BILL & MELINDA GATES FOUNDATION

"A malaria vaccine that really works and is cheap enough for African kids to afford."

Gustav Nossal
Immunologist, University of Melbourne, Australia

A trial vaccine, known as RTS,S/AS02A, was shown this year to shield some children from malaria: the first real success in the field. Much more work needs be done to achieve full protection, and to make the jabs affordable. But more trials are under way.

"I'd wish for two burning plasma experiments in the world, instead of just one."

Gerald Navratil
Plasma physicist, Columbia University, New York

For plasma physics, 2004 was characterized by the constant dispute over where to build ITER, an international experimental reactor aimed at producing power from the fusion of hydrogen atoms. The community is united in its desire to see the project go ahead. But the six partners — Russia, China, South Korea, Japan, the United States and the European Union — are currently deadlocked over whether the reactor should be located in France or Japan.

The stalemate has led the Europeans to decide that, if necessary, they will go it alone. That could be okay, laughs Navratil, if it means that both the European and Japanese consortiums each build a machine. "Obviously we'd like to have at least one ITER," he says; but two would be even better. Observers, however, would be extremely surprised if this wish actually came true.

"I wish for a cataclysmic rearrangement of the tectonic plates — or alternatively some creative legislative gerrymandering — so that the San Andreas Fault line ends up just west of Boston, Massachusetts."

George Daley
Stem-cell scientist, Harvard University

It seems as though nothing short of serious seismic upheaval will be enough to get researchers on the US east coast the money they want to study human embryonic stem cells.

Federal funds for such work remain limited to a few dozen cell lines. But on the day of George W. Bush's re-election,

a referendum in California backed an initiative to plough $3 billion of state funds into the field, turning a lot of researchers farther east green with stem-cell envy.

Those outside California aren't completely bereft. In April, Harvard University announced the creation of a stem-cell institute in and around Boston involving 100 researchers and funded with millions of dollars of private money. Three months later, the governor of New Jersey signed legislation to spend $9.5 million on stem-cell research.

The stage is now set for regulatory battles between the conservative federal government and those states using public money to pursue embryonic stem-cell research. A bill to ban 'therapeutic cloning' — which would use genetic material from a cloned embryo of the patient to make new cells for a potential transplant, for example — that has languished since 2001 may pass next year, thanks to the newly enlarged Republican majority in the Senate. Even if this bill doesn't pass, limitations on stem-cell research could also be tacked on to unrelated legislation and end up as law if supporters of the research fail to muster the political muscle to stop them.

*"I wish to see tranquillity, security and freedom of thought granted for scientists and researchers in parts of the world suffering political turmoil."*

Radwan Barakat
Plant scientist, Hebron University, Palestinian Authority

# Highlights

## Bring in the clones

Scientists in South Korea successfully cloned 30 human embryos and extracted stem cells from them. Others have claimed to do the same before: a US company announced in 2001 that it had produced a short-lived cloned embryo, for example. But evidence for such reports has been scarce until now. It took 242 eggs from 16 women to make these few clones. If the process can be streamlined, some hope it could one day be used to provide replacement cells tailor-made for any patient.

## The hobbit

The skeleton of a tiny hominid was unearthed in Indonesia, providing evidence for a previously unknown branch of human evolution that lived just 18,000 years ago — a startlingly contemporary date. The one-metre-high species, called *Homo floresiensis* after the island it was found on, and nicknamed 'hobbit' by its finders, has made researchers wonder what other creatures might be out there waiting to be found.

## Tracking electrons…

A magnetic microscope was tuned to detect the tiny signal of a single electron's spin. The device — a minuscule cantilever with a magnetic tip — wobbles in the presence of the magnetic field created as a single electron spins. This wobble is in turn tracked by a laser. Although the principle is simple, it took the research team 12 years to attain the sensitivity needed to detect a single electron. The researchers say that the same technique should be able to detect an electron's spin orientation, aiding attempts to produce quantum computers.

## …and taking their picture

A snapshot was taken of an electron orbital, by blasting a nitrogen molecule with laser pulses. The light emitted after these kicks from the laser reveals an image of the space where the molecule's electrons reside. The shapes and sizes of electron orbitals have been determined in the past through experiment and theoretical calculation, but this is the first time their picture has been taken. The same technique should some day let researchers watch electrons as they take part in chemical reactions.

