "I wouldn't want to know whether I've got one and I certainly wouldn't want other people to know." Her lab is forbidden from telling the volunteers their *APOE* status. "It will only be a good idea to know your *APOE* genotype when there's something we can do about it," she says.

An intellectual advantage

DOI: 10.1159/000054890).

More recently, Jenny Rusted of the University of Sussex, UK, and Natalie Marchant at the University of California, Berkeley, have uncovered still more benefits for young people carrying epsilon 4. Those aged between 18 and 30 with the gene variant excelled at tasks requiring the frontal lobe, a brain region involved in higher cognitive skills. In particular, epsilon 4 carriers did better in a card game that asked them to remember a future plan while busy with another task (*Neuropsychopharmacology*, DOI: 10.1038/npp.2009.214).

"Your brain may have to work harder when it's younger and this may have consequences later"

Rusted suggests that epsilon 4 helps people focus on important information. But recalling something also requires you to tune out the irrelevant bits, an ability known to decline with age.

Perhaps, Rusted says, without this second capability, epsilon 4's benefits fall by the wayside. Why it has a negative effect in old age, however, is still a mystery, although a study carried out by Clare MacKay at the University of Oxford in 2009 offers a tentative, hypothesis.

Her team asked 20 to 35-year-olds to remember which pictures of animals or landscapes they had seen before, while having their brains scanned with functional MRI. It was an easy task and all performed equally well. But a brain region critical to memory lit up more strongly in epsilon 4 carriers than in the others, raising the intriguing possibility that carriers' brains get overworked in early life, only to be worn out by the time they hit old age. MacKay wouldn't go that far, but she says: "It's possible that your brain is having to work harder when it's younger and this may have consequences for later life." ■

Earliest animal trails were smeared on the sea floor

MORE like a slug trail than footsteps, the tracks smear through the 565-million-year-old rock overlooking the Atlantic Ocean. They were left by what may have been the first mobile organism to live on Earth.

Alex Liu of the University of Oxford and his colleagues discovered them etched in the rock at Mistaken Point in Newfoundland, Canada. "This is the earliest evidence for controlled locomotion in the fossil record," says Liu. He estimates that the trailblazers themselves, which were not preserved, were up to 13 millimetres wide. They left behind 70 trails, each between 5 and 17 centimetres long (*Geology*, DOI: 10.1130/G30368.1).

"The markings clearly indicate that these organisms could exert some muscular control during locomotion," Liu says. "It is the first evidence that creatures from this early period of Earth's history had muscles to allow them to move around, enabling them to hunt for food or escape and, importantly, indicating that they were probably animals."

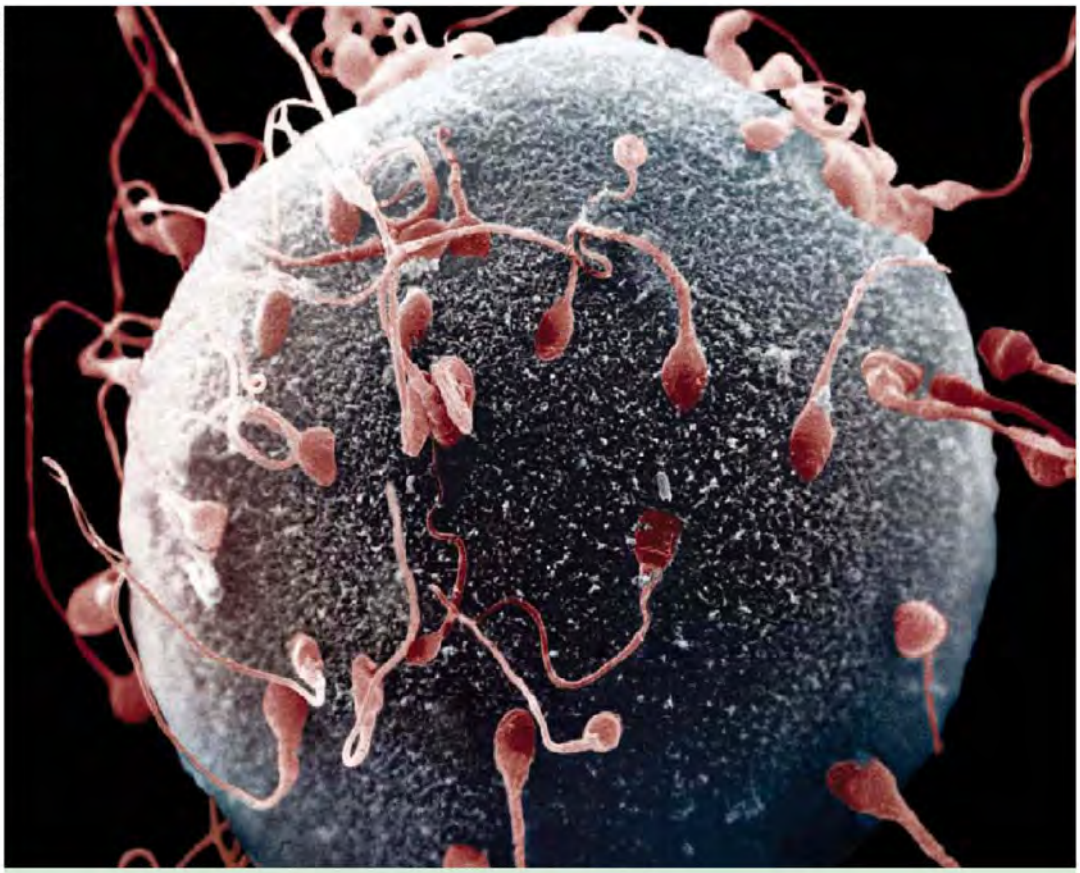
The researchers compared the fossil tracks with those left by sea urchins, sea anemones, marine snails and marine worms, and found they were similar to tracks left by sea anemones. They say the early movers may have had a muscular disc-shaped foot, as sea anemones do.

The tracks are etched in rocks 565 million years old, some 20 million years before the Cambrian explosion, when a huge diversity of animal life suddenly evolved. At the time, the rocks were at the bottom of the ocean, and the trace fossils are unlike anything previously found in the region from that time. Mistaken Point is famous for harbouring the remains of the first large complex life forms to evolve, known as Ediacarans. These were large, sessile organisms with fern-like or disc-shaped bodies that were anchored to the seabed between 575 and 560 million years ago.

But the trace fossils do resemble tracks previously thought to be the world's oldest, which were left about 20 million years later in shallow waters. Locomotion is more likely to have evolved in shallow seas, where sunlight fostered more life and hence more competition for resources. For this reason, Liu thinks the Mistaken Point movers may have been shunted to deeper seas by submarine landslides. James O'Donoghue ■

UNIVERSITY OF OXFORD

Still groovy after 565 million years



D. PHILLIPS / SCIENCE PHOTO LIBRARY

The secret of a sperm cell's wiggle lies in its tail

THE switch that transforms human sperm into super-swimmers has been identified at last.

A team led by Yuriy Kirichok at the University of California in San Francisco discovered a pH-sensitive channel in human sperm tails that explains why they are sluggish before ejaculation but quickly pick up speed.

In the female reproductive tract pH rises towards the uterus, which prompts the channels in the sperm to open. Protons rush out of sperm cells, their pH rises and sperm start to swim (*Cell*, DOI: 10.1016/j.cell.2009.12.053).

Zinc, which is abundant in semen, has the opposite effect and keeps the channels shut. So a zinc deficiency may make men infertile, says Kirichok. "If you don't have enough zinc, sperm cells could be activated prematurely and may burn out."

A similar process might even explain why smoking cannabis can sap fertility. More channels open in response to a substance called anandamide, which is abundant near the egg. Because cannabis binds to the same receptors on sperm as anandamide the drug might cause sperm to swim too soon and exhaust themselves.

The discovery of the channels also raises the prospect of creating drugs that can either open or close them, says Allan Pacey at the University of Sheffield, UK. "It could lead us to either develop a novel contraceptive", or an infertility treatment, he says.

Crash-bang birth of spiral galaxies

SPIRAL galaxies may have emerged from a more cataclysmic past than expected. New simulations suggest they grew their spiral arms after being mashed up in vast collisions.

A group led by François Hammer of the Paris Observatory in Meudon, France, compared a sample of relatively local spiral galaxies with distant galaxies that appear to us as they were 6 billion years ago. Far fewer tidy spirals existed in the ancient era, and far more galaxies boasted peculiar, unclassifiable shapes. Those oddly shaped galaxies must develop into spirals to explain the distribution of galactic shapes we see today.

Hammer says the simulations show that these unusual shapes and internal motions can be the result of two smaller galaxies colliding. This is a surprise because spirals need a supply of cool gas to form new stars, and big collisions are thought to heat and disperse the gas.

Conventional wisdom has it that major collisions produce relatively inactive elliptical galaxies. Yet the simulations show that if there is more gas than stars in the colliding galaxies, then enough cool gas can remain to form a disc and, eventually, spiral arms (*Astronomy & Astrophysics*, DOI: 10.1051/0004-6361/200912115).

Optical clock nears perfect precision

THE new record-holder for the most precise timekeeper could tick off the 13.7-billion-year age of the universe to within 4 seconds.

The optical clock monitors the oscillation of a trapped atom of aluminium-27. It is more than twice as precise as an earlier version, reported in 2008, and was built at the National Institute of Standards and Technology in Boulder, Colorado (arxiv.org/abs/0911.4527). "It's extremely impressive," says Patrick Gill of the UK's National Physical Laboratory, who was not involved with the work.

The second is currently defined by caesium atomic clocks, but optical clocks promise higher precision because their atoms oscillate at the frequencies of light rather than in the microwave band, so they can slice time into smaller intervals. Such clocks could help spot tiny changes in physical constants over time.

Slime mould's taste goes the distance

HMM, a burger or salad? We use our brains to judge the nutritional value of foods. Now it seems that slime mould can make similarly complex decisions – despite being just a giant super-cell.

Yellow slime mould is known to follow traces of sweetness to locate food. Now Audrey Dussutour of the National Centre for Scientific Research in Toulouse, France, has found that it can also detect nutrients from afar and judge the most nutritious food before moving. In the absence of an optimal food source, it will also stretch itself between two sources, precisely calculating how much of its mass to devote to each in order to meet its needs (*Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.0912198107).

Assassin bug lures spider to its death

HERE is one bug that lives up to its name. The assassin bug will stalk its victim on its home territory, or lure it away and eat it.

Anne Wignall at Macquarie University in Sydney, Australia, placed assassin bugs on the webs of five species of spider and watched the drama unfold. She found that the bugs repeatedly either stalk or lure their prey (*Journal of Ethology*, DOI: 10.1007/s10164-009-0202-8).

In stalking mode, the bugs creep towards their prey and tap the web with their forelegs up to five times before each step. They also bounce up and down at irregular intervals. The choppy pattern of vibrations creates a "smokescreen" that helps disguise the bug as it closes in on a hapless spider.

To lure spiders into their clutches, the bugs pluck the silk threads with their forelegs for up to 20 minutes in a manner that closely resembles the behaviour of trapped prey, says Wignall. "The spider thinks it's getting a meal, but instead gets eaten itself."

The study also revealed that assassin bugs pause to tap their prey with their antennae before killing them. Robert Jackson of the International Centre of Insect Physiology and Ecology in Kenya says this strategy may hypnotise the spiders, reducing their ability to respond to the attack.

ANNE WIGNALL

Carcinogenic residue may pose 'third-hand' smoking danger

RESIDUES of cigarette smoke deposited on indoor surfaces can turn carcinogenic when they react with airborne chemicals. This "third-hand" exposure could in theory cause health problems, particularly in children, says Hugo Destaillats, a specialist in indoor pollution at Lawrence Berkeley National Laboratory in California.

His team found several chemicals on the inside of the cab of a half-pack-a-day smoker's truck, including a carcinogen called NNK. Destaillats's team reckon that NNK is produced when nicotine from tobacco smoke reacts with nitrous acid in the air.

To test the theory, the team deposited either nicotine or tobacco smoke on sheets of paper, and exposed them to nitrous acid. In both cases this produced the same chemicals found in the smoker's cab (*Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.0912820107).

"Nicotine can persist on indoor surfaces for days, weeks and even months," says Destaillats. Young children who spend a lot of time on the floor could absorb these compounds through their skin, and the researchers argue that this means people should not smoke in homes and cars, and should replace nicotine-laden furniture and carpets.

Stephen Hecht at the Masonic Cancer Center at the University of Minnesota thinks that this could be an overreaction. There is as yet no direct evidence that chemicals formed in this way have proved harmful. "I personally feel that exposure by this route would be minimal, but the studies need to be carried out," Hecht says.

Australia's rain may have moved south

A NEW attempt to explain the 40-year drought that has blighted the nation says it may be linked to heavy snowfall over Antarctica.

Tas van Ommen and Vin Morgan of the Australian Antarctic Division studied snowfall records in ice cores from East Antarctica's Law Dome. They found that in the last few decades, its snowfall rates far exceeded anything in the past 750 years. The timing matches the Australian drought (*Nature Geoscience*, DOI: 10.1038/ngeo761).

From the past 60 years of pressure and moisture data over the combined region, the team also found a link between the patterns of two atmospheric moisture "corridors". One has been blowing dry air from the Southern Ocean over south-west Australia since the beginning of the drought, whilst another is shifting moist air south towards Antarctica.

Van Ommen says a pressure system that lies between Antarctica and Australia may be the lynchpin for this atmospheric see-saw. The pressure system has been strengthening since the mid-20th century, making the weather patterns in each destination more extreme. It is unclear whether or not climate change is involved.

LUEDKE AND SPARROW/GETTY

Ale is good, make no bones about it

A BEER a day could keep brittle bones at bay. That's because beer is rich in silicon, an element that has been linked to bone health. But what type of beer should you drink?

Previous studies have shown that silicon can aid bone growth, and that moderate beer drinking is linked to increased bone density. Now Charles Bamforth and Troy Casey at the University of California, Davis, have discovered how much silicon each type of beer contains.

They analysed 100 beers from around the world and found that the brews contained between 6.4 and 56 milligrams of silicon per litre, with an average of 29 milligrams per litre. Looking at the silicon levels in beer's ingredients, they found that most of it comes from the husks of malted barley (*Journal of the Science of Food and Agriculture*, DOI: 10.1002/JSFA.3884O).

The pair found that lighter-coloured beers made from pale malted barley and hops, such as pale ales, are richest in silicon, while low-alcohol beers contain the least, along with stouts, porters and wheat beers.

Be alarmed

Designs on cellphone security

IF YOU'RE forever leaving your cellphone on the kitchen table or bus, you may have use for a Bluetooth device that immediately sounds an alarm and locks the phone if the two gadgets move beyond a set distance apart. The device also regularly backs up data from the phone, and would alert you if a thief were to make off with your handset.

Dubbed the "i-migo" (pictured), it is one of three designs to win the UK's Mobile Phone Security Challenge to design crime-proof cellphones.

The other winners include an authentication card which you swipe over a cellphone handset to approve small payments made by phone, and a method to marry a handset to a specific SIM card, thereby reducing the appeal of stolen phones.

The competition is part of an initiative by the UK's Home Office and Design Council to find solutions to problems that the cellphone industry has failed to tackle. It was judged by a panel of design and telecoms experts, including representatives from Vodafone and Nokia.

"The rapidly developing nature of mobile technology means safeguards must be incorporated at the drawing-board stage if we are to stop criminals profiting from this type of crime," says Home Office minister Alan Campbell.

"Safeguards must be incorporated at the drawing-board stage if we are to stop criminals"

Prototypes of all three winning designs will be presented at the Mobile World Congress in Barcelona, Spain, this week.

Two's a blast for magneto-power

SENDING power to gadgets using magnetic fields is a leading contender for wireless supply (*New Scientist*, 6 February, p 43). Now it seems the method is more efficient when several devices are collecting energy (*Applied Physics Letters*, DOI: 10.1063/1.3284651).

A team from the Massachusetts Institute of Technology beamed 25 watts or more to either one or two devices tuned to resonate with a metre-wide copper coil. The pair did not interfere with each other, and together collected more of the beamed power. Two gadgets 2.4 metres from the coil collected half of its energy; one alone only harvested a third.

"We could power multiple devices with reasonably good efficiency over a room-sized area using a coil embedded in a ceiling or wall," says team member André Kurs.

14%

of results provided in response to popular web search terms point to sites containing malware, says IT firm WebSense

Crystal makes memories greener

A SAFFRON-coloured crystal could provide a step towards greener electronics.

Some types of low-power computer memory store information using metals that are ferroelectric, meaning they form positive and negative poles when placed in an electric field. However, many of the more common metals used are either rare or toxic.

Now Sachio Horiuchi at the National Institute of Advanced Industrial Science and Technology in Ibaraki, Japan, and colleagues have discovered ferroelectric behaviour in crystalline croconic acid, which contains just carbon, oxygen and hydrogen.

Croconic acid was discovered 170 years ago but crystallised for the first time within the past decade. When Horiuchi's team applied an electric field to the crystals at room temperature they could reverse its electric polarity.

The researchers noticed a small time lag between removing the field and reversal of the crystal's polarity. This is "typical of ferroelectrics", says Horiuchi, and a "direct indication of the ability to store and switch an electrical polarisation". The finding suggests croconic acid could be used in organic electronics (*Nature*, DOI: 10.1038/nature08731).

"It was essentially allowed to be sabotaged"

Following the unveiling of Apple's iPad, former Microsoft vice-president **Dick Brass** explains why the company's tablet PC never took off. He claims it was undermined by "internecine warfare" in the executive team (*The New York Times*, 4 February)

It's not what you say it's the way that you say it

By picking up non-verbal nuances in our speech, a new generation of software is helping to make audio-conferencing a more natural experience

Colin Barras

MOST of us talk to our computers, if only to curse them when a glitch destroys hours of work. Sadly the computer doesn't usually listen, but new kinds of software are being developed that make conversing with a computer rather more productive.

The longest established of these is automatic speech recognition (ASR), the technology that converts the spoken word to text. More recently it has been joined by subtler techniques that go beyond what you say, and analyse how you say it. Between them they could help us communicate more effectively in situations where face-to-face conversation is not possible.

ASR has come a long way since 1964, when visitors to the World's Fair in New York were wowed by a device called the IBM Shoebox, which performed simple arithmetic calculations in response to voice commands. Yet people's perceptions of the usefulness of ASR have, if anything, diminished.

"State-of-the-art ASR has an error rate of 30 to 35 per cent," says Simon Tucker at the University of Sheffield, UK, "and that's just very annoying." Its shortcomings are highlighted by the plethora of web pages poking fun at some of the mistakes made by Google Voice, which turns voicemail messages into text.

What's more, even when ASR gets it right the results can be unsatisfactory, as simply transcribing what someone says often makes for awkward reading. People's speech can be peppered with repetition, or sentences that just tail off.

"Even if you had perfect transcription of the words, it's often the case that you still couldn't tell what was going on," says Alex Pentland, who directs the Human Dynamics Lab at the Massachusetts Institute of Technology. "People's language use is very indirect and idiomatic," he points out.

Despite these limitations, ASR has its uses, says Tucker. With colleagues at Sheffield and Steve Whittaker at IBM Research in Almaden, California, he has developed a system called Catchup, designed to summarise in almost real time what has been said at a business meeting so the latecomers can... well, catch up with what they missed. Catchup is able to identify the important words and phrases in an ASR transcript and edit out the unimportant ones. It does so by using the frequency with which a word appears as an indicator of its importance, having first ruled out a "stop list" of very common words. It leaves the text surrounding the important words in place to put them in context, and removes the rest.

A key feature of Catchup is that it then presents the result in audio form, so the latecomer hears a spoken summary rather than having to plough through a transcript. "It provides a much better user experience," says Tucker.

In tests of Catchup, its developers reported that around 80 per cent of subjects were able to understand the summary, even when it was less than half the length of the original conversation. A similar proportion said that it gave them a better idea of what they had missed than they could

"An audio record preserves some of the social signals in speech that are missing from a written one"

RANDY FARIS/CORBIS

glean by trying to infer it from the portion of the meeting they could attend.

One advantage of the audio summary, rather than a written one, is that it preserves some of the social signals embedded in speech. A written transcript might show that one person spoke for several minutes, but it won't reveal the confidence or hesitancy in their voice. These signals "can be more important than what's actually said", says Steve Renals, a speech technologist at the University of Edinburgh, UK, who was one of the developers of the ASR technology used by Catchup.

An audio record cannot, of course, convey the wealth of social signals that are available in face-to-face conversation – a raised eyebrow, for example, or a nod of the head – and as meetings are increasingly conducted by phone or online, participants in remote locations suffer. So Pentland and colleagues at MIT have been analysing individual speaking styles, and using the results to fill the gap. This kind of speech analysis could, he claims, improve the quality of audio conference calls by helping participants in a distributed meeting to feel socially connected.

Pentland's work in this area is based on years of studying the non-verbal signals embedded in speech patterns. Those studies have revealed, for example, correlations between how interested someone is in what's being said and how loudly they talk, or the frequency with which they switch from talking to listening.

Working with PhD student Taemie Kim, Pentland has begun to use some of these findings in a device to improve social signalling in distributed meetings. Their "Meeting Mediator" measures how much time four people in two separate locations participating in an audio conference spend talking. If one of them hogs the conversation, all four see that in graphical form on a screen in front of them.

This had a big impact on their behaviour, Kim and Pentland found. The average speech segment – a measure of the time an individual spoke before inviting others to take over – fell from 11.2 seconds to 9.2 seconds.

The system also discouraged participants from splitting into groups and beginning separate conversations. "The feedback was designed to encourage balance and interactivity," says Kim. Just having that "in their face" helped achieve this, she says. By extending such systems to display on-screen variation in interest level as well, participants phoning in to a meeting could get a better sense of the social signals they are missing.

Pentland says that such tools, which move beyond mere recognition of words, will help improve conference-call meetings. "'Reading' the people rather than 'reading' the words can be a real game-changer for collaboration," he says. ■

Over the phone it's even worse

AP PHOTO/PAUL SAKUMA/PA

A gas-pedal fix

Toyota's car recall sparks 'drive-by-wire' concerns

"WE'RE going north on 125 and our accelerator is stuck... We're going 120 [mph]... There's no brakes... We're approaching the intersection! Hold on! Pray!"

The desperate words are followed by shouts, screams and then silence. The clip, circulating on the internet, is a harrowing excerpt from a 911 emergency call made shortly before the crash that killed speaker Chris Lastrella and the three others in the car, which accelerated out of control on a highway in San Diego, California, in August 2009. The case is one of the most infamous examples of what has been termed sudden unintended acceleration (SUA).

The Toyota Lexus model Lastrella was in is not one of the models that the world's largest car maker has now recalled due to accelerator problems, however. Toyota says the problems that led to the recall are purely mechanical - floor mats getting stuck in gas pedals, and the wearing of a pedal component that may cause the throttle to stick in an open position.

But there is a persistent chorus of voices saying that in some instances the problems are associated with the introduction of electronic rather than mechanical throttle control. Jim Lentz, president of Toyota Motor Sales, insists: "It is not an electronics issue."

Those assurances have failed to dispel the concerns of people like Keith Armstrong, a UK-based electronic design consultant, currently acting as an expert witness in an SUA court case in Florida, who think that "drive-by-wire" systems are prone to SUA problems. "There are many cases involving sudden accelerations from standstill," says Armstrong.

