

S. ZIESE/NEWSCOM

Laboratory in California analysed the ZRS DNA sequence — which regulates a key limb-development gene called Sonic hedgehog (*SHH*) in a range of animals — in the genomes of various snakes. The authors found that snakes' ZRS sequence differs markedly from that of other vertebrates. Mice in which the ZRS had been replaced by the cobra or python version did not express *SHH* in their developing limbs and were born with stumps instead of legs.

In a separate study, Francisca Leal and Martin Cohn at the University of Florida in Gainesville identified a series of deletions in the ZRS common to several snake species, but not seen in limbed vertebrates. In experiments in mice and cell culture, these mutations reduced the activity of the ZRS. *Cell* 167, 633–642 (2016); *Curr. Biol.* <http://doi.org/br4z> (2016)

PLANT SCIENCE

How some plants adapt to shade

Shade-loving *Begonia* plants have iridescent blue leaves as a result of a cell organelle that allows them to efficiently harvest light in low-light conditions.

Plants rely on organelles called chloroplasts for photosynthesis. Heather Whitney at the University of Bristol, UK, and her colleagues used light and electron microscopy to study the structure of a variant of these organelles, called an iridoplast, in the surface layers of *Begonia* plants (hybrid of *B. grandis* and *B. pavonina*, pictured). The team found that the

iridoplasts' membranes are stacked in piles of three or four in a highly regular manner — a structure not seen in normal chloroplasts.

Data modelling showed that this structure allows iridoplasts to absorb predominantly green light, which is abundant in forest shade, and enhances photosynthetic efficiency by up to 10%.

Nature Plants <http://dx.doi.org/10.1038/nplants.2016.162> (2016)

EVOLUTION

Fast but invisible evolution

The rate of evolution is consistent across many fossil lineages, even if some show little physical change.

Such seemingly unchanged fossils — described as being in stasis — have often been interpreted as evidence for slow evolution. Kjetil Lysne Voje at the University of Oslo analysed published data on 450 fossil lineages, calculating the rate of evolution and morphological change. In lineages in stasis, he found that traits constantly fluctuated, but these shifts did not lead to large evolutionary changes in a particular direction. However, the traits still evolved just as much as those in lineages that saw major directional changes.

Long periods of stasis in the fossil record are evidence for stable environmental conditions that allowed ecological niches to persist for millions of years, Voje suggests. *Evolution* <http://doi.org/br3n> (2016)

CANCER IMMUNOTHERAPY

Multi-pronged tumour attack

A cocktail of antibodies and proteins can wipe out large tumours in mice — even if the tumours are not particularly visible to the immune system.

Immunotherapies unleash immune-system responses against cancer, but generally fail against large, established tumours in mice. Dane



Wittrup and Darrell Irvine at the Massachusetts Institute of Technology in Cambridge and their colleagues cooked up an immunotherapy with four ingredients: a tumour-targeting antibody, the immune-stimulating protein interleukin-2, a vaccine containing fragments of tumour proteins, and an antibody that blocks an immunosuppressive protein called PD-1.

This unleashed antibodies and immune cells called T cells against the tumour; these even attacked tumour proteins that were not targeted directly by the cocktail. The treatment worked against both tumours transplanted into mice and large tumours grown in mice, which are typically less visible than transplanted tumours to the mouse immune system. *Nature Med.* <http://dx.doi.org/10.1038/nm.4200> (2016)

ENVIRONMENTAL SCIENCE

Heat-polluted rivers ranked

The Mississippi and Rhine rivers are two of the most polluted by heat, mainly as a result of warm-water discharge from power plants.

Catherine Raptis at the Swiss Federal Institute of Technology in Zurich and her colleagues studied this 'thermal pollution', which can disrupt aquatic ecosystems. They quantified the thermal emissions from power plants worldwide, and found that the Mississippi River in the United States received the most heat. They then used a global model to

simulate the impact of power plants on river temperatures and found that the Rhine River in Europe (pictured) had the greatest total percentage of thermally polluted waters.

European rivers showed the most extensive thermal pollution, with readings often well above regulatory limits. *Environ. Res. Lett.* 11, 104011 (2016)

ELECTRONICS

Quantum bits wired up

Scientists have demonstrated a device that can interconnect as many as 100 qubits — the units of information future quantum computers will use to perform calculations that are impossible for conventional computers.

The 'quantum socket' — built by Matteo Mariantoni at the University of Waterloo in Canada and his collaborators — is a 3D arrangement of wires that link superconducting loops, each of which encodes a qubit. The device also enables individual qubits to be read and written on using microwave pulses. The team optimized the system to work at the extremely low temperatures required for superconductivity.

The researchers say that the design could be scaled up to as many as 100,000 qubits, enabling complex quantum computations. *Phys. Rev. Appl.* 6, 044010 (2016)

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