

RESEARCH HIGHLIGHTS

Put the clocks back

Curr. Biol. doi:10.1016/j.cub.2007.10.025 (2007)

As a quarter of the world's population prepares for the clocks to be changed by one hour during the coming weeks, researchers claim that Daylight Saving Time really does mess you up.

Many countries move their clocks by an hour in spring and autumn to ensure more light later in the day. Studying data on 55,000 people, Till Roenneberg of Ludwig-Maximilian University in Munich and his colleagues found that the times we fall asleep and wake up — at least on free days — advance in line with the changing sunrise. But they do not adjust to the new social time imposed by daylight saving.

Their more detailed study of the sleep and activity patterns of 50 individuals in an eight-week period around each of the two annual time changes showed that all subjects adjusted rapidly to being released from daylight saving time. No-one adjusted completely to the imposition of daylight saving time, but natural early risers did better than night owls.



J. HONMA/GETTY

ENVIRONMENTAL SCIENCE

Poplar science

Proc. Natl Acad. Sci. USA doi:10.1073/pnas.0703276104 (2007)

Poplar trees are well equipped to clean up some of mankind's worst messes — if they are given a little help, that is, say researchers in the United States.

Poplar trees naturally metabolize several common pollutants, most notably trichloroethylene (TCE). By inserting into poplars a rabbit gene that encodes an enzyme — cytochrome P450 2E1 — that breaks down such chemicals in mammals, Sharon Doty at the University of Washington in Seattle and her colleagues significantly increased metabolism of TCE and other contaminants by the plants.

Transgenic poplar cuttings were able to remove 51–91% of the TCE in hydroponic solutions (pictured below) during a one-week period, compared with less than 3% uptake in

the control groups. The modified poplars also remove more benzene and TCE from the air.

CHEMICAL PHYSICS

Pearl jam

Phys. Rev. Lett. **99**, 155501 (2007)

Identical ball bearings shaken up into a random configuration will always leave at least 36% empty space between them. Why, if the packing is random, does it always stop at this value?

After decades of research, there is still no good mathematical explanation of the densest random close-packing (rcp) of spheres. But Randall Kamien and Andrea Liu of the University of Pennsylvania in Philadelphia shed new light on the matter. They propose that rcp is a metastable state — always less stable than crystalline packing, which is 10% denser. On squeezing, it runs out of ways to become still denser precisely at the observed packing fraction.

This picture might unify previous efforts that either quantified the amount of disorder in the rcp state or looked at the jamming of the particles.

CANCER BIOLOGY

Resisting hope

Cancer Cell **12**, 395–402 (2007)

A large-scale screen has identified two potential biomarkers for resistance to the breast-cancer drug trastuzumab.

Better known as Herceptin, this antibody is a powerful treatment for aggressive forms of breast cancer,

but resistance is a major clinical problem.

The screen, conducted by René Bernards of the Netherlands Cancer Institute in Amsterdam and his colleagues, revealed that reduced expression of the tumour-suppressor gene *PTEN* enhances trastuzumab resistance in cultured breast-cancer cells.

PTEN inhibits a pathway mediated by the *PI(3)K* protein, and the researchers also found that cells that overexpress *PI(3)K* were trastuzumab resistant. Furthermore, analysis of 55 patients with breast cancer showed that prognosis was worse in patients who had reduced *PTEN* activity and an overactive *PI(3)K* pathway. The two genes could serve as useful markers for trastuzumab resistance, say the scientists.

CONSERVATION BIOLOGY

No home on the range

Conserv. Biol. doi:10.1111/j.1523-1739.2007.00798.x (2007)

Habitat destruction causes more species extinctions than any other factor, and species with a small geographical range are vulnerable. A new method for estimating the true ranges of forest birds has determined at what point a small range becomes too small.

Stuart Pimm and Grant Harris, then at Duke University in Durham, North Carolina, started with the published ranges of individual species. They trimmed out areas with elevations or types of vegetation that the birds avoid, as well as deforested areas. Referring to official lists of endangered birds, they then determined the range threshold that would correctly predict most birds' status. They suggest that any bird with a range of less than 11,000 square kilometres may be in trouble.



UNIV. WASHINGTON

MATERIALS SCIENCE

Negative index

Nature Mater. doi:10.1038/nmat2033 (2007)

Researchers have engineered the first multilayer semiconductor able to bend incoming light in the opposite direction to all known naturally occurring materials.

Anthony Hoffman at Princeton University in New Jersey and his colleagues assembled the material by superimposing many alternating ultra-thin layers of two types of semiconductor. They found that an infrared beam shone into this at any angle was negatively refracted through the material (see picture, right).

Other such 'metamaterials' comprise alternating layers of metals and semiconductors, but can be grown to only limited thickness.

The researchers say that the new material, which is easy to produce, could improve infrared laser devices such as those used in high-speed communication and medical diagnostics, and lead to improved flat lenses to reduce distortion in telescopes and microscopes.