Toyota UK spokesman David Crouch said he was not aware of any reports of sudden acceleration in stationary Toyota cars.

Armstrong says electromagnetic interference (EMI) might be involved in SUA events. "The more electronics you have in a vehicle, the more electrical noise you tend to get." But detecting malfunctions triggered by EMI is extremely hard as such incidents often leave no trace.

"Toyota says that the problems that led to the recall are purely mechanical"

The US National Highway Traffic Safety Administration has already carried out EMI tests on numerous vehicles, including Toyotas, and found no safety issues. However, last week it said it would launch an investigation into the possible effects of EMI on electronic throttle-control systems.

"All our cars are tested for electromagnetic interference," says Crouch. Nic Fleming ■

Pliable power pack will let gadgets feed on your body

SHEETS of material that produce voltage when flexed could generate power from the motion of the human body.

Previous materials were either too rigid or too inefficient to be practical as pliable power generators. Now two research teams have solved the problem using different approaches. The materials could allow future medical implants to harvest their own power, by using the pulsing of arteries, for example.

Yi Qi and Michael McAlpine of Princeton University developed a way to soften up the usually inflexible crystal lead-zirconate-titanate (PZT), which is one of the most efficient piezoelectric materials known.

"People thought, 'this is a crystal'; they never thought about whether they could make it flexible," says McAlpine. But he and Qi found that when an extremely thin film of the ceramic is grown on a solid substrate and cut into strips about 5 micrometres thick, the resulting material can flex (see diagram).

These "nanoribbons" are like fibre-optic cable made using glass, says McAlpine. Being long and thin, they can still bend despite being made of a material that is rigid in bulk.

The strips were attached to conducting silicone rubber to produce a flexible sheet that converts motion to electricity about half as well as traditional, rigid PZT (*Nano Letters*, DOI: 10.1021/nl903377u).

In contrast, Chieh Chang and Liwei Lin of the University of California at Berkeley created fibres from a piezoelectric polymer called PVDF. The polymer is usually made in sheets, but the researchers spun it into fibres by drawing the molten material through a nozzle using an electric field.

This technique usually results in a fibre inside which the charged domains responsible for the material's useful properties are randomly oriented, leading them to cancel out one another's output. The Berkeley team used a strong electric field and the mechanical stress of the spinning process to line up those domains and ensure they work in unison.

When more than 40 samples were tested the fibres proved capable of converting 12.5 per cent of the mechanical energy used to deform them into electricity. Some recovered 20 per cent (*Nano Letters*, DOI: 10.1021/nl9040719). Lin says this makes them competitive with a conventional film of rigid PZT.

"Using flexible materials will open up a new field of mechanical energy harvesting," says Xudong Wang at the University of Wisconsin, Madison, who says "waste" movement is often overlooked as an energy source.

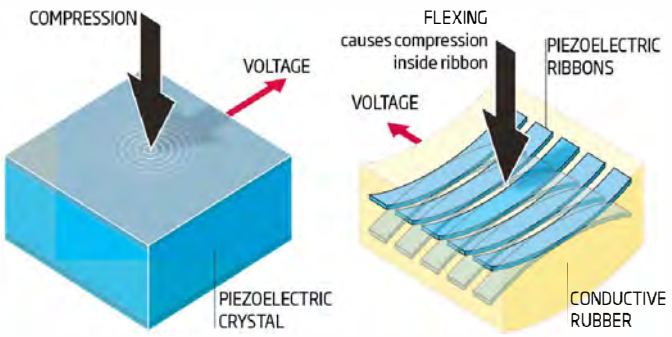
McAlpine says flexible piezomaterials of either kind could be used to make motion-powered generators to extend the battery life of medical devices like pacemakers. "You could even eliminate the battery altogether," he says. **MacGregor Campbell** ■

Flexible generator

Sheets that produce electricity when flexed could provide a new way to power medical implants

Piezoelectric crystals produce voltage when compressed. They can generate power from "waste" movement like vibrations

Thin ribbons of the material are more pliable and can be combined with rubber to make sheets that generate a voltage when flexed



Data thieves caught red-handed by 'USB fingerprints'

WOULD your company know if the blueprints for its next invention had been stolen by an office interloper, who had quietly copied them onto a memory stick or an iPod? Probably not. But now a telltale "USB fingerprint" has been discovered that can identify which files have been targeted in so-called pod-slurping attacks.

Data theft via USB ports is rife, says Alexandra Brodie, an intellectual property lawyer with Wragge & Co in London. "We are encountering increasing volumes of IP theft committed this way, with companies losing their trade secrets and accumulated know-how," she says.

Pod slurpers might simply steal an individual document by copying it onto a USB stick. Hackers can also copy vast numbers of documents using document-scavenging tools such as USB Switchblade. This too springs to life when a memory stick is plugged into a PC running some versions of Windows, including XP. It then automatically copies the contents of the My Documents folder and no one is any the wiser. Now there is a way to spot such data theft.

Vasilios Katos and Theodoros Kavallaris at the Democritus University of Thrace in Komotini, Greece, have been testing every make and model of USB stick and iPod/iPhone. They have discovered that each one has a distinctive transfer rate when copying data from a PC's hard drive (*Computers and Security*, DOI: 10.1016/j.cose.2010.01.002). This is due to the differences in the microcircuitry and components that go into making each type of device.

"If the time it took to access all the files matches the transfer time of a USB then it's a pod-slurping attack"

They are able to find out if files have been copied by consulting the Windows registry, which records the make and model of every USB device plugged into that computer with a time stamp. The pair then check all document folders for any files that were accessed shortly after the USB device was plugged in – the computer registry counts copying as file access.

When they find a folder they suspect has been copied, they list the times the files within it were accessed. If the total time it took to access all the files matches the transfer rate of a particular USB stick or iPod plugged into the PC at that point, then it is fair to assume a pod-slurping attack has taken place.

Kavallaris is writing a program to automate the process of trawling the Windows registry to work out which files have been copied to a USB stick.

Brodie thinks the team's work could help investigators. "The ability to prove that downloads have taken place will be invaluable in building a case when thefts occur." Paul Marks ■

New Scientist 2010 calendar

The fantastic pictures in the New Scientist 2010 calendar have all been taken by New Scientist readers, capturing what science and technology mean to them. Throughout the year you'll be able to see stunning images including birch sawfly caterpillars deterring potential predators, a basket star feeding while perched on Noble Coral, camels sheltering from the sun under a shipwreck and the amazing patterns displayed in a January window frost.

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No new Nobels

A panel convened by *New Scientist* argued for a new set of Nobel prizes. The Nobel Foundation thought about it – then said no. Here's why

LAST year, a group of 10 scientists brought together by *New Scientist* wrote an open letter to the Nobel Foundation calling for an overhaul of the Nobel prizes. The group suggested that to keep the Nobels relevant, the foundation should introduce prizes for the environment and public health, and open them to institutions as well as individuals. It also suggested reforming the existing physiology or medicine prize to recognise contributions from across the life sciences, especially neuroscience and genetics.

The letter was taken very seriously. Marcus Storch, chairman of the board of the Nobel Foundation, discussed it in his opening address to the 2009 award ceremony in Stockholm.

Michael Sohlman, executive director of the Nobel Foundation, wrote to the letter's signatories to explain why the foundation had decided to reject the group's suggestions.

We can now publish his letter in full.

Dear Sirs,

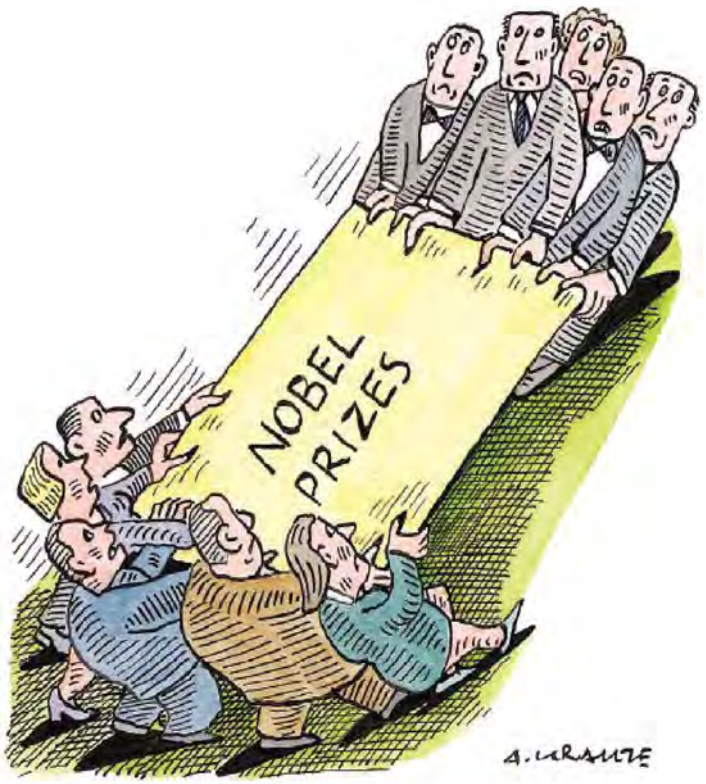
Thank you for your letter suggesting several new Nobel prizes. First we note with satisfaction the high esteem in which you hold the work of the Nobel committees in the "Nobelian" disciplines over the past 108 years.

Your suggestion to introduce a new Nobel prize, however, does not pass the "Occam's razor" of our statutes, which are based on the last will of Alfred Nobel in which he prescribed the five areas which he wanted to be covered by the prize. It is true that in 1968 the Sveriges Riksbank prize in economic sciences in memory of Alfred Nobel – not a Nobel prize sensu stricto – was adopted into the "family" and the procedures underpinning it are similar to those of the other scientific prizes. The board of directors of the Nobel Foundation later decided not to accept any further additions.

But even if one would, hypothetically, put these formal considerations aside, we take the liberty to disagree with your assessment of the flexibility, or lack of it, that the Nobel committees show in relation to the continuous progress in science.

You are perfectly right that Alfred Nobel could not foresee climate change or HIV/AIDS. In both areas, however, Nobel prizes have been awarded (Crutzen, Molina, Rowland, chemistry 1995; Maathai, peace 2004; Gore and IPCC, peace 2007; Barré-Sinoussi and Montagnier, physiology or medicine 2008).

Neuroscience, contrary to what seems to be the assumption in your letter, is hardly neglected: in the past 30 years, 11 neuroscientists were awarded the Nobel prize in physiology or medicine (Sperry, Hubel, Wiesel, Neher, Sakmann, Prusiner, Carlsson, Greengard, Kandel, Axel, Buck) and one received a Nobel prize in chemistry with important implications for neuroscience (MacKinnon). Genetics, another area you proposed for a new Nobel prize, has also been recognised several times in recent years (eight Nobel prizes in physiology or medicine, 17 laureates in the



WINNERS IN CLIMATE, HIV AND NEUROSCIENCE

CLIMATE CHANGE Peace 2007: Al Gore and the IPCC "for efforts to disseminate knowledge about man-made climate change". Peace 2004: Wangari Maathai "for contribution to sustainable development". Chemistry 1995: Paul Crutzen, Mario Molina and Sherwood Rowland "for work in atmospheric chemistry".
HIV/AIDS Medicine 2008: Françoise Barré-Sinoussi and Luc Montagnier "for their discovery of HIV".
NEUROSCIENCE Medicine 1981: Roger Sperry "for discoveries of the functional specialisation of the cerebral hemispheres" and David Hubel and Torsten Wiesel "for discoveries concerning information processing in the visual system". Medicine 1991: Erwin Neher and Bert Sakmann "for discoveries concerning the function of single ion channels in cells". Medicine 1997: Stanley Prusiner "for his discovery of prions". Medicine 2000: Arvid Carlsson, Paul Greengard and Eric Kandel "for discoveries concerning signal transduction in the nervous system";. Medicine 2004: Richard Axel and Linda Buck "for discoveries of the organisation of the olfactory system". Chemistry 2003: Roderick MacKinnon "for structural and mechanistic studies of ion channels".

past 30 years). And there has been no prerequisite that the work is done in humans. Research performed on yeast, flies and other organisms has been recognised when it has proved to have general relevance.

As for awards to institutions, our statues include that alternative, but until now only the Norwegian Nobel committee [which awards the peace prize] has been using that possibility, not the other committees. One explanation is probably the criteria set in Nobel's will. For the scientific disciplines it is "discovery or invention" for physics, "discovery or improvement" for chemistry and "discovery" for physiology or medicine.

"It was Nobel's conviction that discoveries are made by creative individuals, not by institutions"

For literature and peace, the corresponding words are "outstanding work" and "best work", respectively. It seems the scientific-prize awarders have the conviction, which was Nobel's, that inventions and discoveries are made by creative individuals, not by institutions. Without predicting the future, we think the continuous interpretation of Nobel's will by the committees has been reasonably successful up till now in tracing major developments of modern civilisation. ■

Michael Sohlman is executive director of the Nobel Foundation

One minute with...

Paul Nurse

How will the UK's ambitious plans for a new biomedical research centre fare if there is a change of government?

The UK Centre for Medical Research and Innovation (UKCMRI) is planned to be one of the biggest biomedical research centres in the world. Could election of a new government this year lead to it being scaled back?
I don't think so. UKCMRI is one of the UK's most important biomedical research initiatives in a generation. I've been very pleased to see the Labour government's strong support of science in recent years and hope that support will continue whichever party wins the election. Strong science is the key to creating wealth and improving the quality of life and health of the nation.

Which research areas do you want UKCMRI to concentrate on?
It will be large enough to cover a very wide range of biological and biomedical research. My own suggestion for a new research initiative is to make greater use of human material for biological investigations. High-throughput DNA sequencing will soon generate a huge amount of information on human genetic variation, which can be used to relate gene variants to differences in physiology and disease. New stem-cell technologies combined with 3D tissue culture systems could allow tissues and organs to be created in vitro, providing possible alternatives to animal models for biomedical investigations. Whole-body imaging is also becoming increasingly sophisticated, and this combined with the development of new chemical markers might allow more physiological studies in humans to be carried out.

What themes have you chosen for your lectures next month at the Royal Institution in London on the great ideas in biology?
The cell as the basic unit of life; the gene as the basis of heredity; evolution by natural selection; and life as chemistry. A potential fifth idea is understanding life as a complex organised system.

Are you still doing your own research?
I'm working on how cells keep track of how big they are. My laboratory has recently discovered a gradient mechanism for measuring cell size which relies on molecules located at the ends of cells. These molecules diffuse through the cell to sensing components at the middle of the cell. As the cell gets bigger, there is a drop in concentration of these molecules there, corresponding to the cell's size.

PAUL ZIMMERMAN/STARSTOCK

PROFILE
Paul Nurse is chairman of scientific planning at the UKCMRI and president of Rockefeller University, New York. He won a share of the 2001 Nobel prize for his work on cell regulation

You recently made a surprise discovery about your family history. Can you tell us about it?
In 2008 my Green Card application was rejected by the US Department of Homeland Security on the grounds that the details on my birth certificate were inadequate. When I eventually received my full birth certificate, the next few seconds were both unexpected and transforming. The name of my mother on the certificate was the name of the person I thought was my sister. My father may have been a serviceman. I had been brought up by my grandparents and my true origins had been kept from me for half a century. It's ironic that even though I am a geneticist my family managed to keep my genetic origins secret for so long.
Interview by Roger Highfield

Talking aliens

From David Brin
Stephen Battersby discussed the current debate over broadcasting messages into space with the intention of their being detected by extraterrestrial life forms (23 January, p 28). The editorial in the same issue (p 3) endorses the idea.

As an astronomer who has been involved in topics relating to the search for extraterrestrial intelligence (SETI) for 30 years, and as a former member of SETI advisory panels, I feel there is an arrogance in the transmission of these messages by small groups who have claimed the right to shout on behalf of Earth without consulting anybody else.

Many SETI researchers and others, including the editorial board of *Nature*, have asked for there to be a moratorium on these messages until broad international discussions can take place. These should involve biologists, historians, ethicists and members of the public.

That doesn't seem much to ask, given the importance of the matter and our ignorance of the cosmos. However many technological species there are out there, we are almost certainly the youngest children, suddenly shouting in an unknown forest. The daunting silence in the sky has its creepy aspects. Can't we discuss the implications and satisfy reasonable concerns before yelling "Yoohoo"?

The message zealots label as paranoid anybody who wants open discussion. With their peremptory broadcasts, they bet our future on the assumption that all technological alien species will be altruistic. In doing so they ignore all the indications from human or biological history that suggest this is highly unlikely to be the case.

They deploy a host of blithe excuses, such as "aliens have already picked up our radio leakage" and "harm cannot span interstellar distances", but they do not hold up under scientific scrutiny.

Eagerness to achieve "first contact", while laudable, should be tempered by awareness of the history of first contacts between human cultures, and between previously isolated Earthly biomes. These make a sad litany that suggests patience, caution and lengthy discussion are in order before we make our presence known to the cosmos at large.
Encinitas, California, US

From Kevin Buckley
The discussion of how to format a suitable message for transmission to an alien civilisation misses the reality of what it means to communicate with beings who probably experience the world in a different way to us.

Most of the current proposals

seem to take it for granted that the recipients will be capable of receiving a message if it is in a form that we ourselves could easily pick up and interpret. But there is no reason why this should be the case.

Consider, if you will, how a human civilisation of just a few thousand years ago might imagine "communications from beyond this world" would occur. Stone tablets from the sky would clearly be a good starting point.

These days most proposed templates seem based on images, but how might that be interpreted by, for example, an advanced civilisation of fish? They might sense more through the skin or electronic waves than through sight and smell.

Even if our target alien civilisation is sufficiently well developed that its members can receive, decode and visualise our transmission, we cannot assume they share with us the sensory mechanisms by which we understand the external world.

Unless we take into account the very different ways in which different species could build their internal "world models", it seems that any form of communication currently under consideration has a very low likelihood of being understood.
Woodcote, Berkshire, UK

From David Collins
I am always concerned that we assume that aliens will all look alike, come from a global village, speak the same language and share a culture.

From H. G. Wells's time traveller to *Star Trek*'s Captain Kirk, visitors to other worlds seem to explore only a few hundred metres from their landing point – an extremely misleading view of alien life. Suppose our visitors dropped in on the Democratic Republic of the Congo, Greenland or Nevada – what impression would they get?

On our own planet, aliens may have dropped in a long time ago. Prions? Archaea? Slime moulds? Cetaceans? Nematodes?
Harpenden, Hertfordshire, UK

From Tim Malyon
I was born at a time when our own world was not yet even fully mapped. As a child I thought that landing a man on the moon would be the greatest thing that would happen in my lifetime. Now if someone could only provide definite proof of extraterrestrial life, I would feel that I had lived in humanity's greatest ever period of discovery.
Beattock, Dumfriesshire, UK

From F. Gwynplaine MacIntyre
The message that was transmitted from Arecibo more than three decades ago, signalling our presence to extraterrestrials, included a diagram of the solar system as perceived in 1974: nine planets of varying sizes orbiting the sun, ranging from Mercury to Pluto. Now that Pluto is no longer officially categorised as a planet, shouldn't we transmit a correction?
Glasgow, UK

Enigma Number 1582

Bit tricky

BOB WALKER

Joe thought he would test Penny's ability to manipulate equations this week. So he asked her to find the values of the integers A, B and C in the following equation.

$$\frac{(A.B+1)}{(A.B.C+A+C)} \div \frac{}{0.138}$$

What are the values of A, B and C?

WIN £15 will be awarded to the sender of the first correct answer opened on Wednesday 17 March. The Editor's decision is final.
Please send entries to Enigma 1582, New Scientist, Lacon House, 84 Theobald's Road, London WC1X 8NS, or to enigma@newscientist.com (please include your postal address).
Answer to 1576 The holly and the ivy and the...: Holly on red, ivy on silver, mistletoe on gold
The winner Beth Morgan of Palo Alto, California, US

More the merrier?

From Caroline Dumonteil
Laura Fortunato and Marco Archetti have created a mathematical model suggesting that "monogamous marriage [can be] a better strategy for men as well as for women" (9 January, p 13). They argue that "social monogamy is not inevitable" but arises in agricultural societies where men wish to prevent subdividing landholdings among their heirs.

This model includes the assumption that "women in early agrarian cultures did not provide much in the way of material resources". However, in agricultural economies women could be considered a resource because of the food and offspring they produce on plots of land allocated by their husbands. In such societies it would therefore be in the man's interests to have more than one wife and his role would be to provide protection for his family. This system still exists in parts of rural Africa, where women produce most of the food but a husband's death can deprive them of land and leave them and their children destitute.
Montigny sur Loing, France

Democracy's demise

From Nick Deane
In highlighting how unlikely it would be for a government to be voted in if it proposed to enforce changes to our lifestyles great enough to mitigate climate change, Richard Platt puts his finger on a profound dilemma for all democratic systems (9 January, p 27).

Historically, it can be argued that democracy has only flourished as long as the promise of "more for everybody" has been capable of fulfilment. Platt rightly points out that this may not be possible for much longer.

A logical extension of this thought is that our cherished democratic political system may not have what is necessary to resolve our current predicament. If this is correct, the future may offer much bleaker prospects than just cutting back on long-haul flights and journeys by car.
Marrickville, New South Wales, Australia

Military benefit

From Ben Haller
You report that researchers at the Massachusetts Institute of Technology have discovered how the structure of a snail's shell absorbs and dissipates impacts (23 January, p 17). They are then quoted as saying this could allow us to improve body armour – a comment I find particularly sad.

I can think of lots of ways this discovery could be used to help make life better: improved car bodies that protect us from accidents, damage-absorbing cases for laptops and other electronic devices, or better bicycle helmets.

Their paper indicates that funding for the research came from the US army, the Department of Defense and US defence supplier Raytheon, among others.

It is high time there was a real discussion in the scientific community of the ways that defence funding of research can distort science. Not only does it change the questions that we ask, directing us towards problems

that are applicable to warfare, it also changes how we perceive the utility of our most general and useful discoveries.

Is finding new and improved ways to kill each other the best use we can think of for science?
Montreal, Canada

In your head

From Colin Morrison
Ray Tallis discusses the "insuperable problem" of explaining how intracranial nerve impulses can be "about" extracranial objects, but thinking in these terms rather confuses the issue (9 January, p 28).

Our experiences are not "about" extracranial things any more than your experience of your hand is about the appendage on the end of your wrist. As amputees experiencing phantom limbs know all too well, the pattern of experiences you call your hand is located within your brain. The sensation of pain in your hand is actually an addition to the many other experiences that are generated by the same region of your brain.

We only think of the hand as a part of a body operating in an external world because our brains have evolved to consistently encode data from that part of our body in that part of our experience.

The "aboutness" connection is indeed mysterious but it is not an unprecedented "reaching out" of a part of the brain into the external world as Tallis suggests – and it should not prevent us recognising as our consciousness whatever neurological phenomenon turns out to be identical with it.
Cupar, Fife, UK

A little knowledge

From Derek Hallam
While I agree wholeheartedly with the concerns expressed in Paul Parsons's article on the dangers of increased availability of information (16 January, p 38), it is disappointing to see the words "information" and "knowledge" so freely interchanged. When we complain that "a little knowledge is a dangerous thing", we are referring to the danger that arises when we draw a flawed conclusion from limited relevant information we hold in our brains, and then base our actions on the consequent flawed knowledge.

