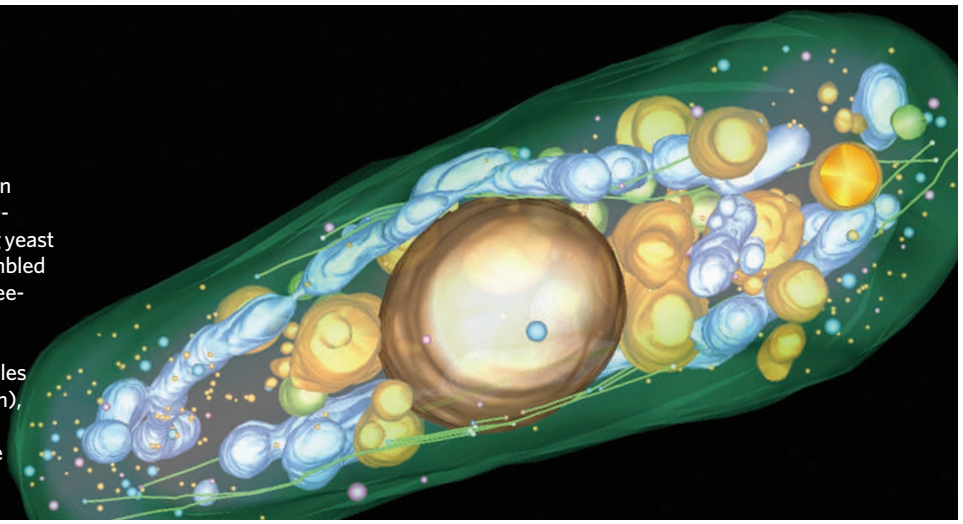
RESEARCH HIGHLIGHTS

An added dimension

Dev. Cell **12,** 349–361 (2007)
This high-resolution, three-dimensional image of a eukaryotic cell was created by researchers led by Claude Antony of the European Molecular Biology Laboratory in Heidelberg, Germany. They scanned 250-nanometre-thick slices of frozen budding yeast (*Schizosaccharomyces pombe*), and assembled the scans into a computer-generated three-dimensional image.

The snapshot here shows the nucleus (coloured brown) and vacuoles and vesicles (gold). Also seen are microtubules (green), which form the cell's 'cytoskeleton', and mitochondria (blue) — most of which are strung along the microtubule bundles.



J. HÖÖG, EMBL

DRUG DELIVERY

Transport in the fast lane

Nature Biotechnol. doi:10.1038/nbt1292 (2007)
Researchers have caught on film a technique that can rapidly transport drugs to cells deep within tissue compartments.

The method targets pockets in cell membranes, called caveolae, which import molecules into a cell and are abundant in blood-vessel linings. Jan Schnitzer of the Sidney Kimmel Cancer Center in San Diego, California, and his colleagues injected live mice with fluorescently labelled antibodies targeted to lung caveolae. Videos revealed that the caveolae actively pumped the antibodies from the blood into lung tissue within seconds. Drugs, nanoparticles or gene-therapy vectors could be attached to such antibodies.

CELL BIOLOGY

Sun sensor

Cell **128,** 853–864 (2007)
The tumour-suppressor protein p53 can boast a new function: regulator of the suntan.

A. SIEGEL

It was already known that p53 governs DNA repair responses to ultraviolet radiation and other stresses. Now, David Fisher of Harvard Medical School in Boston, Massachusetts, and his colleagues have found that p53 also directly stimulates expression of a protein called pro-opiomelanocortin, which is involved in producing the skin pigment melanin.

Mice lacking p53 did not tan in response to either ultraviolet radiation or a drug that normally causes hyperpigmentation. Furthermore, human skin cancers that contained a mutated form of p53 also lacked pigment-producing cells. Taken together, the results indicate that p53 may act as a ultraviolet sensor in the skin that activates tanning.

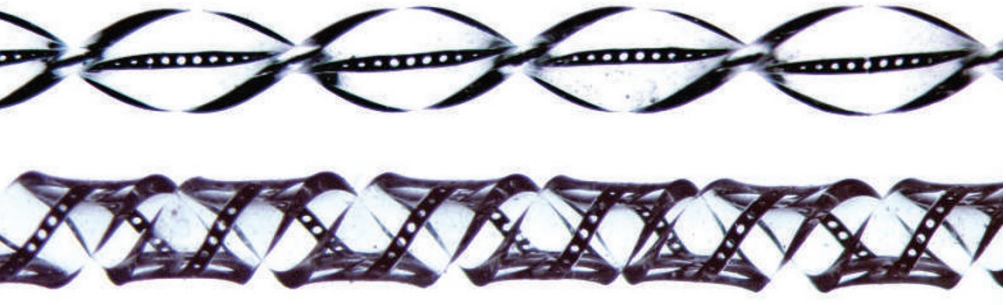
MATERIALS

Microsolidics starts here

Adv. Mater. **19,** 727–733 (2007)
Solder would seem a strange thing to inject into microfluidic channels, but George Whitesides and his colleagues at Harvard University in Cambridge, Massachusetts, have created micrometre-wide wires and three-dimensional structures by doing just that. They dub the technique 'microsolidics'.

