RESEARCH HIGHLIGHTS

Go with the airflow

Geophys. Res. Lett. **33,** L04804 (2006)
The flow of warm, dry air from the Sahara to the Atlantic Ocean is thought to inhibit the formation of tropical storms. Now, NASA researchers have shown that careful modelling of this airflow, known as the Saharan air layer, can improve simulations of storms forming off the coast of western Africa.

Liguang Wu of the Goddard Earth and Technology Center in Baltimore, Maryland, and his team used satellite data to build atmospheric temperature and humidity profiles. They then simulated the formation of Hurricane Isabel (pictured), which hit the United States in 2003, with and without this detailed data describing the Saharan air layer. Inclusion of the data yielded a much more accurate model of Isabel's observed track.

M. TRENCHARD/JOHNSON SPACE CENTER

OPTICS

Mirror image

Appl. Phys. Lett. **88,** 091119 (2006)
Mirrors don't just reverse right and left — they also invert the phase of light waves that bounce off them. More precisely, they reverse the phase of the electrical component of an electromagnetic wave, but leave the magnetic component intact.

Nikolay Zheludev of the University of Southampton, UK, and his colleagues have now made a mirror that does the opposite. Dubbed a 'magnetic wall', the reflector preserves the electrical phase of reflected microwaves, but reverses the magnetic phase. It is a metamaterial made from undulating copper strips 0.8 millimetres wide and arranged in a 'fish-scale' pattern.

CELL BIOLOGY

Fever pitch

J. Neurosci. **26,** 2590–2597 (2006)
A problem in protein transport could underlie some cases of febrile seizures, the fever-triggered convulsions that afflict over 6% of children worldwide.

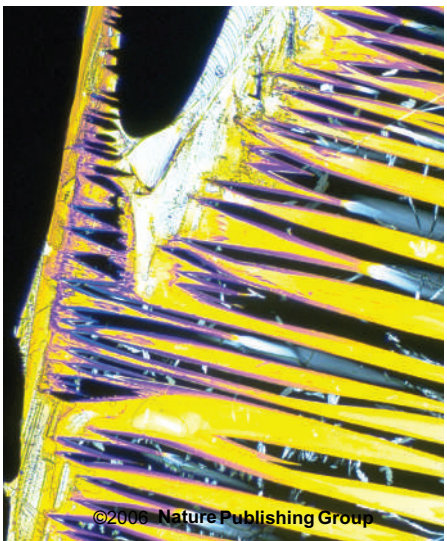
Febrile seizures have been linked to mutations in one subunit of the $GABA_A$ receptor, a protein complex that is a key ion channel in the nervous system. Robert Macdonald of the Vanderbilt University Medical Center in Nashville, Tennessee, and his colleagues show that the amount of the $GABA_A$ receptor at the surface of mammalian cells drops abnormally within minutes of the thermometer jumping from body temperature (37 °C) to a feverish 40 °C. This could be how a rapid rise in body temperature triggers the seizures, the authors propose.

CHEMICAL BIOLOGY

Small yet perfectly formed

Nature Chem. Biol. doi:10.1038/nchembio775 (2006)
Hard to find, but valuable: this is the nature of a small molecule that specifically binds to just one protein. Such molecules can be used to elucidate the cellular function of the protein, or in therapeutic treatments.

Thus Eric Prossnitz of the University of New Mexico in Albuquerque and his co-workers are set to reap the rewards for their hard work. The team has discovered the first small molecule that binds to the oestrogen-binding G-protein-coupled receptor GPR30, but not to the two oestrogen receptors ERα and ERβ (crystals of oestrogen pictured below). They used computational methods and cell-based assays to find the molecule, which they hope to use to define the role of GPR30 *in vivo* and to develop new contraceptive and anti-cancer agents.



OXFORD SCIENTIFIC (OSF)

MICROFLUIDICS

In a heartbeat

Lab Chip **6,** 362–368 (2006)
Researchers in Japan looking for a new way to power microdevices have turned to one of nature's most dynamic inventions: the heart.

A group led by the University of Tokyo's Takehiko Kitamori tethered a sheet of rat cardiomyocytes to a microfluidic chip. It is the contraction and expansion of layers of these cells that makes the heart beat. On the chip, the cardiomyocyte sheet is used as a pump actuator. It generates enough force, at a few micronewtons per cell, to drive fluids in the chip's channels.

The cells are powered chemically, with glucose and oxygen. But Kitamori says that to be viable in applications such as drug delivery, the bioactuator needs to be longer lasting.

CELL BIOLOGY

Saved by cleavage

Nature Cell Biol. doi:10.1038/ncb1378 (2006)
One of the cell's mechanisms for coping with DNA damage is regulated by a self-destructing enzyme, say researchers.

Alan D'Andrea of the Dana Farber Cancer

Institute in Boston, Massachusetts, and his colleagues focused on a mechanism that exploits the protein PCNA to prevent DNA replication stalling at a point of damage. When a ubiquitin molecule is attached to PCNA, damage-tolerant DNA polymerases are recruited — but this is risky because the polymerases are not faithful replicators.

D'Andrea's group identified an enzyme, USP1, that curbs the risk when the chances of damage are low by stripping ubiquitin from the protein. They also showed that USP1 can bow out of the system, leaving PCNA ubiquitinated, when there is a strong possibility of DNA damage. Irradiation with DNA-damaging ultraviolet light caused USP1 to cleave, and therefore inactivate, itself.