I suggest that the real risk lies in us not knowing, or even worse not caring, whether we have adequate or good quality information to draw a sound conclusion. However, clearly anything which alerts us to, and maintains an awareness of, that risk has to be of great value.
Tallong, New South Wales, Australia

For the record

■ Spencer Brown is the director of research in the Department of Plastic Surgery at the University of Texas Southwestern Medical Center in Dallas, not a surgeon as we stated (23 January, p 42)

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Unearthing China's feathered fossils

Xu Xing's dinosaur finds range from a pint-sized creature with four wings to the feathered ancestor of *Tyrannosaurus rex*. Between them, they have cemented the evolutionary link between dinosaurs and birds. He talks to **Phil McKenna** about his work

How did you become interested in dinosaurs?
I grew up in a remote region in Xinjiang province. I didn't even know what a dinosaur was when I was young, not even when I was in high school. I was interested in physics, but when I got in to Beijing University I was assigned to study palaeontology. I was later admitted as a graduate student to the Chinese Academy of Sciences to continue studying palaeontology. I was only interested because it meant I could stay in Beijing and didn't have to go back to Xinjiang, but early in my career I got to study some very interesting fossils. Now it's hard to imagine how I could live without dinosaurs.

Before your discoveries of feathered dinosaurs, what was the prevailing thinking on the relationship between dinosaurs and birds?
It was generally accepted that birds were descended from dinosaurs. People had found many dinosaurs that shared striking similarities with early birds, yet a few things didn't quite fit. The time sequence didn't seem to be correct, for instance. Most of these bird-like dinosaurs were from the Cretaceous, from 145 million to 65 million years ago, but the earliest known bird, *Archaeopteryx*, was much older – from the Jurassic, 200 million to 145 million years ago. Also, if birds were descended from dinosaurs, you would predict that their dinosaur ancestors should have feathers or feather-like structures. But at that time there was no fossil evidence for this.

What have you found that changed this?
In 1996 a feathered dinosaur, *Sinosauropteryx*, was discovered in north-eastern China by other Chinese researchers. So in 1997 we organised an expedition in that area, and that year we discovered a second feathered dinosaur, *Beipiaosaurus*. That specimen supported the conclusion earlier researchers had made that primitive feathers are widely distributed among bird-like dinosaurs. Then in 1998 we found another feathered genus, *Sinornithosaurus*. Collectively, these fossils were the first solid evidence of primitive feathers and they were found in dinosaurs. This provided very good evidence supporting the idea that birds evolved from dinosaurs; before this, feathers were only known in birds.

Many of the early bird-like feathered dinosaurs you describe could not fly. What did they use their feathers for?
Some believe the initial purpose of feathers was for flight, some say it was for insulation. Based on my observations, I don't think it was either. Primitive feathers were not good for flight: they were weak, hair-like structures. They were also very rigid, not an ideal structure for insulation, and they were less densely populated on the body than you would expect for insulation. It's still not entirely clear, but they appear to initially have had a display function.

The transition from dinosaurs to birds involved some unexpected turns. Do any of your other findings tell us about this process?
In 2003 we made another, even bigger discovery – a new species called *Microraptor gui*. This species is amazing because it has feathers attached to its legs as well as its forelimbs, so we called it a four-winged dinosaur.

This was one of the most important discoveries in understanding the transition from dinosaurs to birds because it revealed an entirely new stage of morphology during the transition. A hundred years ago, the American palaeontologist William Beebe predicted that there would be a phase in evolution involving a hypothetical four-winged "tetrapteryx". He suggested bird ancestors used not only arm feathers but also big feathers attached to their legs. But at the

PROFILE
Xu Xing is at the Chinese Academy of Sciences Institute of Vertebrate Paleontology and Paleonanthropology in Beijing. He has named some 30 species of dinosaurs, more than anyone else alive, and has played a leading role in some of the most important fossil discoveries of the past decade

COURTESY OF THE IVPP

Many of Xu Xing's important finds came from the desertsof northern China

time there was no fossil evidence to support his theory. Our discovery of *M. gui* showed that there was a four-winged stage in the evolution of birds. Laterwe found others: *Pedopenna* fromInner Mongolia, and in 2009 we published on another species, *Anchiornis huxleyi*, or "near bird". They are all from different lineages but all have four wings.

What was the response to finding *M. gui*?
Its existence argues so strongly against the mainstream understanding of the dinosaur-to-bird transition that some people didn't believe it was a real specimen, or even that it was the true morphology for the species. Later, our group and others found more specimens – more than 1000 in all – of four-winged dinosaurs across a number of different lineages, which showed that it is definitely a common and important condition for the origin of birds.

What about the problematic issue of the time sequence?
Anchiornis belongs to one of the most bird-like groups of dinosaurs and lived about 160 million years ago, roughly 10 million years before the first known bird. Since 2001 we have discovered a lot of specimens from Xinjiang, where there is a huge exposure of Jurassic rocks, including the feathered dinosaur *Guanlong*, the earliest known ancestral form of *T. rex*, as well as many others that haven't yet been published. And just last month in *Science* (DOI: 10.1126/science.1182143), we described *Haplocheirus sollers* from the Alvarezsauridae, a bizarre group of bird-like dinosaurs with a large claw on one hand and very short, powerful arms. This creature has helped us solve the puzzle of how dinosaurs came to look like birds and takes the evolution of another group of bird-like dinosaurs back a further 63 million years. Until this find we had no direct evidence that dinosaurs like this lived 160 million years ago in the late Jurassic. So in terms of establishing the time sequence, this is a huge discovery.

You bought some fossils from farmers and dealers. Is this a common practice – and do you have any concerns about it?
It is true that we purchased many of the specimens from Liaoning province – including some of the first feathered dinosaurs we found – from local farmers or dealers. The density of fossil-bearing rocks is very rich there and the farmers are also very poor. It's common in China to buy fossils, though it is not encouraged. In all other areas – Inner Mongolia, and Xinjiang and Shandong provinces – we have dug all the fossils ourselves. I don't like to buy fossils, and I will say I've bought fewer and fewer in recent years. My colleagues have the same idea. It's not good to buy fossils as it encourages people to dig illegally, and it's not good for science because fossils can be damaged in the process. But in China, so many people are digging and it's not just the museums that buy them. The most difficult decision is when you see a very scientifically important fossil: do you let it go or keep it for science? If you don't buy it, it will go somewhere else and will be a loss for science, but if you do buy it, it will encourage farmers to continue digging.

"*Microraptor gui* is amazing. It has feathers attached to its legs as well as its arms"

What are you working on now?
I have found four new dinosaur species that will be published soon. One species is the first known ceratopsid, or "horned dinosaur", from outside of North America. Many of my new finds are from a quarry that recently opened in Shandong province and is the largest known dinosaur graveyard in the world. We have already explored thousands of dinosaur bones and found several new species there. I'm also filming a documentary for *National Geographic*, on the evolution of feathers. ■

An "impossible" stellar explosion may provide an unexpected window onto the earliest days of the cosmos, says **Stuart Clark**

The star that time forgot

At first, there didn't seem anything earth-shattering about the tiny point of light that pricked the southern Californian sky on a mild night in early April 2007. Only the robotic eyes of the Nearby Supernova Factory, a project designed to spy out distant stellar explosions, spotted it from the Palomar Observatory, high in the hills between Los Angeles and San Diego.

The project's computers automatically forwarded the images to a data server to await analysis. The same routine kicks in scores of times each year when a far-off star in its death throes explodes onto the night sky, before fading back to obscurity once more.

But this one did not fade away. It got brighter. And brighter. That's when human eyes became alert.

The supernova finally reached its peak brightness after 77 days. After 200 days – long after most supernovae have dwindled back into obscurity – it was still burning brightly. Only in October 2008, an unprecedented 555 days after it was first spotted, had it faded enough for the supernova hunters to call off their observations.

Digesting what they had seen took longer still. SN 2007bi, as dry protocol labelled the event, was one of the most extreme explosions ever recorded, of that there was no doubt. It was so intense that it didn't fit any model of how normal stars die. But then, it was rapidly becoming clear that, in life as in death, this had been no normal star.

If the interpretation of what popped up that April night is correct, this was a star that should not have existed, in a place where it should never have been. It was a mind-bogglingly massive star that was a throwback to a universe long since gone. It was a star that time forgot.

That picture began to emerge only after long months of monitoring the supernova's afterglow with the Samuel Oschin Telescope, a 61-year-old veteran atop Mount Palomar. This afterglow is powered by the decay of heavy radioactive elements generated in the runaway processes of nuclear fusion that occur during the initial explosion. The critical process is the decay of radioactive nickel, which quickly turns to cobalt, which in turn decays to iron, radiating gamma rays as it does so. The brightness and persistence of the afterglow reveal how much of these elements the supernova produced.

Plugging these observations into models of conventional supernovae brought a startling conclusion. To keep the supernova glowing that brightly, and for that long, the explosion must have produced 10 times more radioactive nickel than a normal supernova can muster – a discrepancy so huge that it demanded an explanation.

TIM GRAVESTOCK

A clue to what was going on came in a few largely forgotten papers buried in journals from 40 years ago. In the core of any massive star, the outward pressure of photons created in nuclear fusion reactions counters the weight of the material bearing down on it, preventing the star from collapsing in on itself. Sometimes, in massive stars many times the size of the sun, gravity can eventually overwhelm this photon pressure, initiating what is known as a core-collapse, or type II, supernova. That is one of two common types of supernova. The other, called type Ia, occurs when a dying white dwarf star accretes mass from a companion star and grows unstable, igniting in a final searing fireball (see diagram, page 31).

In the old papers, astronomers speculated on what might happen to cause a truly giant star – one bigger than about 200 suns – to go supernova. In this case, they calculated, the core of the star could eventually become so hot during nuclear fusion that photons would start to convert spontaneously into pairs of particles: an electron and its antimatter doppelgänger, a positron. This would rob the star of some of the photon pressure needed to support its outer layers, causing it to collapse in on itself in a gargantuan supernova that would vaporise the star. This final titanic burst of fusion would create vast quantities of heavy radioactive elements, far larger than a conventional supernova can produce. The astronomers called it a "pair-instability" supernova.

Implausible interloper

No supernova explosion answering to this description had ever been witnessed, and the idea remained a mere twinkling in the theorists' eyes. That is, it did until Avishay Gal-Yam, an astrophysicist at the Weizmann Institute of Science in Rehovot, Israel, and his collaborators started looking at SN 2007bi. The more they compared the data with various supernova models, the more they became convinced that the pair-instability model was the answer to the conundrum this explosion posed. "Only a pair-instability supernova can produce that much radioactive nickel," says Gal-Yam. With the model, they could even calculate how big the exploding star had been: a whopping 300 times the mass of the sun (*Nature*, vol 462, p 624). ›

"We would dearly love to see one of these cosmic giants directly, if only to confirm the grounds for our own existence"

Problem solved? Not a bit of it. The finding came with a massive sting in its tail: according to all our theories and all our observations, stars that big simply should not exist.

At least, they should not exist in the kind of universe we see around us today. In the decades since the pair-instability model was born, theory and some comprehensive sweeps of the night sky have combined to show that the composition of the modern cosmos prevents stars reaching such huge sizes. The presence of appreciable quantities of what astronomers call metals – elements heavier than hydrogen and helium – causes gas clouds to collapse speedily into "pocket-sized" stars. That is why most stars today are celestial minnows, containing less mass than our sun. The absolute upper limit on a modern star, theory and observations of our galaxy agree, lies at about 150 solar masses. A monster of 300 solar masses is an implausible interloper into this settled scene.

Things were different in early cosmic times, some 13 billion years ago in the pristine universe immediately after the big bang. Back then, solar giants ruled the roost. Only hydrogen, helium and trace amounts of lithium were floating around the cosmos, and much bigger quantities of these elements had to accumulate before they fell under the spell of gravity and were pulled together to form a star. As a result, the first stars in the universe were humongous, containing anything up to several hundred solar masses.

Fossil universes

Existing before proper galaxies had been able to form, these stars lived brief, wild lives of just a few million years as they furiously burned their vast stocks of hydrogen. Yet in their violent deaths, these stars were of huge significance. As theory has it, these explosions fused the first elements heaver than hydrogen, helium and lithium. They provided the raw materials for the cosmos we see today: its galaxies, its sun-like stars, its planets and, in one insignificant corner at least, its life.

No one has ever seen these cosmic giants directly. We would dearly love to, if only to confirm the grounds for our own existence. Unfortunately, we can't. Even as they were sowing the seeds of the future cosmos, these megastars were precipitating their own demise. By increasing the metal content of the cosmos as they died, they destroyed the very conditions that nurtured them in the first place. By the end of the first few hundred million years after the big bang, metal levels were so high that stars of their like could never form again. Direct evidence for the existence of megastars lies far beyond the horizon of even our most powerful telescopes.

Or does it? If SN 2007bi is what it seems, we might have found a get-out clause: a loophole that allows us to spy if not the first megastars, then something very similar. Against the odds, the cosmic trailblazers may have lived on into the modern universe. But how?

The secret lies in where this supernova was situated: an otherwise unassuming dwarf galaxy some 1.6 billion light years away from Earth. Dwarf galaxies, as their name suggests, are runtish structures that never made it to full size. Whereas a fully formed galaxy such as our own Milky Way contains several hundred billion stars, a dwarf galaxy can have as few as just a couple of million.

Observations of the distant universe show that dwarf galaxies were once much more prevalent. "We know that the first galaxies to form were dwarfs," says Nils Bergvall of the Uppsala Observatory in Sweden. The idea is that these were the basic blocks that built up to form the much larger galaxies of today.

We also know that dwarf galaxies, even those relatively nearby which we can see as they were in comparatively recent cosmic time, have just 5 to 10 per cent of the metals that our sun has – or markedly less than one-hundredth of their total mass. The earliest dwarf galaxies may have had even less.

We have been slow to grasp the implication: that the tiniest dwarf galaxies could be pristine chunks of the early universe, preserving its composition and conditions in a cosmos that has long since moved on. Their degree of preservation could be the result of their sheer dwarfishness: because gravity within them is weaker than within a normal galaxy, a supernova exploding within it will fling the metal-rich products outwards at such speed that they mostly escape altogether.

If the original conditions of the universe were preserved in these dwarf galaxies, there would be no reason why further waves of megastars should not continually form and die within them throughout cosmic time. If it is the absence of metals that determines stellar size, behemoth stars are not restricted to the furthest reaches of the universe: they could be found in any dwarf galaxy with a low enough metal content, including places well within reach of our telescopes. It is a line of reasoning that the identification of SN 2007bi now seems to support in spectacular fashion.

The discovery of a nearby population of megastars in what amounts to suspended animation would have huge implications for stellar science. We do not understand the processes of star formation and death as well as we would like to think. "It is surprisingly difficult to get the models to agree with the observations," says Gal-Yam. He cites the example of gold, the abundance of which in the universe essentially defies explanation, although most astronomers assume it must somehow be made in supernovae. To find some answers, we might need to look no further than nearby dwarf galaxies.

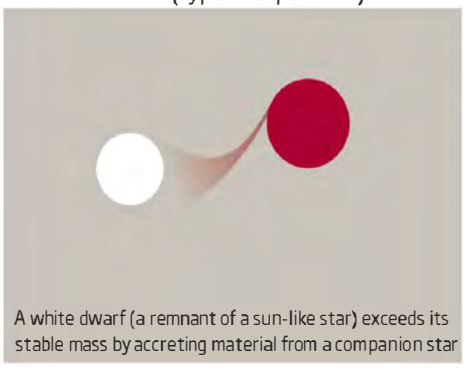
But wait a moment. If these huge living fossils have always been lurking on our cosmic doorsteps, how come we have not seen them before now? Stars that big would surely be hard to overlook, either during their tempestuous lives or spectacular deaths. Yet apart from one peculiarly luminous supernova in 1999, we have never seen anything that looks like SN 2007bi.

Part of the explanation, says Alexei Filippenko of the University of California, Berkeley, is that we have been looking in the

Going out with a bang

How a star's life ends depends on its size

WHITE DWARFS (type Ia supernova)

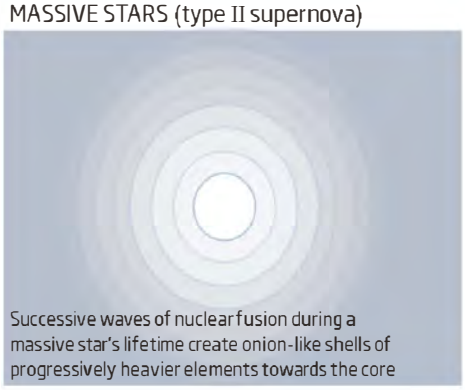


A white dwarf (a remnant of a sun-like star) exceeds its stable mass by accreting material from a companion star

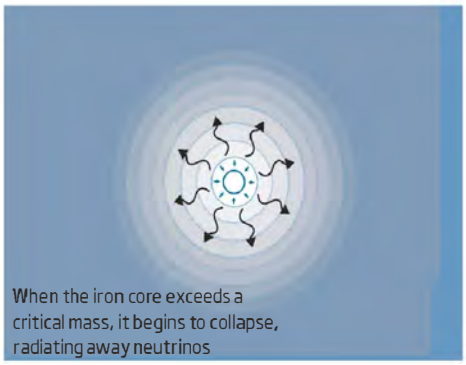
Carbon and oxygen start fusing uncontrollably in the dwarf's core

The star becomes unstable and explodes, pushing its companion away and leaving behind a nebula of gas

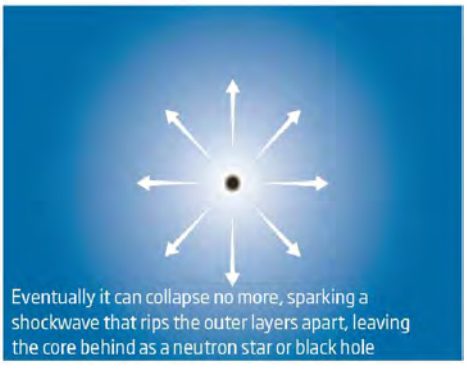
MASSIVE STARS (type II supernova)



Successive waves of nuclear fusion during a massive star's lifetime create onion-like shells of progressively heavier elements towards the core

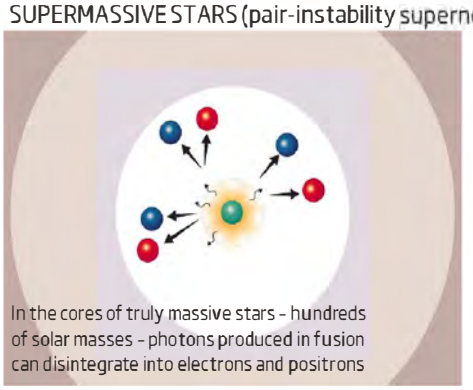


When the iron core exceeds a critical mass, it begins to collapse, radiating away neutrinos



Eventually it can collapse no more, sparking a shockwave that rips the outer layers apart, leaving the core behind as a neutron star or black hole

SUPERMASSIVE STARS (pair-instability supernova)



In the cores of truly massive stars – hundreds of solar masses – photons produced in fusion can disintegrate into electrons and positrons

This robs the core of some of its outward pressure, causing it to collapse

The energy of the rebound vaporises the entire star, core and all

wrong places. "Telescope time is precious, and in a pathetic dwarf galaxy there are not that many stars, so not that many opportunities for one to go supernova," he says. Astronomers have understandably focused their attention on the big galaxies that are richly stocked with stars.

Tantalising glimpse

That is now changing as fast robotic sky searches, such as the Palomar Transient Factory based at the observatory that first spotted SN 2007bi, swing into action. Such projects make no judgement about where best to look; they just keep their electronic eyes open for anything that is changing in the sky. This new strategy is already bearing fruit. "We are now tracking a number of supernovae that could also turn out to be pair-instability supernovae. But we want to be absolutely certain before we announce," says Filippenko.

Direct observations of any living megastars lurking out there are more tricky. Giant stars with their huge stocks of hydrogen and helium fuel would be so hot that most of their energy would be emitted as ultraviolet light, which is absorbed by Earth's atmosphere before it reaches ground-based telescopes. "Without seeing the ultraviolet, these stars will just hide away and look like ordinary high-mass stars," says Gal-Yam.

Because astronomers have traditionally believed that there is little of interest to see at ultraviolet wavelengths, there are no general-purpose ultraviolet space telescopes, either. The Hubble Space Telescope can see at these wavelengths, but the kind of painstaking programme to map relatively nearby dwarf galaxies would mean tying it up for thousands of hours of observation time. Gal-Yam has just submitted a proposal to do just that, but he is competing against about 40 other projects.

Hubble was serviced for the final time last year, and attention is now switching to its replacement, NASA's James Webb Space Telescope, which is scheduled for launch in 2014. But this telescope has no ultraviolet capability. "Once Hubble is gone, we are going to be totally blind," says Gal-Yam. "There is an urgency about doing this work."

At it stands, that April supernova could have been a tantalising and wholly unexpected glimpse into a universe we thought we would never see, that of the first stars, the cosmos makers. That would be an explosion to truly blow our minds. ■

Stuart Clark is the author of *Galaxy* and *Deep Space* (Quercus). Read his blog at www.stuartclark.com

ALL PHOTOGRAPHY BY JON HURST

With this test tube, I thee wed

How far should a journalist go in the name of science? Just ask Linda Geddes

Get any blood on my dress, mister, and this experiment is finished

WE'D booked the venue, chosen the bridesmaids' dresses and even decided on the colours of the table decorations. But finding a refrigerated centrifuge and a ready supply of dry ice in rural south-west England was proving tricky. Then there were the worries about getting blood on my silk wedding dress, and what to do if someone fainted.

Organising a wedding can be stressful enough, but we had a whole extra dimension to consider. We were turning it into a science experiment to probe what happens in our bodies when we say the words "I do".

Our focus was the hormone oxytocin, sometimes dubbed the "cuddle chemical" for its role in promoting bonding, trust and generosity. The usual setting for investigating its effects is a lab where volunteers may be asked to play games that involve trust and generosity, for example. But how well do these contrived tests reflect what happens in real life?

I had written several articles about this hormone before, so my wedding last July seemed the perfect chance to see if it would surge in the ultimate public display of affection. I contacted leading oxytocin researcher Paul Zak, head of the Center for Neuroeconomics Studies in Claremont, California, and he leapt at the opportunity to translate his lab studies into real life.

The plan was to measure blood levels of oxytocin in the bride, groom, three close members of our families and eight friends both before and after the ceremony. OK, it was a small sample size, but Zak (pictured above) saw this as a pilot study that might point the way for future research, and perhaps even shed some light on why people stage public weddings in the first place.

Oxytocin is released from the pituitary gland in the brain, on the command of specialised nerve cells. It has long been known to help trigger childbirth as well as the release of milk during breastfeeding. And in the 1980s it transpired that, in American prairie voles at least, the hormone promotes pair-bonding between mates. Zak and other research groups have since found oxytocin at work in a range of human social interactions, including strengthening the bond between mother and child and fostering closeness after sex. How the brain translates mental processes into signals to release oxytocin, however, remains mysterious.

Last year, Zak suggested a new role for oxytocin. The hormone rises in people watching a sad film clip; those who reported the greatest emotion experienced the biggest spike (*Annals of the New York Academy of Sciences*, vol 1167, p 182). What if oxytocin is the empathy chemical as well as the cuddle chemical? My wedding would be the perfect place to find out, I thought. If oxytocin really is the empathy chemical, those close to us might have a hormone surge as they witness our public pair-bonding.

