PHYSIOLOGY

Filling Up on Fats

Although weighing only 30 g, semipalmated sandpipers are impressive endurance athletes—each summer these migrant shorebirds migrate from their breeding grounds in the Arctic to their winter home in South America, with one leg being a nonstop, 3-day transoceanic journey of 4500 km. Before embarking on this flight, they spend 2 weeks on the mudflats of the Bay of Fundy, Canada, where they feed voraciously on a burrowing shrimp (*Corophium*). Intriguingly, *Corophium* is unusually rich in *n*-3 polyunsaturated fatty acids (PUFA), which form a class of phospholipids that increases the fluidity of cell membranes and may facilitate fatty acid mobilization.

Because burning fats is the means by which migrant birds typically fuel long flights, Maillet and Weber hypothesized that the sandpipers use the dietary PUFA acquired during their stopover as an endurance-enhancing substance to prepare their flight muscles for migration. To investigate this, they examined the composition and distribution of fatty acids in the birds at various stages of fat loading. In less than 2 weeks, dietary *n*-3 PUFA was both incorporated into flight muscle cell membranes and stored within fat depots; in the latter tissues, much of the PUFA had been converted to monounsaturated fatty acids, as a more readily oxidized, energy-dense form of fuel. — PAK

J. Exp. Biol. **209**, 2686 (2006).

VIROLOGY

Portable Energy Supplements

In light of the importance of photosystem II (PSII) for photosynthetic cyanobacteria, one might have thought, naïvely as it turns out, that tampering with PSII proteins would be either too hazardous or merely ineffectual. Instead, a bewildering genetic diversity exists, as revealed by Sullivan *et al.* from their identification and sequencing of *psbA* and *psbD* genes (which encode core PSII proteins) from 20 strains of the abundant cyanobacteria *Synechococcus* and *Prochlorococcus* and from 33 cyanophage isolates—primarily the narrow–host-range podoviruses and the broad–host-range myoviruses. Phylogenetic analyses support a history of phage-to-host, host-to-phage, and phage-to-phage exchanges, in addition to intragenic recombination. Carrying a copy of *psbA* may be advantageous for a phage in supplementing the labile host PsbA protein; many of the broad–host-range cyanophages also carry *psbD*, which may expand their capabilities in augmenting host energy production. — GJC

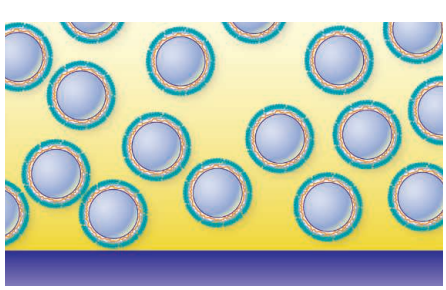
PLoS Biol. **4**, e234 (2006).

CHEMISTRY

A Reservoir to Reduce Rust

Many coatings that effectively impede the corrosion of metal surfaces contain chromates, which pose a substantial toxicity hazard. Conversely, passive polymer coatings can be damaged, and thus allow corrosive species to penetrate through to the metal surface. A polymer coating can be augmented using sol-gel techniques to add a thin organic or hybrid film that acts as a second barrier and also improves adhesion. Such layers are even more effective when doped with active corrosion inhibitors, but, over time, the inhibitors can weaken the structural integrity of the film. An appealing solution would be to use nanometer-scale reservoirs that bind corrosion inhibitors and release them in active form upon changes in pH, light, or humidity.

Shchukin *et al.* used layer-by-layer deposition to prepare reservoirs with pH-responsive storage and release characteristics for aluminum surface protection. They coated silica nanoparticles with alternating poly(ethylene imine) and poly(styrene sulfonate) layers that entrapped a benzotriazole inhibitor and rendered it compatible with a zirconia/silica-based sol-gel coating. Electrochemical impedance measurements revealed that the corrosion resistance of films loaded with these reservoirs was comparable to that of the undoped sol-gel film and superior to that of sol-gel films treated with free benzotriazole. When the coatings were damaged with a microneedle before the measurements, the reservoir-doped films evinced a self-healing capacity and much longer-lasting corrosion resistance. — MSL



Incorporation of inhibitory reservoirs.

Adv. Mater. **18**, 1672 (2006).

PHYSICS

Atoms Modeling Electrons

Correlated electron systems such as Mott insulators and high-temperature superconductors are generally difficult to model, primarily because of the mathematical challenge of accurately accounting for interactions between neighboring electrons. Moreover, experimental approaches toward uncovering the underlying physics of such systems are hindered by structural, compositional, and chemical boundaries that limit the parameter space over which the materials can be prepared.

