RESEARCH HIGHLIGHTS

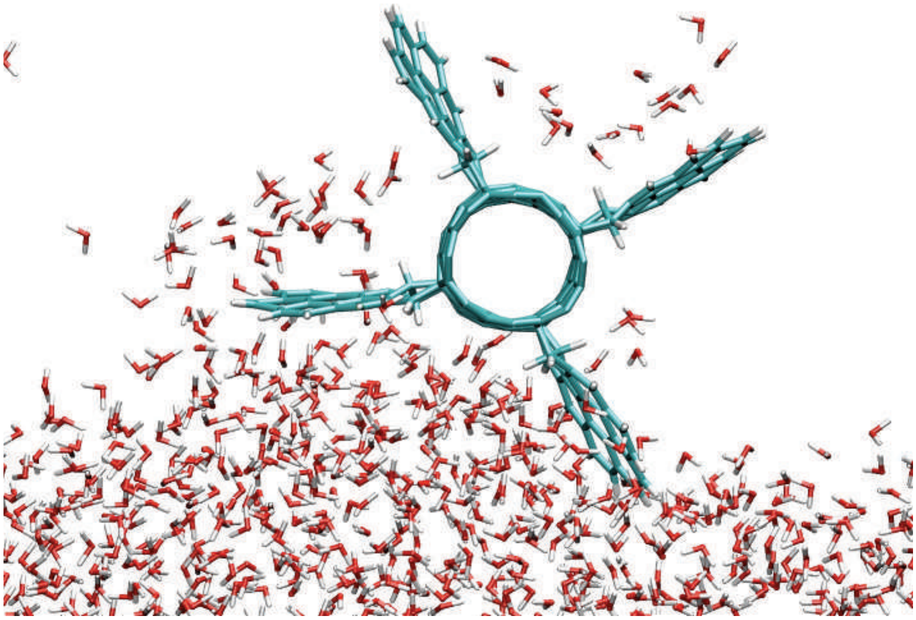
Wheels in motion

Phys. Rev. Lett. **98,** 266102 (2007)

Could a molecular-scale paddlewheel drive nanoscale liquid flows? Boyang Wang and Petr Král of the University of Illinois, Chicago, tested the idea using computer simulations.

The researchers modelled a paddlewheel made from a single-walled carbon nanotube with four flat molecular propellers attached around its circumference. As the tube spins, the paddles dip into a liquid layer below (pictured).

It was conceivable that the paddles might have simply disturbed the liquid molecules without forcing them forward, but the researchers say that the motion can indeed induce flow. The pumping rate depends on how the propellers interact with the liquid. For example, water sticks to hydrophilic paddles, clogging up the flow, whereas liquid long-chain alkanes create problems because the paddles struggle to drag them out of their entanglements.



AM. PHYS. SOC.

NEUROSCIENCE

Distracted by pain

Neuron **55,** 157–167 (2007)

You might try doing some work to distract yourself from a toothache, but the pain will stop you concentrating. Neuroscientists have now collected the first neurobiological clues to the way pain comes to override the brain's cognitive resources.

Ulrike Bingel and her colleagues at the University Medical Center Hamburg-Eppendorf in Germany took images of the brains of 16 people who had been asked to identify objects in a series of clear or blurred pictures. During the task, some subjects were pricked on the hand and others were given memory exercises to do.

Both types of interference lowered activity in the brain area known as the lateral occipital complex, which is involved in processing visual data. This reduced the accuracy of subjects' object recognition. The researchers found that the brain regions directing this modulation differed for pain and working memory.

CLIMATE SCIENCE

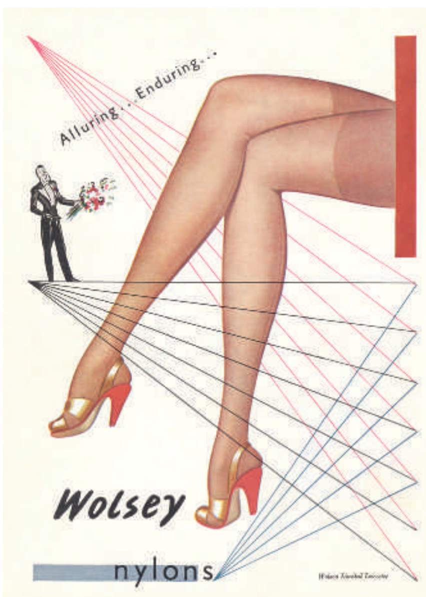
Kept under ice

Science **317,** 111–114 (2007)

DNA has been extracted from a silty layer at the base of an ice core drilled in southern Greenland, which reveals details of the pine forests and insect life the island once enjoyed. Found 2 kilometres down, the DNA is dated from between 450,000 and 800,000 years ago.

Greenland is known to have once been green — fossil plants have been found in the far north of the country dating to 2.4 million years ago. But the DNA provides the first evidence of what the landscape was like in regions now covered by ice.

The researchers, led by Eske Willerslev of Copenhagen University in Denmark, conclude that the absence of DNA younger than 450,000 years old means that this portion of land has been covered by ice ever since. This contradicts most interpretations of the sea-level record, which suggest that most of the Greenland ice cap melted during the last interglacial period.



BRIDGEMAN ART LIBRARY

CHEMISTRY

Nylon from biomass

Chem. Commun. doi:10.1039/b705782b (2007)

Researchers in the Netherlands have developed a distillation process that efficiently turns a chemical derived from the cellulose-rich parts of plants into a feedstock from which nylon polymers can be made.

Jean-Paul Lange of Shell Global Solutions in Amsterdam and his colleagues took γ-valerolactone, made from the biomass derivative levulinic acid, and mixed it with methanol and a strong acid catalyst to form the nylon precursor methyl pentenoate.