Oxytocin may have a dark side, however. Work published last year hinted that oxytocin may also promote envy and the desire to gloat. Volunteers were asked to play a game of chance, in which people could win various sums of money. Those who inhaled a dose of oxytocin before playing the game felt more like gloating when they won the most money, and more envy when their opponent was ahead (*Biological Psychiatry*, vol 66, p 864).

One possibility is that oxytocin makes people more sensitive to social cues, says Salomon Israel, who studies decision-making at The Hebrew University of Jerusalem in Israel. "If you get a social cue to be more trusting, you're more trusting. But if ›

you get a social cue that's threatening, you feel more threatened."

Whatever the answer, it is clearly difficult to measure complex emotions with simple games in the lab. For one thing, volunteers know their actions are being recorded, which may alter their behaviour. For example, people who share more money with other players are usually seen as more altruistic, but maybe they just care more about what people think of them. In reality, they might be quite selfish.

"We're not sure of the motivation that drives behaviour," says Richard Ebstein, also at The Hebrew University of Jerusalem, who studies the genetics of human behaviour. That is why scientists need to start looking at hormones such as oxytocin in real-life situations, he says. Like weddings.

That's where I came in. Once Nic, my husband-to-be, had resigned himself to turning the most romantic day of our lives into a science experiment, I realised there were several additional hormones we could check at the same time (see "Hormones gathered here today", opposite). The obvious first choice was vasopressin, a hormone structurally related to oxytocin, which has been implicated in mate-guarding and jealousy in animals. You could say it's oxytocin's ugly cousin.

As the stress hormones cortisol and adrenocorticotropic hormone (ACTH) can affect the release of oxytocin, they went on the list, as did testosterone. A study in 2004 by neuroscientist Donatella Marazziti at the University of Pisa in Italy, and colleagues, had shown that levels of the male sex hormone dipped in men who have recently fallen in love, possibly to ensure they devote their energies to their partner, rather than looking for other women. Would a public exchange of vows have the same effect on testosterone? There was only one way to find out.

Kettle, toaster... OK, who put the centrifuge on the wedding list?

"I hoped I'd be too excited on the day to remember that I'm not very keen on needles"

In the run-up to the wedding, several people said we were mad to run an experiment on our big day. For one thing, I'm not very keen on needles. I hoped I'd be too excited on the day to remember that. I waited till the day itself to confess my phobia to Zak, but he took it in his stride. An hour before the vows, the 13 volunteers were whisked into a dining room at the wedding venue, which had been temporarily converted into a lab. Amid a clacking centrifuge, needles and a tray of champagne cocktails for afterwards, two medically trained wedding guests removed 20 millilitres of blood. I survived the ordeal by looking away and chatting to my bridesmaids.

Straight after the vows we did it all again. This time the first attempt to draw my blood failed and I had to be stuck twice. Zak later told me I looked about to pass out. "I've caught many a fainter," he says. "I was fiddling with the smelling salts in my pocket and was ready to catch you at the same time."

I managed to stay upright, however, and at last it was over. Zak spun the blood samples in the centrifuge (kindly loaned to us by the University of Exeter, UK) to separate the blood cells from the hormone-containing fluid, and then froze the fluid ready for shipping back to the US. Nic and I could forget about the experiment and enjoy the rest of our day.

A month later and the results were in. To my delight – OK, relief – in terms of oxytocin, our hypothesis proved correct. Both Nic and I experienced a rise in the hormone during the ceremony, as did the mother of the bride, the father of the groom and Nic's brother – all the relatives tested.

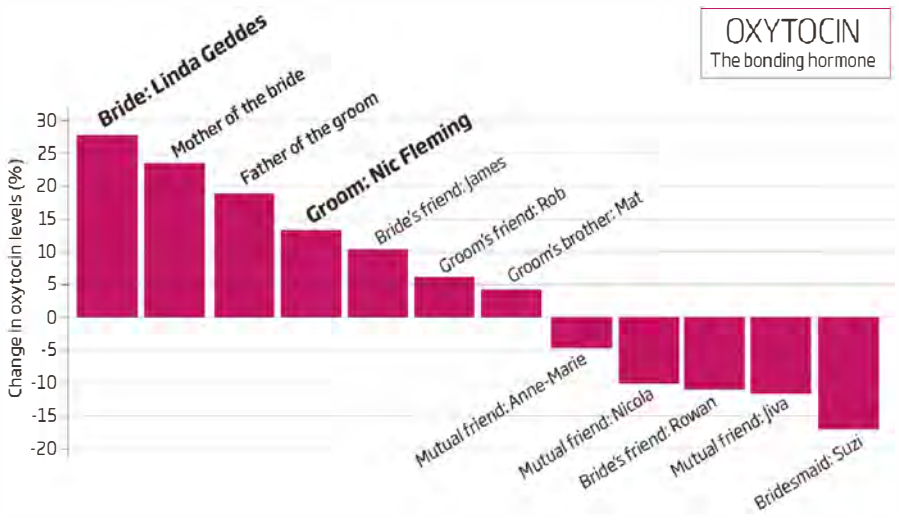
The results from our friends were mixed: two did and five didn't (see graph, left). One bridesmaid was excluded from the analysis because her readings were so high they were off the scale. This could have been the result of a faulty test, or perhaps she naturally has very high levels.

Group hug

Zak thinks the group oxytocin surge supports the theory that public weddings evolved as a way of binding couples to their friends and family, perhaps to help out with future child-rearing. This may explain why weddings are more common than eloping. It might also be why some people cry at weddings. "Maybe we cry for the same reason we cry at movies,"

Feeling the love

The bride, groom and close family members experienced a surge in the bonding hormone oxytocin during the wedding ceremony, a response that may have evolved to bind the couple to those who will help to bring up any future children



Hormones gathered here today

Levels of five hormones were measured before and after the wedding ceremony.

Oxytocin
Released from the pituitary gland in the brain during childbirth and breastfeeding, as well as social situations and sex. Recent studies suggest it increases trust and generosity, and perhaps empathy, too.

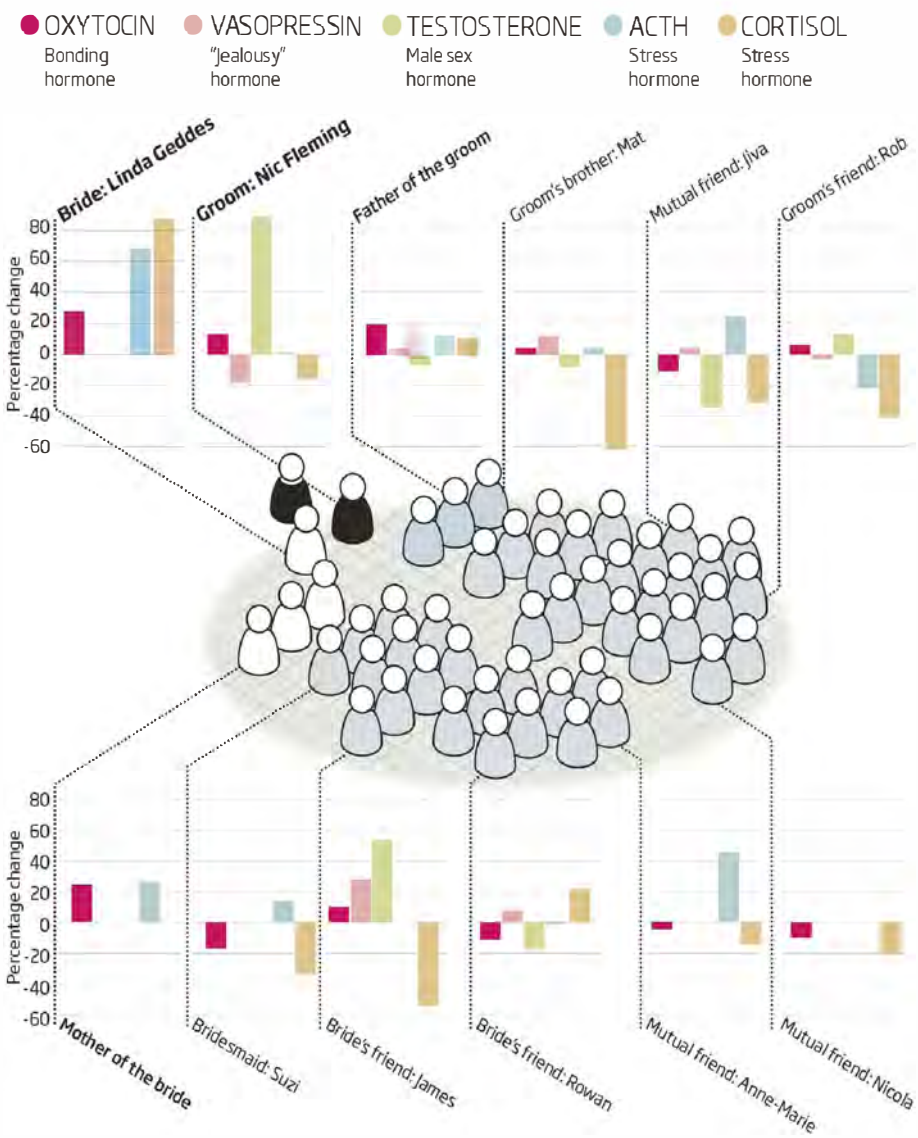
Vasopressin
Also released from the pituitary. In animals it is released during sex, and is also involved in male aggression, jealousy, territoriality and pair bonding. It is unclear if it also has this role in people.

Testosterone
Mainly released by the testes, but also from the adrenal glands. Promotes muscle growth, male sexual organs, secondary sex characteristics and libido. Studies suggest men's testosterone levels fall in the early stages of a relationship.

ACTH and Cortisol
ACTH is released by the pituitary gland, triggering cortisol secretion by the adrenal glands. Moderate levels of these stress hormones promote oxytocin release, but high levels inhibit it.

Of the five hormones tested, only oxytocin behaved as expected

Nic's results, in particular, went against expectations with an increase in testosterone and a decrease in vasopressin



he says. "We see ourselves in the couple."

Although the small sample size means the results are not statistically significant, we can still speculate about the trends seen. For example, I had the biggest spike in oxytocin, followed by my mother. "For every scenario we've looked at, women get the biggest rise," says Zak. "We know women are more empathic." It's also likely that women get more benefits from a marriage than men do and so may have more invested in it, adds Marazziti.

The other satisfying result was that we saw bigger spikes in family members than in friends. "It's what we would expect," says Ebstein. "Those who are genetically closest to you have a bigger investment in your wedding, and their oxytocin goes up more."

Not all the results fitted our predictions, however. Take vasopressin, the mate-guarding hormone. Zak thought we would see a spike in Nic's levels during the wedding ceremony – but instead we saw a fall. "Perhaps Nic didn't need to aggressively defend you as you have publicly committed to him," says Zak.

Nic's testosterone levels didn't behave either. Contrary to our hypothesis, it almost doubled during the wedding vows, with one male guest also experiencing a rise. Marazzeti has a possible answer: since testosterone is linked to libido, the sight of lots of women dressed up for the wedding may have been arousing.

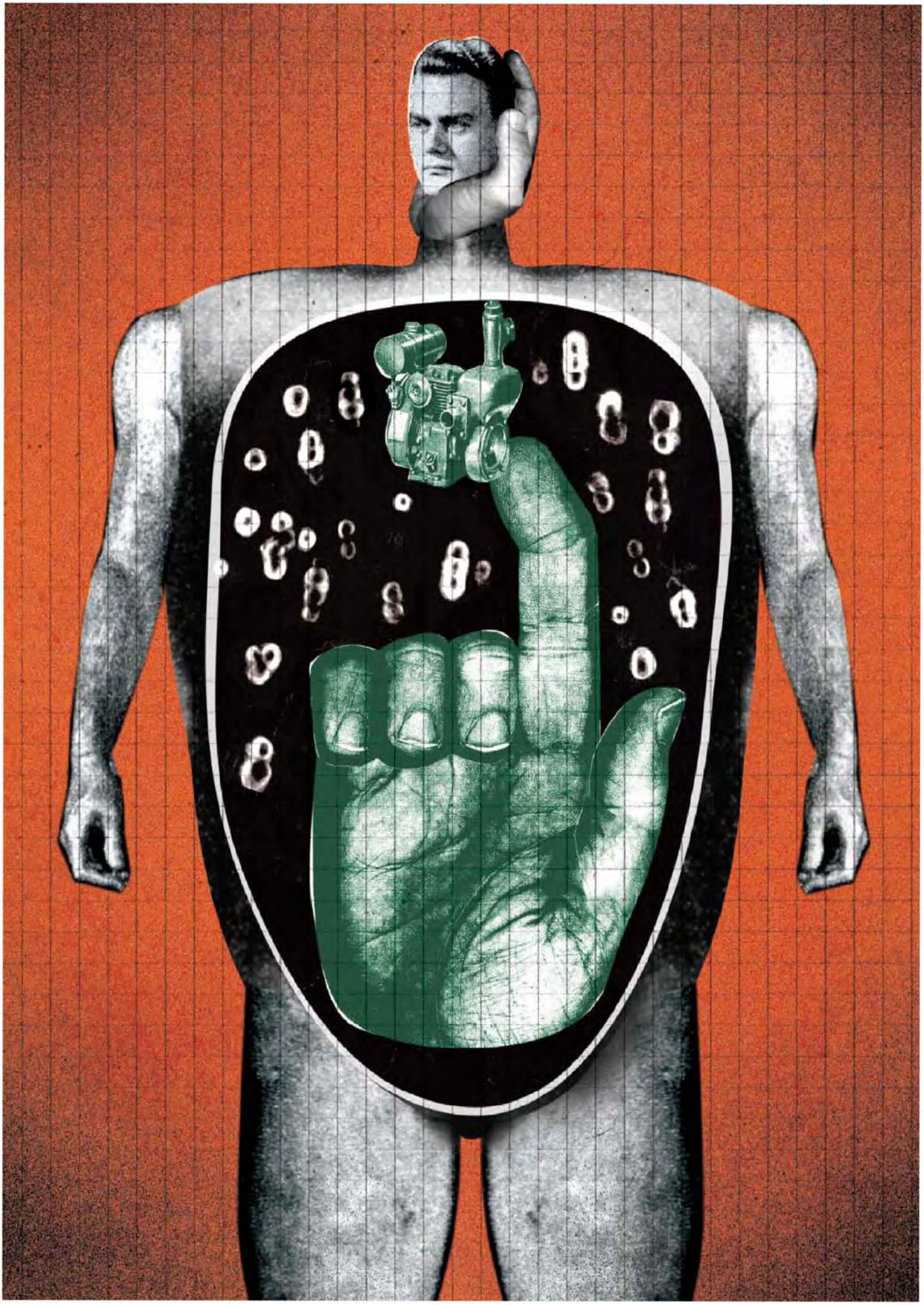
As for the stress hormones, I didn't need the test results to know that mine were up. Although very high stress shuts down oxytocin release, moderate stress seems to promote it, which may be another reason why my oxytocin levels were boosted.

So do our results take us any closer to understanding why people choose to get married? Zak thinks so. "Maybe the reason we have these weddings is not just because of the emotional contagion – the empathy, the love – but because these emotions are linked to helping maintain the human race," he says.

By bringing our friends and relatives closer to us, we now have a host of people to mediate if we fight, or – should our oxytocin take us to the point of having children – to babysit. And I might just have cured my needle phobia.

Zak is already dreaming up larger field studies to see if he can replicate the results. "I'm convinced now that our studies in the lab have direct implications for the world outside," he says. "This was one of the highlights of my research career." ■

Linda Geddes is a London-based reporter for *New Scientist*



DAVID PLUKERT

The secret to repairing our bodies and growing new organs is getting all touchy-feely, says Bob Holmes

The healing touch

YOU started life as a single cell. Now you are made of many trillions. There are more cells in your body than there are stars in the galaxy. Every day billions of these cells are replaced. And if you hurt yourself, billions more cells spring up to repair broken blood vessels and make new skin, muscle or even bone.

Even more amazing than the staggering number of cells, though, is the fact that, by and large, they all know what to do – whether to become skin or bone and so on. The question is, how?

"Cells don't have eyes or ears," says Dennis Discher, a biophysical engineer at the University of Pennsylvania in Philadelphia.

"Simply expose stem cells to flowing fluid and they turn into blood vessels"

"If you were blind and deaf, you'd get around by touch and smell. You'd feel a soft chair to sit on, a hard wall to avoid, or whether you're walking on carpet or concrete."

Until recently, the focus was all on "smell": that is, on how cells respond to chemical signals such as growth factors. Biologists thought of cells as automatons that blindly followed the orders they were given. In recent years, however, it has started to become clear that the sense of touch is vital as well, allowing cells to work out for themselves where they are and what they should be doing. Expose stem cells to flowing fluid, for instance, and they turn into blood vessels.

What is emerging is a far more dynamic picture of growth and development, with a great deal of interplay between cells, genes and our body's internal environment. This may explain why exercise and physical therapy are so important to health and healing – if cells don't get the right physical cues when you are recovering from an injury, for instance, they won't know what to do. It also helps explain how organisms evolve new shapes – the better cells become at sensing what they should do, the fewer genetic instructions they need to be given.

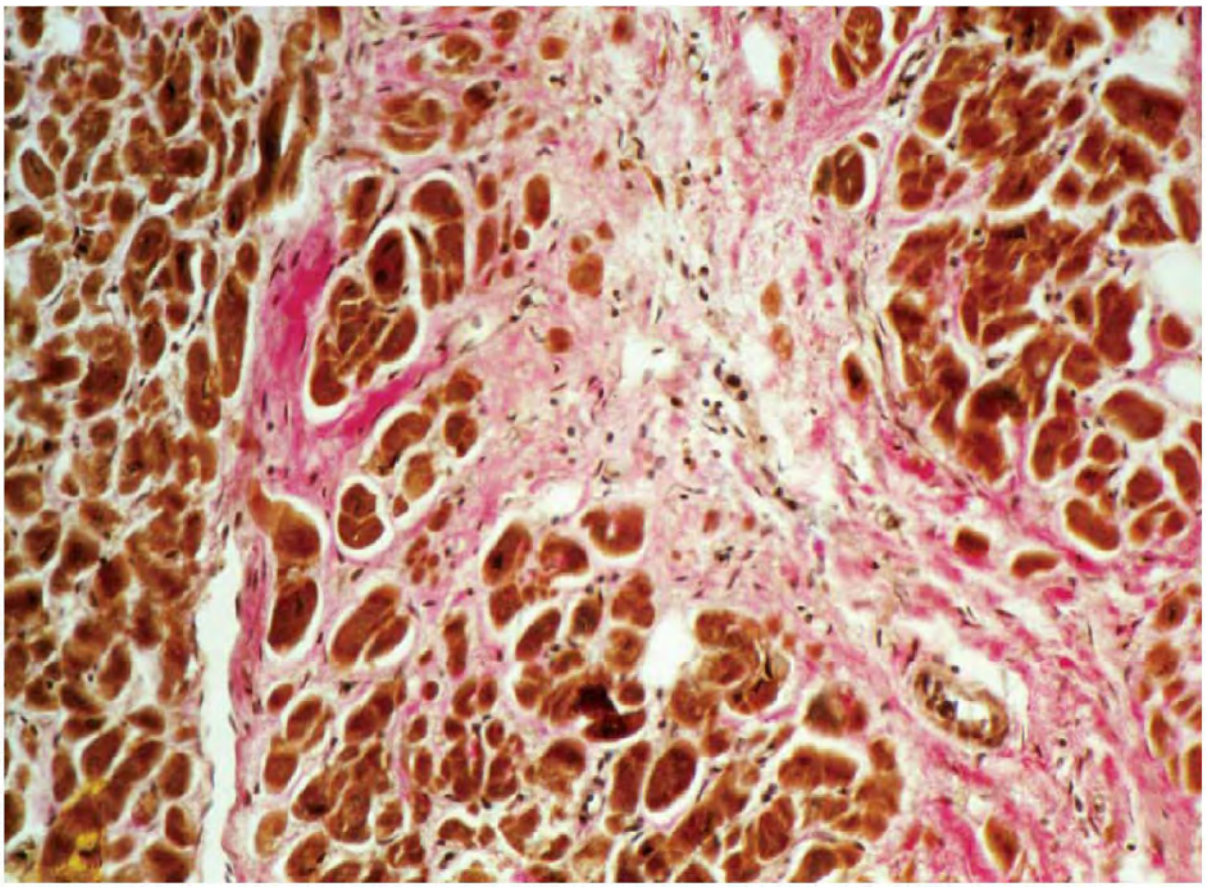
The latest findings are also good news for people who need replacement tissues and organs. If tissue engineers can just provide the right physical environment, it should make it easier to transform stem cells into specific tissues and create complex, three-dimensional organs that are as good as the real thing. And doctors are already experimenting with ways of using tactile cues to improve wound healing and regeneration.

Biologists have long suspected that mechanical forces may help shape development. "A hundred years ago, people looked at embryos and saw that it was an incredibly physical process," says Donald Ingber, head of Harvard University's Wyss Institute for Biologically Inspired Engineering. "Then when biochemistry and molecular biology came in, the baby was thrown out with the bath water and everybody just focused on chemicals and genes."

While it was clear that physical forces do play a role – for example, astronauts living in zero gravity suffer bone loss – until recently there was no way to measure and experiment with the tiny forces experienced by individual cells. Only in the past few years, as equipment like atomic force microscopes has become more common, have biologists, physicists and tissue engineers begun to get to grips with how forces shape cells' behaviour.

One of the clearest examples comes from Discher and his colleagues, who used atomic force microscopy to measure the stiffness of a variety of tissues and gel pads. Then they grew human mesenchymal stem cells – the precursors of bone, muscle and many other tissue types – on the gels. In each case, the cells turned into the tissue that most closely matched the stiffness of the gel.

The softest gels, which were as flabby as brain tissue, gave rise to nerve cells. In contrast, gels that were 10 times stiffer – like muscle tissue – generated muscle cells, and ›



ASTRID & HANNS-FRIEDER MICHLER / SCIENCE PHOTO LIBRARY

Softening scar tissue could be all it takes to regenerate damaged hearts

yet stiffer gels gave rise to bone (*Cell*, vol 126, p 677). "What's surprising is not that there are tactile differences between one tissue and another," says Discher. After all, doctors rely on such differences every time they palpate your abdomen. "What's surprising is that cells feel that difference."

The details of how they do this are now emerging. Most cells other than blood cells live within a fibrous extracellular matrix. Each cell is linked to this matrix by proteins in its membrane called integrins, and the cell's internal protein skeleton is constantly tugging on these integrins to create a taut, tuned whole. "There's isometric tension that you don't see," says Ingber. In practice, this means changes in external tension – such as differences in the stiffness of the matrix, or the everyday stresses and strains of normal muscle movement – can be transmitted into the cell and ultimately to the nucleus, where they can direct the cell's eventual fate.

Since stem cells have yet to turn into specific cell types, biologists expected them to be extra sensitive to the environment, and this does indeed seem to be the case. Ning Wang, a bioengineer at the University of Illinois at Urbana-Champaign, found that the embryonic stem cells of mice are much softer than other, more specialised cells. This softness means that tiny external forces can deform the cells and influence their development (*Nature Materials*, vol 9, p 82).

