RESEARCH HIGHLIGHTS

Spot the difference

Phys. Rev. E 74, 011914 (2006)

Jungle cats have true spots only when they are kittens. As they grow, the spots become rosettes — broken rings in leopards (pictured) and polygons in jaguars. This changing pattern is the latest to be successfully described using Turing models.

Alan Turing suggested in 1952 that biological patterns could be generated by two chemicals diffusing between cells and interacting under the animal's coat. Sy-Sang Liaw of National Chung-Hsing University in Taichung, Taiwan, and his team adjusted parameters in Turing's reaction-diffusion equations to create spots. They then tweaked the parameters so that the patterns resembled the coats of middle-aged big cats. However, no one has found the chemicals, which Turing called morphogens, that might make this model work in mammals.

I. ARNDT/NATUREPL.COM

BIOCHEMISTRY

DNA redesign

J. Am. Chem. Soc. doi:10.1021/ja062548x (2006)

Few would dispute the genius of DNA's chemical design. But some do question why its backbone evolved to be made from chains of five- rather than six-membered rings, when the latter might more easily be derived from common sugars, such as glucose.

Since the idea was first raised in the early 1990s, chemists have suspected that sugars' hexose rings might simply be too bulky to fit into DNA's neat structure. At last, Martin Egli of Vanderbilt University in Nashville, Tennessee, and his colleagues have confirmed this experimentally.

They studied the crystal structure of double-stranded homo-DNA, which has hexose in the backbone in place of DNA's deoxyribose. The result was a "slowly writhing ribbon", the team reports, with irregular twists and steps between base pairs.

PLASMA PHYSICS

Particle vision

Phys. Rev. Lett. 97, 045001 (2006)

Protons act as photographers in a study that could lead to better imaging of compressed plasmas, such as those found in nuclear weapons or in some kinds of proposed fusion power plants.

In principle, energetic proton beams can take ultra-fast snap shots of the plasma, making it possible to study the material's evolution over time. Andrew MacKinnon of the Lawrence Livermore National Laboratory, California, and his colleagues present the first images taken using the technique.

The team created their pictures by firing a powerful laser at a thin foil of tungsten. The laser sent protons flying through an imploding plastic capsule into a detector.

IMMUNOLOGY

A spoonful of sugar

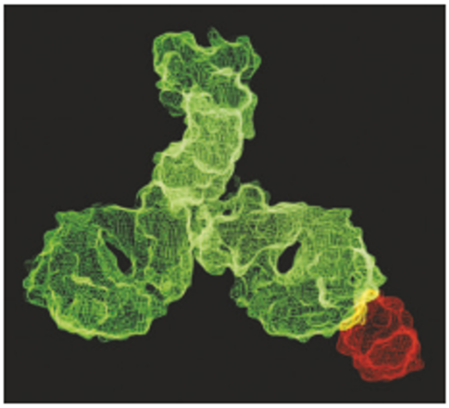
Science 313, 670–673 (2006)

Researchers in the United States have revealed a longstanding paradox in immunology to have sugar-coated roots.

The antibody immunoglobulin G (IgG; pictured green below) plays an important role in activating inflammation to fight invaders but, puzzlingly, it can also soothe inflammatory autoimmune diseases when injected into the bloodstream.

Jeffrey Ravetch of the Rockefeller University, New York, and his colleagues report that IgG switches between these roles by altering the sugars attached to one region of the molecule. IgG is anti-inflammatory when it carries side chains of the sugar sialic acid, but boosts inflammation when the sugar residues are removed. The two forms might bind different receptors on immune cells.

Doctors may be able to artifically boost the fraction of sugary IgG in intravenous gamma globulin, used to treat autoimmune diseases.



J. C. REVY/SPL

GENETICS

On standby

Genome Res. doi:10.1101/gr.5147406 (2006)

The parasite that causes African sleeping sickness, *Trypanosoma brucei*, devotes more than three-quarters of some chromosomes to standby genes, which it recruits to help it evade the host's immune system. This finding, by researchers at the University of Cambridge, UK, stretches current ideas about how chromosomes are organized.

It also reinforces the notion that the search for a vaccine to provoke immunity against *T. brucei* is a fruitless task — the parasite has multiple copies of variant surface glycoprotein genes, which make the proteins that are recognized by the immune system.

Sara Melville and her colleagues show that the regions in which the contingency copies are stored, just below the chromosomal tips, occupy huge tracts of the chromosome in some strains.

CELL BIOLOGY

Gene machine

Proc. Natl Acad. Sci. USA 103, 12027–12032 (2006)

Hotspots that bind multiple regulatory molecules have been identified in the genome of the fruitfly *Drosophila*. These may act as storage sinks or assembly sites for 'machines' with more complex function, researchers in the United States and the Netherlands suggest.

The team studied a short portion of the genome, and noticed that transcription factors — which control the expression of sets of genes — congregated in distinct regions dotted along the section's length.

