

# THE YEAR IN NATURE

*Nature's* manuscript editors made a selection of 'favourites' from the papers we published in 2008.

## Where to look for monopoles

Magnetic monopoles in spin ice

C Castelnovo, R Moessner & S L Sondhi

*Nature* 451, 42–45 (3 January 2008)

All magnets have north and south poles. Except that in the thirties, Dirac invoked monopoles to explain charge quantization; now they crop up elsewhere in particle physics — in theory. Physicists searched in vain for monopoles in cosmic rays and particle accelerators. Then this theoretical study suggested a better place to look: in exotic magnetic 'spin ice' materials. The search, though, continues...

## Nanostructures via DNA

Programming biomolecular self-assembly pathways

P Yin, H M T Choi, C R Calvert & N A Pierce

*Nature* 451, 318–322 (17 January 2008)

DNA-guided crystallization of colloidal nanoparticles

D Nykypanchuk, M M Maye, D van der Lelie & O Gang

*Nature* 451, 549–552 (31 January 2008).

DNA-programmable nanoparticle crystallization

S Y Park *et al.*

*Nature* 451, 553–556 (31 January 2008)

Three nanotechnology papers with DNA the common thread. First a proof-of-principle experiment that recruits DNA hairpins to program biomolecular synthesis. The eventual goal is the automated design of biomolecules with specific functions. The other two put a 10-year-old theory into practice by showing that DNA attached to gold nanoparticles can be selected to self-assemble as nanocrystalline structures of the type that may serve as the optical and electronic materials of the future.

## The missing antimatter

Difference in direct charge-parity violation between charged and neutral *B* meson decays

The Belle Collaboration

*Nature* 452, 332–335 (20 March 2008)

Intriguing results from the 'B factory' electron-positron collider at the KEK high-energy physics facility: the measurement of anomalous asymmetry in the decay rates of the exotic particles known as *B* mesons. Physicists say that the new value, taken with similar results from an experiment run on the SLAC linear accelerator, may help explain the near disappearance of antimatter from the Universe.

## Artificial enzymes

Kemp elimination catalysts by computational enzyme design

D Röthlisberger *et al.*

*Nature* 453, 190–195 (8 May 2008)

This example of computational protein design is a major step towards the goal of designing artificial enzymes to catalyse reactions beyond the repertoire of natural biocatalysts. Potential



enzymes comprising about 200 amino acids were synthesized and the best, at removing a proton from carbon, underwent 'directed evolution' to make them even better. The design strategy, which mobilizes the power of many thousands of home computers via the Rosetta@home project, is generally applicable.

## Atmospheres from the past

High-resolution carbon dioxide concentration record 650,000–800,000 years before present

D Lüthi *et al.*

*Nature* 453, 379–382 (15 May 2008)

Orbital and millennial-scale features of atmospheric CH<sub>4</sub> over the past 800,000 years

*Nature* 453, 383–386 (15 May 2008)

L Loulergue *et al.*

Direct evidence of ancient environments is rare and therefore extremely valuable, and that's what the air bubbles trapped in polar ice cores provide. The evidence is hard-won: quite apart from obtaining and handling the core, extracting the gases intact is technically demanding. With these two publications adding new data from the EPICA Dome C core, the record of past atmospheres is extended to 800,000 years ago. Included is the lowest CO<sub>2</sub> concentration so far measured in an ice core.

## The day the temperature fell

A large discontinuity in the mid-twentieth century in observed global-mean surface temperature

D W J Thompson, J J Kennedy, J M Wallace & P D Jones

*Nature* 453, 646–649 (29 May 2008)

How come nobody noticed? The record of global sea-surface temperatures during the past century has underpinned much of our thinking on the effect of human activity on climate. Surely there were no surprises left in the data. But this paper identified a 'glitch' — a fall of

about 0.3 °C coinciding with a change in the equipment used to measure the temperatures in 1945. The discontinuity is 40% as large as the century-long warming trend, so correcting for it may change the overall record substantially.

## Your tissues in colour

Micro-engineered local field control for high-sensitivity multispectral MRI

G Zabow, S Dodd, J Moreland & A Koretsky

*Nature* 453, 1058–1063 (19 June 2008)

MRI scans are one of the big success stories of medical diagnostics. This clever piece of microengineering could refine the technique by adding 'colour'. It uses tiny injectable metallic microstructures to respond to a range of radiofrequency signals that can be displayed as different colours. There's more work to be done — finding a less toxic metal than the nickel used initially for a start — but information-rich colour MRI scans are now a distinct possibility.

## Enter the 'adipomyocyte'

PRDM16 controls a brown fat/skeletal muscle switch

P Seale *et al.*

*Nature* 454, 961–967 (21 August 2008)

This was a surprise. Brown fat cells, the ones that burn calories to generate body heat, were found to share a common origin with skeletal muscle cells. White fat cells, the energy stores, have a quite separate origin. The zinc-finger protein PRDM16 is a powerful regulator of the cell fate switch between muscle and brown fat, so may have therapeutic potential in obesity.