For instance, if stem cells are exposed to flowing fluid, they turn into the endothelial cells that line the inner surface of blood vessels. In fact, fluid flow – particularly pulses that mimic the effect of a beating heart – is proving crucial for growing replacement arteries in the laboratory. The rhythmic stress helps align the fibres of the developing artery, making them twice as strong, says Laura Niklason, a tissue engineer at Yale University. A biotech company Niklason founded, called Humacyte, has begun animal testing on arteries grown this way.

"The secret of growing cartilage that is as strong as the real thing is to mimic the effects of walking"

Surprisingly, pulsatile motion can help heal injuries in situ too. At Harvard, Ingber and his colleague Dennis Orgill are treating patients with difficult-to-heal wounds by implanting a small sponge in the wound and connecting this to a pump. The pump sucks the cells surrounding the wound in and out of the sponge's pores, distorting them by about 15 to 20 per cent – an almost ideal stimulus for inducing the cells to grow and form blood vessels and thus boost the healing process, says Ingber.

Meanwhile, tissue engineers are finding that they can grow far better bone and cartilage by mimicking the stresses that the tissues normally experience in the body. For instance, human cartilage grown in the lab is usually nowhere near as strong as the real thing. Recently, however, Clark Hung, a biomedical engineer at Columbia University in New York City, has grown cartilage that matches its natural counterpart strength for strength. The secret, he has found, is rhythmically squeezing the cartilage as it grows to mimic the stress of walking.

Hung says this is partly because the pressure helps to pump nutrients into cartilage, which has no blood vessels. But his experiments suggest that the loading alone also plays an important role. His team hopes the engineered cartilage will eventually be used to resurface arthritic human joints.

Even relatively mild stresses make a big difference. Attempts to grow replacement bone by placing stem cells in a culture chamber of the desired shape have not been very successful, with the cells often dying or producing only weak bone. But Gordana Vunjak-Novakovic, a biomedical engineer also at Columbia, has found that mimicking the internal flow of fluid that growing bones normally experience helps maximise strength. Last year, her team used this approach to successfully grow a replica of part of the temporomandibular joint in the jaw from human stem cells, producing a naturally shaped, fully viable bone after just five weeks.

"If you don't stimulate bone cells, they don't do much," says Vunjak-Novakovic. "But if you do, they wake up and start making bone at a higher rate."

There is still a long way to go, however. The replica bone lacks the thin layer of cartilage that lines the real bone, and it also lacks a blood supply, so it begins to starve as soon as it is removed from the culture chamber.

Again, though, the answer could be to provide the cells with the right physical cues. For example, Vunjak-Novakovic has used lasers to drill channels in the scaffolds used to grow heart muscle in the lab. When fluid begins flowing through these channels, endothelial cells move in to line the channels while muscle cells move away. "Each of the cells will find its own niche," she says. Her team is now testing to see whether stem cells will turn into endothelial cells in the channels and into muscle cells elsewhere. Early results suggest that they will.

Even small differences in forces can influence development. Christopher Chen of the University of Pennsylvania grew flat sheets of mesenchymal stem cells and exposed them to a mixture of growth factors for bone and marrow development. The cells on the edges of the sheets, which were exposed to the greatest stresses, turned into bone cells, while those in the middle turned into the fat cells found in marrow, as in real bone (*Stem Cells*, vol 26, p 2921).

If this kind of sorting-out according to physical forces is widespread in development, it could be very good news for tissue engineers. Instead of having to micromanage the process of producing a replacement organ, they need only to provide the right cues and let the cells do the rest.

Indeed, it makes a lot of sense for some developmental decisions to be "devolved" to cells. The growth of tissues like muscles, bone, skin and blood vessels has to be coordinated as our bodies develop and adapt to different activities and injuries. A rigid genetic programme could easily be derailed, whereas using tactile cues as guides allows tissues to adapt quickly as conditions change – for instance, carrying heavy loads will make our bones grow stronger.

"If tissue engineers provide the right physical cues when growing organs, cells will do the rest"

This kind of plasticity may play a vital role in evolution as well as during the lifetime of individuals. When the ancestors of giraffes acquired mutations that made their necks longer, for instance, they did not have to evolve a whole new blueprint for making necks. Instead, the nerves, muscles and skin would have grown proportionately without needing further changes in instructions. The result of this plasticity is a developmental programme that is better able to cope with evolutionary changes, says Ingber.

There is, however, a drawback. When disease or injury changes the stiffness of a tissue, things can go awry. Some researchers suspect that tissue stiffening plays a role in multiple sclerosis, in which nerves lose their protective myelin sheath (*Journal of Biology*, vol 8, p 78). It may also play a role in some cancers (see "Lumps and bumps", below).

It could also explain why many tissues fail to heal perfectly after an injury. To prevent infection, the body needs to patch up wounds as quickly as possible. So it uses a form of collagen that is easier to assemble than the normal one. "It's a quick patch, things are sealed off and you go on – but it's not perfect regeneration," says Discher. The quick-fix collagen is stiffer than normal tissue, as anyone with a large scar will tell you.

After a heart attack, for example, the dead portion of the heart muscle scars over. Why, Discher wondered, don't heart muscle cells then replace the scar tissue? To find out, he and his colleagues grew embryonic heart cells on matrixes of differing stiffness. When the matrix was the same stiffness as healthy heart muscle, the cells grew normally and beat happily. But if the matrix was as stiff as scar tissue, the cells gradually stopped beating (*Journal of Cell Science*, vol 121, p 3794).

The constant work of trying to flex the stiffer matrix wears the cells out, Discher thinks. "It's like pushing on a brick wall. Finally, they give up."

Discher believes the solution may lie in finding a way to soften the scar tissue so that heart cells can repopulate it. Several enzymes, such as matrix metalloproteinases and collagenases, might do the job, but overdoing it could be risky. "If you degrade the matrix too much, you lose the patch," he warns.

The stiffness of scar tissue may also prevent regeneration in nerve injury, because nerve cells prefer the softest of surroundings. "It might just be that the growing tip of the axon senses that there's a stiff wall ahead of it and doesn't grow through because of that," speculates Jochen Guck, a biophysicist at the University of Cambridge in the UK.

There is still a long way to go before we fully understand how cells sense and respond to the forces on them. But it is becoming clear that the touchy-feely approach could be the key to regenerating the body. ■

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

LUMPS AND BUMPS

Many tumours are stiffer than the tissues in which they form – after all, doctors often first detect many cancers of organs such as the breast and prostate by feeling a hard lump. Some researchers now suspect that this stiffness is not always just a consequence of the cancer. It may be a cause as well.

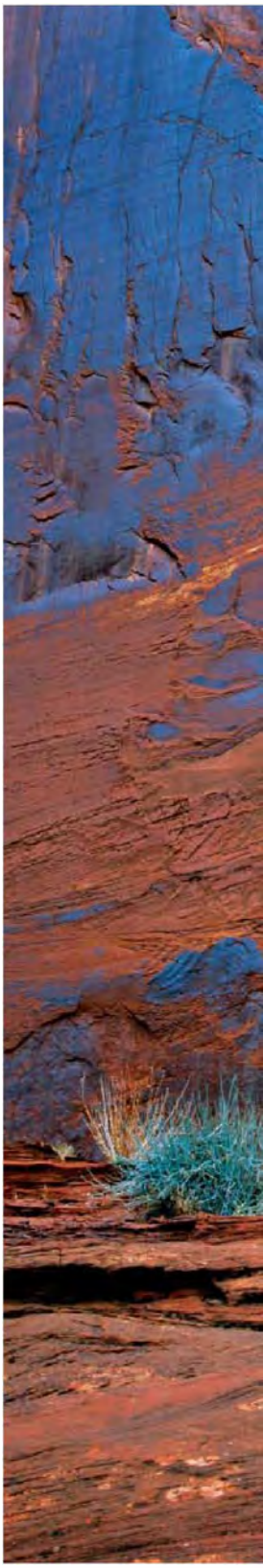
A team led by Paul Janmey, a biophysicist at the University of Pennsylvania in Philadelphia, has found that the cycle of cell division in breast cells stops when they are grown on a soft gel, keeping them in a quiescent state (*Current Biology*, vol 19, p 1511). Anything that signals stiffness – even just touching a cell with a rigid probe – can be enough to start it dividing again.

Similarly, when Valerie Weaver, a cancer biologist at the University of California at San Francisco, and her team used chemicals to soften the extracellular matrix in which breast cells were growing in the lab they found the cells were less likely to become malignant (*Cell*, vol 139, p 891). If her findings are confirmed, they could explain why women with denser breast tissue are more likely to develop breast cancer.

Some researchers, too, have reported seeing tumours form around the scars from breast-implant surgery. "This needs to be looked at again," says Weaver. If the link is confirmed, it might be possible to block tumour growth by interfering with the way cells detect stiffness.

Life on the

Maybe the Red Planet isn't such a dead zone after all, says **Barry E. DiGregorio**



WHEN NASA's Viking landers touched down on Mars, they were looking for signs of life. Instead, all their cameras showed was a dry, dusty – and entirely barren – landscape.

Or so it seemed. But what the 1976 Viking mission, and every subsequent one, saw was a scene littered with rocks coated with a dark, highly reflective sheen. That coating looks a lot like a substance known on Earth as "rock varnish", found in arid regions similar to those on Mars. The latest evidence hints that rock varnish is formed by bacteria. Could there be microbes on Mars making such material too?

Rock varnish has long been something of a mystery. It is typically just 1 to 2 micrometres thick, but can take a thousand years or more to grow, making it very hard to discover whether biological or purely chemical processes are responsible. If it is biological, though, the race will be on to discover whether the same thing has happened on Mars – and whether microbes still live there today.

If you go to Death Valley in California, you can find rock varnish covering entire desert pavements. Also known as desert varnish, it forms in many places around the globe, and despite its glacial growth rates, can cover vast areas. The smooth, high sheen, dark brown-to-black coating is mainly made up of clay particles, which bind the iron and manganese oxides that give the coating its mirror-like reflectivity. In the Khumbu region of Nepal, not far from Mount Everest, it has turned the boulders black. Halfway around the world, it enabled ancient peoples to create the Nazca Lines in the Peruvian desert. These giant, elaborate images – some over 200 metres across and created over 1000 years ago – were made by simply removing rows of varnished stones to exposing the lighter stones or soil beneath.

NASA/JPL-CALTECH/CORNELL/NMNH

Are microbes hiding under the dark rock coatings on Mars?

George Merrill coined the phrase desert varnish in 1898, while working for the US Geological Survey (USGS). No one really studied it, though, until 1954, when Charles Hunt showed that the veneer forms on many different rock types – meaning that it wasn't simply a chemical production from a certain kind of rock and prompting the first questions about where it might come from (*Science*, vol 120, p 183). Hunt went on to find rock varnish in humid regions, tropical rainforests and at high altitudes in the Alps and the Rocky mountains.

Theories on how rock varnish forms weren't long in coming – and, initially at least, ›

CARR CLIFTON/MINDEN/FLPA

rocks

biology didn't get a look-in. In 1958 Celeste Engel of the USGS and Robert Sharp from the California Institute of Technology explained it as a chemical weathering phenomenon similar to iron oxide stains – red/orange coatings arising when iron particles from the air collect on the surface of rocks and bind together when made wet by dew (*Geological Society of America Bulletin*, vol 69, p 487).

It made sense to think that rock varnish had a chemical origin, since many similar-looking coatings were already known to form chemically. Silica glaze, for example, is one of the most common coatings and forms when silicic acid carried in dust and dew condenses onto rock surfaces.

Rock varnish grows quickly in caves, bacteria are prime suspects

VICTOR POLYAK

Layer cake

Everything changed, though, when people saw the internal structure of rock varnish. Electron microscopic images taken by Randal Perry and John Adams at the University of Washington in Seattle in 1978 revealed an intricate layer-cake pattern, with black strips of manganese oxides alternating with orange layers of clay and iron (*Nature*, vol 276, p 489). No other rock coating combines this microlayered mixture of clays and metal oxides.

The implications here were enormous. This microstructure looked strikingly similar to that of fossil stromatolites – layered rock-like structures formed by ancient microbes as they collected sediments from seawater to build themselves a home. Though they still grow today in some isolated spots, stromatolites were one of the first life forms on Earth, dominating the fossil record from 3.5 billion years ago until about 600 million years ago.

That meant rock varnish could have a biological origin, and a flurry of investigations ensued to find out which microbes were responsible. Backing up the idea was the fact that microbes developed the ability to make a manganese oxide coat early in their evolution, to protect themselves from the harsh UV rays of the young sun.

"Rock varnish grows at rates as slow as 1 or 2 micrometres every thousand years"

DAVID NUNUK/SPL

Peruvians "drew" the Nazca Lines by moving rows of varnished rock

Manganese proved pivotal three years later, for Ronald Dorn at Arizona State University in Tempe and Theodore Oberlander of the University of California, Berkeley. They found what looked like the fossilised remains of a few budding bacteria within the manganese oxide layer. Manganese concentration peaked around them, suggesting these bacteria were involved in producing it.

Dorn and Oberlander then managed to isolate two manganese-depositing microbes, *Metallogenium* and *Pedomicrobium*, from the surface of varnish samples collected in California's Mojave desert. When they added these to sterilised chips of rock in test tubes, they were able to grow a thin manganese varnish in about six months. The findings were published under the title "Microbial Origin of Desert Varnish" (*Science*, vol 213, p 1245).

That proved to be premature. The microstromatolite texture of natural rock varnish was absent in the lab-grown version, and anyway it formed way too quickly. It was around then that natural rock varnish was discovered to grow as slowly as 1 or 2 micrometres every thousand years.

Although Dorn conceded that his experiments were not conclusive proof, he believed the manganese layering had to be microbial and stuck by his theory. Two key questions remained. Why does rock varnish contain so few fossilised microbes, and how could they take so long to concentrate manganese but leave no trace of their existence?

David Krinsley might have an explanation: over thousands of years, chemical changes within the deposit could have destroyed any bacterial remains, he argues. A sedimentologist from the University of Oregon in Eugene, Krinsley has studied dozens of rock varnish samples and in every one he has seen a scattering of fossilised

bacteria. But it's still not proof that they made the varnish, he admits.

Dorn is not surprised there are so few bacteria in rock varnish, considering the time it takes to form. "My hypothesis is that very rare bacterial forms concentrate the manganese and iron," he says. He also believes the slow rate rules out chemical theories of rock varnish formation because silica glaze and other types of chemical rock coating grow in relatively rapid annual cycles.

But the real answer to the rock varnish mystery could come from a remarkable cave in New Mexico. The floor of the Fort Stanton cave is made of a sparkling white calcite "river" formed by hundreds of years of flooding – but it is the dark coatings covering the cave walls that interest rock varnish researchers.

Most of it is just simple manganese oxide minerals, but on their most recent trip to the cave, Mike Spilde of the University of New Mexico in Albuquerque and Penny Boston at New Mexico Institute of Mining and Technology in Socorro found coatings that seem to fulfil all the definitions of rock varnish – iron and manganese oxides bound together by clays, in the characteristic microstromatolite layers. The coatings were covered with bacteria known to deposit manganese. "These deposits are biological in origin," Spilde concluded when he presented the findings at the Geological Society of America meeting in Portland, Oregon, last October.

Further confirmation is needed, says Dorn, but the cave deposits "sure look like rock varnish". One difference is that the cave varnish seems to form far more rapidly: the coating is already starting to grow back in areas where Spilde's team had removed deposits a few years earlier. The cave is damp, so perhaps this helps the coating grow more rapidly and explains the incredibly slow growth rate of rock varnish in desert conditions, Spilde suggests.

Equipped for the hunt

Where does all this leave the search for life on Mars? If Earth is anything to go by, there are only three possible explanations for the shiny rocks on Mars – rock varnish, silica glaze or a simple polishing of the rocks themselves by wind-blown sand.

The latter is the easiest to discount. Martian rocks are entirely cloaked in their shiny coating, whereas natural sandblasting would polish only the windward face. To confirm matters, infrared images from Mars rovers have proved that the shiny surface is an extra coating rather than part of the rocks themselves.

Silica glaze seems unlikely too. NASA's Mars exploration rovers Spirit and Opportunity can detect silica, and in 2007, Spirit dug into the soil and found a large deposit of it, providing strong evidence that liquid water once flowed on the planet's surface. The rovers have never detected silica glaze on the rocks they have analysed, however.

Which leaves rock varnish. All the raw ingredients are known to exist on Mars – and, given the harsh UV rays that continually bombard the planet, under a protective coating might be exactly where you would expect to find evidence of life. Mars is free of many of the processes that erode rock varnish on Earth, from rain to lichens, so it might harbour evidence of ancient life millions of years old.

The uncertainty over rock varnish's origins – and its complex structure and chemical make-up, which make it difficult to definitively detect – mean that no instrument has ever been designed specifically to search for rock varnish on Mars. It should be possible to identify some components, though.

For example, the thermal emission spectrometer that enabled Spirit to detect silica should theoretically be able to detect manganese oxides too. The mineral has never been spotted, but that might be because it is present in such small quantities compared with the underlying rock, says Steve Ruff at Arizona State University, who runs the TES instruments on the rovers. That means any signal is too low for the instrument to detect.

Both rovers are also fitted with an alpha proton X-ray spectrometer, which fires alpha particles and X-rays at rock surfaces to detect which chemical elements are present. These instruments have never detected the elevated manganese levels that would be expected in rock varnish – but again the signal could be obscured by the elements in the underlying rock. "We can't say for certain if the rock coating is manganese-enriched or not," says Harry McSween, a geologist on the Mars rover projects.

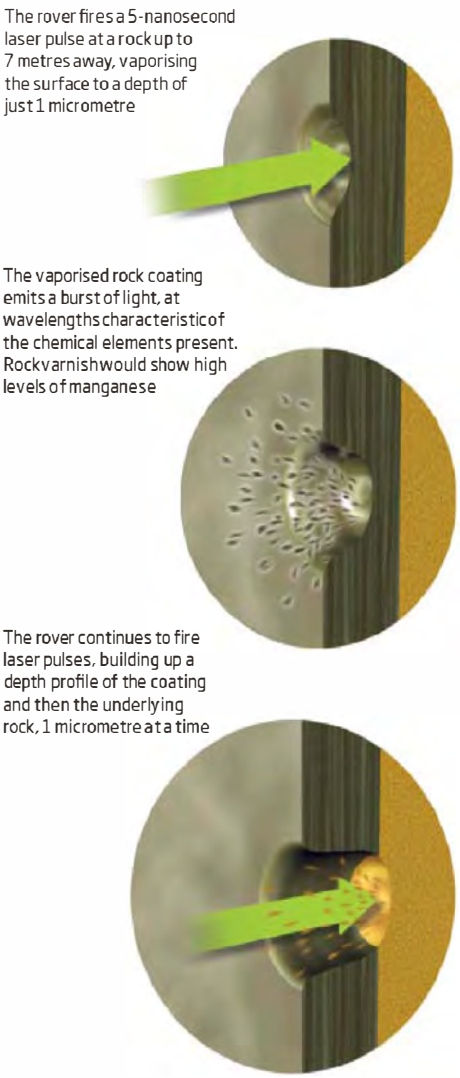
Future missions will be better equipped for the hunt. The next rover to land on the Red Planet will be NASA's Mars Science Laboratory, due to arrive in 2012. MSL can detect rock varnish, says Roger Wiens, the Los Alamos National Laboratory scientist who will run a new instrument on MSL called a laser-induced breakdown spectrometer. This will fire laser pulses at the rock coatings, and the wavelengths of light emitted as the coating atomises will tell Wiens what elements are present.

NASA is also working with the European Space Agency on the ExoMars programme, which will send two rovers in 2018, in part to hunt for evidence of life on rock surfaces. ExoMars might finally get the definitive answer, as for the first time the mission will bring Mars samples back to Earth.

If the cave varnish and the Mars varnish turn out to be the same as rock varnish, then ExoMars might actually be bringing Martians to Earth. ■

Martian sheen

NASA's Mars Science Laboratory rover will use laser-induced breakdown spectroscopy to determine whether the coating on Martian boulders is rock varnish – a possible home for microbes



"Under a protective coating might be exactly where you would expect to find evidence of life on Mars"

Barry E. DiGregorio is a science writer and a research associate at the Cardiff Centre for Astrobiology, UK

Psychiatry's hubris

If depression is a disease, who's to say what constitutes healthy sorrow?

Manufacturing Depression: The secret history of modern disease by Gary Greenberg, Simon & Schuster, $27

Reviewed by Liz Else

CHALLENGING a multibillion-dollar global industry is bound to be an uncomfortable mission, all the more so if you risk being accused of promoting suffering, being a denialist, or even of culpable ignorance. Few writers who take on the mental health industry can be doing it for the money or in the hopes of sales matching Peter Kramer's 1990s hit *Listening to Prozac*.

It was Kramer who coined the phrase "cosmetic psychopharmacology" to describe a not-too-distant utopia in which drugs such as the selective serotonin reuptake inhibitor Prozac, normally used to treat depression, would be used to enhance or change personality. Kramer did warn of the drug's downsides (tremors, loss of libido, suicidal ideation), but the prospect of exchanging shyness, timidity and other social dysfunctions for self-assurance, gregariousness and success ensured the book's popularity.

Fast-forward to 2010 and optimism about biochemical aids in the endless pursuit of happiness or as fixes for misery seems to be vanishing like the morning mist. Writers continue to take the mental health industry apart, big genetics still fails to nail "genes for" mental illness in any important sense, and the deadline for a new edition of the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* has slipped a year amid ugly rows and claims that tens of millions of dollars could be spent on unnecessary drugs should new diseases with no clear scientific foundation be included in the *DSM*.

ANTHONY MARSLAND/RISER/GETTY

Treating unhappiness is big business, with little science to back it up

Gary Greenberg's contribution to this melee is thoughtful and well written, though quite different from the scholarly, understated work of Allan Horwitz and Jerome Wakefield, whose *The Loss of Sadness: How psychiatry transformed normal sorrow into depressive disorder* (Oxford University Press, 2007) threw down such a powerful marker a few years ago. Greenberg is a psychotherapist and himself suffers from depression. He takes us with him on a journey that starts with the reminder that "everyone is against depression, just as everyone is against war and child abuse and global warming". The issue is that we need to work out what doctors mean when they diagnose depression, and where that meaning came from.

Depression, says Greenberg, is not the result of any dark conspiracy but of the transmutation of unhappiness into a treatable illness. The disease is as much a "matter of history as it is of science", he argues. And history we certainly get in a chapter amusingly entitled "Job versus his therapists". But unlike poor old Job, who was sorely tried as a test of his faith, those who look to science for revelation expect suffering to be cured in a very different way from God's restoration of Job's wealth.

"That depression is treated as a disease is as much a matter of history as it is of science"

As Greenberg warns, we would do well to recognise that the "depression doctors" and drug company sponsors "don't know any better than you or I what life is for or how we are supposed to feel about it".

Manufacturing Depression is full of fascinating stories, such as the time Greenberg, curious to get close to the "machinery" of depression, enrolled himself in a drug trial. Expecting a label of minor depression, his comeuppance for trying to exploit the system was a label of major depressive disorder.

