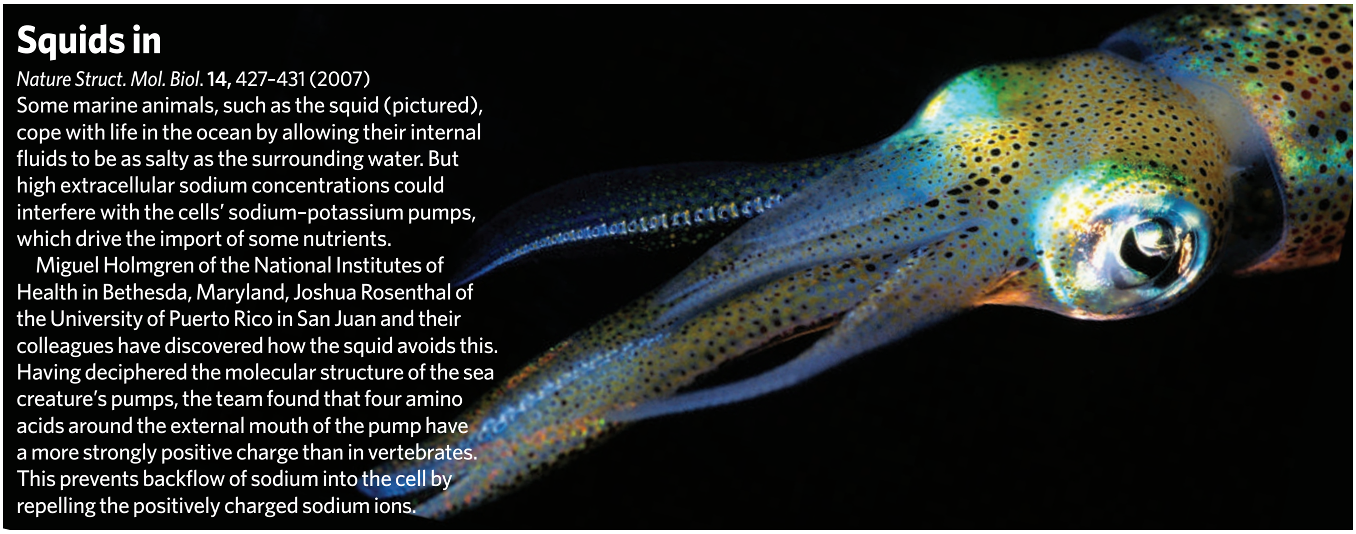
RESEARCH HIGHLIGHTS



BRANDON COLE MARINE PHOTOGRAPHY/ALAMY

Squids in

Nature Struct. Mol. Biol. **14,** 427–431 (2007)

Some marine animals, such as the squid (pictured), cope with life in the ocean by allowing their internal fluids to be as salty as the surrounding water. But high extracellular sodium concentrations could interfere with the cells' sodium–potassium pumps, which drive the import of some nutrients.

Miguel Holmgren of the National Institutes of Health in Bethesda, Maryland, Joshua Rosenthal of the University of Puerto Rico in San Juan and their colleagues have discovered how the squid avoids this. Having deciphered the molecular structure of the sea creature's pumps, the team found that four amino acids around the external mouth of the pump have a more strongly positive charge than in vertebrates. This prevents backflow of sodium into the cell by repelling the positively charged sodium ions.

NEUROSCIENCE

Light-headed

Nature Neurosci. doi:10.1038/nn1891 (2007) and *Neuron* **54,** 205–218 (2007)

A light-activated ion channel found in algae, known as channelrhodopsin-2, has enabled two teams to map neural circuits in the brains of mice. The researchers transferred the ion channel into discrete sets of neurons, which then fired in response to light.

By simultaneously stimulating and recording from the neurons, Karel Svoboda at the Howard Hughes Medical Institute in Ashburn, Virginia, and his colleagues mapped part of a circuit in the somatosensory cortex, which processes information about touch.

Michael Ehlers at Duke University Medical Center in Durham, North Carolina, and his colleagues studied a part of the brain involved in conveying information about odours to the cortex. To do this, Ehler's team created transgenic mice that express the ion channel, whose offspring can be used in future rounds of experiments.

ORGANIC CHEMISTRY

The colour purple

Chem. Commun. doi:10.1039/b618926a (2007)

The compound that launched the modern chemical industry is more complex than anyone had realized, say scientists in Portugal.

João Seixas de Melo of the University of Coimbra and his co-workers have reproduced the synthesis of 'mauveine' conducted in 1856 by William Perkin. The purple substance that Perkin produced was the first of the aniline dyes, on which many of today's big chemical companies were founded.

