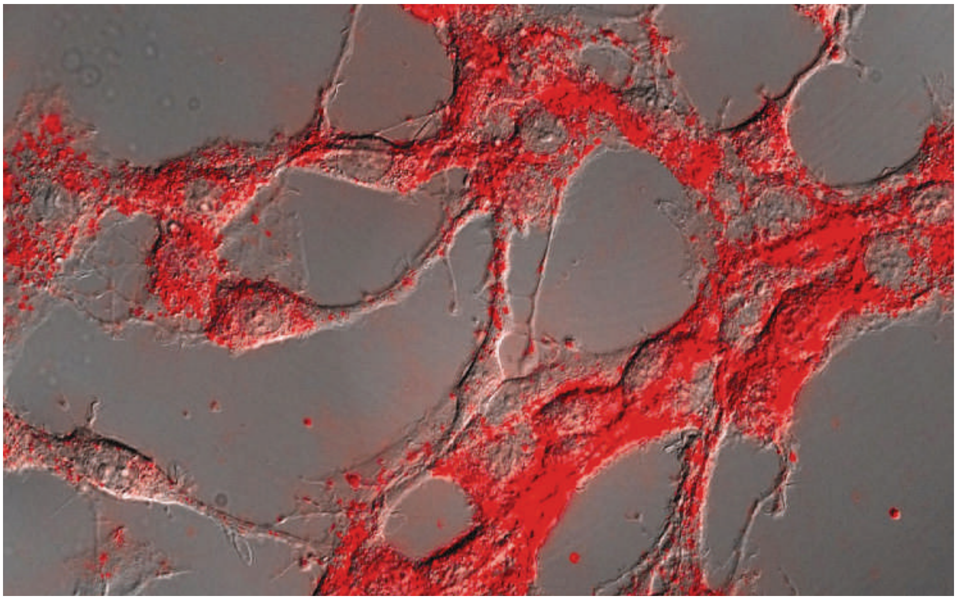
# RESEARCH HIGHLIGHTS

## A bright idea

*Nature Biotechnol.* doi:10.1038/nbt1188 (2006)

Researchers in the United States have designed a new kind of glowing nanocrystal, or quantum dot, for *in vivo* biological imaging.

Quantum dots can be targeted at certain tissues or processes. But their usefulness in imaging has been limited by the need for external illumination to make the dots glow. Light can't penetrate deep into tissue, and the dots' visibility is reduced by the tissue itself fluorescing. Now Jianghong Rao and his colleagues at Stanford University, California, suggest a solution. They linked dots to the light-producing enzyme luciferase. When the luciferase is turned on by the addition of a substrate, its light makes the quantum dots glow — pictured here in glioma cells, a type of neural cell.



CANCER BIOLOGY

## Can't resist

*Cancer Cell* **9,** 133–146 (2006)

Researchers have found a way to tackle the resistance that some cancers show to certain kinds of chemotherapy.

Brent Stockwell and his team at Columbia University, New York, focused on the commonly used cancer drug doxorubicin, which triggers cancer cells to commit suicide through a process known as apoptosis. However, in many cancers the cell's apoptosis machinery is crippled.

By screening a range of compounds, the team identified one group of compounds, known as indoxins, which can make such cells more responsive to the drug. Indoxins increased the expression of the protein needed for doxorubicin to trigger cell death, and stalled the cells at an especially sensitive point in their division cycle.

ASTRONOMY

## Drifting clouds

*Astrophys. J.* **638,** 772–785 (2006)

The Large Magellanic Cloud, a dwarf galaxy that orbits the Milky Way, has been clocked moving at 378 ± 18 kilometres per second relative to our own Galaxy.

The measurement, made using the Hubble Space Telescope to track the galaxy's movement in relation to 21 distant quasars, is by far the most accurate until now.

It should help astronomers to deduce the size, shape and density of the dark-matter halo that constitutes most of the mass in our Galaxy and which keeps the Large Magellanic Cloud in orbit, say Nitya Kallivayalil of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, and her colleagues.

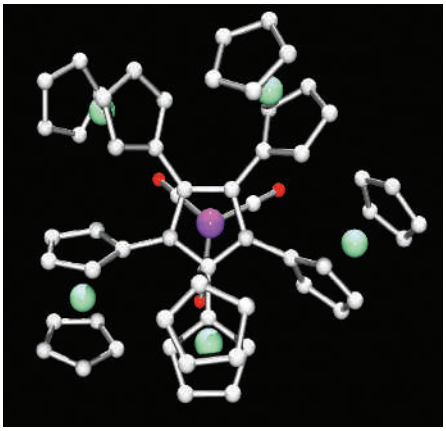
CHEMISTRY

## Supersize me

*Angew. Chem. Int. Edn* doi:10.1002/anie.200504047 (2006)

The discovery in the early 1950s that metals could be 'sandwiched' between organic molecules led to tremendous advances in organometallic chemistry, producing useful chemicals such as magnetic resonance imaging (MRI) contrast agents and industrial catalysts. Now chemists have supersized what was the very first such sandwich, a compound known as ferrocene ($Cp_2Fe$).

In ferrocene, two ring-shaped molecules — cyclopentadienyls (Cp) — serve as bread around an iron-atom filling. Peter Vollhardt of the University of California, Berkeley, and his colleagues supersized the bread by attaching a ferrocene to each of the five carbon atoms in another Cp ring. Sandwich compounds made from this molecule (pictured below) may have unusual magnetic or electrochemical properties.



P. LEONARD/UNIV. CALIFORNIA, BERKELEY

SOLID-STATE PHYSICS

## Mind the step

*Nature Phys.* doi:10.1038/nphys245 (2006)

Quantum physics does strange things to electrons in graphite. Graphene — a single sheet of graphitic carbon — differs from other semiconducting materials in how it manifests the quantum Hall effect, whereby step-like changes are seen in a material's conductivity as a magnetic field is applied.