Greenberg's greatest contribution, though, is insisting on few certainties, and in offering himself to us in messy detail. With Greenberg, you are free to call your sorrow a disease, or not, to take drugs or not – to see a therapist, or not. All he asks is that you "don't settle for being sick in the head... you can tell your own story about your discontents". ■

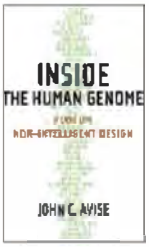
Liz Else is associate editor of *New Scientist*

Don't blame God

Our mindless mess of a genome demolishes any notion of an intelligent creator

Inside the Human Genome: A case for non-intelligent design by John C. Avise, Oxford University Press, $19.95

Reviewed by Michael Le Page



LESCH-NYHAN syndrome causes compulsive self-mutilation. Children eat their lips or fingers and stab their faces with sharp objects. They feel the pain, but they can't stop themselves. Why would a loving, all-powerful creator allow anyone to be born with such an awful disease?

Lesch-Nyhan is just one of tens of thousands of genetic disorders that afflict humanity. At least 1 in 10 people have some kind of debilitating genetic disease, and most of us will become sick as a result of mutations that cause diseases such as cancer.

The reason? Our genome is an unmitigated mess. The replication and repair mechanisms are inadequate, making mutations commonplace. The genome is infested with parasitic DNA that often wreaks havoc. The control mechanisms are prone to error. The huge amount of junk, both between genes and within them, wastes cellular resources. And some crucial bits of DNA are kept in the mitochondria, where they are exposed to mutagenic waste products. "It is downright ludicrous!" declares John Avise, an evolutionary geneticist at the University of California, Irvine.

The human genome, concludes Avise, offers no shred of comfort for those seeking evidence of a loving, all-powerful creator who had a direct hand in designing us, such as believers who accept evolution. If some entity did meddle with life on Earth, either it didn't know what it was doing or didn't care.

There is a need for a popular book explaining what a botch job our blueprint is but *Inside the Human Genome* is heavy going. And Avise's conclusion made my jaw drop. "Evolution by natural selection emancipates religion," he writes. "No longer need we agonize about why a Creator God is the world's leading abortionist and mass murderer."

I'd call it emasculation, not emancipation. If "God" is not the creator, why intervene in human affairs at all? Why worship a deity who can't or won't help? Avise never addresses these issues.

Instead, he goes further: "The evolutionary-genetics sciences can thus help religion... return to its rightful realm... as a respectable philosopher counsellor on grander matters including ethics and morality." Yet, if conventional religious notions about biology are so misguided, it is downright ludicrous to suggest believers have some privileged insight into the morality of issues such as IVF, abortion and homosexuality.

To me, Avise misses the big point. Why do we continue to allow children to be born with hideous diseases? Our ethics have been so distorted by superstitious nonsense that we cannot see the clear moral imperative: we need to sort out our mess of a genome just as soon as we can.

MAGALI COROUGE/DOCUMENTOGRAPHY

Xeroderma pigmentosum condemns children to a life without sun

Gossip columns

How Many Friends Does One Person Need? by Robin Dunbar Faber & Faber, £14.99

Reviewed by Kate Douglas

PERHAPS it is not surprising that a man who has studied gossip should have a magpie's eye for sparkling factoids and precious anecdotes. Evolutionary anthropologist Robin Dunbar's new book is full of such gems. This is an eclectic collection of essays on humanity and evolution with something for everyone.

Dunbar explains, among other things, why monogamists need big brains, why it is worth buying a new suit for an interview, how to interpret an advert in a lonely hearts column, the perils of messing with evolution and, of course, how many friends one person needs (150 as it happens, aka "Dunbar's number"). He speaks with authority and seduces us as only a master storyteller can.

This is a book to dip into whenever life seems dull or meaningless. Keep a copy in your bag or by the lavatory as an antidote to ennui.

Soul food

The Age of Absurdity by Michael Foley, Simon & Schuster, £10.99

Reviewed by Michael Bond

THERE seems little point in raging publicly at the ills of modern life unless you can suggest a cure. Michael Foley's book is an amusing gambol through science, religion, philosophy and literature in search of strategies for fulfilment in a contemporary culture that seems designed to resist them.

His distaste for the way other people behave makes the crumbs of comfort he offers up hard to swallow. Foley takes issue with almost everything the 21st century has thrown at him, from the cheeriness of once famously grumpy Parisian waiters to the audacity of his online book store in recommending books to him.

He writes so well and covers so much ground that you can forgive some of his crabbiness. But some solutions, such as a Buddhist approach to life, are hardly revelatory, while others – the writings of Nietzsche, jazz solos – are clearly not to everyone's taste. As a recipe for helping us "face the world re-nourished", the whole enterprise looks a little absurd.

The third industrial revolution

In *The Empathic Civilization*, **Jeremy Rifkin** argues that before we can save ourselves from climate change we have to break a vicious circle. He explains why to **Amanda Gefter**

What is the premise of *The Empathic Civilization*?
My sense is that we're nearing an endgame for the modern age. I think we had two events in the last two years that signal the end. In July 2008 the price of oil hit $147 a barrel. Food riots broke out in 30 countries. That was the earthquake; the market crash 60 days later was the aftershock. The second event was the breakdown at the Copenhagen climate summit. Why couldn't our leaders anticipate or respond to the global meltdown? And why can't they deal with climate change?

So why have our leaders failed us?
They are using 18th-century ideas to address 21st-century challenges. The Enlightenment view is that human beings are rational, detached agents who pursue their own self-interest; nation states reflect that view. How are we going to address the needs of 7 billion people and heal the biosphere if we are all agents pursuing our individual interests?

A lot of new discoveries suggest that human nature might not be as the Enlightenment philosophers imagined. For instance, the discovery of mirror neurons suggests that we are not wired for autonomy but for empathy. We are a social species.

How does an empathic view of human nature change the picture?
We see how consciousness, which is wired for social engagement, changes over history. My belief is that when communications and energy revolutions converge, this changes consciousness by shifting our boundaries, causing empathy to expand.

For instance, wherever there were agricultural societies based on large-scale irrigation, humans created writing. Writing made it possible to manage a complex energy regime. It also changed consciousness, transforming the mythological consciousness of oral cultures into a theological one. In the process, empathy evolved. Oral communication is limited: you can't extend empathy beyond blood ties. With script you empathise further.

In the 19th century, the printing press converged with coal and steam. This led to mass literacy. In the 20th century the second industrial revolution, the electronics revolution, gave rise to psychological consciousness.

"When communications and energy revolutions converge, this causes empathy to expand"

Each convergence of energy and communications technology extended our social networks and in turn expanded our empathy.

But all of that happens at the expense of the environment.
It's the conundrum of history that more complex civilisations bring more people together, but they create more entropy in the process. If we are going to ward off the dangers posed by climate change we need to find a way to increase empathy while decreasing entropy. The question is, how do you do that?

You argue that the answer is another convergence of technologies. Can you explain?
In the last 15 years we have had a very powerful communications revolution with the internet. This revolution is beginning to converge with distributed renewable energy. When they converge, it's likely to change consciousness once again.

How will this "third industrial revolution" change our consciousness?
As people begin to harvest renewable energy, they can share electricity peer-to-peer across an energy grid that extends across nations. With everyone taking responsibility for their swathe of the biosphere and then sharing their energy, that would allow us to think biosphere politics and give us a possibility of breaking the empathy/entropy paradox. It's a tough challenge, but if human nature really is *Homo empathicus* we can begin to create new institutions that reflect our core nature. Then I can see how this revolution will happen. ■

ROGER CREMERS/HOLLANDSE HOOGTE/EYEVINE

An extended version of this interview is at newscientist.com/blogs/culturelab

PROFILE
Jeremy Rifkin is an adviser to governments around the world. He is the president of The Foundation on Economic Trends in Washington DC. *The Empathic Civilization* is published by Penguin

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A time to transform

Postdocs provide valuable opportunities for publication and research. **Melissa Lee Phillips** gets advice from those in the know

Between graduate school and a first faculty, teaching or industry job, many scientists will take a postdoctoral position. The right postdoc will build on graduate training while offering the opportunity to acquire new skills. It can turn young researchers into successful independent scientists – but finding the perfect place can be a daunting task. To help you on your way, we asked current postdocs for their top tips.

Most grad students begin their search by targeting groups that work in a similar field, but think about stretching yourself further, says Brian Mayer, a postdoc at Lawrence Livermore National Laboratory in California. "Seek out the chance to broaden your scientific experience," he says.

Mayer's work applies solid state nuclear magnetic resonance spectroscopy to art conservation, which is a departure from his graduate training in chemical engineering. "Looking for an institution that was willing to take a risk and allow me to develop a breadth of new knowledge wasn't easy, but I felt that finding this type of environment was necessary to grow as a scientist," he says.

Looking at publication records is an important next step, says Stephanie Colvin, a grad student at Indiana University School of Medicine. She recommends finding out how frequently your investigator publishes their work, and in what type of journal. "Do they put themselves as first author frequently, or does he or she give the graduate students and postdocs the credit?" she says.

Thomas Adams, a postdoc in chemical engineering at the Massachusetts Institute of Technology (MIT) in Cambridge, agrees: "A strong publishing record is really good in the sense that your own papers are more likely to get published and noticed with that group's name on it, too."

The details of a group's publication record may also tell you something about how they work together, says Ryan Widau, a grad student at Indiana University. When searching for his postdoc at the University of Chicago, Widau paid attention to the number of authors on the publications "as a means to gauge the collaboration within a lab".

Laura Thomas, a postdoc at the National Institute of Mental Health in Bethesda, Maryland, focused on the same priority: "I was interested in doing my postdoc in a lab that had a common focus and was not too individualistic and competitive."

"It is important to understand the dynamics of the research group," agrees Carolyn Seto, a postdoc in chemical engineering at MIT. "You are spending at least a year with this group, and you will make the most productive use of your time if you are in an environment in which you feel comfortable working."

> "You want someone who understands and treats you as a person, not as a slave"

The work environment will also likely extend outside of your individual research group, so you may want to look for a place that has a "strong, networked postdoctoral community", says Lauren O'Donnell, a postdoc at Fox Chase Cancer Center in Philadelphia. "Navigating your postdoc can be an intense experience."

Among all of the relationships you will have with other scientists as a postdoc, the most important one will probably be with your direct advisor, so getting this relationship right is a must. "You want someone who understands and treats you as a person, not as a slave," says Maria Aronova, a postdoc at the National Institute of Biomedical Imaging and Bioengineering in Bethesda. "This heavily influenced my choice of a postdoc mentor."

A mentor should understand and appreciate your professional goals, says O'Donnell, whether those include teaching, industry, an alternative career or a classic academic position.

While assessing a mentor's style can be difficult when you're interviewing, says Sara Howden, a postdoc at the Morgridge Institute for Research at

Publication records, collaboration, funding and facilities are key considerations when deciding on a postdoctoral position

GETTY IMAGES

the University of Wisconsin in Madison, you'll usually be able to meet with lab members as part of the interviewing process. "This provides an excellent opportunity to ask other postdocs and grad students about the group's dynamics and the day-to-day running of the lab," she says.

And don't discount your impressions of other members of the group, adds John Bochanski, an astronomy postdoc at MIT. "Try to seek out another postdoc to bounce ideas off of," he says. "Your supervisor may be busy or out of town, but if you can think out loud with another peer, it will make the research process a lot easier – and you may even get a friend out of it."

Show me the money

Evaluating your chances for funding in a particular field is an essential part of picking a postdoc position, says Steven Smith, a postdoc studying HIV at the National Cancer Institute (NCI) in Bethesda. First, it's important to pick a research project in an area that has solid funding. "I learned from my grad school days to pick a disease that has worldwide effects and is of extreme importance," he says.

Beyond the field or project in general, the type of institution and the history of a specific investigator can tell you a lot about your funding chances. "I knew that by doing a postdoc at the National Cancer Institute, I would not have to worry too much about funding," says Caroline Davis. "They have a good record of securing grants."

For his part, Widau checked out potential labs' funding through the National Institutes of Health (NIH) database and only seriously considered labs with multiple sources of funding.

It's also important to check out the resources an institution has to offer. For Bochanski, working at MIT appealed because it has access to the Magellan telescopes in Chile – a major resource for his research into low-mass stellar astronomy. "Being able to use world-class facilities puts me at a distinct advantage compared with those at smaller schools, who would need to apply for telescope time among a national pool," he says.

No matter where you decide to apply, start to think about options as early as possible in your graduate career. "I wish that I would have started the postdoc search much earlier than I did. I would recommend emailing large labs up to a year in advance," says Widau.

Thomas recommends treating the entire process as a learning experience. "Visit multiple labs, even ones you aren't sure you'd want to join," she says. "The more information you gather about what type of lab, mentor and environment you do or do not want to be in, the more informed a decision you can make.

And don't forget how your choice will affect your life outside of science, Mayer says. "Being able to live in the Bay Area has helped to maintain my sanity when away from the lab bench."

Expanding your horizons might even present an opportunity to live and work in an entirely different country. "I strongly recommend looking at labs overseas for potential postdoc positions," says Howden, who is from Australia. "I think working overseas not only looks great on a CV but is also an incredible experience that often gives you a much greater perspective on life." ■

CONTACTS

NIH index of postdoctoral openings
www.training.nih.gov/apps/publicForms/postdoctoral/forms/adIndex.aspx

NNIH index of ARRA grants
report.nih.gov/recovery/arragrants.cfm

Research in Germany

Alexander von Humboldt
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The Alexander von Humboldt Foundation enables highly-qualified scientists and scholars of all nationalities and fields to conduct extended periods of research in Germany in cooperation with academic hosts at German institutions. Fellowships are awarded solely on the basis of the applicant's academic record, the quality and feasibility of the proposed research and the candidate's international publications. The Humboldt Foundation particularly welcomes applications from qualified, female junior researchers.

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www.humboldt-foundation.de

BRIGHAM AND WOMEN'S HOSPITAL

The Division of Pulmonary and Critical Care Medicine is seeking 2 highly motivated post-doctoral fellows to work on 2 separate projects. One project co-funded with the Lovelace Respiratory Research Institute that will investigate the roles of ADAMs in COPD. A second project will investigate the activities of ADAM15 in Acute Lung Injury.

Job Details

1. The applicant must have a PhD in cell biology, biochemistry or similar scientific field or MD degree with previous wet-lab experience.
2. Ability to work with mice is required.
3. A strong publication record is essential
4. Experience in proteinases, leukocytes, or murine model systems is preferred.
5. The candidate must be detail oriented and self-motivated. In addition, the candidate must be able to contribute to the overall success of the lab by assisting other lab members as needed.
6. The applicant must be able to communicate effectively in English.
7. The candidate will be required to present their research in departmental meetings as well as at general lab meetings

The applicant will receive training in enzyme biochemistry, cell biology, and several murine models of lung disease. State of the art techniques and equipment for molecular biology, cellular imaging, and murine model systems will be available to the applicant. A two year commitment to the position is required.

If interested, please email your curriculum vitae, a copy of your most recent publications (within the last 5 years), a cover letter describing your interest, background, qualifications, and a list of previous principal investigators for whom you have worked to provide a reference to:

Caroline A. Owen, MD, PhD
Division of Pulmonary and Critical Care Medicine
Brigham and Women's Hospital, 905 Thorn Building
75 Francis Street, Boston, MA 02115

E-mail: Jennifer Cusick (Lab manager) jcusick@partners.org

Cleveland Clinic
Lerner Research Institute

Special Postdoctoral Fellowship Award in Biomedical Research

Cleveland Clinic Lerner Research Institute (LRI) is now accepting applications for the competitive prestigious David and Lindsay Morgenthaler Endowed Fellowships that provide up to 3 years of support at a minimum stipend of $55,000/yr.

Cleveland Clinic is one of America's leading hospitals in biomedical research. The LRI is well supported by NIH funding and houses more than 150 laboratories conducting cutting-edge research in all areas of biomedical science **(www.lerner.ccf.org/research).** All LRI investigators are potential mentors for Morgenthaler Fellows. Applicants must have received their PhD and/or MD after May, 2005, or expect their degrees by December, 2010.

Successful candidates will have outstanding research training and publication records. Application materials and a detailed description of the program requirements may be obtained at **www.lerner.ccf.org/education/morgenthaler.**

Deadline for receipt of applications is May 12, 2010.

Post-doctoral Research Fellows

BloodCenter of Wisconsin, an internationally recognized leader in vascular biology, thrombosis and hemostasis, immunobiology, transfusion medicine and stem cell/hematopoiesis research, is seeking outstanding candidates to fill NIH-funded Post-doctoral Training Grant positions at its Blood Research Institute (BRI). The BRI provides state-of-the-art facilities, and offers an excellent environment for scientific interaction and interdisciplinary collaboration. Opportunities are available with BloodCenter investigators in the following areas:

Richard H. Aster, MD – Pathogenesis of immune disorders affecting blood cells
Bonnie Dittel, PhD – Regulation of T cell mediated inflammation in the central nervous system
Joan C. Gill, MD – Molecular diversity of the immune response to Factor VIII in patients with hemophilia
Jack Gorski, PhD – Molecular genetic analysis of T cell repertoires
Cheryl Hillery, MD – Mechanisms of vaso-occlusion in sickle cell disease
Subramaniam Malarkannan, PhD – Signaling through NKG2D receptor
Laurent Malherbe, PhD – Regulation of T helper cell fate during the immune response
Alan Mast, MD, PhD – Molecular and cellular biology of tissue factor pathway inhibitor
Robert R. Montgomery, MD – Molecular and cellular biology of von Willebrand factor and platelet glycoprotein Ib
Michael W. Mosesson, MD – Fibrin formation and its role in angiogenesis; mechanisms of thrombophilia in dysfibrinogenemias
Debra K. Newman, PhD – Signal transduction pathways that regulate blood cell activity
Peter J. Newman, PhD – Cell adhesion and signaling receptors in vascular cells
Demin Wang, PhD – Cytokine receptor and B cell receptor signaling
Renren Wen, PhD – T cell signal transduction and T cell development
Hartmut Weiler, PhD – Blood coagulation biology
Gilbert C. White, II, MD – Integrin biology and signaling mechanisms in platelets
Magdalena Wodnicka, PhD – Small G protein signaling in vascular cells

Because these positions are funded through an NIH Training Grant, only American citizens or permanent residents are eligible to apply. Alternate funding may be available for other candidates. Qualified applicants should send curriculum vitae, a brief description of recent research, and the names and telephone numbers of three references to:

Gilbert C. White, II, M.D.
Director, Blood Research Institute
BloodCenter of Wisconsin
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POSTDOCTORAL FELLOW
Department of Neuroscience, Physiology and Pharmacology

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Please send your curriculum vitae, a statement of research interest and the names of three references to:
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Several postdoctoral positions are available in the Center for Substance Abuse Research at Temple University School of Medicine to carry out interdisciplinary research on drugs of abuse including opioids, psychostimulants, cannabinoids, and nicotine. Fellows can work with faculty members in several basic science departments including Pharmacology, Microbiology & Immunology, Anatomy & Cell Biology, Physiology, and Psychology. Examples of research interests include the molecular pharmacology of opioid and cannabinoid receptors; molecular and behavioral effects of psychostimulants, opioids, cannabinoids, and nicotine; neurobiology of addictive behaviors; cross-talk between opioid and chemokine receptors; novel opioid analgesics with peripheral actions; neuroprotective effects of cannabinoid ligands; opioid effects on HIV infectivity; and effects of drugs of abuse on immune function, body temperature and analgesia. Detailed research program descriptions can be found on our web site, **www.temple.edu/medicine/csar**.

Candidates should have a Ph.D. and/or M.D. with experience in pharmacology, neurobiology, cell biology, immunology, or molecular biology. Please send resume, statement of research interests, and names of three references to **Dr. Ellen Unterwald, Temple University School of Medicine, Department of Pharmacology, 3420 N. Broad Street, Philadelphia, PA 19140 or ellen.unterwald@temple.edu.**

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POSTDOCTORAL POSITIONS
Center for Genes, Environment and Health

National Jewish Health located in Denver, Colorado invites PhDs with demonstrated scientific expertise in immunology, genetic engineering, or genetic epidemiology to apply for post-doctoral positions in the laboratory of Dr. David Schwartz in the Center for Genes, Environment, and Health.

The overall goal of this Center is to discover the etiology and understand the biology of immune-mediated conditions, infectious diseases, and lung diseases. The research projects will focus on the role of epigenetic mechanisms on immune phenotypes, the development of humanized models of innate immunity, and gene discovery in familial pulmonary fibrosis.

Applicants must have a Ph.D. and scientific accomplishments in immunology, genetic engineering, or genetic epidemiology.

Interested candidates should submit their curriculum vitae and contact information for three references to Dr. Ivana Yang, National Jewish Health, 1400 Jackson Street, Denver, CO 80206 or yangi@njhealth.org.

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Postdoctoral Fellow in Cancer Systems Biology

Postdoctoral position at Microsoft Research New England in Cambridge, MA, to work on a joint project with the Computational Biology Center at Memorial Sloan Kettering Cancer Center, New York, and Politecnico di Torino University, Italy.

The project goal is to apply techniques from statistical physics, and newly developed algorithms, to analyze a rich set of genomic, epigenetic, molecular profiling and patient data from several extensive clinical studies, including The Cancer Genome Atlas. This position represents a unique opportunity to develop and apply new computational methods to problems such as the discovery of candidate markers for early screening or disease prognosis, the understanding of cancer pathogenesis and the development of personalized therapies. Deep expertise in algorithm development or statistical physics, and demonstrated creativity in biological research required. This position might be especially suitable for a recent Ph.D. from an interdisciplinary graduate program that emphasizes strong quantitative skills together with cell, developmental or cancer biology. The position is initially for two years and is based in Cambridge, MA, at Microsoft Research New England, but will require frequent travel to MSKCC in New York, and occasional travel to Torino, Italy.

To be considered for employment for post-doctorate opportunities, you will require your CV, your publications list, a research statement, and at least three letters of recommendation. To express your interest in applying, contact **irenem@microsoft.com**, Business Manager of Microsoft Research, New England.

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Penn Medicine
biomedical postdoctoral programs

THE UNIVERSITY OF PENNSYLVANIA

Biomedical Postdoctoral Programs (BPP) invites applications for postdoctoral appointments.

The University of Pennsylvania has long been revered and respected for its belief in the importance of education and its pursuit of excellence. The office of Biomedical Postdoctoral Programs (BPP) continues to uphold this tradition by providing Biomedical Postdoctoral Appointees with the highest quality training in and outside of the laboratory experience. From its first-rate programming series to its emphasis on career development to intramural sports teams, BPP works to enhance the life of Biomedical Postdocs.

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The partnering institutions are Delaware County Community College, Lincoln University and Rutgers University Camden Campus. All institutions are minority serving institutions in the Philadelphia locality. The program is intended to enhance research-oriented teaching at partner institutions, foster collaboration in research and teaching between the faculty at the University of Pennsylvania and that of partner minority-serving institutions, and encourage undergraduates to enter a career in biomedical research. We thus seek applicants with a demonstrated interest in minority education.

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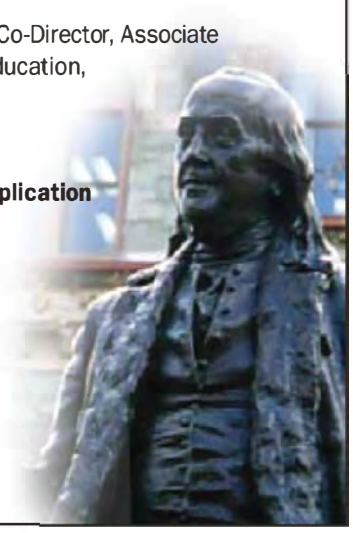

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Fatty Acid Trafficking. This position uses high-resolution mass spectrometry to follow the trafficking and metabolism of different classes of exogenous fatty acids in mammalian cell lines. Expertise in mammalian cell culture and associated expression and knockdown technologies, lipid metabolism, and ability to apply state-of-the-art mass spectrometry methods are preferred; candidates should e-mail their current CV to pblack2@unl.edu.

