

Field-Testing Entanglement

The production of pairs of entangled photons has been demonstrated in the laboratory and over several tens of kilometers in closed optic-fiber systems. However, the use of entangled pairs in practical quantum cryptography applications will require them to be distributed in free space.

Aspelmeyer et al. (p. 621; see the Perspective by **Rarity**) present results of distributing entangled pairs of photons across the Danube under typical atmospheric conditions. ✂

Stable Electrines

When sodium is dissolved in liquid ammonia, an intense blue solution forms that results from a solvated electron. Such chemically trapped electrons, which act as anions, can also form in solid materials called electrines. Most of these materials are quite unstable but have interesting potential uses, such as cold cathode sources in devices. **Matsui et al.** (p. 626; see the Perspective by **Dye**) now report that reaction of the insulating compound $12\text{CaO}\cdot 7\text{Al}_2\text{O}_3$ with calcium replaces the caged O_2^- anion with electrons. The resulting material is air-stable and has appreciable electrical conductivity up to 100 Siemens per centimeter.

Good Mutation, Bad Mutation

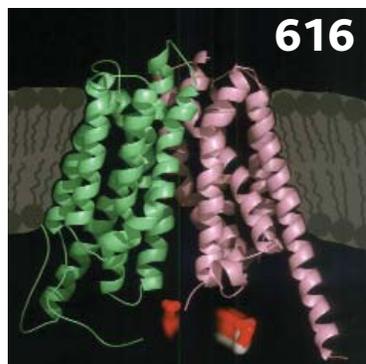
Among a few human genes, there has long been evidence for a significant difference in specific mutations between males and females and an increase in mutation with paternal age. The gene for fibroblast growth factor receptor 2, *FGFR2*, encodes a receptor tyrosine kinase protein, and mutation of position 755 of this gene frequently results in offspring with conditions such as Apert syndrome, which causes craniofacial and limb malformations. **Goriely et al.** (p. 643; see the Perspective by **Crow**) now examine the prevalence of *FGFR2* mutations in sperm and show the age dependence of this event. The mutations occur infrequently but become enriched through cellular selection within the testis. Hence, the mutation that occurs is one that is good for the spermatogonial cell in which it arises, but bad for any resulting offspring.

A Probabilistic Approach to Turbulence

Numerical modeling of turbulence with the standard conservation-of-momentum equation (the Navier-Stokes equation) often requires numerous and sometimes ad hoc assumptions. The prob-

Snap Shot of Transporters

The question of how membrane proteins transported small, hydrophilic molecules across the hydrophobic lipid bilayer was assumed to have been settled long ago in favor of a central binding site that opened alternately to the cytoplasm and to the external space. Still, a close-up picture of how secondary transport occurs, which couples uphill pumping of the desired molecule to downhill flow of another, has been lacking (see the Perspective by **Locher et al.**). **Abramson et al.** (p. 610; see the cover) and **Huang et al.** (p. 616) provide snapshots of two such membrane proteins—lactose permease and the glycerol-3-phosphate transporter, respectively—from the class known as major facilitators. Both are components of *Escherichia coli*: One uses a proton gradient to drive



inward movement of a single proton for each lactose, and the other allows inorganic phosphate to flow outward in exchange for glycerol-3-phosphate. Both have been captured with their binding sites facing into the cytoplasm, and, in the case of lac permease, with a sugar substrate bound.

lems encountered include the interaction of eddies of different sizes, including some that are smaller than the spatial grid used in the models. **Chen et al.** (p. 633; see the Perspective by **Benzi**) take an approach to turbulence rooted in statistical physics (the extended Boltzmann equation), in which a distribution function is derived for numerous particles in the flow, that can greatly ease some of the computation difficulties.

Top-Down Weathercasting

Accurate weather forecasts are difficult to make more than a few days in advance because tropospheric dynamics are complicated and chaotic. Stratospheric circulation data may provide a better handle on long-term trends. **Baldwin et al.** (p. 636) report that the time scale of the Arctic Oscillation (AO), which is associated with variations in wintertime high- to mid-northern latitude weather, appears to be related to stratospheric circulation anomalies that affect surface weather by modulating waves along the top of the troposphere (the tropopause region). The predictability of the AO can be improved by using the lowermost stratospheric circulation instead of that of the troposphere, as is done now.