## Rat tales

The Brown Norway rat became the third mammal to have its genome sequenced, joining mice and humans. The rat is a model of choice for many studies in physiology and pharmacology, and is used to investigate everything from cardiovascular disease to space motion sickness. Researchers pored over the animal's 25,000 genes to enlighten this work. Next year should see several more mammals join the club of sequenced creatures, including the chimpanzee and the dog.

"A definitive cure in gene therapy for some sort of routine disorder that's applicable to a large number of other diseases."

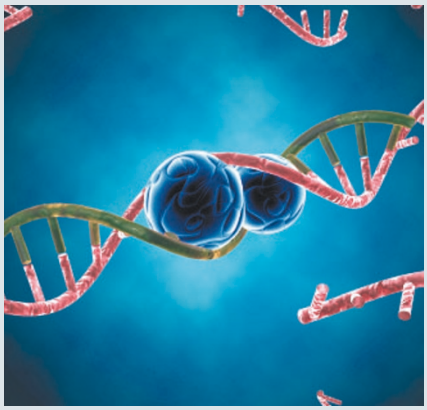
Mark Kay
Gene-therapy researcher, Stanford University

This year, the gene-therapy field began regrouping after a difficult period — and received a shot in the arm from a young technology called RNA interference.

In France, authorities allowed Alain Fischer of the Necker Hospital in Paris to restart a gene-therapy trial that had been on hold for almost two years. The trial uses gene therapy to cure children who have the fatal condition X-linked severe combined immunodeficiency disease (SCID), which leaves sufferers unable to fight off infections. But it and other SCID gene-therapy trials around the world have been on hold since last January because Fischer's treatment caused cancer in two out of eleven children.

Now, regulatory authorities in France and elsewhere have decided that the SCID trials can resume, because the alternative — bone-marrow transplants — isn't always successful. In the United States, the Food and Drug Administration (FDA) has likewise decided to allow at least one trial to go ahead.

But will gene therapy prove successful? Enter RNA interference, a technique that takes advantage of natural human defence mechanisms and that many researchers think could deliver the first full cure in molecular medicine. Biotechnology companies seem to agree; this year, two of them — Sirna Therapeutics in Boulder, Colorado, and Acuity Pharmaceuticals in Philadelphia, Pennsylvania — filed applications with the FDA to begin clinical trials using RNA interference to treat macular degeneration, a progressive eye disease.



QIAGEN

They are likely to be joined next year by Alnylam Pharmaceuticals of Cambridge, Massachusetts. Researchers at this firm have already demonstrated that RNA interference can be used to cut cholesterol in mice. A cholesterol-lowering treatment would be blockbuster for RNA interference, but that is still years away.

In the immediate future, look for more clinical trials in 2005 — including some using RNA interference to combat hepatitis C or HIV.

"A cure for jet lag — or super-fast flight. And fool-proof, fast, invisible airport screening technology. Actually, I'd settle for super-comfortable flight."

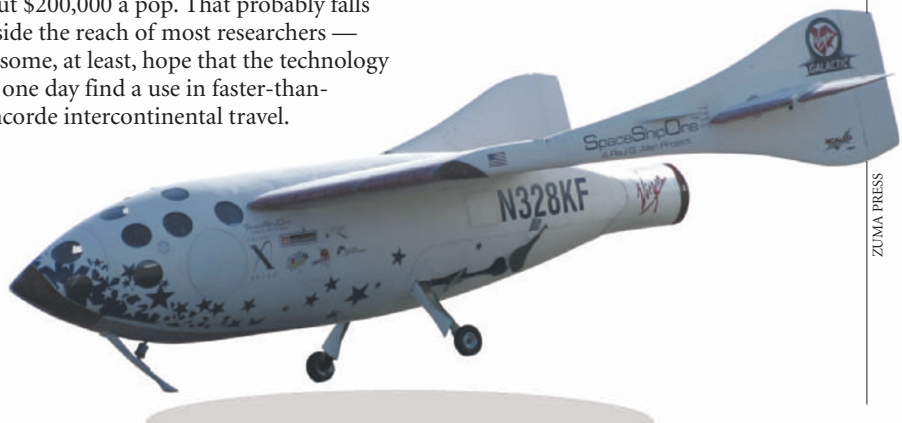
George Daley
Stem-cell scientist, Harvard University

If there's one thing scientists agree on, it's that they spend too much time scrunched up in economy class and not enough in the lab — and travel only seemed to take longer in 2004.