Lipid Metabolism/Small Molecule Analysis. This position advances current studies that have identified small molecules that block fatty acid import. Expertise in mammalian cell culture, the use of mouse models, lipid metabolism and pharmacological analysis of small molecules and how they impact metabolism are preferred; candidates should e-mail their current CV to cdirusso2@unl.edu.

Lipidomics and New Generation Biofuels, This position addresses the accumulation of triglycerides in different species of algae and will involve high throughput screening of different algal species and genetic engineering of selected species for maximal oil production. Expertise in lipid metabolism, molecular genetics and high-resolution mass spectrometry methods are preferred; candidates should e-mail their current CV to pblack2@unl.edu.

A PhD in biochemistry or related field and publication in peer-reviewed journals are required. Lincoln Nebraska boasts an outstanding quality of life that includes fine culinary and artistic treasures, a live music scene and numerous parks, golf courses and bike trails.

Postdoctoral Position

Postdoctoral position is available immediately at the University of South Carolina (USC) to study the role of urinary bladder smooth muscle ion channels, such as BK, SK, IK and Kv channels, and their regulation by muscarinic and beta-adrenergic receptors. Applicants should have a PhD degree with a strong background in physiology/pharmacology, electrophysiology (patch-clamp and/or microelectrodes), cell and molecular biology, bladder cystometry, and experience in animal handling and rodent surgery. A good background in urinary bladder smooth muscle function and regulation is strongly required. This project is ideal for a highly motivated individual with demonstrated experience in electrophysiology (patch-clamp and microelectrodes), molecular biology (RT-PCR, Western blot, immunocytochemistry), calcium imaging (fura-2, flou-4, high speed confocal), bladder cystometry, and smooth muscle tension recordings. Experiments will involve use of whole-cell patch-clamp and single channel recordings, calcium imaging, molecular biology, and functional studies utilizing urinary bladder smooth muscle tissues from experimental animals and humans (post-surgical material from open bladder surgeries). Good communication and organizational skills, and excellent knowledge of English (both oral and written) are required. Applicants should have demonstrated scientific productivity, have a strong publication record, and be able to conduct independent research. Five years of funding are currently available. Salary will be commensurate with experience and in accordance with the USC guidelines and pay-scale.

To apply for this position, please send CV, letter of interest, statement of research interests, and contact information for 3-5 referees to Dr. Georgi Petkov: petkov@cop.sc.edu

The College of Pharmacy is located in downtown Columbia, one block from the State House. Columbia offers a high standard of living with good access to both cultural and outdoor activities.

Post Doctoral Positions Available

Cancer Bioinformatics and Computational Biology of Drug Response Biomarkers

Research associate: the discovery and validation of drug response biomarkers in cancer. Excellent skills in oral and written English and the ability to work independently are required. Individuals with a very recent Ph.D. degree in Computer Science, Molecular Biology, or related field and expertise in cancer bioinformatics and/or systems biology are strongly preferred. Candidates should have a demonstrated competence in deploying bioinformatics tools and techniques and relevant technologies including scripting language and possess the ability to absorb and integrate publicly available genetic databases. This position offers mentoring by two supervisors with complementary expertise in bioinformatics and cancer biology/translational oncology.

Signal Transduction and Cell Biology of Tumor Metastasis

Research associate: the role of GTPases and related proteins in cell migration and metastasis. We have identified the Ral GTPase family of proteins as promoters and RhoGDI family as novel suppressors of metastasis in bladder and prostate cancers. Molecular, cellular, transgenic and functional genomic approaches are being employed to define the molecular mechanisms whereby the RhoGDI2, Ral and associated binding partners affect the metastatic phenotype. Candidates with a very recent PhD degree in the areas of transcriptional control or biochemistry/proteomics are strongly preferred.

Candidates should have an outstanding record in graduate school. Excellent skills in oral and written English and the ability to work independently are required. These positions provide an excellent opportunity to highly motivated individuals to work in a supportive collaborative environment.

By virtue of scientific interactions and opportunities to work on human tumor materials this fellowship prepares the applicant for a career in translational cancer research in either academia or industry.

To apply to these positions, please email Dr. Dan Theodorescu: dt9d@virginia.edu

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Interested in cutting edge science?
Then consider our Service Fellowship Program!

The Center for Biologics Evaluation and Research's mission is to protect and enhance the public health through the regulation of biological products including blood, vaccines, allergenics, tissues, and cellular and gene therapies. Biologics, in contrast to drugs that are chemically synthesized, are derived from living sources (such as human, animals, and microorganisms) and are not easily identified or characterized, and many are manufactured using biotechnology. These products often represent cutting-edge biomedical research and, in time, may offer the most effective means to treat a variety of medical illnesses and conditions that presently have few or no other treatment options. To accomplish its mission, CBER seeks candidates whose expertise covers a broad range of scientific disciplines and whose responsibilities include the mission-oriented research and regulation of biological products.

Qualifications:
Staff Fellow and Senior Staff Fellow applicants must be U.S. citizens. Non U.S. citizens holding a valid U.S. employment visa are eligible for Visiting Associate and Visiting Scientist positions. These positions may also be filled by appointment in the US Public Health Service, Commissioned Corps.

Staff Fellow - must possess a Ph.D. or equivalent degree (e.g., MD, VMD, or Sc.D) plus less than 2 years of post-doctoral health-related research/regulatory review experience.

Senior Staff Fellow - Must possess a Ph.D. or equivalent degree (e.g., MD, VMD, or Sc.D) plus 2 or more years of post-doctoral health-related research/regulatory review experience.

Candidate must either have been awarded their doctoral degrees in a bio-medical, behavioral, or related science or have been certified by a university as meeting all the requirements leading to such a doctorate.

Salary Range:
Salary is equivalent to GS-11/13. Salary is commensurate with education and experience.

How to Apply:
For current vacancies and application procedures, visit: **http://www.fda.gov/AboutFDA/CentersOffices/CBER/ucm103202.htm.**

For future vacancies, submit CV/resume & cover letter to our resume bank by 3/31/2010 to: **CBER.Employment@fda.hhs.gov Attn: Job Code: Postdoc.**

Department of Health and Human Services is an equal opportunity employer with a smoke free environment.

Postdoctoral Position

A Postdoctoral position is available in the laboratory of Prof. Nicholas Baker, in the Department of Genetics at Albert Einstein College of Medicine in New York, USA. (http://fruitfly4.aecom.yu.edu/index.html). The successful applicant will use molecular and genetic approaches to study growth and/or neural differentiation in vivo using the fruitfly Drosophila melanogaster. Our interests include the regulation of the cell cycle and other aspects of cell physiology during terminal differentiation of neurons, and the pathways or cell death, cell engulfment, and cell orientation during cell competition and organ growth. Applicants should have a relevant doctoral degree, a strong research background and a passion for science. Salary will be based on the NIH scale.

Please send CV including list of publications and names of 3 references by email to **postdoc_baker@yahoo.com**, mentioning this ad. EOE

MAYO CLINIC

Pharmacogenomics Bioinformatics Fellowship.

The Pharmacogenomics Laboratory at the Mayo Clinic College of Medicine is seeking a postdoctoral fellow with a Ph.D., M.D. or M.D.-Ph.D. degree for a position as a "Pharmacogenomics Bioinformatics" fellow. This laboratory is part of the NIH-sponsored Pharmacogenomics Research Network (PGRN) and our studies involve very large datasets that include genomic, transcriptomic and metabolomic data, as well as both cell line-based and clinical drug response phenotypes. This bioinformatics position would prepare a candidate for an academic faculty position or a position in the pharmaceutical-biotechnology research industry.

Mayo Clinic College of Medicine is a not-for-profit organization that integrates research with clinical practices and education in multi-campus environment. Mayo offers an attractive benefit package. Salary will be determined by the candidate's experience.

Applications, including curriculum vitae and bibliography, summary of past accomplishments, and 3 signed reference letters, should be sent to:
Richard Weinshilboum, M.D. | Mayo Clinic | Department of Molecular Pharmacology and Experimental Therapeutics | 200 First Street SW | Rochester, MN U.S.A. 55905
Email: Weinshilboum.richard@mayo.edu

McGill — Micro & NanoBioengineering Lab

Postdoc or Research Associate on Cancer Biomarker Discovery Using Our Novel Antibody Microarray Platform

We seek an outstanding postdoctoral fellow or research associate to lead our effort on biomarker discovery and validation for breast cancer. The work is on using and improving our novel high performance microfluidic antibody platform for multiplex profiling of biomarker proteins in tissue and blood for cancer and other diseases.

Major Activities: Use proteomics platform, optimize and develop it for new applications. Identify and validate new antibody reagents and improve assay performance, perform statistical data analysis and interact with collaborators. Help with project coordination and grant writing.

Requirements: Drive; curiosity and autodidactic skills; strong interest for technology development; excellent writing skill; in depth knowledge of molecular biology and biochemistry; experience with omics science, immunoassay development, proteins, and antibody reagents. Interdisciplinary experience and expertise in multiplex immunoassays and breast cancer is a plus.

Please send your application (cover letter, CV, names of three references and pertinent reprints and preprints, preferred format .pdf) by email with the subject "Postdoc/RA in biomarker discovery" to david.juncker@mcgill.ca. For more info: http://wikisites.mcgill.ca/diggroup

FOX CHASE CANCER CENTER

POSTDOCTORAL POSITION in the laboratory of Dr. Richard Hardy at the Fox Chase Cancer Center in Philadelphia, to study the role of pre-B and B cell antigen receptor in B cell development, growth regulation, and transformation (leukemia). The role of self-antigen in generation of chronic B cell leukemia, potential cancer stem cells, and mechanism(s) of growth dysregulation will be explored in mouse models and human leukemias. Applicants must have Ph.D./M.D. with substantial research experience, preferably in immunology and molecular biology. The successful candidate will be hard working and highly motivated.

Send CV, summary of research experience, and names of three references to: richard.hardy@fccc.edu.

Trudeau Institute, Inc. has immediate openings for postdoctoral fellows to carry out research in murine models of infectious disease, virology, cellular and molecular studies of host pathogen interactions, mouse molecular genetics, signal transduction, chemokines, immune memory and lymphocyte adhesion, trafficking and homing.

Research opportunities for creative Ph.D., M.D. or D.V.M. scientists with a strong interest in pursuing the mechanisms that regulate responses to pathogens, tumors and autoantigens are available.

FACULTY RESEARCH INTERESTS
Andrea Cooper, Ph.D. - Immunopathogenesis of mycobacterial disease
Markus Mohrs, Ph.D. - Cellular and molecular mechanisms governing cytokine responses to infection
Edward Pearce, Ph.D. - Immune regulation in chronic helminth infections, dendritic cell biology, schistosome biology.
Erika Pearce, Ph.D. - Molecular mechanisms regulating CD8 T cell fates

Trudeau Institute, Inc. located in the heart of northern New York State's Adirondack Mountains offers competitive salaries, affordable housing, a full complement of benefits and on-site childcare. The Institute fosters a highly collaborative research environment focused on basic immunology and infectious disease. Further details may be found at **www.trudeauinstitute.org**

Interested candidates should send a CV, cover letter, a brief statement of research interests and three references (preferably with an e-mail address included) to **Amy Richardson, Human Resource Manager, Trudeau Institute, Inc., 154 Algonquin Avenue, Saranac Lake, NY 12983 or arichardson@trudeauinstitute.org**

If interested in interviewing with a particular lab or labs, please specify in the cover letter.

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Postdoctoral Positions

The University of Alabama at Birmingham (UAB) is one of the premier research universities in the US with internationally recognized programs in AIDS & bacterial pathogenesis, bone biology & disease, cancer, diabetes & digestive & kidney diseases, free radical biology, immunology, lung disease, neuroscience, trauma & inflammation, and basic & clinical vision science among others. UAB is committed to the development of outstanding postdoctoral scientists and has been consistently ranked in recent years as one of the top locations among US universities for training postdoctoral scholars.

UAB is recruiting candidates for postdoctoral positions in a variety of research areas. UAB faculty are well funded (20th in NIH funding), utilize multidisciplinary approaches, and provide excellent research training environments that can lead exceptional candidates to entry level positions in academia, government or the private sector. Full medical coverage (single or family), competitive salaries/stipends, sick leave, vacation, and maternity/paternity leave are offered with every position. Depending on the source of funding, other benefits may be available. Birmingham is a mid-size city centrally located in the southeast near beaches and mountains and enjoys a moderate climate for year round outdoor activities and a cost of living rate lower than most metropolitan areas.

Visit our web site at **www.postdocs.uab.edu**, under Postdoctoral Opportunities to view posted positions. Send your CV and cover letter to the contact name for those positions for which you are qualified and which interest you. University of Alabama at Birmingham, Office of Postdoctoral Education, 205-975-7020.

UAB is an equal employment opportunity employer.

OSU Oregon State University

Postdoctoral Positions:
Molecular Developmental Toxicologist

Our laboratory investigates the mechanisms by which chemicals and nanoparticles interact with and adversely affect early life stage development. Our group primarily uses zebrafish as a vertebrate model to identify the molecular pathways that are perturbed by exposures that ultimately lead to lasting functional deficits.

The candidate must have a Ph.D. degree in molecular biology, biochemistry or a related field. Experience with gene expression analysis, quantitative PCR, automation, and bioinformatics are preferred. Effective written and oral communication skills are essential. The projects involve the use of high throughput in vivo screening, global gene expression analysis, behavioral assessments, and transgenic animal use and production. Salary will be based on University guidelines for postdoctoral fellows.

To apply for this position, please e-mail a cover letter describing previous training and research interests, career goals, a CV, representative papers, and three letters of recommendation to:

Robert L. Tanguay
Department of Environmental and Molecular Toxicology, Oregon State University
1007 ALS, Corvallis, OR 97331
E-mail: robert.tanguay@oregonstate.edu

150 YEARS OF MEDICAL EDUCATION

A **Postdoctoral position** is available to study sexual dimorphic tolerance / dependent mechanisms as well as sex-dependent expression and utilization of spinal opioid systems. The research utilizes a multidisciplinary approach that integrates behavioral, pharmacological, biochemical and molecular levels of analysis. In addition to using whole animals, experiments make use of ex vivo preparations and cells maintained in culture. Examples of research projects include identification of sex-dependent spinal pathways activated by morphine, sex-dependent effects of chronic opioid exposure on opioid signal transduction. The successful candidate could also be involved in investigating subcellular localization of opioid receptor Gs signaling and determinants / consequences of opioid receptor heterodimerization. A Ph.D. with experience in cell / molecular biology with a strong background in biochemistry is desired. The position offers the opportunity to work with dynamic well-funded investigators in a collegial and collaborative environment.

Interested applicants should submit their CV, statement of research interests, and contact information for three references to: alan.gintzler@downstate.edu.

SUNY Downstate is an EEO/AA employer and strongly encourages applications from women and minorities.

CANADIAN BLOOD SERVICES Postdoctoral Fellowships

Canadian Blood Services
it's in you to give

Canadian Blood Services (CBS) is accepting applications for Postdoctoral Fellowships (PDF) to work with our affiliated Research & Development groups across Canada. CBS has active research programs within transfusion science emphasizing platelets, stem cells, plasma proteins, infectious disease, epidemiology and clinical transfusion practice. Applicants should have a Ph.D. or M.D. degree and a strong research background. This two-year award includes a salary and research allowance, and the possibility of a one-year renewal. Candidates must select and contact a CBS affiliated scientist to serve as the Postdoctoral Fellowship supervisor. CBS also supports a Graduate Fellowship Program and a Summer Internship Program.

Information, forms and a list of CBS affiliated scientists are available at **www.blood.ca**, and from the R&D Office (**elaine.konecny@blood.ca**), **Canadian Blood Services, Research & Development, 1800 Alta Vista Drive, Ottawa, Ontario, K1G 4J5, Canada**.

Please note that the 2010 campaign will not accept on-line applications. Candidates are encouraged to respond by hard copy.

PDF Application deadline: July 2, 2010.

Idaho National Laboratory

Idaho National Laboratory is seeking a **STAFF MEMBER OR POST-DOC** who will develop and demonstrate solutions to a variety of moderately large and/or complex problems related to systems technologies, including modeling and simulation, through the general use and application of design/development practices, theories, and techniques. Typical R&D areas of interest may include, but not necessarily be limited to, sensor networks/systems, monitoring, decision, and control systems, system integration and optimization, probabilistic reasoning, and on-line predictive conditioning monitoring and anomaly detection and interpretation techniques with diagnostic/prognostic capabilities.

Candidate must have an earned Ph.D. in electrical engineering or a closely related engineering discipline with a strong emphasis in systems technologies.

Applicants should send a CV and summary of research interests by email to vanessa.vandyk@inl.gov

POSTDOCTORAL OPPORTUNITIES

The Wadsworth Center of the New York State Department of Health, with basic and applied research programs in the biomedical and environmental sciences, provides a unique and dynamic postdoctoral training experience. Enhancing this environment are state-of-the-art core facilities; broad-based graduate programs with the University at Albany, State University of New York; and new initiatives in bioinformatics, genomics, nanobiotechnology, and biodefense. Positions are available in the following areas:

- Atmospheric Chemistry
- Biodefense
- Biomarkers/Nutrition
- Cancer Biology/Chemotherapy
- Carcinogenesis
- Cell Biology/Mitosis
- DNA Repair/NMR
- Drug Metabolism/Resistance
- Gene Expression/Regulation
- Immunology
- Infectious Disease
- Medical Entomology
- Microbial Genetics/Pathogenesis
- Mobile Genetic Elements
- Neuroscience/Disease
- Stem Cell Biology
- Structural Biology
- Toxicology/Neurotoxicology

For additional information, go to:
www.wadsworth.org/educate/postdocs.htm
and to apply, contact:
Dr. Donal Murphy, Research Office,
Wadsworth Center, New York State Department of Health
P.O. Box 509, Albany, NY 12201-0509
murphy@wadsworth.org

Wadsworth Center
New York State Department of Health
Health Research Incorporated
AA/EOE

Post-doctoral Position Available Immediately

Dana-Farber Cancer Institute, Department of Cancer Immunology & AIDS, is seeking a post-doctoral fellow with expertise in molecular virology to join a dynamic team involved in studying lentiviral pathogenesis and host immunity in primate models. The project involves construction of mutant proviruses and the analysis of their biology and evolution in primates. The position offers training in primate lentivirology and immunology. Ph.D. in molecular biology/virology is required; a strong background in gene expression analysis is a plus. The successful candidate will have a joint appointment at Harvard Medical School and the Dana-Farber Cancer Institute. Interested candidates should send their CV and the names of three references by e-mail to:

Dr. Ruth Ruprecht, Dana-Farber Cancer Institute
44 Binney Street, Boston, MA 02115
e-mail: ruprecht_lab@dfci.harvard.edu

Applicants must be residing within the U.S. or eligible to work in the U.S. within 90 days

Two postdoctoral positions are available at the UCSF School of Medicine in San Francisco

I. Study Mouse Genetic Models of Cerebrovascular Disease. Interested individuals should have a published record in genetics, molecular biology or cell biology. Candidates with experience in vascular biology, matrix biology or mouse genetics are especially encouraged.

II. Study a novel mouse genetic model of retinal degeneration. Interested individuals should have a published record in genetics, molecular biology or cell biology. Candidates with experience in vision research, matrix biology or mouse genetics are especially encouraged.

Interested individuals should email the following to GouldD@vision.ucsf.edu:
1) their CV
2) a statement of research experience
3) a statement of career goals
4) contact information for two references

Doug Gould, PhD., Departments of Ophthalmology and Anatomy, Institute for Human Genetics
UCSF School of Medicine, 10 Koret Way, Room K235, San Francisco, CA, 94143

MILLER SCHOOL OF MEDICINE UNIVERSITY OF MIAMI

Postdoctoral Position Available at the Miami Project to Cure Paralysis, University of Miami Miller School of Medicine

Funded laboratory seeks a highly motivated researcher to st dy combination strategies to repair the injured rat spinal cord, including the use of cultured cell transplantation and bioengineered materials. Laboratory is highly collaborative and benefits from outstanding milieu due to a high number of interactive scientists using a wide variety of technologies to study spinal cord injury and to a wealth of seminars. Expertise in rat spinal cord surgery and animal care and behavioral testing very strongly preferred. Salary is competitive and depends upon experience. ***Please send CV, a letter of interest and names and addresses of three (3) references to:***

Prof. Mary Bartlett Bunge, the Miami Project, Lois Pope LIFE Center, U Miami Miller School of Medicine, Box 016960, R-48, Miami, FL 33101. mbunge@miami.edu

Applications should be received by March 15th for consideration

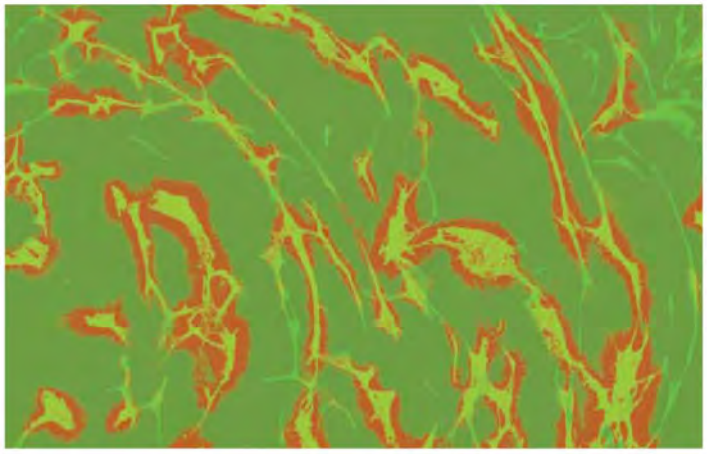
NIH SUPPORTED POST DOCTORAL POSITION

We are investigating interactions between exposure to environmental contaminants and sexually dimorphic differences in brain development and neurodegeneration using in vitro techniques including primary neuronal and organotypic brain cultures. Techniques used include immuno- and histochemical visualization with advanced imaging, neurochemical analysis and protein measurements including Western blot analysis and ELISAs.

This position is at the Wadsworth Center of the New York State Department of Health in Albany, NY which has been recognized as one of the best research institutes for both senior investigators and post doctoral fellows, and is affiliated with the School of Public Health at the University at Albany.

Please forward a recent CV and letters of reference to: Dr. Richard Seegal, Wadsworth Center, New York State Department of Health, Empire State Plaza, Albany, NY 12201 or to seegal@wadsworth.org.

This is an NIH funded position administered by Health Research Inc., an Affirmative Action/Equal Opportunity Employer



Maribel, Patient

BECAUSE

Our CAUSE is Maribel and her allergic asthma.

For more than 30 years, Genentech has been at the forefront of the biotechnology industry, using human genetic information to develop novel medicines for serious and life-threatening diseases. Today, Genentech is among the world's leading biotech companies, with multiple therapies on the market for cancer and other serious medical conditions. Please take this opportunity to learn about Genentech, where we believe that our employees are our most important asset.