The binding hotspots may simply store the molecules. Another possibility is that the transcription factors interact to somehow draw together distant parts of the genome so that genes of similar function are close together. This would make their regulation easier to coordinate.

QUANTUM PHYSICS

Go with the grain

Science doi:10.1126/science.1130879 (2006)

When is a solid not a solid? When it's a supersolid — for frozen helium can flow like a superfluid, devoid of viscosity.

Researchers have suspected that the flow of supersolids — in which, like superfluids, the behaviour is dictated by quantum mechanics — is due to defects such as boundaries between helium-ice grains. Now Sébastien Balibar of the Ecole Normale Supérieure in Paris, France, and his colleagues present evidence for that.

They watched the level of solid helium-4 in a tube equilibrate with the reservoir in which the tube stood, indicating mass flow. Only solids full of grain boundaries can do this, suggesting that flow might occur in superfluid films at the grain surfaces.

IMMUNOLOGY

Flick the switch

Cell 126, 375–387 (2006)

The transcription factor NFAT may act as a sort of molecular switch, allowing an organism both to launch an immune attack on a foreign protein, and to suppress a response to a 'self' protein, suggest researchers.

NFAT is known to activate attacking lymphocytes when bound to its partner molecule, AP-1.

Now, Anjana Rao of Harvard Medical School in Boston, Massachusetts, Lin Chen from the University of Colorado, Boulder, and their colleagues have found evidence that NFAT also binds to another transcription factor, FOXP3. FOXP3 controls the function of specialized lymphocytes known as regulatory T cells, which prevent immune responses to the body's own cells and tissues.

NASA/JPL/TEXAS A&M/CORNELL

PLANETARY SCIENCE

Snow on Mars

Astrobiology 6, 439–450 (2006)

The excitement surrounding recent reports of methane in the martian atmosphere centred on the gas's sources, which could conceivably be biological. The flip side to the puzzle is working out where the methane ends up. Understanding how the gas is degraded is important, both in estimating how much is formed and explaining the observed variation in its concentration.

Sushil Atreya of the University of Michigan, Ann Arbor, and his colleagues suggest that electrical discharges in storms and whirlwinds may play an important role. Such discharges could produce large quantities of hydrogen peroxide, a powerful oxidant that will break down organic molecules. They calculate that such a mechanism could create 200 times the hydrogen peroxide produced by light-driven reactions, and may dust the surface of Mars (pictured above) with a peroxide 'snow'.

NEUROBIOLOGY

Brain sprouts

Nature Neurosci. doi:10.1038/nn1747 (2006)

Neuroscientists studying the way that brain cells make new connections face a chicken-and-egg conundrum. Many of the synapses in the cortex are junctions between cell branches known as dendritic spines. But which comes first, the spine or the synapse?

Graham Knott of the University of Lausanne in Switzerland and his colleagues argue that the spine sprouts first. They studied neurons in mice, imaging the appearance and disappearance of spines over 28 days, then using electron microscopy to examine tissue slices in more detail. Of the 57 spines identified, some of the youngest — seen only in the last day of *in vivo* imaging — lacked synapses.

This suggests that the spines grow 'naked', rather than swelling up under synapses that have already formed.

JOURNAL CLUB

Rasmita Raval
University of Liverpool, UK

A surface scientist observes how self-seeking molecules build up asymmetry.

Nobel laureate Jean-Marie Lehn described supramolecular chemistry as 'molecular sociology'. Lehn, who won the 1987 chemistry prize for his work in this field, thus neatly encapsulated the concept of molecules congregating under the influence of multifarious intermolecular forces.

One guiding force, important in biology, is the property of chirality, or 'handedness'. Chiral molecules exist in two mirror-image forms that cannot be superimposed. Some of us try to capture in our work the ease with which biological systems can distinguish chiral molecules or create chirality in reactions.

As a first step, we study how chirality can propagate from molecules to larger, supramolecular structures. Wolf Dieter-Schneider and co-workers at the Swiss Federal Institute of Technology in Lausanne recently revealed a system of impressive complexity (M.-C. Blüm *et al. Angew. Chem. Int. Edn* 44, 5334–5337; 2005).

They used a scanning tunnelling microscope to image the structures formed by rubrene, a chiral molecule, on a gold surface. First it groups into pentagonal rings, resembling complex gearwheels. These wheels then link up into chains or form ten-membered rings. At each stage, intermolecular forces ensure that only molecules of the same chirality assemble together.

It is striking that an essentially simple molecule — rubrene ($C_{42}H_{28}$) is a small, buckled sheet of carbon rings — can create such intricate homochiral architectures spontaneously.

The separation of molecules by chirality is a process that must have emerged at our very beginning, as proteins assembled from chiral amino acids in the primordial soup. Thus we, as molecular sociologists, are mapping the very first steps in the evolution of complex matter.