Innate Adaptations

Viruses, bacteria, and fungi express broadly distinct molecular patterns that activate innate arms of the immune system. Most prominently, the Toll-like receptors (TLR) use these pathogen-specific cues to elicit intracellular signals that can be either dependent or independent of the Toll/IL-1 Receptor (TIR) domain-containing adaptor proteins, MyD88 and TIRAP. **Yamamoto et al.** (p. 640) define a third TIR adaptor, TRIF, as critical for MyD88-independent signaling by particular TLRs. Cells deficient in TRIF failed to initiate either the interferon regulatory factor-3 or NF- κ B pathways in response to TLR3 or TLR4 activation, but responded normally to activation of other TLR family members. ✂

Easy Twisting

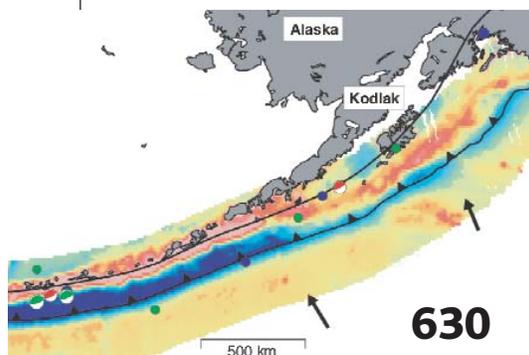
Because of their weak intermolecular interactions and their ability to respond to electric fields, liquid crystals can be easily switched between orientation states and thus are commonly used in display technologies and other optical devices. However, clever tricks are often needed to control the reorientation, and the required driving force or voltages could be reduced.



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Luk and Abbott (p. 623) show that by altering the oxidation state of ferrocene-decorated electrodes, they can significantly reduce the switching voltage. They also control the out-of-plane orientations through a dielectric coupling of the liquid crystal with the electrical double layer that forms as the ferrocene oxidizes.



The Negatives of Gravity Anomalies

The largest earthquakes of the 20th century, 1960 Chile (moment magnitude $M_w = 9.5$), 1964 Alaska ($M_w = 9.2$), and 1952 Kamchatka ($M_w = 9.0$), occurred along subduction zones. **Song and Simons** (p. 630) analyzed subduction-zone gravity data (which reveals variations in density). Comparison with seismic data shows that great earthquakes tend to occur where the gravity anomalies parallel to the ocean trench (which must be separated from the much stronger anomalies in the normal direction) are very negative.

These negative gravity anomalies are caused by higher shear tractions along the plate interface, which create greater stick-slip behavior and thus great earthquakes.

Prunin' and Reelin

Reelin plays a significant role during cortical development, but it continues to be expressed after its critical function in directing development of the brain's architecture is over. **Quattrocchi et al.** (p. 649) now analyze what other processes may involve reelin. Reelin is expressed in mouse neuromuscular junctions in both motor axons and muscle fibers. During development, the initially exuberant innervations of muscle fibers are normally pruned to minimize multiple innervations. In mice lacking reelin, this pruning process is deficient. Reelin function at the neuromuscular junction seems to be through its endogenous protease function, rather than through the Disabled1 signaling pathway that mediates its role in brain development.

Understanding Ethylene

The development of tools that help in the functional characterization of genes is important as genomic advances continue. **Alonso et al.** (p. 653) developed a genome-wide collection of sequence-indexed insertion mutants in the model plant *Arabidopsis thaliana*. Nearly two-thirds of the total complement of *Arabidopsis* genes were individually knocked out by generating more than 225,000 insertional mutations with *Agrobacterium*-transferred DNA. Integration did not occur randomly at the chromosome or gene level. The authors identified new genes that are involved in responses to the plant hormone ethylene.

Find Your Partners

The yeast two-hybrid method is widely used as a screen for interactions of mammalian proteins, but yeast cells can differ from mammalian cells in critical ways. For example, yeast cells maintain very low concentrations of nitric oxide (NO), which is known to have regulatory functions in mammalian cells. **Matsumoto et al.** (p. 657) developed a modified two-hybrid screen that allowed them to hunt for NO-dependent protein interactions. They screened for partners that bound procaspase-3, a molecule that contributes to signals that cause cell death and whose activity is regulated by S-nitrosylation. Acid sphingomyelinase (ASM) was one of several proteins that showed NO-dependent association with procaspase-3. Endogenous ASM interacted with caspase-3 in a NO-dependent manner in cultured mammalian cells and inhibited activation of the protease. Thus, like phosphorylation, covalent modification of proteins by S-nitrosylation can acutely regulate cellular activity by altering interactions of proteins in signaling complexes.