

## ECOLOGY

### A Quick Sniff and She's Off

Insects often use their sense of smell to locate food; some carry disease-causing pathogens, and in general, being infected makes an organism smell more strongly. Several pathogens have evolved to exploit these odor-tracking behaviors to entrain their life cycles in advantageous ways. Mauck *et al.* show that infection by cucumber mosaic virus increases the amount of aphid-attracting volatiles emitted by their plant hosts. Despite the delectable odors, virus infection makes the host plant less palatable, and consequently the aphids don't feed for long. For cucumber mosaic virus, fickle visitors are not a problem because it happens to be a nonpersistent virus—one sip of infected sap is enough to imbibe an infectious dose. The repellent host hastens the vector's departure and the transmission of the virus to a new host. In contrast, persistent viruses, such as barley yellow dwarf virus, induce both sweet odors and juicy fruit, which encourage their aphid vectors to prolong their visits. This allows the virus to complete a lengthy replicative cycle within the insect, after which onward transmission occurs. — CA

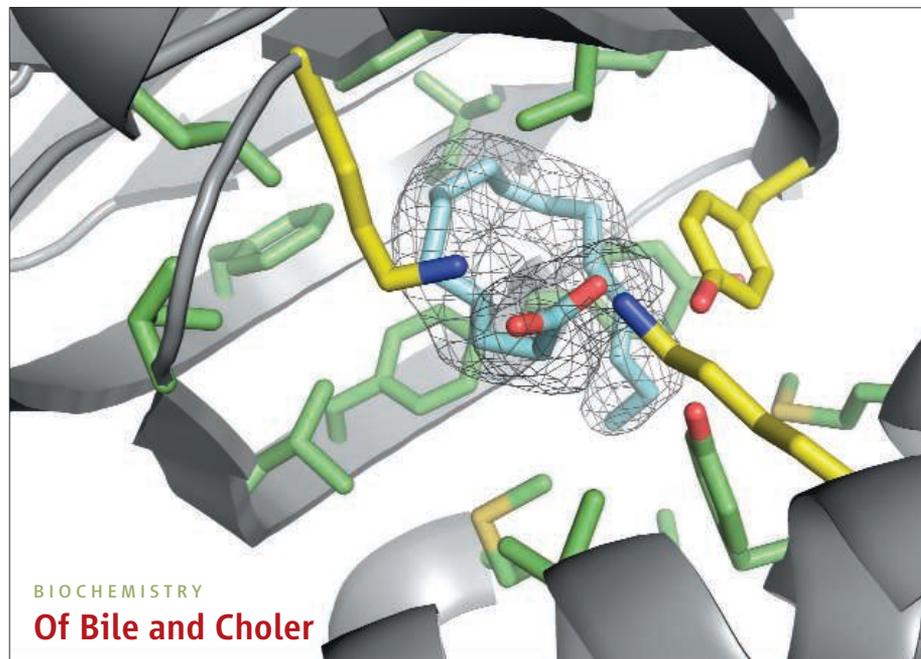
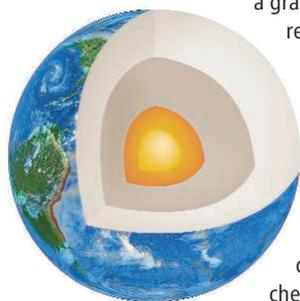
*Proc. Natl. Acad. Sci. U.S.A.* **107**, 10.1073/pnas.0907191107 (2010).

## GEOPHYSICS

### Seismic Spinning

Some boundary layers in Earth's interior (including the crust/mantle and core/mantle boundaries) are often identified by sharp seismic discontinuities, whereas finer-scale interlayer structures require constraints from geochemistry and mineral physics to complement less obvious, or sometimes completely absent, seismological signals. For example, because some mantle minerals gradually change in structure or chemical composition with depth (and the associated pressure and temperature shifts), seismic velocities

from these regions also vary along a gradient. Based on recent elasticity measurements of the abundant lower mantle mineral ferropericline, Cammarano *et al.* computed seismic models that identify one such broad chemical or thermal gra-



## BIOCHEMISTRY

### Of Bile and Cholera

*Vibrio cholerae* is the Gram-negative bacterium that causes cholera, a disease that afflicts multitudes of people who lack access to a source of disinfected drinking water. When the bacterium enters the host's intestine, the master virulence regulator ToxT activates the expression of other virulence factors and cholera toxin. ToxT is a member of the AraC family of transcription factors; some of these regulate carbon metabolism (AraC) as dimers, whereas the stress response regulators (SoxS, Rob, and MarA) act as monomers. The promoters to which ToxT binds can be found singly and as inverted repeats. Lowden *et al.* have solved the ToxT crystal structure. It has an N-terminal regulatory domain and a C-terminal DNA binding domain that shares structural features with AraC, MarA, and Rob. ToxT is a monomer in the crystal, but helix  $\alpha 3$  is analogous to the helix that mediates coiled-coil dimerization in AraC. The N-terminal domain contains a hydrophobic pocket that in the crystal is occupied by *cis*-palmitoleate (slate blue), and the activity of ToxT is known to be inhibited by components of bile. Palmitoleate binds to a lysine residue in the C-terminal domain and locks ToxT into a closed conformation that is not oriented to bind DNA and would also prevent dimerization. This conformation probably occurs in the lumen of the intestine where bile acids are present, yet in the mucus of the intestine, ToxT might be able to reorient into a conformation that can bind DNA and dimerize. — VV

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dient in the mid-lower mantle. The presence of this transition, which accounts for the preferential stability of high spin states of ferrous iron ( $\text{Fe}^{2+}$ ) in ferropericline, suggests that the viscosity and thermal conductivity of the mid-mantle may be different than previously thought. Specifically, recycled crustal material driven down into the mantle by subduction zones could flatten or broaden at this depth, which would affect the extent and dynamics of mantle mixing throughout Earth history. — NW

*Geophys. Res. Lett.* **37**, L03308 (2010).