Micrometre-sized channels in polymer sheets typically serve as conduits for chemicals in microreactors, or for fluids in biological assays. To adapt such channels to carry molten solder, the researchers chemically treated the inside surfaces, oxidizing the polymer then adding a layer of silane.

Wires that formed when the solder solidified could be twisted (pictured below), knotted or woven; re-heating and applying pressure fixed any breaks. The team demonstrated the technique's potential by fabricating a wire that wraps around an open channel; it operates as a heating element.



EARTH SCIENCE

Field reversal

Europhys. Lett. **77,** 59001 (2007)
Clues to how the Earth's magnetic field flips may come from a spinning bathtub-sized cylinder of molten sodium.

Researchers in France have used this experimental set-up to simulate Earth's spinning core of molten iron. Electrical currents in the swirling sodium, hotter than 98 °C, set up a magnetic field analogous to that of Earth.

Michaël Berhanu of the École Normale Supérieure in Paris and his co-workers observed that the sodium's field spontaneously flipped direction every minute or so — mimicking the magnetic field reversals seen when Earth's magnetic poles disappear, then re-emerge upside down. Geological records reveal Earth's field to have reversed sporadically throughout history, but the mechanism remains poorly understood.

STRUCTURAL BIOLOGY

Drug-hunters on target

Science **315,** 1402–1405 (2007)

Antibiotic drug-hunters have long been searching for ways to disrupt a particular enzyme that bacteria use to build their cell walls. Knowing its structure should help.

The enzyme, known as glycosyltransferase, is one of two that can occur as separate domains on the same membrane protein. The other is already the target of antibiotics such as penicillin.

Natalie Strynadka and her colleagues at the University of British Columbia in Vancouver, Canada, have now deciphered the crystal structure of both parts of this membrane protein from *Staphylococcus aureus*. The team also worked out the structure of the protein when it was bound to an antibiotic that's effective in animals and works by blocking glycosyltransferase. That complex might provide clues as to how the antibiotic could be modified to work in humans.

CELL BIOLOGY

Energy from indigestion

Cell **128,** 931–946 (2007)

Cells undergoing apoptosis, or programmed cell death, digest material within themselves to summon up the energy to send out 'clean-up' signals, researchers have shown.

This helps to explain why autophagy — a digestive process activated in normal cells to recycle components such as mitochondria — happens in cells that are destined to die. The finding may also be relevant to understanding diseases associated with cell remnants, such as inflammatory and autoimmune disorders.

Beth Levine and her colleagues at the University of Texas Southwestern Medical Center in Dallas made the discovery by growing mouse embryonic cells under conditions that mimic embryo development, a process that involves massive apoptotic cell death. Apoptotic corpses accumulated when cells lacked either of two autophagy genes, *atg5* or *beclin 1*.

SOLID-STATE PHYSICS

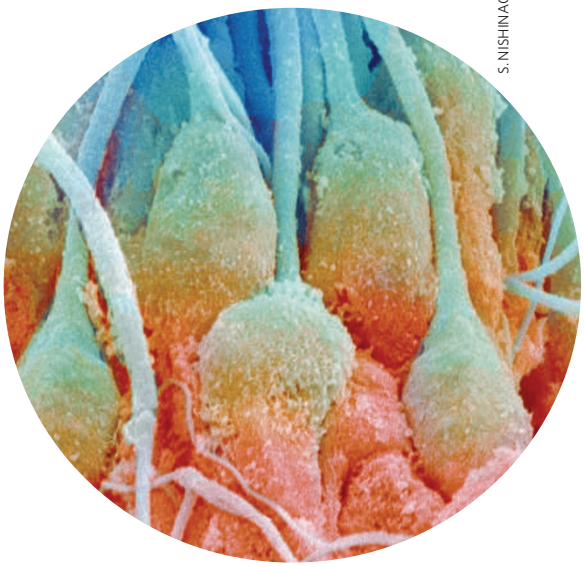
Four thought

Nature Mater. doi:10.1038/nmat1860 (2007)

The first memory device to simultaneously exploit the electric and magnetic properties of a 'multiferroic' material has been demonstrated by researchers in France.