ASTRONOMY

Spin cycle

Astrophys. J. **639,** 1238–1251 (2006)

Discovered among the icy debris at the outskirts of the Solar System, the Kuiper belt object 2003 EL61 is the fastest-spinning body in our neighbourhood that is greater than 100 kilometres across. So say David Rabinowitz of Yale University in New Haven, Connecticut, and his colleagues.

Each rotation of the body takes less than four hours, and the authors believe that this rapid spinning squeezes the icy object into an ellipsoid at least 1,960 kilometres long and as little as 500 kilometres wide. After Pluto and 2005 FY9, 2003 EL61 is the third brightest trans-Neptunian object — orbiting the Sun at a greater distance, on average, than Neptune. Its light spectrum suggests that its surface is covered in methane or water ices.

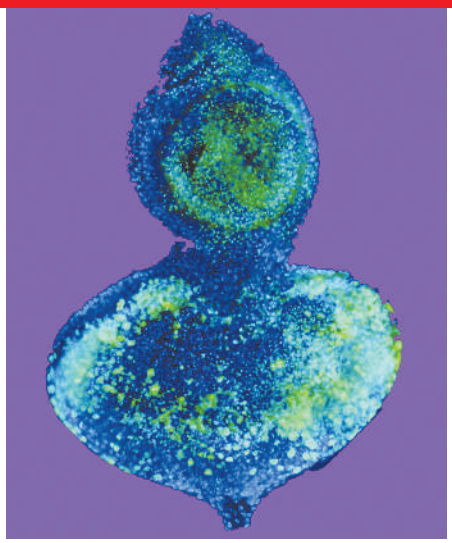
DEVELOPMENTAL BIOLOGY

Telling up from down

Cell **124,** 1011–1023; 1025–1037 (2006)

Cells need to know which way is up to coordinate growth, division and migration, and biologists are curious to know how they make this distinction.

Two groups of researchers, led by Christine Jacobs-Wagner of Yale University in New Haven, Connecticut, and Patrick Viollier at Case Western Reserve University in Cleveland, Ohio, studied the process in the crescent-shaped bacterium *Caulobacter crescentus*, which divides asymmetrically to create two different daughter cells. The teams show that a protein they dub 'tip of new pole' (TipN) marks one pole of the dividing cell, and then moves to the new poles of each progeny cell. TipN works by directing construction of a flagellum at one end of the cell.



HEUN *ET AL. DEV. CELL*

CANCER

Location, location, location

Dev. Cell **10,** 303–315 (2006)

Abnormal chromosome structure is a hallmark of cancer and certain birth defects. Now, researchers have uncovered a mechanism that could trigger such problems.

Gary Karpen of the Lawrence Berkeley National Laboratory, California, and his colleagues studied a protein called CID that helps to form the kinetochore, a structure needed for chromosomes to be pulled into daughter cells during cell division. Each chromosome normally has one kinetochore. Working in the fruitfly *Drosophila melanogaster* (eye-antenna disc pictured above), the team found that abnormally high levels of CID (shown in green) resulted in the protein sticking to extra locations on the chromosomes, causing additional kinetochores to form. The chromosomes were then pulled to pieces during cell division.

COMPUTATIONAL CHEMISTRY

Molecular map-making

J. Am. Chem. Soc. **128,** 3228–3232 (2006)

Designing a molecule with tailor-made properties is laborious when it involves testing many possible structures. One way to speed this process up, suggest David Beratan, Weitao Yang and their colleagues at Duke University in Durham, North Carolina, is to convert a discrete set of combinations of atoms into a continuous 'molecular space' in which atoms — and their contributions to the property of interest — can be gradually turned 'on' and 'off'. This smooth terrain can be explored with well developed mathematical tools to search for peaks, corresponding to maxima of the desired property. The nearest positions to these peaks that correspond to discrete molecules represent the candidates of interest.

The researchers used the technique to find the optimal electronic polarizabilities for simple small molecules; but the generality of the approach remains to be seen.

JOURNAL CLUB

David MacMillan
California Institute of Technology, Pasadena

Bond with a chemist over the search for asymmetry in reactions.

In synthetic chemistry, even the conceptually simple task of creating a chemical bond can be a formidable challenge.

Symmetry in particular can be problematic. Many organic molecules are chiral; that is, not superimposable on their mirror image. The configurations in which such a molecule exists, known as enantiomers, often differ in behaviour, especially in biological systems. So chemists strive for ways to preferentially produce just one enantiomer.

The design of such 'enantio-selective' reactions is central to synthetic chemistry. Significant advances have been made using new catalysis concepts, but many key problems remain unsolved.

A challenge I had always thought particularly daunting was developing a catalytic system to join an electrophilic alkyl group to a nucleophilic carbon centre in a second alkyl group, with control over the symmetry of the product.

There are two complicating issues. First, the alkyl–transition metal complexes mostly used as the starting material are unstable and so decay into metal hydrides. Second, the alkyl halides that act as reactants are themselves chiral and are a racemic, or 50:50, mixture of enantiomers. Thus, we must engineer a process that simultaneously destroys chiral information in the reactants and creates asymmetry in the product.

I was excited to learn that this is now possible. Gregory Fu and his colleagues have recently described efficient nickel-catalysed couplings of a racemic alkyl halide with organozinc nucleophiles, and they achieve superb enantiocontrol (F. O. Arp and G. C. Fu *J. Am. Chem. Soc.* **127,** 10482–10483; 2005). The method is ground-breaking as a proof of concept, and I predict that it will be widely used.