EDITORS' CHOICE

edited by Gilbert Chin

CHEMISTRY

Water in the Voids

Water frequently plays an important structural role in supramolecular systems, both in solution and in the solid state. For example, water can stabilize the native conformation of biopolymers. In crystals, clusters of several water molecules may fill voids between molecules, thus contributing to the stability of a regular crystal lattice, but the structure of such water clusters is often hard to determine precisely.

Barbour *et al.* have obtained a high-resolution structure of a cobalt cage complex in which the globular cage assemblies are arranged in a staggered manner. The intervening voids are filled with clusters of ten water molecules that adopt an ice-like conformation. Comparison with the structure of the corresponding copper cage shows that the water cluster is sufficiently flexible to respond to small changes in its environment, but that the overall conformation is robust. — JU

Chem. Commun. **2000**, 859 (2000).

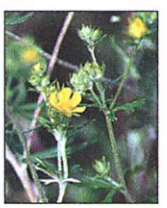
MATERIALS SCIENCE

Making Subsurface Diamonds

Ion beam implantation is used in the fabrication of silicon devices; for example, in the SIMOX process, implanted oxygen ions are used to create buried insulating layers of silicon dioxide.

Heera *et al.* have studied the implantation of carbon ions (C^+) into single crystals of silicon carbide (SiC) at elevated temperatures; high temperatures should help relieve the huge lattice strains caused by the implanted ions. At 300°C, high ion doses formed amorphous carbon, and at 600°C graphite formed. However, at 900°C, small grains of diamond formed (between 2 and 5 nanometers in size), as verified by selected-area electron diffraction. The authors suggest that the tetrahedral coordination of SiC acts as a template for diamond formation. — PDS

Appl. Phys. Lett. **76**, 2847 (2000).

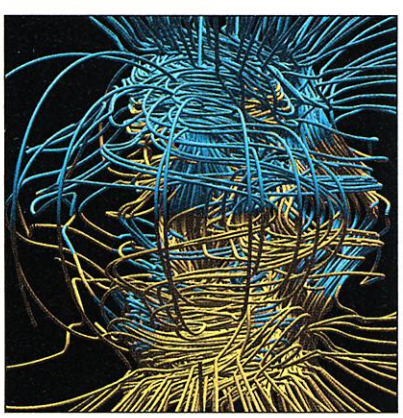


Wild garlic bulbils (top); Apomictic hoary cinquefoil (bottom).

GEOPHYSICS

Modeling Earth's Dynamo

Earth's magnetic field is thought to be generated by fluid motions in the iron-rich, liquid outer core. The geodynamo represents a closed system in which a homogeneous medium of rotating conductive fluid creates electric and magnetic fields without any external forcing or ferromagnetism, unlike mechanical dynamos. Computer models have simulated the geodynamo, but experimental simulation has been challenging because of the large amount of fluid needed and the requirement that the velocity of the fluid motion be high enough to excite a magnetic field (at lower velocities, the trivial zero-field solution of magnetic induction equation holds).



Magnetic field lines in computer simulation of Earth's dynamo.

Gailitis *et al.* have completed a large-scale experiment in the joint Latvian and German Dynamo Facility in Riga which shows the development of a self-excited magnetic field in a rotating fluid. The experiment uses 2 cubic meters of liquid sodium contained in a multiple compartment cylinder. In the central section of the cylinder, sodium is propelled downward in a spiral flow at about 15 meters per second; the backflow travels upward in a coaxial cylinder. When the propeller was rotated at 2150 rpm at 250°C, a self-exciting magnetic field was observed. This observation confirms the theory of liquid metal dynamos and offers a new method for tackling the complexities of Earth's dynamo from a distance. — LR

Phys. Rev. Lett. **84**, 4365 (2000).

ECOLOGY AND EVOLUTION

To Clone or Not to Clone

Most plant species have the capacity to reproduce both by seed and by vegetative means. Seed production is usually, but not always, the result of sexual fertilization; vegetative reproduction is always asexual and can involve specialized structures such as bulbils, or simply new shoots sprouting from roots, standing trunks, or fallen trees. How do plants balance sexual and asexual propagation, and is one mode favored by particular environmental circumstances?

In herbaceous plants that can produce both sexual and asexual seed, reproduction is usually all sexual or all asexual (apomictic). On the other hand, sexual reproduction can coexist more happily with other forms of asexual propagation, even when these forms are very seedlike. Bengtsson and Ceplitis have used an evolutionary model to show that the two forms of reproduction can coexist in a balanced fashion when the relative fitness of the sexual and asexual propagules varies, as is often the case with seeds and nonseeds; whereas, when there is little relative variation in fitness, the system tends to evolve to domination by only one form of reproduction.

Bellingham and Sparrow model the trade-offs between seeding and vegetative resprouting in woody species. Their scheme entails the relative allocation to seeding and resprouting according to frequency and severity of disturbance; in an advance over earlier models, they also scale disturbance regimes according to ecosystem productivity. Their model suggests that allocation to resprouting will be greatest at low levels of severity of disturbance and intermediate frequency of disturbance. — AMS

J. Evol. Biol. **13**, 415 (2000); *Oikos* **89**, 409 (2000).

MICROBIOLOGY

Assessing Antifungals

The activity of a candidate drug is normally determined in vitro with a purified target molecule. But drug effects on a specific target can perturb linked metabolic pathways in surprising and complex ways.