Andre Geim of the University of Manchester, UK, and his co-workers showed recently that the conductivity steps sit at different values in graphene compared with other thin films (*Nature* **438,** 197–200; 2005). Now they have found another new form of the quantum Hall effect, in double layers of graphene. It is marked by the disappearance of the lowest 'step', and by metal-like rather than insulating behaviour in high magnetic fields.

CELL BIOLOGY

## Uneven split

*Science* **311,** 1146–1149 (2006)

Scientists have long hypothesized that stem cells retain their oldest DNA when they divide, to avoid accumulating replication errors — but this has been difficult to prove.

Now Athanasios Armakolas and Amar Klar, both at the National Cancer Institute at Frederick, Maryland, have used a neat genetic trick to track the inheritance of DNA in dividing cells. The two strands in a DNA double helix are never the same age. One, call it Crick, will have been the template against which the other, Watson, was built. The researchers find that in certain embryonic mouse cells, including embryonic stem cells, the replication of the DNA in chromosomes is handled so that copies containing the old Cricks end up in one daughter cell whereas copies containing the old Watsons end up in the other. In other types of cell the inheritance was random.

IMMUNOLOGY

## Complementary effects

*EMBO J.* doi:10.1038/sj.emboj.7601004 (2006)

The proteins of the mammalian complement system help to protect against infectious disease by promoting inflammation. Local activation of the complement system in the brain after stroke, however, is thought to contribute to brain damage.

Marcela Pekna from Göteborg University in Sweden and her colleagues have now discovered a more positive side to the story. They show that complement proteins also promote the maturation of replacement neural cells in both normal situations and after stroke. In their mouse model, the balance of the positive and negative effects of the complement system favoured an overall reduction of stroke damage.

BIOREMEDIATION

## Cleaning up the Antarctic

*Environ. Sci. Technol.* doi:10.1021/es051818t (2006)

A five-year field study in the Antarctic has shown that fertilizing polar soils could help in the clear up of fuel spills.

Some estimates suggest that a million cubic metres of Antarctic soil has been contaminated with hydrocarbons, which leaked from vehicles and storage tanks. Shane Powell of the University of Tasmania in Australia and her colleagues investigated how organisms that live in the soil could help to remediate this damage. They identified some anaerobic denitrifying bacteria, which metabolize hydrocarbons, as being suitable for the job. But denitrifiers have been little studied in polar soils. Adding fertilizer pellets to the soil, which provided the denitrifying bacteria with nutrients, boosted the rate that petroleum hydrocarbons were degraded.

LIFE HISTORY

## Double the fun

*Curr. Biol.* **16,** R117–R188 (2006)

Having sex doubles the lifespan of the lucky Ansell's mole rat, concludes a long-running study of *Cryptomys anselli* (pictured below).

Philip Dammann and Hynek Burda, both at the University of Duisburg-Essen, Germany, measured the lifespan of mole rats in captivity. Although the struggle to reproduce generally shortens lifespans in mammals, some breeding mole rats lived for 20 years, whereas all non-breeders were dead by their eighth birthday. The authors do not

H. BURDA

propose a mechanism for the effect, nor do they show whether the pattern exists in the wild where, like many insects, mole rats live in social colonies featuring a single breeding pair. But they do rule out the possibilities that breeding pairs enjoy higher status, better health or preferential access to food.

QUANTUM COMPUTING

## The logical path

*Science* **311,** 1133–1135 (2006)

Even if quantum computers could easily be made, they wouldn't yet be able to do much; the algorithms they would need to run are hard to write and in short supply. Michael Nielsen and his co-workers at the University of Queensland in Australia claim that this deficit could be made up through the application of geometry.

In their analysis, the steps from logic gate to logic gate that make up a computation are treated as a path through the computer's 'space' of possible quantum states. The optimal algorithm will correspond to a geodesic in this space — the shortest path from input to output.

Such geodesics can be found using the trusty tools of Riemannian geometry, and this could mark a significant improvement on today's hit-or-miss approaches.

# JOURNAL CLUB

**Daan Frenkel**
**FOM Institute for Atomic and Molecular Physics, Amsterdam, The Netherlands**

**What to do when all the seats are taken? A materials scientist considers his options.**

Adding particles to a crystal can be a bit like seating passengers in an aeroplane. As people board a plane, row after row of seats fills up until, at some point, they are all taken and the aeroplane is full.

In a crystal of fixed volume, there is a limited number of lattice sites to be filled by its passengers, such as atoms or molecules.

To seat more people without using a larger aeroplane, you must move the seats closer together. Likewise, I was taught — and I accepted — that moving the lattice sites of a crystal closer together was the only way to squeeze more particles into a solid of a given volume. This is a strategy resisted by aeroplane passengers, atoms and molecules alike.

However, computer simulations and theory presented in a recent paper (B. M. Mladek *et al. Phys. Rev. Lett.* **96,** 045701; 2006) suggest that another solution is possible: sufficiently soft particles should be able to form a 'cluster solid' with several particles per lattice site. This leads to the question, do these kinds of solids exist in nature?

The authors suggest that certain polymeric macromolecules could form such crystals, but experiments are lacking.

Interestingly, a real example of a cluster solid may come from a different field of physics, namely the study of quantum phase transitions (M.O. Goerbig *et al. Phys. Rev. B* **69,** 115327; 2004). This paper explains the observed behaviour of a thin layer of cold electrons in a magnetic field by assuming that the electrons form a crystal with more than one particle per lattice site.

This arrangement may be comfortable for particles, but the aeroplane equivalent is too horrible to contemplate.