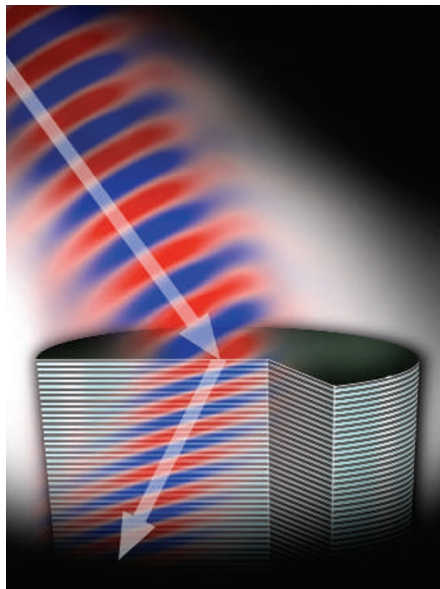
IMMUNOLOGY

Nod in the right direction

Immunity doi:10.1016/j.immuni.2007.08.013 (2007)

When pathogens infect a person, they prime dendritic cells to inform another, more specialized, cell of the immune system — the T cell — to tune itself up for defence. Scientists have now identified a key receptor involved in the transfer of information about a bacterial infection.

Martien Kapsenberg, Esther de Jong and their co-workers at the University of Amsterdam in the Netherlands found that



a receptor called NOD2 in the cytoplasm of dendritic cells binds to fragments of bacterial cell walls. The activated NOD2 then switches on a set of genes that results in the release of several cytokines. The particular profile of cytokines informs T cells to differentiate into Th-17 T-cells, which are tuned to recognize bacteria and organize their destruction.

Viruses, the scientists showed, did not activate the NOD2 sensor.

MICROBIAL GENOMICS

Toxic genes

Science doi:10.1126/science.1147112 (2007)

Microbes share genes between species so frequently that their evolutionary relationships aren't always clear. Edward Rubin of the Department of Energy's Joint Genome Institute in Walnut Creek,

California, and his colleagues say that there are some limits to this horizontal transfer.

Every time a microbe is sequenced, its DNA is transferred by researchers, using plasmids, into the model microbe *Escherichia coli* in what amounts to a large-scale experiment in horizontal transfer. The team took the genes that fail to transfer into *E. coli* from multiple species, and smuggled them into *E. coli* so that they would not be expressed until specifically induced. When induced, the *E. coli* stopped growing, suggesting that the genes were toxic. These transfer-resistant genes could have a future as antibiotics.

QUANTUM PHYSICS

Skipping levels

Nature Phys. doi:10.1038/nphys748 (2007)

Quantum dots are fabricated structures that confine negatively charged electrons and positively charged holes to discrete energy levels.

The rules of quantum mechanics suggest that electrons and holes added to a dot would fill the lowest available energy level before moving up to the next. But Richard Warburton of Heriot-Watt University in Edinburgh, UK, Gabriel Bester at the National Renewable Energy Laboratory in Golden, Colorado, and their colleagues have found an exception to the rule. When five or six additional positively charged holes are crammed into a dot, the researchers find that the newly added holes actually skip an energy level.

The authors say that understanding quantum dots and their unusual behaviour will be important for future applications such as quantum computing.

JOURNAL CLUB

Minhaeng Cho
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A spectroscopist tells how the tools of his trade are revealing quantum effects in biological molecules.

In introductory quantum mechanics, one learns that particles can behave like waves, with each particle having a wavelength inversely proportional to its momentum. I am fascinated by recent work that examines how, at the molecular level, life takes advantage of these wave-like

properties.

The effects aren't visible when moving biomacromolecules are viewed whole, because their large mass means they have a negligibly small 'de Broglie' wavelength. However, atoms and electrons within a molecule — for example, in active sites, where reactions such as catalysis and light-absorption take place — may interact in a wave-like way.

Researchers are thus investigating what role the wavefunctions of these molecular constituents have during biochemical reactions. And if they do interact, over what

distance and for how long does the wavefunctions' phase relationship, or quantum coherence, persist?

Spectroscopists have found evidence for coherences in a few biological systems, thanks to a technique known as multidimensional spectroscopy (A. Nagy *et al. Curr. Opin. Struct. Biol.* **16**, 654–663; 2006). This involves tracking changes in a molecule's configuration over very short timescales with laser pulses that last femtoseconds (10^{-15} s).

Further results reported this year suggest that the energy transfer in a photosynthetic system is wave-like (G. S. Engel

et al. Nature **446**, 782–786; 2007).

For this process, the quantum coherence of the light-excited charges may help the charges search out an efficient pathway through the molecule, by means of a mechanism analogous to a quantum computation.

This observation provokes a question that I look forward to seeing answered. Might biological systems have evolved to use matter's wave-like properties to optimize their efficiency?

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