The United States, for one, lengthened queues when it phased in the largest biometric scheme yet deployed at national borders, demanding that foreign visitors give electronic fingerprints for checking against a database of undesirables. Next year, many countries are expected to introduce passports that encode biometric information about their owners on microchips. This will either shorten or lengthen queues, depending on your faith in technology.

But although some scientists were grumbling about the limits of today's transportation, others were working on a project that they think could revolutionize tomorrow's. Proving that space is accessible to your average billionaire as well as to space agencies, aerospace designer Burt Rutan and Microsoft co-founder Paul Allen launched the first private rocket to the outskirts of suborbital space and scooped the US$10-million X prize in the process.

Rocket enthusiasts celebrated the achievement as the dawn of a new era of space tourism. But sceptics said that private space travel is unlikely to take off until engineers conquer the much harder feat of getting tourists into orbit. Virgin Galactic expects to begin commercial flights as early as 2007, with seats going for about $200,000 a pop. That probably falls outside the reach of most researchers — but some, at least, hope that the technology will one day find a use in faster-than-Concorde intercontinental travel.




ZUMA PRESS

"My wish? ET: call me."

Louis Friedman
Executive director, Planetary Society

For Friedman, who heads a large space-advocacy group, there is no question about the major goal of space exploration: it is to find life. To this end the Planetary Society strongly supports SETI — the search for extraterrestrial intelligence that scans the skies for signs of communication.

In contrast, NASA now seems relatively unsure of its goals. Should it finish building the International Space Station? Stick with robots for most voyages, or push for piloted missions?

The Bush administration tried to create some focus this year by declaring that NASA would put astronauts back on the Moon by 2020, and then head for Mars. Initial funding for the president's 'Vision for Space Exploration' was passed by Congress in November despite reservations from many lawmakers and scientists. It may provide a focus for the space programme, but it doesn't seem to be a wildly popular one.

Some US scientists worry that if the tide shifts back to an expensive astronaut programme, it will detract from pure research without much obvious benefit. Missions already launched won't feel the squeeze — including Messenger, which is due to arrive at Mercury in 2011, and the Cassini craft, which should release a probe down to one of Saturn's moons, Titan, in January. But plans for spacecraft to study black holes and dark matter have been put on hold, conceivably delaying our discovery of wormholes and pockets of alien life in far reaches of the Universe. Unless, of course, ET calls us first.

NASA/JPL/MSSS

"I'd wish to find out if there is life on Mars; perhaps martians can be detected by a whiff of their farts."

Roger Buick
Geologist, University of Washington, Seattle

If you're looking for extraterrestrial life, then Mars is a great place to start. Tantalizing discoveries this year meant that the possibility of finding microbial life — ancient or contemporary — on the red planet once again came to the fore.

Earth-based telescopes and Mars Express — a European mission sent to orbit the planet — detected the presence of methane in the martian atmosphere. As methane is a short-lived gas, researchers say that this must have been produced within the past 300 years or so. With no known active volcanoes on the planet to generate the gas, this has left researchers "twitching and excited" about the possibility of contemporary microbes as the source, says Buick.

Is there a way to find out if the methane comes from life? Buick suggests that we now look for traces of hydrogen sulphide — another gas commonly produced by biological activity. If sufficient volumes of hydrogen sulphide are coupled with the leaking methane, it would suggest that subsurface life is producing the gases, he says. Mars Express did see hints of hydrogen sulphide, but these measurements have not been confirmed.