The device was built from a thin layer of lanthanum bismuth manganite, a material described as multiferroic because it has both ferroelectric and ferromagnetic properties. The promise is that memory elements made from such materials could be written electrically and read magnetically — both desirable features for next-generation memory devices.

Manuel Bibes at the Institute of Fundamental Electronics (part of the CNRS, France's basic-research agency) in Orsay and his colleagues have taken a first step by making a device that can adopt four different states. Such memory elements could be used for 'quarternary' logic, rather than the binary logic of conventional memories.



S. NISHINAGA/SPL

REPRODUCTIVE BIOLOGY

RNA reveals male infertility

Hum. Mol. Genet. doi:10.1093/hmg/ddm012 (2007)

Sperm don't just deliver DNA to the egg; they also carry a side-order of RNA. Now, Stephen Krawetz of Wayne State University in Detroit, Michigan, and his colleagues have exploited this RNA to probe the underlying causes of male infertility.

Some infertile men have normal-looking sperm, making it hard to know what the problem is. Others produce sperm with physical abnormalities and other identifiable defects, but even in these cases, the molecular causes are largely unknown.

Krawetz and his team compared the RNA profiles of normal and abnormal sperm. They found marked differences, and showed that many abnormal sperm lacked RNAs involved in processing proteins. The team hopes that the technique will provide diagnoses for men with unexplained infertility.

JOURNAL CLUB

Takuzo Aida
The University of Tokyo, Japan

A chemist sees a commercial future for designer polymers.

Just over a decade ago, a discovery in polymer chemistry triggered explosive progress in macromolecular engineering. A trio of papers published last year will, I think, help to usher the benefits of this development into industry.

The results concern chemists' ability to grow tailored polymers, which have controllable size and architecture. Such polymers are becoming more and more important as major players in the burgeoning field of nanotechnology.

The original breakthrough was the development of a method known as atom-transfer radical polymerization, which made it easy to grow polymers to design.

The method uses a catalyst containing a transition metal, such as copper. The catalyst interacts with the polymer, turning it briefly into a reactive radical that will bind another monomer. Each molecule grows one step at a time, so producing polymers with uniform properties.

A problem with this method has been the large amount of catalyst needed to drive the reaction — leaving residues that are costly to remove. Two recent papers do away with this concern, cutting the concentration of catalyst required by up to 1,000-fold (W. Jakubowski & K. Matyjaszewski *Angew. Chem. Int. Edn* **45,** 4482–4486, 2006; K. Matyjaszewski *et al. Proc. Natl. Acad. Sci. USA* **103,** 15309–15314, 2006).

Another advance, which takes advantage of an unexpectedly active oxidation state of the catalyst's copper, will allow production of polymers with an ultra-high molecular weight and a narrow molecular-weight distribution (V. Percec *et al. J. Am. Chem. Soc.* **128,** 14156–14165, 2006).

Some chemical companies are already setting up industrial plants to make polymers by atom-transfer radical polymerization. These developments mean that more are sure to follow.

is sandwiched at the radical's core between two chemical groups that contain vanadium atoms. This stabilizes the structure, report Christopher Cummins at the Massachusetts Institute of Technology in Cambridge and his team, because the phosphorus shares its lone electron with the two metal atoms. They hope that the same strategy will stabilize radicals centred on other elements, and that varying the metal will tune the radical's reactivity.

MALARIA

Which mozzies win out?

Proc. Natl Acad. Sci. USA **104,** 5580–5583 (2007)

Genetic resistance to the malaria parasite gives mosquitoes feeding on infected blood a fitness advantage, researchers have found. Release of mosquitoes that are resistant to infection with malaria is one control strategy being considered to curb the disease.

Marcelo Jacobs-Lorena of the Johns Hopkins University in Baltimore, Maryland, and his colleagues put 250 transgenic and 250 wild-type mosquitoes of opposite sexes into a cage, where they fed on mice infected with the *Plasmodium berghei* parasite. The transgene, which blocks infection through the mosquitoes' gut, was found in around 70% of the mosquito population after 10 or so breeding cycles. Mosquitoes in the wild only occasionally become infected with the parasite, but this study gives hope that the transgene could persist in the population.

