Illustration of *Vibrio cholerae*.

MICROBIOLOGY

Self-Puncturing Pathogens

To interact (often adversely) with the outside world, bacteria have several types of mechanism for transporting toxins and enzymes across complex cell envelopes. A recently described Type 6 secretion system (T6SS) has been added to the list, and its highly conserved gene clusters are found in numerous Gram-negative organisms, including strains of *Vibrio cholerae*. Pukatzki *et al.* used the social amoeba *Dictyostelium discoideum* as an experimental host in which to test T6SS mutants of this pathogen. Four proteins are needed to assemble a complete apparatus: The authors speculate that initially trimers of VgrG proteins penetrate the membrane to form a channel, and then units of a ringlike substrate, Hcp, are exported and stack up to form a hollow needle that facilitates its own transport. Remarkably, the components have homologs in the tail-spike membrane-puncturing device of the T4 bacteriophage. After export, the VgrG-1 component promotes pathogenesis by cross-linking host actin. — CA

Proc. Natl. Acad. Sci. U.S.A. **104**, 15508 (2007).

CHEMISTRY

Gently Excising Nitrogen

Removal of nitrogen from heterocyclic aromatic components of crude petroleum is performed at enormous scale through high-temperature catalytic hydrogenolysis, with the aim of minimizing generation of nitrogen oxides during combustion. However, the mechanistic details of this process are only loosely understood, and there has been little headway in finding well-characterized homogeneous systems that excise aromatic nitrogen directly. Fout *et al.* have now discovered that a titanium carbene complex cleanly and selectively swaps its carbon for the nitrogen in pyridine on treatment with trimethylsilyl chloride. The homogeneous reaction proceeds at 65°C to yield a substituted benzene and Ti imido complex as products. The authors propose a mechanism of electrocyclic rearrangements initiated by N-silylation; substituting a protic acid for the silyl reagent failed to drive the swap. The titanium reagent is recoverable by alkylation after donation of its imido group to high-valent molybdenum, which leads to an easily separable insoluble Mo nitride species. — JSY

J. Am. Chem. Soc. **129**, 10.1021/ja075326n (2007).

CROP SCIENCE

A Boost from Wild Wheat

Nitrification, a microbial process that generates nitrate in the rhizosphere through the biological oxidation of ammonia with oxygen, deleteriously affects the availability of soil nitrogen to plants and is a major agricultural concern, as approximately one-third of fertilizer nitrogen is lost in this manner. Subbarao *et al*. report a potentially powerful strategy to reduce nitrification in cultivated wheat. A wild relative of wheat, *Leymus racemosus*, releases biological nitrification inhibitors that dramatically reduce nitrification in the root rhizosphere in comparison to domesticated wheat. When a *Leymus* chromosome containing the relevant gene(s) was introduced into wheat, biological nitrification inhibitors were also produced, and productivity increased. New strains of wheat can now be bred to transfer this trait stably into the domesticated wheat genome. — LMZ

Plant Soil 10.1007/s11104-007-9360-z (2007).

CLIMATE SCIENCE

More Water in the Air

Anthropogenic influence on the climate system is manifest not only in the rise of near-surface tropospheric temperatures (the effect people experience most directly), but also in the hydrological cycle. Recent observational studies have shown that continental river runoff, zonal-mean rainfall, and surface humidity all display trends that can be ascribed to the results of human activity, primarily the temperature rise caused by increasing concentrations of atmospheric greenhouse gases. Another atmospheric attribute of great importance, the total amount of atmospheric water vapor, W, has been more difficult to study. Santer *et al.* use data from the satellite-based Special Sensor Microwave Imager (SSM/I) to show that the total atmospheric moisture content over the oceans has increased by 0.41 kg/m^2 per decade since 1988. They then use results from 22 different climate models to show that the size of the observed increase in W, and the pattern of changes that it has displayed over that interval, can be explained only if the primary cause is the human-induced increases in greenhouse gases in the atmosphere. In this way, they show that the "fingerprint" of anthropogenic impact can be seen in the moisture content of Earth's atmosphere, and that the increase is consistent with theory, thereby strengthening confidence both in those models and in how well the mechanics of climate are understood. — HJS

Proc. Natl. Acad. Sci. U.S.A. **104**, 15248 (2007).

