RESEARCH HIGHLIGHTS

Dynamics of a dance

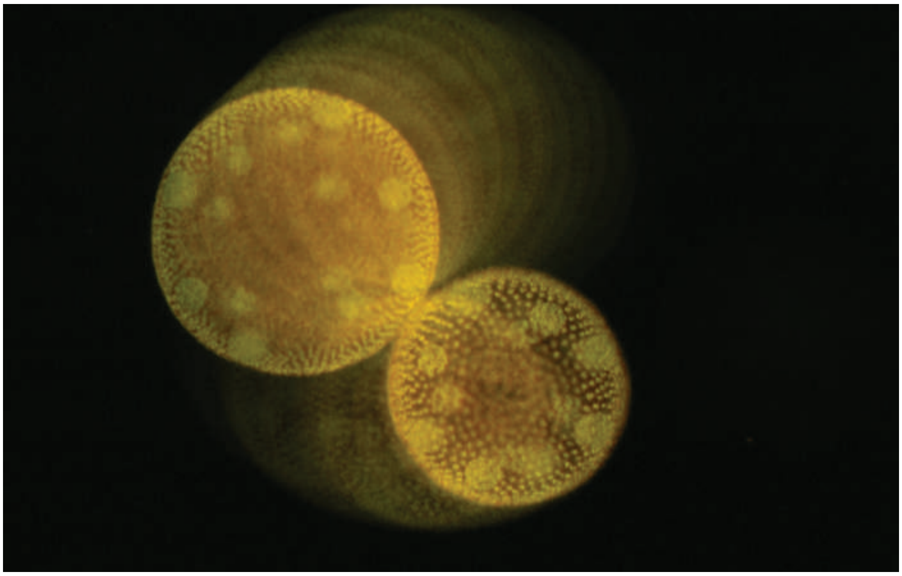
Phys. Rev. Lett. **102,** 168101 (2009)

Volvox are microscopic algae, spherical aggregates of thousands of flagellated cells. The spheres twirl about in ponds, swimming up and down in the water and interacting with their neighbours in seemingly orchestrated dances.

Physicist Raymond Goldstein of the University of Cambridge, UK, and his colleagues investigated the fluid dynamics used by *Volvox carteri* contained in a microscope-equipped chamber. Near the top of the chamber they observed the tiny dancers 'waltzing', spinning about each other in a clockwise fashion. Near the bottom, the spheres participated in a more complex 'minuet'.

The authors suggest that the careful dances increase female encounters with sperm packets during sexual reproduction.

For movies, see http://tinyurl.com/degwdj.



K. DRESCHER, R. E. GOLDSTEIN, UNIV. CAMBRIDGE

CHEMISTRY

Fuel from thin air

Angew. Chem. Int. Edn **48,** 3322–3325 (2009)

Carbon dioxide can be sucked out of the air (see News Feature, page 1094) and turned into a useful fuel using a metal-free catalyst.

The carbene catalyst — a compound with a pair of electrons available to react — is not only metal-free, and so better for the environment, it also works in air. Metal catalysts are often degraded by oxygen.

The system, which also uses a silicon-containing molecule, a silane, to activate carbon dioxide and drive the reaction, was developed by Jackie Ying, Yugen Zhang and Siti Nurhanna Riduan at the Institute of Bioengineering and Nanotechnology in Singapore.

The reaction product, methanol, can be turned into other carbon-based fuels, or used itself as a biofuel.

BIOCHEMISTRY

DNA base maker

Science doi:10.1126/science.1170116 (2009); *Science* doi:10.1126/science.1169786 (2009)

Although four DNA bases — adenine, thymine, cytosine and guanine — make up much of the genome, modified bases can serve special purposes. Trypanosomes, parasitic protozoa, contain an additional base called J that is a hypermodified version of thymine that has not been documented in other organisms.

Anjana Rao of Harvard Medical School and her colleagues searched for enzymes similar to those responsible for making base J that might make a similar base in mammals. They found TET1, which makes a modification to cytosine to create hydroxymethylcytosine. This accounts for 4–6% of all cytosines in the DNA of mouse embryonic stem cells.

Meanwhile, independently, Skirmantas Kriaucionis and Nathaniel Heintz at the Rockefeller University in New York have identified the modified base in the mouse brain.

STEM-CELL BIOLOGY

New stem-cell formula

Cell Stem Cell doi:10.1016/j.stem.2009.04.005 (2009)

Ever since Kyoto University's Shinya Yamanaka showed that cultured skin cells could be made to behave like embryonic stem cells by the addition of a handful of genes, researchers have been trying to repeat the trick without introducing DNA to the cells. Now, Sheng Ding at the Scripps Research Institute in La Jolla, California, and his colleagues say they can reprogram cells — in this case mouse embryonic fibroblasts — with those genes' protein products, specifically engineered to cross the cellular and nuclear membranes.

The resulting cells are "morphologically indistinguishable" from embryonic stem cells, the authors say, and express similar markers.

Although such work has not yet been reported in human cells, Ding predicts that similar techniques will replace those requiring DNA or viruses, which are deemed risky in therapeutic applications.

For a longer story on this research, see http://tinyurl.com/cgonae.

PHOTONICS

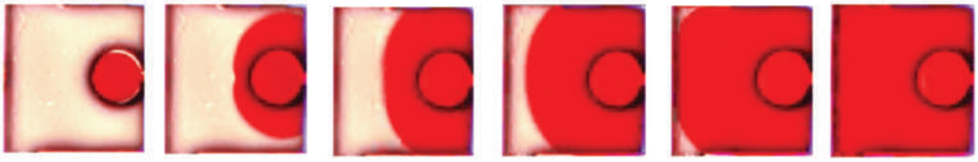
E-ink goes colour

Nature Photon. doi:10.1038/nphoton.2009.68 (2009)

Electronic readers without backlit screens can't beat the contrast and brightness of traditional ink and paper when it comes to colour.