NASA's martian rover, Opportunity, also found clues to add to the growing body of evidence that Mars once held liquid water: marks in rock that looked as though they had made by ripples; sulphate and other deposits that seemed to have been left when a briny pool evaporated; and tiny spherical rocks that probably formed as minerals precipitated out of water bubbles. Sadly Europe's equivalent lander, Beagle 2 — the only one explicitly designed to look for signs of life — didn't survive the trip to the planet's surface.

*"For the French government to take on board scientists' proposals for the future of research, so that France once again becomes an attractive destination for young scientists."*

Alain Trautmann, cell biologist and leader of Save Research, an unprecedented scientific revolt against French government policies and science funding

"For legal enforcement of the Hippocratic oath 'first, do no harm' to ensure that all physicians and researchers are held accountable if they violate ethical standards."

Vera Sharav
President, Alliance for Human Research Protection, New York.

Every year has its share of people who lie, steal, cheat or fall prey to subtler ethical slip-ups in the lab.

Although 2004 wasn't the worst of recent years, an array of scientists were nevertheless accused of plagiarism, fraud and other misbehaviour. Even the editors of journals confessed to the occasional ethical slip-up in their publishing practices — such as asking authors to add specific references to their papers to boost the journal's impact factor. As a result, one association of medical journals, at least, has drawn up a code of good practice for themselves to keep things in line, which came into force this month.

The pharmaceutical industry came under attack when GlaxoSmithKline (GSK) was accused of suppressing results of clinical trials that suggested some antidepressants could increase the risk of suicidal behaviours in children. Rules were changed in the United States to ensure that these drugs were labelled with a warning, and that more data would generally be made available for public scrutiny. Twelve leading international medical journals decided that companies would have to register details of clinical trials in a public database if they want to have their results published. This, they hope, will redress the fact that only trials with positive results tend to be published or aired in public. GSK also promised to put summaries of its clinical-trial data for marketed drugs online for free — and has begun to do so.

The physical sciences suffered some unusual problems as well: staff were fired from Los Alamos National Laboratory in New Mexico after some classified computer-storage devices disappeared, forcing the lab to shut down for weeks for a security review.

And one of this year's science highlights — the successful cloning of human embryos in South Korea — was clouded by suspicions that one of the lab's researchers was the source of some of the eggs; usually considered to be ethically unacceptable. Lab chief Woo Suk Hwang at Seoul National Laboratory put his work on hold after the accusations hit. A national bioethics law that comes into effect in January 2005 may help to sort out future issues.

# Highlights

## Mum's the word

Mouse eggs were persuaded to grow into apparently healthy mice without being fertilized by sperm, making for the first birth of a mammal without contribution from a father. The success doesn't make men irrelevant — the genetic manipulations used by the team are for now, at least, technically and ethically infeasible in humans: the experiments produced far more dead and defective baby mice than normal ones.

## As old as ice

Results have started to pour in from a core of Antarctic ice that dates as far back as 740,000 years, giving researchers a hint of temperatures and greenhouse-gas levels during the past eight ice ages. It took eight years, two attempts, and more than a bit of luck to extract the core. Initial tests suggest that our present interglacial period, like a similar one about 400,000 years ago, might last an exceptionally long time — another 16,000 years or so, without taking account of global warming.

## In the hot seat

Climate researchers estimated that anthropogenic climate change has at least doubled the chances of a heatwave like the one that hit Europe in the summer of 2003. Although scientists have long thought that a warmer world will have more extreme weather, this result provided the most solid link so far between global warming and a single weather event. Such work could open the door for groups to win lawsuits against big emitters of greenhouse gases for damages caused by bad weather.

## Table-top accelerators

High-quality electron beams for use in accelerators were produced by laser focusing. This eliminates the need for the massive magnets that have traditionally been used to focus such beams, and whittles down the instrumentation needed to make a particle accelerator from the size of a football stadium to the size of a lab. The ever-shrinking size of these devices will make them increasingly accessible to universities and individual research teams.

## Home-made cure

A compound was mixed in the lab that could make for cheaper antimalarial drugs. Doctors currently recommend that high doses of artemisinin-based treatments be used in countries that have problems with resistance to drugs such as chloroquine. But artemisinin, which comes from a Chinese plant, is very expensive. A public–private partnership created a cheaper synthetic version, which is now in clinical trials in Britain.