Bammert and Fostel have used DNA microarrays to assess the response of the yeast *Saccharomyces cerevisiae* to previously characterized azole antifungals known to target enzymes

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SOURCE: (BOTTOM) G. GLATZMAIER/ LANL, P. ROBERTS/ UCLA, PITTSBURGH SUPERCOMPUTING CENTER, G. FOSS/ PCS; (TOP LEFT) S. HOLM, MID SWEDEN U.; A. CEPLITIS, LUND U.; (TOP RIGHT) TECHNICAL RESEARCH CENTRE OF FINLAND MULTIMEDIA SYSTEMS.

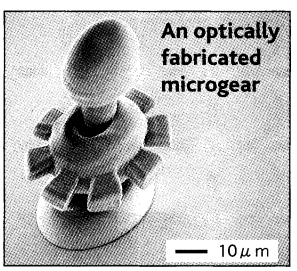
in the ergosterol biosynthetic pathway. In addition to effects on expression of these enzymes, they found what appear to be secondary effects on the transcription of genes involved in mitochondrial function, reaction to oxidative stress, and heme biosynthesis. A structurally distinct imidazole-containing compound produced a similar expression pattern to that of the established azole drugs, suggesting a similar mode of action and offering a high-throughput approach to finding alternatives to circumvent the increasingly serious problem of azole drug resistance among opportunist fungal pathogens, such as *Candida albicans*. — CA

Antimicrob. Agents Chemother. **44**, 1255 (2000).

APPLIED PHYSICS

Sculpting with Single Photons

Photosensitive resins that polymerize (solidify) under exposure to light are useful materials for lithographic patterning processes. Recently, the use of two-photon absorption processes has allowed three-dimensional (3D) structures to be fabricated within the resin. However, the low efficiency of two-photon absorption processes requires the use of expensive, short-pulse lasers.



An optically fabricated microgear

Maruo and Ikuta show that the nonlinear optical response of a photosensitive resin to a weakly absorbed continuous light source localizes polymerization by single-photon absorption and makes it feasible to form movable 3D structures with submicrometer resolution. The high viscosity of the resin removes the need for scaffolding or sacrificial layers to hold the movable parts in place. Only regions of the resin exposed to intensities greater than the threshold intensity are polymerized, and this technique offers a simple route to fabrication of intricate 3D structures. — ISO

Appl. Phys. Lett. **76**, 2656 (2000).

CELL BIOLOGY

Recruiting Folders

Membrane and secretory proteins are imported cotranslationally into an intracellular membrane network known as the endoplasmic reticulum (ER). Here the newly synthesized proteins fold and assemble, but, if the proteins do not fold correctly, they are sequestered in the ER and subsequently degraded. When cells are subject to stress, such as high temperature, the number of proteins misfolding and thus requiring disposal increase, and a cellular quality control mechanism—the unfolded protein response (UPR) pathway—is recruited.

Bertolotti *et al.* examined the UPR pathway in mammalian cell lines and discovered that two ER-resident transmembrane kinases interact reversibly with the folding chaperone BiP. When BiP is particularly busy binding to unfolded protein substrates, the kinases are freed to form activated complexes, which then trigger the synthesis of more ER folding factors. Travers *et al.* used DNA microarrays to look at the relationship between the UPR pathway and ER-associated degradation and found that the two pathways were coordinately regulated, even in unstressed cells. — SMH

Nature Cell Biol. **2**, 326 (2000); *Cell* **101**, 249 (2000).

HIGHLIGHTED IN *SCIENCE*'S SIGNAL TRANSDUCTION KNOWLEDGE ENVIRONMENT

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Counterintuitive Therapy

Stress releases adrenaline, which stimulates heart muscle, which contracts more vigorously. Why, then, are β-blockers (inhibitors of the β-adrenergic signaling pathway) used to treat heart failure?

Marx *et al.* provide an answer by showing that the calcium release channel (also known as the ryanodine receptor) of the cardiac sarcoplasmic reticulum (SR) is phosphorylated by the cAMP-activated protein kinase, which leads to dissociation of the FKBP12.6 subunits, which results in an increased sensitivity to calcium, which triggers opening of the channel. The SR provides the major source of calcium for excitation-contraction coupling in the heart, and cAMP is produced by the adrenergic pathway. In heart failure patients, however, high steady-state phosphorylation of the channel not only blunts the response to calcium but also limits the capacity of exogenous β-agonists to stimulate heart contraction. The authors suggest that diminished phosphatase activity may exist in the pathologic state and thus that β-blockers may act by throttling back the endogenous protein kinase activity and in this fashion diminish diastolic phosphorylation levels. — NG

Cell **101**, 365 (2000).

CREDIT: MARUO AND IKUTA, *APPL. PHYS. LETT.* **76**, 2656 (2000).