## An upheaval in ocean biology

Major viral impact on the functioning of benthic deep-sea ecosystems

R Danovaro *et al.*

*Nature* 454, 1084–1087 (28 August 2008)

The way that biologists and climatologists view the impact of viruses on the carbon cycle was transformed this year, and this was one of several papers that began the transformation. Ocean sediments contain large numbers of prokaryotes involved in organic carbon degradation, but the impact of viruses on these deep-sea ecosystems was unknown. The discovery that most deep-sea bacteria are infected by bacteriophage that kill their hosts, releasing sequestered carbon into the waters above and at the same time stimulating bacterial growth, means that this 'viral shunt' may be a key driver in the global carbon cycle.

## Found horizon

Event-horizon-scale structure in the supermassive black hole candidate at the Galactic Centre

S S Doeleman *et al.*

*Nature* 455, 78–80 (4 September 2008)

You can't 'see' a black hole but this piece of

observational astronomy gets close by picking out structure in the radio emission just outside the event horizon of Sgr A\*, the supermassive black hole candidate at the centre of the Milky Way.

## An artificial tree

The transpiration of water at negative pressures in a synthetic tree

T D Wheeler & A D Stroock

*Nature* 455, 208–212 (11 September 2008)

The 'synthetic tree' that validates the cohesion-tension theory of transpiration has trunk and root systems in the shape of centimetre-scale disks of a hydrogel that contains tiny, homogeneous pores. Water evaporates from the 'leaves' to generate a transpirational pull a hundredfold greater than the pull in a synthetic wick. This 'tree' is a good starting point for new technologies for the management of water — even devices able to mimic the ability of plants to extract purified water from the soil.

## Cell biology revisited

Frequency-modulated nuclear localization bursts coordinate gene regulation

L Cai, C K Dalal & M B Elowitz

*Nature* 455, 485–490 (25 September 2008)

Here's an example of how systems biology can completely change the way we think about a familiar cellular process. Traditional biochemistry pictured cells as responding to environmental changes by sending regulatory proteins to the nucleus in an all-or-none fashion to activate target genes. This Article, combining cutting-edge single-cell imaging, cellular noise biophysics and computational modelling, reveals that translocation from cytoplasm to cell nucleus in the yeast cell occurs in bursts. The frequency — but not amplitude — of these bursts varies in response to extracellular signals, maintaining the relative rates of expression among target genes despite their varying absolute levels.

## Watching speciation

Speciation through sensory drive in cichlid fish

O Seehausen *et al.*

*Nature* 455, 620–626 (2 October 2008)

This elegant demonstration of speciation in action filled in important mechanistic gaps in our knowledge about the barriers that prevent mating between species. The cichlids of the African lakes are the most rapidly speciating species known. Here it was a change in the visual system, which affects females' preference for mating with different coloured males, that was the driver for a parting of the ways.

## Turn on the insulin

*In vivo* reprogramming of adult pancreatic exocrine



cells to  $\beta$ -cells

Q Zhu, J Brown, A Kanarek, J Rajagopal & D A Melton  
*Nature* 455, 627–632 (2 October 2008)

Various strategies exist to 'dedifferentiate' mature cells to a state where they resemble an embryonic cell with the potential to regenerate to perform a new function. Here though, there is no 'in-between' stage: mature exocrine pancreatic cells in live diabetic mice were reprogrammed to produce insulin by exposure to a cocktail of three transcription factors.

## Crossing the membrane

Structure of a complex of the ATPase SecA and the protein-translocation channel

J Zimmer, Y Nam & T A Rapoport

*Nature* 455, 936–943 (16 October 2008)

The determination of the crystal structure of a complex between a single bacterial protein



conducting channel and the SecA motor that powers the protein across the cell membrane was an impressive technical feat. And — with two other papers in this issue tackling the mechanisms involved — it revealed some of the details about how proteins make their way through the cell membrane.

## The personal touch

Accurate whole human genome sequencing using reversible terminator chemistry

D R Bentley *et al.*

*Nature* 456, 53–59 (6 November 2008)

The diploid genome sequence of an Asian individual  
J Wang *et al.*

*Nature* 456, 60–65 (6 November 2008)

Feats of DNA sequencing that once took many years and millions of dollars can now be achieved in just months and for several thousand dollars. The 6 November issue included these landmark papers — genome sequences of Yoruba African and Han Chinese individuals — to be added to the three personal genomes already published (those of Craig Venter, Jim Watson and the NIH reference sequence). Also in this issue is the genome sequence of a patient with leukaemia and a series of features on what the new era of personal genomics has in store for us.

## Cancer stem cells in the news

Efficient tumour formation by single human melanoma cells

E Quintana *et al.*

*Nature* 456, 593–598 (4 December 2009)

This demonstration that most cells in mouse melanomas are capable of continuous proliferation has caused a flurry of interest in the cancer stem cell hypothesis. The hypothesis assumes that only a few cells in a solid tumour are tumorigenic — and that targeting those cells may be the best form of therapy. The new results question this approach for some melanomas, but the cancer stem cell hypothesis remains in the frame for other cancers, such as leukaemia.

## Neuromotor prosthetics

Direct control of paralysed muscles by cortical neurons  
C T Moritz, S I Perlmutter & E E Fetz

*Nature* 456, 639–642 (4 December 2008)

Advances in brain–machine interfaces came thick and fast this year. This work followed on from research in which monkeys were trained to move robotic arms by signalling through electrodes implanted into the brain by showing that a single neuron not previously associated with controlling movement can be co-opted to restore movement to a paralysed arm. Such techniques are beginning to look like a plausible strategy that could be used in humans.