The boiling points of γ-valerolactone and methyl pentenoate differ by 80 °C. This makes the product easy to distil and collect. Previous routes to methyl pentenoate from biomass involved less efficient gas-phase reactions.

NANOTECHNOLOGY

Shape shifters

Nature Mater. doi:10.1038/nmat1957 (2007)

Many of the potential uses of nanoparticles, for example as catalysts or in magnetic memories, demand that the particles have well-defined sizes and shapes. But that's not easy to arrange at such small scales, and it has previously been largely a matter of trial and error.

Peidong Yang of the University of California, Berkeley, and his co-workers have now shown how to control the size and shape of metal nanocrystals.

When they deposit palladium on to

nanocubes of platinum, each cube acts as a seed for uniformly sized cubic palladium nanoparticles. Adding nitrogen dioxide to the mixture changes the particle growth rates in different crystallographic directions to give cuboctahedral or octahedral nanocrystals instead.

MATERIALS SCIENCE

Film conductor

Nano Lett. doi:10.1021/nl070477 (2007)

Science's newest wonder material, graphene, can be used to make glass conduct electricity, say researchers led by Rod Ruoff at Northwestern University in Evanston, Illinois. Their transparent and conductive composite material containing graphene — sheets of carbon one atom thick — could find applications in devices such as solar cells.

Transparent materials can be given a conductive coating of indium tin oxide, but indium is expensive. Previous carbon-based coatings have had problems with adhesion and opacity.

Ruoff's group combined graphene-oxide sheets with silica to form a solution that could be spin-coated quickly and cheaply on to glass.

GENETICS

Anemone genenome

Science **317,** 86–94 (2007)

The genome of the starlet sea anemone, *Nematostella vectensis* (pictured below), has helped researchers to tease out details of early animal evolution.

Daniel Rokhsar at the US Department of Energy Joint Genome Institute in Walnut Creek, California, and his collaborators have put together most of the 450-million base-pair genome, revealing some 18,000 genes.

By comparing this sequence with those of distant relatives, they put together a genomic picture of the last common ancestor of cnidarians (such as anemonies and jellyfish) and bilaterians (such as flies, worms and humans). Humans and the starlet sea anemone seem to have kept some features of this putative primordial genome that have been discarded by flies and worms.

MEDICAL RESEARCH

Drugs doubled up

Cancer Cell **12,** 81–93 (2007)

Researchers have found a way to prolong the effectiveness of targeted cancer therapies in a mouse model of lung cancer.

The therapies gefitinib and erlotinib inhibit a protein called epidermal growth factor receptor kinase, thus shutting down tumour growth in some non-small-cell lung cancers. But the tumours soon acquire secondary mutations that make them resistant to the drugs.

Geoffrey Shapiro and Kwok-Kin Wong of the Dana-Farber Cancer Institute in Boston, Massachusetts, and their co-workers show that a drug designed to combat these secondary mutations, HKI-272, doesn't work well on its own in mice engineered to get cancer. But when combined with an existing drug, rapamycin, HKI-272 quickly fights back tumours, suggesting that this one-two punch may serve as a back-up to extend the benefits of targeted therapies.

MICROBIOLOGY

Birth of a plague

Cell. Microbiol. doi:10.1111/j.1462-5822.2007.00986.x (2007)

Scientists may have identified a step in the evolutionary path that produced the bubonic plague.

Bubonic plague is caused by the bacterium *Yersinia pestis*, which is transmitted to humans by rat fleas. B. Joseph Hinnebusch of Rocky Mountain Laboratories in Hamilton, Montana, and his colleagues report that a related bacterium, *Yersinia pseudotuberculosis*, is toxic to fleas, causing diarrhoea.

They think this toxicity is due to a protein that acts in the flea gut. The researchers ruled out Tc toxins, a class of bacterial toxins with known insecticidal activity, as being to blame, leaving the identity of the protein unknown.

The group suggests that modification of the toxic protein may have enhanced flea-borne transmission and played a part in the genetic divergence of the two bacteria.

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JOURNAL CLUB

Michael A. Marletta
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A biochemist marvels at a molecule that shares his love of playing with fire.

I like to capture my students' attention by recounting how my early fascination with fire inspired my interest in the stability of sugars.

Glucose will 'burn' to carbon dioxide and water, liberating lots of energy. But it is stable enough that you can stamp on it without triggering the reaction — the energy barrier to the reaction is too high.

In my research, I am interested in how biology harnesses and controls oxygen reactivity. Most reactions, such as burning glucose, are held back by an energy barrier to getting things started. Enzymes can bypass this, finding a lower energy route through some reaction intermediate, to carry out a 'controlled burn'. Their control is not perfect, sometimes causing damage to both themselves and surrounding molecules, but by and large it works.

Typically, these enzymes have metal or organic components, which drive the oxidation. I often tell students that enzymes need their metal and organic cofactors because the 20 naturally occurring amino acids cannot carry out all the chemistry. Two recent papers shake that belief.

The surprise comes from the enzyme DpgC, which is involved in the biosynthesis of the antibiotic vancomycin. The first paper (C. C. Tseng *et al. Chem. Biol.* **11,** 1195–1203; 2004) reports that DpgC uses oxygen in a complex dioxygenase reaction with no bound metal or organic cofactor.

More recently, researchers reported the structure of DpgC and confirmed that it has no cofactor (P. F. Widboom *et al. Nature* **447,** 342–345; 2007). They find that the enzyme has a structure known as an oxyanion hole, which helps to stabilize the reaction intermediate.

I am still amazed that DpgC does oxygen chemistry with no help — and my students should be too.

Discuss these papers at **http://blogs.nature.com/nature/journalclub**