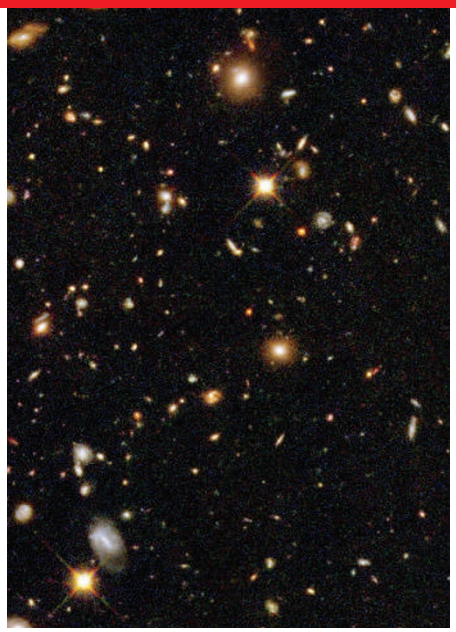
ASTRONOMY

Seeing things

Astrophys. J. **657,** 669–680 (2007)

Infrared light thought to have been emitted by the Universe's first stars isn't seen in a new survey of the skies.

Researchers had previously found a 'near-infrared background excess' in some



NASA/ESA/R. THOMPSON

satellite images that they couldn't account for with known sources. They argued that it was light from early galaxies, stretched by the expansion of the Universe to appear at infrared wavelengths.

Rodger Thompson of the University of Arizona, Tucson, and his colleagues analysed sharper and more sensitive images from the Hubble telescope (pictured above). They say the claimed excess was due to inaccurate estimates of emission from zodiacal dust. What's more, they could attribute spatial variations in the background to previously undetected nearby galaxies.

NANOTECHNOLOGY

Spheres inside cells

Environ. Sci. Technol. doi:10.1021/es062541f (2007)

Concerns about nanoparticle toxicity have prompted researchers to look closely at how C_{60} molecules interact with cells.

Alexandra Porter at the University of Cambridge, UK, and her colleagues imaged C_{60} that had infiltrated human macrophages — cells that have a role in clearing debris from the lungs. The researchers showed that a technique known as energy-filtered transmission electron microscopy can pick out the carbon spheres. They could see individual molecules and tell apart aggregates that were crystalline or disordered.

C_{60} appeared in the cells' cytoplasm and nuclei. The molecules were concentrated just inside the cell wall, suggesting that they had infiltrated the cell through its membrane.

GENETICS

Mutations linked to autism

Nature Genet. **39,** 319–328 (2007)
Science doi:10.1126/science.1138659 (2007)

Two studies point to genetic changes that may contribute to the spectrum of autism disorders.

The Autism Genome Project Consortium scanned the genomes of more than 1,000 affected families for single-nucleotide variations in DNA inherited alongside the disorder. They also searched for inherited versions of mutations known as copy-number variants — deletions or duplications of chunks of the genome. Their findings implicate two major regions of DNA, one of which is linked to neuronal proteins called neurexins.

Independently, Jonathan Sebat and Michael Wigler at Cold Spring Harbor Laboratory, New York, and their colleagues compared the role of copy-number variants in sporadic and inherited cases of autism. They found that such mutations appear spontaneously in 10% of patients with sporadic autism, but in only 2% of patients from families with more than one affected member. This suggests that the two classes of autism differ in the primary genetic mechanism involved.

Correction

The Research Highlight 'An added dimension' (*Nature* **446,** 234; 2007) incorrectly referred to *Schizosaccharomyces pombe* as budding yeast. It is fission yeast.

JOURNAL CLUB

James Bauer
College of William and Mary, Gloucester Point, Virginia, USA

A marine scientist marvels at connections between the cold war and slimy mudflat worms.

Having grown up on the coast of New England, my childhood involved a good deal of digging around in the intertidal mud, unearthing things that most people of good sense do their best to avoid — things such as slimy, slithering worms, which often bite or smell bad, or both.

Older but no wiser, I was delighted to come across a recent paper (E. Teuten *et al. Mar. Ecol. Prog. Ser.* **324,** 167–172; 2006) that has cleverly extracted a surprising scientific result from studies of such mudflat worms.

As well as reminding me of my dubious childhood pastime, the work recalls the period in which I grew up, during the cold war, when much of the world lived in fear of the nuclear weapons then being tested. This work takes advantage of one legacy of those tests.

The bomb tests sent into the atmosphere lots of the isotope carbon-14, normally present only at low levels. This bomb carbon-14 subsequently made its way into the oceans, where it became incorporated into plankton. The plankton in turn sank and became part of the coastal mud, providing a home and a food source for marine sedimentary animals.

Mudflat worms are generally believed to ingest wholesale the nondescript sediment in which they live, yet the worms examined in this study contained more bomb carbon-14 than the sediment surrounding them.

Thus, it seems that the worms assimilate from the amorphous goop, material that has been deposited since the cold war and so is younger than the average age of the sediment. Presumably, they do so because the newer material is more nutritious, but how they extract it is unknown.

Makes me want to get back out by the sea with my bucket.