It was discovered in 1994 that the dye contains two molecules, dubbed mauveines A and B. Now de Melo and his colleagues report that their synthesis yields two further variants of the basic mauveine structure, also present in historical dye samples. Perkin's glorious mauve is therefore a subtle blend of the molecules' slightly different colours.

NANOTECHNOLOGY

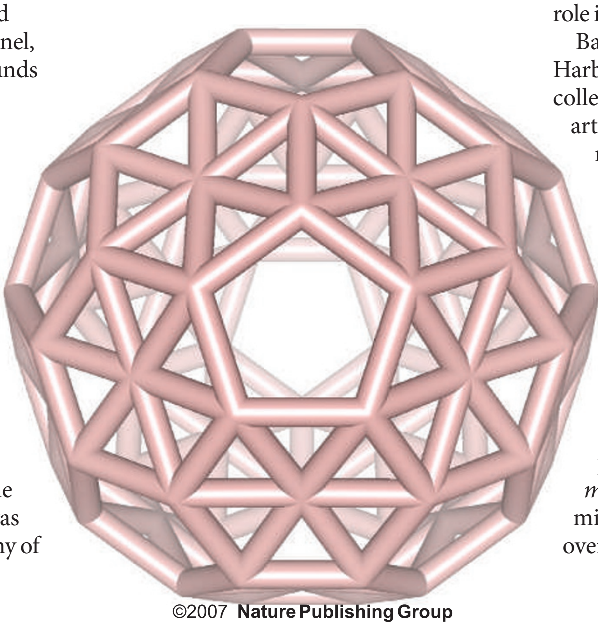
New balls, please

Phys. Rev. Lett. **98,** 166804 (2007)

Carbon 'buckyballs' are facing competition from boron balls: new calculations predict that boron can assemble into spherical molecules, too.

Buckyballs are cage-shaped molecules made from 60 carbon atoms arranged in a pattern of hexagons. Their round, hollow structure is enticing to researchers, who have turned the molecules into wheels for molecular cars, as well as exploring more serious applications in composite materials and electronics. The most stable of the predicted boron balls — which should have similar technological appeal — contains 80 atoms (pictured below).

Boris Yakobson of Rice University in Houston, Texas, and his colleagues say that their calculations can't predict how easy this molecule might be to make, but encourage experimenters to try.



O. PUPYSHEVA/RICE UNIV.

RNA BIOLOGY

Tiny heartbreakers

Nature Med. **13,** 486–491 and 613–618 (2007)

Tiny RNA molecules known as microRNAs regulate everything from development to stress responses — they also play an important role in heart function, two studies report.

Baofeng Yang and Zhiguo Wang of the Harbin Medical University in China and their colleagues report that people with coronary artery disease express more of a microRNA named *miR-1*. Overexpressing *miR-1* in rats promoted irregular heartbeats; inhibiting *miR-1* relieved the condition.

Meanwhile, a team led by Cesare Peschle of the Italian National Institute of Health in Rome and Gianluigi Condorelli of the University of California, San Diego, has shown that patients with a pathological thickening of heart muscle known as cardiac hypertrophy produce less of another miRNA, *miR-133*. Inhibiting *miR-133* in mice triggered the condition, whereas overexpressing *miR-133* prevented it.

MICROBIOLOGY

Respiration in reverse

Proc. Natl Acad. Sci. USA doi:10.1073/pnas.0610456104 (2007)

Microbial geneticists have sequenced the genome of a bacterium that plays a key role in the global anaerobic carbon cycle, in a bid to study its unorthodox lifestyle. *Syntrophus aciditrophicus* runs its electron-transport chain — a crucial set of respiratory reactions — backwards.

Researchers led by Robert Gunsalus of the University of California, Los Angeles, sequenced *S. aciditrophicus*'s 3.2 million letters of DNA code. They discovered genes that underpin the bacterium's consumption of organic molecules such as alcohols and fatty acids, and that allow its electron transport to function in this unusual direction.

QUANTUM INFORMATION

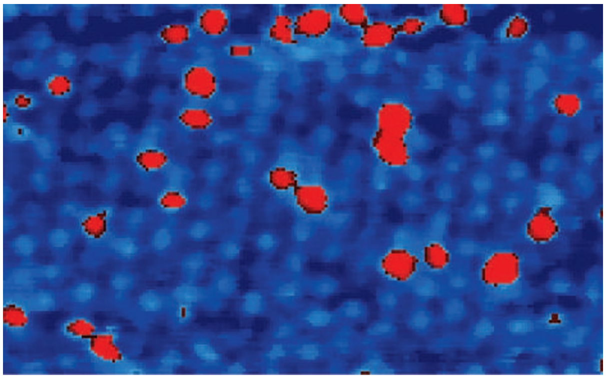
Which way did it go?