Trebst *et al.* present an artificial model system that uses cold atoms confined to an optical lattice to mimic the behavior of correlated electron systems. Their numerical simulations controllably vary the depth and geometry of the confining potential lattice, as well as the loading of each lattice site with cold atoms of appropriately chosen properties such as spin. By doing so, they are able to reproduce signature properties of high-temperature superconductors, such

CREDITS (TOP TO BOTTOM): FERRIN 2004; S. MAUTNER; ADAPTED FROM *ADV. MATER.* **18**, 1672 (2006)

as resonating valence bonds and d-wave symmetry. The authors suggest that the technique should be further applicable to other correlated electron systems as a tunable test bed. — ISO

Phys. Rev. Lett. **96**, 250402 (2006).

ECOLOGY/EVOLUTION

Wet Forests in Dry Lands

Coastal mountains in many parts of the world are obscured by clouds that are produced as humid onshore winds are pushed upward. On arid coasts, this can produce upland islands of mesic ecosystems sustained by "horizontal" or "occult" precipitation – the interception of cloud droplets by the vegetation. The stature and three-dimensional complexity of the vegetation would therefore be expected to have a direct influence on the amount of precipitation in the ecosystem. Hildebrandt and

The Dhofar cloud forest.

Eltahir have measured the occult precipitation (which was twice the amount of rainfall) in the seasonal cloud forests of the Dhofar Mountains of Oman and find that the immersion of the forest within the clouds expands the growing season from 3 months to half a year. They went on to model the climate-vegetation interactions and feedbacks; these dynamic simulations suggest that, for this system, any degradation of the forest canopy would lead to a reduction in precipitation sufficient to cut the feedback loop and cause a permanent conversion to grassland. — AMS

Geophys. Res. Lett. **33**, 10.1029/2006GL026022 (2006).

CHEMISTRY

Costs of Cyclobutadiene

Chemists attribute much of the unusual stability of benzene and related aromatic hydrocarbons to the delocalized network of π-orbital electrons numbering 2 more than a multiple of 4. By the same logic, carbon rings with a π-electron count divisible by 4 ought to be especially unstable. In the case of the simplest such anti-aromatic compound, cyclobutadiene (C_4H_4), this electronic instability is compounded by the strain inherent in the square bonding geometry of the carbons. Nonetheless, this small square ring and a number of its derivatives have been synthesized and characterized. The thermodynamic cost of its formation from the elements, however, has eluded quantification without the help of theoretical modeling.

Fattahi *et al.* present a fully experimental derivation of the heat of formation of cyclobutadiene from carbon and hydrogen. They begin by gas-phase ionization of 3-chlorocyclobutene, which leads to loss of Cl and formation of the cyclobutenyl cation. Deprotonation of this compound yields cyclobutadiene. By adding various bases to bracket the enthalpy of this deprotonation step, as well as electron donors to bracket the electron affinity of the cation, they determine the reaction enthalpy for cyclobutene dehydrogenation to cyclobutadiene. They then add the cyclobutene heat of formation (known from calorimetry) to derive a cyclobutadiene heat of formation of 429 ± 16 kJ/mol, in good agreement with accompanying theoretical computations. — JSY

Angew. Chem. Int. Ed. **45**, 10.1002/anie.200600839 (2006).

IMMUNOLOGY

Outnumbered, But Not Outgunned

During an immune response, cytotoxic T lymphocytes (CTLs) make contact with other cells in two ways: first, in the form of a stimulatory synapse, which requires prolonged interaction with an antigen-presenting cell or target cell to turn on effector functions in the CTL; and second, in a brisk-acting "lytic" synapse in which the intracellular weapons needed for the destruction of infected or transformed cells are rapidly brought to the contact site.

In order to explore the spatial and temporal relation of these functionally distinct kinds of synapse, Weidemann *et al.* mapped the kinetics of CTL–target cell interaction with the signatures of killing and CTL activation. When a CTL was seen to undertake a high-affinity encounter with an antigen-bearing target cell, a high threshold stimulatory synapse was formed and maintained, even after the target cell had been lysed. This suggests that sustained activation via prolonged contact with a relevant antigen is important for ongoing cytolytic activity. A CTL could simultaneously form short-lived lytic synapses with several other cells, but showed considerably less regard for antigen specificity in these interactions. Coordinating antigen-dependent activation with the rapid and simultaneous killing of multiple cells may help CTLs deal effectively with potentially overwhelming numbers of targets. — SJS

Proc. Natl. Acad. Sci. U.S.A. **103**, 10985 (2006).

CREDIT: ANKE HILDEBRANDT