Jason Heikenfeld of the University of Cincinnati, Ohio, and his colleagues, working with the Sun Chemical Corporation, also in Cincinnati, say that they have found a way to improve colour displays. Using inexpensive photolithographic techniques, the researchers made pixels with a reflective background and small wells containing water-dispersed pigments. Apply a voltage and pigment flows out of the well, coating the pixel (pictured left). Surface tension sucks the pigment back when voltage is removed; the switching is fast enough for video displays.

The researchers say their technique offers brightness, matt appearance and contrast that is superior to a related method that uses electric current to flip coloured oil droplets from beads to thin films across a pixel.



CHEMICAL BIOLOGY

Getting the glow

Nature Chem. Biol. doi:10.1038/nchembio.174 (2009)

Green fluorescent protein (GFP), originally isolated from the jellyfish *Aequorea victoria*, has had a transformative effect on biology. However, its purpose in nature has remained unclear. Now, Konstantin Lukyanov of the Shemyakin and Ovchinnikov Institute for Bioorganic Chemistry in Moscow and his colleagues have discovered that GFP can transfer electrons to certain proteins in a process powered by light.

When in the presence of certain electron acceptors such as cytochrome *c* or benzoquinone in an *in vitro* system, the authors noticed that signals changed from green to red. They suggest that the protein is passing an electron and changing conformation. They also found that GFP seems able to find protein electron acceptors in living cells.

Rather than being passive light-absorbing, glowing molecules, GFP may serve a chemical role, one that the authors suggest should be considered in the many research applications of this workhorse protein.

For a longer story on this research, see http://tinyurl.com/dz8xrh.

MATERIALS

Improving on nature

Science **324,** 488–492 (2009)

Spider silk is naturally tougher than steel, but adding metal makes it stronger still.

Seung-Mo Lee and Mato Knez of the Max Planck Institute of Microstructure Physics in Halle, Germany, and their colleagues took dragline silks from a spider caught in the institute gardens and pulsed them with metals in a process called multiple pulsed vapour-phase infiltration. Zinc oxide, titanium oxide or aluminium oxide not only coated the silk but also infiltrated the protein structure, resulting in much higher strength and extensibility.

The technique could be used on other biomaterials, the researchers say, such as collagen membranes from eggs.

GENOMICS

X-linked mysteries

Nature Genet. doi:10.1038/ng.367 (2009)

Efforts to resequence genetic variants that have been associated with disease may produce more questions than answers, at least at first.

Case in point: the results of Michael Stratton and Andrew Futreal of the Wellcome Trust Sanger Institute in Cambridge, UK, and their team, who have performed the largest resequencing study of its kind so far. They catalogued the protein-coding regions of 718 genes on the X chromosomes of individuals from 208 families affected by X-linked mental retardation.

By identifying variants predicted to truncate protein-coding genes and render them non-functional, the effort unearthed nine new genes probably involved in X-linked mental retardation. But it also found many similar truncating variants in normal individuals. The team estimates that people can function normally despite mutations that render 1–2% of genes on the X chromosome non-functional — a fact that could further complicate resequencing studies.

BIOPHOTO ASSOCIATES/SPL

CLIMATE

Ground truths

Geophys. Res. Lett. doi:10.1029/2009GL037666 (2009)

Changes in land cover during the latter half of the twentieth century have affected the local climate and exacerbated droughts in eastern Australia. Replacing native vegetation with cropping or grazing lands can change how much sunlight is reflected and how much moisture evaporates, altering temperature and rainfall patterns.

Clive McAlpine of the University of Queensland in Australia and his colleagues simulated the period from 1951 to 2003 on computer climate models — comparing actual land use change with a scenario in which land stayed in its late-eighteenth-century pre-European state. The results imply that clearing native vegetation has worsened droughts, even if climate change is factored out.

JOURNAL CLUB

Michelle Peckham
University of Leeds, UK

A cell biologist ponders an outstanding mystery in muscle formation.

Heart and skeletal muscles have a beautiful, almost crystalline structure of repeating contractile units called sarcomeres. The length of these units is precisely regulated along with the lengths of two types of overlapping filament (thick and thin) that they contain. Muscles contract when crossbridges from thick filaments interact with actin in thin filaments. The amount of contraction depends on the length of each filament and how much they overlap.

A thick filament contains exactly 294 myosin molecules — a limit imposed by the giant 'ruler' protein titin. Yet it is not clear what regulates the length of thin filaments. The protein nebulin has been a key candidate: its size corresponds to thin filament length in several species. Puzzlingly, however, in mice with a targeted deletion of nebulin, skeletal muscle thin filaments are the right length, at least at birth. And Ryan Littlefield at the University of Washington in Friday Harbor and his colleagues have now shown that nebulin is too short to be the ruler — its end is located just short of the tips of the thin filaments (A. Castillo *et al. Biophys. J.* **96,** 1856–1865; 2009).

Because of the way in which thick filaments are built, their middles — at the centre of the sarcomere — have no crossbridges. Littlefield and his colleagues suggest that thin filaments, which grow towards the middle of sarcomeres from their edges, stop growing when they reach this 'bare' zone. Intriguingly, this paper also shows that thin filament lengths in different muscles correspond to the length of titin in those muscles. A single titin molecule stretches from the edge to the middle of the sarcomere. If titin modulates overall sarcomere length, and thus the distance to the bare zone in the centre of the sarcomere, this could indirectly regulate thin filament lengths. Maybe the biggest protein known has yet another job.

Discuss this paper at **http://blogs.nature.com/nature/journalclub**