Genentech's research organization features world-renowned scientists who are some of the most prolific in their fields and in the industry. Genentech researchers have consistently published in prestigious peer-reviewed journals and have secured approximately 7,400 current, non-expired patents worldwide (with about 6,250 more pending). Genentech's research organization combines the best of the academic and corporate worlds, allowing researchers not only to pursue important scientific questions but also to watch an idea move from the laboratory into development and out into the clinic.

Genentech Postdoctoral Program

The Genentech Postdoctoral Program is designed to create a vibrant and supportive environment for rigorous scientific training. The primary aim of the program is to train postdocs to conduct research of the highest possible quality, to publish results in top-tier journals and to transition to independent scientific investigators, both in academia and industry.

As a Genentech Postdoctoral Research Fellow, you will find yourself collaborating with world-class scientists both at the company and beyond Genentech's walls. Our fellowships typically last four years and offer the chance to do cutting-edge research in an inspired, purposeful and resource-rich environment. Throughout the program, you will be encouraged to publish and present the progress and results of your work both internally and at external scientific conferences. As our many Postdoctoral Program alumni can attest, the program offers an unrivaled opportunity to put yourself at the forefront of science.

Consistently recognized as one of the top companies to work for in the United States, Genentech offers employees one of the most comprehensive benefits programs in the industry. For more information on the program and to read commentary from current and past postdocs, please visit **postdocs.gene.com**. For a complete listing of current postdoc opportunities and to apply, please visit **careers.gene.com**.

Genentech is an equal opportunity employer.

In October 2009, Genentech was named "top employer in the biopharmaceutical industry" by Science Magazine.

Science 2009 TOP EMPLOYER

Genentech
A Member of the Roche Group

East Coast Office
225 Wyman Street
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Email NSSales@NewScientist.com
Phone 781 7348770
Fax 7203569217

West Coast Office
201 Mission Street, 26th Floor
San Francisco, CA 94105
Email NSSales@NewScientist.com
Phone 415908 3353
Fax 415543 6789

BIOLOGY

Postdoctoral Position in Immunology at New York University (NYC)
New York University NYU
NY - New York
A postdoctoral position is available immediately in the Feske lab at New York University Medical Center (NYUMC) to study the role of calcium channels and calcium-dependent signaling pathways in cells of the immune system both in vitro and in vivo. Experimental models focus on T cell immune responses in knock-out and transgenic mice in the context of autoimmunity, infectious diseases, cancer and development. In addition, our lab studies the mechanisms regulating calcium channels at the molecular level.
For more information visit NewScientistJobs.com Job ID: 200684137

Postdoctoral Research Fellow
Genentech
CA - California
A Postdoctoral Research Fellow position is available in Protein Analytical Chemistry department to study conformational and biophysical properties of proteins by using nuclear magnetic resonance (NMR) techniques.
For more information visit NewScientistJobs.com Job ID: 200706166

Postdoctoral Research Fellow - Ellen Filvaroff's Lab
Genentech
CA - California
A postdoctoral opening is available in the Department of Molecular Oncology to join a group studying the mechanisms of regulation of tumor growth. The successful candidate will apply molecular, biochemical and cellular approaches to identify and characterize in vitro and in vivo activity of novel regulators of tumor growth and metastasis.
For more information visit NewScientistJobs.com Job ID: 200706248

Postdoctoral Research Fellow - Germaine Fuh's Lab
Genentech
CA - California
The Postdoctoral fellow will involve in cutting edge technology development to advance the art of antibody discovery and engineering, and will analyze the molecular mechanism of novel antibody interaction by structure-function and biophysical analysis
For more information visit NewScientistJobs.com Job ID: 200706250

Postdoctoral Research Fellow - Wayne Fairbrother's Lab
Genentech
CA - California
The main focus of the protein NMR group is to apply and develop techniques for studying the solution structures of proteins and protein/protein or protein/ligand complexes of therapeutic interest.
For more information visit NewScientistJobs.com Job ID: 200706226

Postdoctoral Research Fellow - Weilan Ye Lab
Genentech
CA - California
We are seeking a talented postdoc to delineate the molecular and cellular functions of new factors involved in vascular development and tumor angiogenesis.
For more information visit NewScientistJobs.com Job ID: 200706186

Postdoctoral Research Fellow- Dan Eaton's Lab
Genentech
CA - California
The study will focus on further delineating the mechanism by which these pairs interact to deliver an inhibitory signal and to further delineate their signaling pathways. Requirements: The successful candidate should possess a Ph.D. either in Biochemistry, Chemistry or Immunology from a leading institution.
For more information visit NewScientistJobs.com Job ID: 200706207

POSTDOCTORAL RESEARCH FELLOW POSITION
Columbia University, Department of Physiology & Cellular Biophysics
NY - New York
The Department of Physiology and Cellular Biophysics at Columbia University seeks a Postdoctoral Research Fellow to work on the structure and function of eukaryotic membrane proteins associated with cardiovascular disease.
For more information visit NewScientistJobs.com Job ID: 200711491

Post-doctoral Position
Dana-Farber Cancer Institute
MA - Massachusetts
Post-doctoral Position Available Immediately Dana-Farber Cancer Institute, Department of Cancer Immunology & AIDS, is seeking a post-doctoral fellow with expertise in molecular virology to join a dynamic team involved in studying lentiviral pathogenesis and host immunity in primate models.
For more information visit NewScientistJobs.com Job ID: 200707767

Postdoctoral Fellowships
Canadian Blood Services (CBS)
ON - Ontario
Canadian Blood Services (CBS) is accepting applications for Postdoctoral Fellowships (PDF) to work with our affiliated Research & Development groups across Canada. CBS has active research programs within transfusion science emphasizing platelets, stem cells, plasma proteins, infectious disease, epidemiology and clinical transfusion practice.
For more information visit NewScientistJobs.com Job ID: 200712053

POSTDOCTORAL FELLOWSHIPS
Harvard University, Department of Molecular and Cell Biology
MA - Massachusetts
The Department is actively seeking postdoctoral fellows in a wide variety of fields within molecular and cellular biology. Some appointments are funded through research grants awarded to Faculty members and are ordinarily for one year, sometimes renewable; other appointments are possible through individual postdoctoral fellowships.
For more information visit NewScientistJobs.com Job ID: 200708230

Postdoctoral Fellow in Cancer Systems Biology
Microsoft Research
MA - Massachusetts
The project goal is to apply techniques from statistical physics, and newly developed algorithms, to analyze a rich set of genomic, epigenetic, molecular profiling and patient data from several extensive clinical studies, including The Cancer Genome Atlas.
For more information visit NewScientistJobs.com Job ID: 200712520

POSTDOCTORAL OPPORTUNITIES
Wadsworth Center
NY - New York
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

Das DKMS Life Science Lab GmbH in Dresden führt in Zusammenarbeit mit der DKMS Deutsche Knochenmarkspenderdatei gemeinnützige GmbH im Kampf gegen Leukämie Laboruntersuchungen bei der Suche und Vermittlung von Stammzellspendern durch.

Die DKMS Deutsche Knochenmarkspenderdatei gemeinnützige GmbH gehört weltweit zu den führenden Organisationen bei der Suche und der Vermittlung von Stammzellspendern im Kampf gegen Leukämie. Einen wesentlichen Beitrag leistet hierbei das DKMS Life Science Lab GmbH in Dresden, wo ein großer Teil der für unsere Arbeit wichtigen immungenetischen Charakterisierung der Spender mittels direkter Sequenzierung sowie Laboruntersuchungen zur Histokompatibilität erfolgen.

Zum weiteren Ausbau des Labors und seines Tätigkeitsspektrums suchen wir zum nächstmöglichen Zeitpunkt den/die

Ärztliche/n Direktor/in

Die DKMS folgt der Leitlinie „Jeder Einzelne zählt" sowohl bei unseren Spendern als auch bei unseren Mitarbeitern. Dem/der zukünftigen ärztlichen Direktor/in fällt dabei fachlich und vor allem menschlich eine Schlüsselrolle zu.

Auf der Grundlage einer abgeschlossenen fachärztlichen Weiterbildung im Bereich der Humangenetik, Transfusionsmedizin oder Laboratoriumsmedizin prägt der/die ärztliche Direktor/in die zukünftige Technologie zusammen mit dem Kreis der Abteilungsleiter des Labors. Erfahrungen im Bereich der ambulanten kassenärztlichen Versorgung sind für diese herausragende Funktion hilfreich.

Im Bereich der Immungenetik und Histokompatibilität erfüllt der/die zukünftige Stelleninhaber/in die für die Akkreditierung des Labors erforderlichen Qualifikationen gemäß ASHI und EFI.

Wir sprechen bewusst auch Persönlichkeiten mit wissenschaftlichem Hintergrund an, die ihren bisherigen beruflichen Werdegang in den Feldern der Biotechnologie oder molekularen Medizin begonnen und dort Erfahrungen als Führungskraft mit modernen Sequenzierungstechniken gewonnen haben. Kenntnisse im Bereich der Labor-EDV mit dem Schwerpunkt Automation für den Hochdurchsatz im genetischen Screening sind hilfreich.

Die DKMS fördert in diesem Zusammenhang auch die Forschung im Rahmen von Förderprojekten zur Sicherstellung der Zukunftsfähigkeit.

Diese Tätigkeit setzt selbstständiges und verantwortungsvolles Arbeiten, analytisches und strategisches Denken, Engagement und überdurchschnittliche Fach- und Führungskompetenz sowie Freude an der Zusammenarbeit im Team voraus.

Senden Sie bitte Ihre aussagefähigen Bewerbungsunterlagen unter Angabe Ihrer Gehaltsvorstellung und des frühestmöglichen Eintrittstermins an:

DKMS Life Science Lab GmbH
Dietmar Pawlik, Fiedlerstr. 34, 01307 Dresden oder pawlik@dkms.de

health sciences among others.
For more information visit NewScientistJobs.com Job ID: 200711495

Associate Research Scientist - Tobacco Development

Altria Group
VA - Virginia
We are currently seeking a highly qualified Associate Research Scientist to join our Product Design and Technology department in Richmond, VA. The successful candidate will conduct field and greenhouse research targeting agronomic and genetic modifications to produce desired tobacco leaf qualities.
For more information visit NewScientistJobs.com Job ID: 200708886

Associate Research Scientist, Division of Digestive and Liver Diseases

Columbia University
NY - New York
The candidate must have a PhD or MD and be an experienced researcher with postdoctoral training and strong expertise in mouse models of cancer, carcinogenesis, transgenic design, lineage tracing and IHC or ISH for the analysis of gene expression.
For more information visit NewScientistJobs.com Job ID: 200711489

Scientist - Neuroscience

Genentech
CA - California
This individual will lead a small team that will use molecular, genetic, imaging and/or biochemical techniques to investigate the molecular mechanisms of nervous system disorders and to participate in drug discovery projects.
For more information visit NewScientistJobs.com Job ID: 200706228

Senior Epidemiologist

Henry M Jackson Foundation
MD - Maryland
Provide epidemiologic expertise

Internships with the The Microsoft® Medical Media Laboratory (M3L)

Washington, District of Columbia

Microsoft's Health Solutions Group, in conjunction with Microsoft® Research, has an immediate opening for an internship position exploring the application of **Touch Wall / Ultra-Scale Display Technology in Healthcare.**

Additional internships will be available for summer and fall 2010 in areas of cloud computing, unified communications, human-computer interaction, workflow and decision support.

Interns will have the opportunity to design and build novel solutions in these areas and examine the impact of this technology in a real-world healthcare environment.

Applications will be considered for students currently enrolled in PhD or Masters programs in Computer Science who demonstrate exceptional skills in C#/.NET and Windows Presentation Foundation.

Stipend and expenses paid.
Contact: Hank Rappaport, MD | **Email:** M3L_int@microsoft.com

More information, including an on-line application, can be found at http://research.microsoft.com/en-us/jobs/intern/medicalmedia.aspx

Microsoft®

and review of Medical Surveillance Monthly Report (MSMR) articles and other AFHSC publications and reports to ensure sound epidemiologic study design, methodology, analyses, interpretation of results, conclusions and recommendations.
For more information visit NewScientistJobs.com Job ID: 200709946

PHARMACOGENOMICS RESEARCH SCIENTIST
Medical Diagnostic Laboratories
NJ - New Jersey
MDL is currently seeking a post-doctoral fellow with a strong background in cell cycle biology and/or cancer genetics to join the Pharmacogenomics division of our Research & Development department in our corporate office in Hamilton, NJ.
For more information visit NewScientistJobs.com Job ID: 200706951

Internships with the The Microsoft; Medical Media Laboratory (M3L)
Microsoft
DC - District of Columbia
Internships with the The Microsoft® Medical Media Laboratory (M3L) Washington, District of Columbia Microsoft's Health Solutions Group, in conjunction with Microsoft® Research, has an immediate opening for an internship position exploring the application of Touch Wall / Ultra-Scale Display Technology in Healthcare.
For more information visit NewScientistJobs.com Job ID: 200707729

BIOLOGY INSTRUCTOR (General Biology with emphasis in Physiology)
MiraCosta College
CA - California
One full-time (10 months per year), tenure-track faculty position, beginning August 16, 2010. The position is based in the Department of Biological Sciences. The individual selected for this position will be subject to assignment at any district facility during any hours of operation.
For more information visit NewScientistJobs.com Job ID: 200712593

Research Associate - Structural Biology
Novartis Institutes for BioMedical Research (US)
MA - Massachusetts
The candidate will join a state-of-the art unit that provides structural biology information to expedite drug discovery projects undertaken at the NIBR Cambridge campus. The candidate will be part of the biomolecular structure group responsible for expression, purification, crystallization and structure determination of proteins and protein-ligand complexes.
For more information visit NewScientistJobs.com Job ID: 200711353

Statistician
Pfizer US
CT - Connecticut
The statistician will be an integral member of a systems biology team which develops and/or uses computational and statistical approaches to manage and derive knowledge of biological processes from large biological datasets (e.g., expression profiling, and other 'omics' sets).
For more information visit NewScientistJobs.com Job ID: 200710067

Faculty Positions - Basic Science - Philadelphia
Temple University School of Medicine
PA - Pennsylvania
Positions may be available in any of several basic science departments and/or research programs and institutes. The School of Medicine consists of 7 basic science and 18 clinical departments, and a variety of multidisciplinary research programs and institutes.
For more information visit NewScientistJobs.com Job ID: 200707748

Faculty Positions - Clinical Specialties - Philadelphia
Temple University School of Medicine
PA - Pennsylvania
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For more information visit NewScientistJobs.com Job ID: 200707754

CHEMISTRY

Principal Scientist; Medicinal Chemist
AstraZeneca US
MA - Massachusetts
The qualified individual will be an active laboratorian with strong synthetic and medicinal chemistry skills and the ability to devise chemical solutions to issues arising in medicinal chemistry programs.
For more information visit NewScientistJobs.com Job ID: 200707737

Member of Technical Staff - Hydrocarbon Scientist
ExxonMobil Research and Engineering Company
NJ - New Jersey
The researcher will utillize both computational tools as well as experimental methods to develop a comprehensive and validated understanding of scientific problems in hydrocarbon science.
For more information visit NewScientistJobs.com Job ID: 200712226

Senior Associate Scientist
Pfizer US
MA - Massachusetts
Preparation and in vitro characterization of innovative protein, peptide and other biomolecular conjugates; - Protein formulation related analytical method development, process development, and associated trouble-shooting activities -
For more information visit NewScientistJobs.com Job ID: 200705851

CLINICAL

Director** Clinical Research-Crestor/Certriad Brand Team
AstraZeneca US
DE - Delaware
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For more information visit NewScientistJobs.com Job ID: 200707735

Associate Scientist/Scientist - In Vivo Pharmacology
AstraZeneca US
MA - Massachusetts
Seeking a highly motivated, experienced individual for the Bioscience/ Pharmacology Group, within Oncology. Position requires conducting pharmacological techniques for drug discovery research.
For more information visit NewScientistJobs.com Job ID: 200705780

Associate Medical Director (MD)
Genentech
CA - California
Stays abreast of internal and external developments (scientific, clinical, commercial, competitive, legal, regulatory and like) as such developments may implicate or otherwise impact the product pipeline and portfolio within the assigned therapeutic area(s).
For more information visit NewScientistJobs.com Job ID: 200706280

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LONDON'S underground rail map has been an inspiration to topologists ever since Harry Beck produced his 1933 masterpiece. Before then, travellers had to grapple with representations of the messy geography of the city linked by a confusing network of tunnels dug by competing companies. Beck tidied it all up by showing the various lines as, well, lines, emphasising their connectedness rather than their geography.

In December 2009, Transport for London (TfL) took the topological theme a step further. It had had problems with the Circle line, one of which was a fashion among some citizens for occupying the trains' carriages for loopy parties circling beneath the city. Another was that, even in the absence of revellers, delays tended to accumulate. Only on a line that has an end, which the aptly named Circle line didn't, can one send a train back from the end early in order to speed up the service.

So TfL "unwound" the Circle. They made Edgware Road – one of the stations on the existing Circle – a terminal where trains travelling clockwise reversed and went back round in the opposite direction, and they added a "tail" to send these trains off to a second terminal at Hammersmith.

TfL chose snappy phrases to accustom passengers to this change. They were "extending the Circle", they said in posters and leaflets. Into what? A sphere, a topologist might ask? Not quite: as Jim Grozier spotted, they declared Edgware Road to be the "corner" of the New Circle, or the Teacup, or whatever name eventually sticks. So now the underground map defies geometry as well as geography.

AT FIRST glance it looks as though a new word might be appearing in cyberspace – namely "phpects", as in "phpects of vegetarian nutrition", "phpects of the hospitality industry" and "phpects of security". According to a famous internet search engine, there are literally thousands of examples (see bit.ly/phpects).

On closer inspection though, this mysterious word seems to be merely a stand-in for "aspects" – but why is the mistake, if that's what it is, occurring so often? Surely it can't be a typo – the letters "a" and "s" are nowhere near "p" and "h" on a qwerty keyboard. Can anyone explain?

THE website My-Drugs.com, which purports to be a drug information site, sternly advises: "Do not drink alcoholic beverages while taking Metronidazole." It goes on to list the unpleasant side effects, such as nausea and vomiting, that can ensue from doing so.

It then cautions: "Do not drink alcohol while you are taking Metronidazole and for at least 3 days after you stop taking it." It goes on to list the side effects, such as nausea and vomiting, if this warning is ignored.

It then warns: "Alcoholic beverages should be avoided while taking Metronidazole and for at least one day afterward."

Lastly – and all of this is on the same page – it says: "You should avoid alcohol while taking Metronidazole, and for at least 48 hours after finishing the course." It concludes by saying that this can cause unpleasant symptoms such as nausea and vomiting.

Leonard Winocur, who alerted us to this, wonders if Metronidazole and alcohol interact to induce repetitiveness and incoherence of thought in the people who write about them, even if they don't ingest them.

FEEDBACK has observed that the word "quantum" often translates to "magic" or "expensive fruitloop magic remedy" (30 May 2009). Threatening to put this observation on a sound academic footing, Graham Barrow carried out a pilot literature-survey.

In just 5 minutes, a famous web search engine showed him many variants, starting with – of course! – "quantum crystal healing". Then there was "quantum kinesiology", which presumably begins with the recipient's arm in a superposition of floppiness and firmness, and "quantum reflexology", which could lead to your feet changing position without passing through intervening space – handy for avoiding the cracks in the pavement.

"Quantum homeopathy" is so obvious in retrospect that we're ashamed we didn't invent it: the remedy does and does not contain any molecule of the claimed active substance, until you open the bottle.

In "quantum acupuncture" we imagine the needle both punctures the skin and misses it altogether. And would a "quantum massage" involve a hand all over your body at once? But what on earth, or anywhere else, is "quantum reiki"?

We fear there may be answers – and more examples.

FINALLY, our colleague Stephen Battersby wonders if the most complex scientific experiment in the world could be replaced by a simple piece of kitchen apparatus. In a recent London pub quiz organised by Whitaker's Almanack, one team's scrawled answer to the question "Name the new particle

accelerator in Geneva that is looking for the Higgs boson" was "The Large Hadron Colander".

It makes a kind of sense, says Stephen. Presumably all the small hadrons fall through the holes in the colander, leaving only the more interesting large ones behind.

The care instructions for the dog kennel John Straede bought advised: "Hand wash in warm water with mild detergent. Do not spin dry."

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.

Blood brothers

At the risk of flogging a dead, er, penguin, why don't polar bears' feet freeze?

■ Unlike the penguin with its fancy internal plumbing, the reason that polar bears' feet do not freeze is good insulation, pure and simple.

Polar bears (*Ursus maritimus*) are just about the best-insulated animals on the planet, certainly among those species of mammal that do not live primarily immersed in water. An adult bear has 10 centimetres of blubber beneath its skin which, in turn, is covered by a thick coat of fur. This fur relies not only on its density, but also on its unique structure: each hair is a hollow tube, so that air is trapped inside the hairs as well as between them. Even without covering its nose with its paws (as it is reputed to do, although the evidence is very limited) a polar bear is almost invisible to heat-sensitive infrared photography or the latest military image-intensification technology.

"A polar bear's paw is dotted with dozens of papillae, which provide extra grip like footballers' studs"

The polar bear also has very hairy pads on its feet, and the tough skin is extremely callused on the underside of the paws, so there is a sturdy layer of dead tissue between the ice and any blood vessels.

There may also be another factor at work. The underside of a polar bear's paw is dotted with dozens of papillae – small nipple-shaped extrusions of even-more callused skin – which provide extra grip in the same way as the studs on a footballer's boot. It is these papillae that enable a polar bear to accelerate to a very respectable pace on the ice and overcome its awesome inertia. They also prevent it skating out of control, past a potential meal.

On really compacted ice, the bears tend to lift part of the underside of the paw clear of the surface. The papillae enable an additional cushion of insulating air to be trapped between most of the pad and the ice.

Such highly developed thermal adaptations can, however, be a double-edged sword. A bear attempting a brisk trot in ambient temperatures of 10 °C or greater would succumb, almost immediately, to a fatal attack of heat stroke. During the Arctic summer it can often be far hotter than that, limiting the polar bear's ability to function as a hunter.

This potential cramping of the polar bear's style may prove as fatal to the species' chances of survival as the actual destruction of its territory. If global warming causes the polar bear to die out, it would surely be the most terrible irony that this was because it had mastered the art of conserving the very energy that a profligate humanity has squandered so obscenely.

"A bear trotting in temperatures around 10 °C would succumb to a fatal attack of heat stroke"

Hadrian Jeffs
Norwich, Norfolk, UK

This week's questions

MINDLESS DISCOVERY

Vandals regularly smash the windows of our local railway station, and they are equally regularly replaced with laminated glass consisting of two sheets with a flexible layer between. When the windows break (see photo), the glass on the side the stone came from cracks in concentric circles, but the other layer cracks radially, together forming a spiderweb pattern. Why is this?

Hugh Young
Pukerua Bay, New Zealand

BARBECUE DECAY

Over our Christmas barbecue – it was 35 °C here on 25 December – we started an argument. If it was raining (which it wasn't) which would rust faster, a scalding hot barbecue or a cold one, presuming they were made out of an iron-containing material?

Jayne Millington
Perth, Western Australia

PAINFUL THOUGHTS

I understand that there are no pain receptors in the brain, so people undergoing brain surgery can be alert, with anaesthetic administered only locally to the scalp. If this is so, how do we experience the pain of headaches and migraines, especially those that seem to come from a specific point inside the head and which throb and radiate from that point?

Sophie Yauner
By email, no address supplied

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