CHEMISTRY

Where Water Holds Still

When polar molecules dissolve in water, the solvent's accommodation of groups that resemble its own structure (such as hydroxyls and amines) is unsurprising. Less clear is how the network of hydrogen-bonded H_2O molecules accommodates

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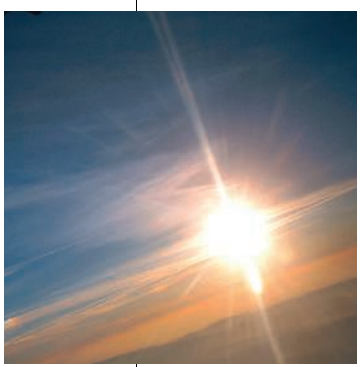
a solute's nonpolar alkyl components. Rezus and Bakker explored this question through ultrafast vibrational anisotropy measurements of nitrogen-based aqueous solutes with varying degrees of N-alkylation. After tagging water molecules in the solvation shell with low-level vibrational excitation, the authors used the femtosecond time resolution of a laser probe to monitor rotational mobilities of these molecules before diffusional exchange with the surrounding bulk region. The data revealed two distinct reorientation rates, and the population of more slowly rotating water molecules steadily increased as the number of hydrophobic methyl groups on the solute rose. A correlation of four immobilized OH groups with each methyl group suggests a strong disruption of the solvent dynamics in the hydrophobic vicinity, though the authors emphasize that the structure in which the waters are briefly locked remains disordered, rather than ice-like. — JSY

Phys. Rev. Lett. **99**, 148301 (2007).



MATERIALS SCIENCE

Wiry Approaches to Solar Harvesting

Silicon wire arrays could in principle provide a cost-effective alternative to high-performance single-crystal Si wafers. Wires grown via vapor-liquid-solid methods are also single crystals and avoid problems of recombination at grain boundaries. Moreover, the wire geometry facilitates carrier collection and fosters carrier generation in the space charge region deep within the array. Two studies have explored the use of Si wire arrays in photoelectrochemical cells. Goodey *et al*. grew p-type Si nanowire (NW) arrays either from a base of gold-capped cobalt NWs in anodic aluminum oxide membranes, or from a gold-coated p-type Si (111) substrate. On array immersion in dry acetonitrile solutions of Ru(2,2′-bipyridyl)$_3^{2+}$ and Hg/Xe arc lamp illumination, cyclic voltammetry showed a shift in reduction wave peaks to more positive voltages relative to a Pt disk electrode. Photocurrent densities were about twice that of planar p-type Si. Maiolo *et al*. grew single-crystalline Si wires with diameters of ~1 μm using a gold catalyst on an n-type Si(111) substrate with a silicon oxide buffer layer. In a 1,1′-dimethylferrocene redox system in methanol, illumination with simulated sunlight produced a short-circuit photocurrent density of 2.2 mA/cm^2. In both systems, better protection of the wire surfaces may improve performance. — PDS

J. Am. Chem. Soc. **129**, 10.1021/ja073125d; 10.1021/ja074897c (2007).

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<< Serpins Save Cells

Biologically active proteases are held in check in part by a family of peptidase inhibitors known as serpins. Most serpins are secreted, but some are intracellular proteins implicated in regulating lysosomal proteases. Luke *et al*. found that in the worm *Caenorhabditis elegans*, loss of the intracellular serpin SRP-6 caused animals to become highly sensitive to hypo-osmotic stress and to die as a result of necrotic cell death. This effect appeared to require inhibition of cysteine peptidases because survival of the knockout worms was improved in mutant animals engineered to express wild-type SRP-6 but not in animals that expressed a mutant serpin that lacked inhibitory activity. Calcium mobilization appeared to be required for cell death because SRP-6 knockout animals lacking the ryanodine receptor, the inositol-1,4,5-trisphosphate receptor, or the Ca^{2+}-binding protein calreticulin showed suppression of cell death. Lysosome-like gut granules also appeared to be required, because death was suppressed in animals lacking a guanosine triphosphatase required for formation of these acidic granules. Animals lacking SRP-6 were also more susceptible than wild-type animals to heat shock, hypoxia, or hyperoxia. The authors argue that the common effects of serpins on these stimuli may indicate that there is a central necrotic death mechanism that can be regulated by serpins. If so, serpins could act as an antidote to cells undergoing, for example, hypoxic stress during heart attacks. Such a prosurvival function of intracellular serpins might also explain why increased expression of some serpin family members portends a poor prognosis in various human cancers. — LBR

Cell **130**, 1108 (2007).

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