## CHEMISTRY

### Order at a Distance

The classic view of crystallization is the addition of atoms, colloids, or other small segments to a growing ordered crystal, where anisotropies in the growth are caused by differences in the thermodynamic or kinetic influences at different crystal faces. For some systems, such as metal oxides, nanocrystals are believed to form ordered aggregates through a fusion process. It has been proposed that these

primary crystals form a crystallographically aligned aggregate, even though each crystal unit is separated from the other by solvent. Yuwono *et al.* observe this process in the slow growth of crystals in solutions of ferrihydrite nanoparticles, using cryogenic transmission electron microscopy to preserve the structure of the sample at various ages. They observe the slow aggregation of primary crystals, with the formation of rodlike assemblies, which they speculate are composed of oriented goethite nanocrystals. They also note occasional twinned aggregates in which the angle at the junction matches that observed in a twinned goethite crystal. Under the beam intensity required for high-resolution imaging, the water between the crystals sublimates and the authors are able to see the crystallographic alignment of each of the primary units. — MSL

*J. Am. Chem. Soc.* **132**, 10.1021/ja909769a (2010).

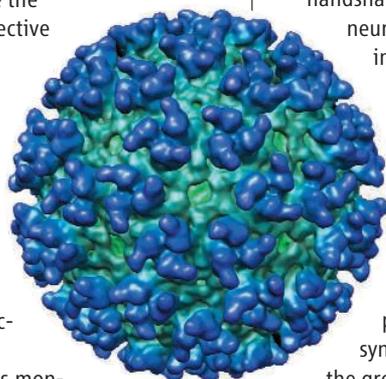
#### IMMUNOLOGY

### A Protective Shell

Originally carried primarily by forest mosquitoes living between the Tropics of Cancer and Capricorn, Chikungunya virus has become a growing public health threat in Africa, Asia, and parts of Europe. Infection is followed by fever, headache, and nausea and then by debilitating peripheral joint pain that can persist for months or even years. This alphavirus has adapted to urban vectors, such as the Asian tiger mosquito *Aedes albopictus*, which enhances its potential to spread worldwide. Akahata *et al.* describe the development of a protective vaccine by expressing the Chikungunya virus structural proteins in eukaryotic cells and purifying the resultant virus-like particles, which resemble the virus structurally but lack the encapsulated genomic RNA necessary for replication.

Immunization of rhesus monkeys with the viruslike particles protected them against subsequent challenge with live virus, and the protective effect was shown to be mediated by the vaccine-induced humoral immune response (IgG). Previous attempts at making vaccines for Chikungunya virus have shown limited efficacy; hence these findings offer a step forward in the development of a protective vaccine for humans. — KLM

*Nat. Med.* **16**, 10.1038/nm.2105 (2010).



#### MATERIALS SCIENCE

### Cations Minding the Gap

The band gap of a material—the energy threshold for excitation of electrons and thus the major determinant of properties ranging from color to conductivity—is usually set by the crystal structure of the constituent atoms or ions. It could prove useful for a variety of applications to be able to vary band gaps associated with a particular type of bulk framework in a systematic way, much as it is currently possible to do at the nanometer scale by tuning the size of dispersed individual particles. Qian *et al.* studied the assembly of the arsenic-based Zintl cluster  $As_7^{3-}$  with various cations and examined the effects of charge transfer between cation and anion. The cations included  $Cs^+$ , cryptand-sequestered  $K^+$  and  $Rb^+$ , and  $Au^+$ . The band gap, as determined from optical measurements, could be varied from 1.1 to 2.1 electron volts. Density functional calculations revealed that the changes mainly arose from variation in the positions of the lowest unoccupied orbitals, principally affected by the cations, although some changes were associated with charge transfer induced by the cations that led to covalent links between the clusters. — PDS

*ACS Nano* **4**, 235 (2010).

#### NEUROSCIENCE

### Signal Effectors

Neurons convey information in part by transmission of small molecules such as  $\gamma$ -aminobutyric acid (GABA) across gaps termed synapses. The handshake between pre- and postsynaptic

neurons that allows synapses to develop in the central nervous system is bolstered by surrounding astrocytes. Studying hippocampal neurons and astrocytes from embryonic rats, Hughes *et al.* show that the signals used by astrocytes to promote GABAergic (inhibitory) neuron development are different than those already shown to promote glutamatergic (excitatory) synapses. These signals encourage the growth of axons, but not dendrites, of the GABAergic neurons and seem not to affect the neurite length of glutamatergic neurons. Both the number and the density of synapses in GABAergic neurons are pumped up by signals from astrocytes. Although some potential mediating factors, such as the thrombospondins, have been excluded in this work, the relevant signaling proteins secreted by these astrocytes remain at the moment incognito. — PJH

*Mol. Cell. Neurosci.* **43**, 136 (2010).