Phys. Rev. Lett. **98,** 160403 (2007)

Even by the surreal standards of quantum physics, the result predicted by Lev Vaidman of Tel-Aviv University in Israel is bizarre: a quantum particle can arrive somewhere without having taken the route that leads there.

Vaidman reached this conclusion after examining a recent proposal for 'counterfactual computation' (O. Hosten *et al. Nature* **439,** 949–952; 2006), in which a quantum computer performs a computation without running the algorithm it involves — where 'running the algorithm' means passing a photon through the computer.

In the set-up proposed by Hosten *et al.*, the photon is directed away from the device, but, nevertheless, measurement of the state of the photon at the end of the procedure yields the result of the computation. Vaidman shows that a photon sent away from the device can still reach and pass through it. Thus, the computer does actually run the algorithm and the computation isn't 'counterfactual'.



CANCER

Aid to resistance

Science doi:10.1126/science.1141478 (2007)

The drug gefitinib is at first an effective treatment for certain types of lung cancer, but most cancers become resistant to it. New research provides insight into one mechanism by which this happens.

Gefitinib inhibits an enzyme known as EGFR kinase, and around half of the resistance cases are due to mutations in this target. Among the rest, Pasi Jänne of the Dana-Farber Cancer Institute in Boston, Massachusetts, and his colleagues found that some resistant cells showed increased expression of a tyrosine-kinase receptor named MET. This activates the same signalling pathway that EGFR kinase triggers — a pathway that mediates cell survival.

The researchers found that the *MET* gene had multiplied rather than mutated, and that inhibiting *MET* restored the cells' sensitivity to gefitinib.

CHEMISTRY

Work in progress

Nature Nanotechnol. doi:10.1038/nnano.2007.106 (2007)

Snapshots of catalytic molecules at work have been taken with a scanning tunnelling microscope. Johannes Elemans of Radboud University Nijmegen, the Netherlands, and his team have watched individual disk-shaped organic molecules known as porphyrins as they add oxygen atoms to alkenes.

A manganese ion at the centre of each porphyrin seizes an oxygen atom from molecular oxygen (O_2) before inserting it into the alkene. The image (left) reveals which of the porphyrins on a gold surface have an oxygen, showing that these tend to come in pairs: the two oxygens from an O_2 molecule are captured by adjacent porphyrins.

CELL BIOLOGY

Algal aptitude

Genes Dev. **21,** 1190–1203 (2007)

MicroRNAs have shown up for the first time in a unicellular organism, suggesting that they evolved before multicellularity.

Previous searches in yeast and bacteria have failed to find any microRNAs. But Yijun Qi of the National Institute of Biological Sciences, Xiu-Jie Wang of the Chinese Academy of Sciences, both in Beijing, and their colleagues have now isolated some from the unicellular green alga *Chlamydomonas reinhardtii*.

The team showed that several of these microRNAs cleave specific messenger RNAs, a key part of the mechanism by which microRNAs regulate gene expression. What's more, expression of some microRNAs changed during gamete formation, suggesting a role in the reproductive process.

JOURNAL CLUB

Phil Bland
Imperial College London, UK

A planetary scientist learns how comet dust gets from the inner to the outer Solar System.

I was lucky enough to be part of a team studying the grains of comet dust collected last year by NASA's Stardust mission. Comets are primitive, pristine objects, and the Stardust samples are changing the way we think about how our Solar System formed.

Among many surprising findings, perhaps the most significant is that a large fraction of the dust grains are minerals formed at high temperatures — temperatures expected only in the inner Solar System. How did this stuff get out to where the comet began its life, in the cold, outer regions of the Solar System?

At the recent Lunar and Planetary Science Conference in Houston, Texas, I learned about a numerical simulation that potentially offers a neat solution (F. J. Ciesla and J. N. Cuzzi, abstract at www.lpi.usra.edu/meetings/lpsc2007/pdf/1386.pdf).

Observations of dusty disks around young stars show an inward flow towards the central star. Ciesla and Cuzzi's simulation suggests that this inward transport is confined to the top and bottom of the disk. It predicts that there is a narrow region near the disk's midplane where dust flows outwards — a flow sufficient to account for the Stardust results.

So now we know that comets contain a mixture of stuff from the inner Solar System, and we have a physical model that can explain how it got there. But we're still left with one question.

Virtually everything in the inner Solar System — Earth, Mars, the Moon, almost all meteorites — is depleted in volatile elements, which can't condense at high temperatures. But the cometary dust grains don't show this depletion signature. Why not? It'll be fun finding out.