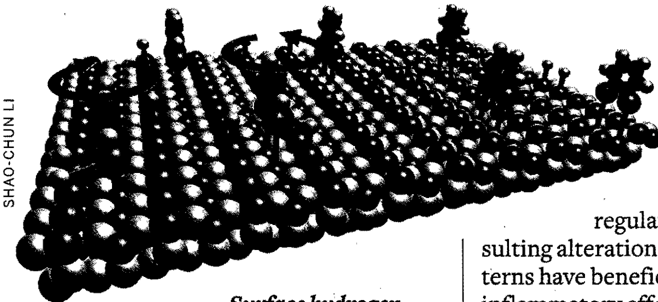
TOO MUCH CARBON DIOXIDE LIMITS PLANTS

Earth's atmospheric carbon dioxide concentration is expected to rise substantially from the current level of about 390 ppm to as much as 970 ppm by 2100, according to the Intergovernmental Panel on Climate Change. Global warming aside, the CO_2 increase is expected to benefit plant growth and food production by facilitating photosynthesis. But this positive effect has a limit—too much CO_2 over time inhibits assimilation of nitrate (NO_3^-) into proteins by plants. Arnold J. Bloom of the University of California, Davis, and coworkers are reporting results of experiments on wheat and *Arabidopsis* plants that provide better details of the biochemistry behind this limiting process (*Science* **2010**, *328*, 899). Most plants draw NO_3^- and ammonium (NH_4^+) from soil and then convert NO_3^- into more NH_4^+, which plants use to produce the amino acid glutamine and other organic nitrogen compounds. The researchers assessed NO_3^- assimilation via several methods, including changes in the relative rates of CO_2 consumption and O_2 evolution and the fate of ^{15}N-enriched NO_3^-. They showed that additional CO_2 disrupts the conversion of NO_3^- to NH_4^+. As CO_2 levels rise, adding NH_4^+-based fertilizer could bypass the NO_3^- bottleneck and help maintain the yield and quality of food crops, Bloom and colleagues note.—SR

H-BONDING ENABLES MOLECULAR DANCING

Hydrogen bonding plays a key role in the diffusion of organic molecules across solid surfaces in a dancelike performance, according to a study published in *Science* (**2010**, *328*, 882). Previous surface studies based on area-averaging techniques have established that hydrogen adsorbed on solids influences diffusion of other adsorbates. But atomic-scale details of such diffusion processes, which can control chemical reactivity and self-assembly on surfaces, have remained largely unknown. With a combination of scanning tunneling microscopy and computational methods, Tulane University's Shao-Chun Li and Ulrike Diebold (now at Vienna University of Technology, in Austria) and coworkers have worked out a mechanism by which catechol, $C_6H_4(OH)_2$, moves across a titanium dioxide crystal surface.



SHAO-CHUN LI

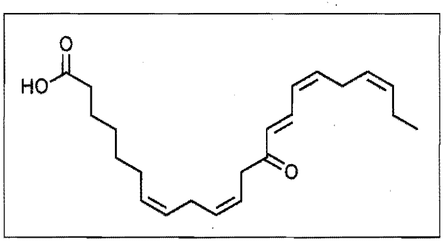
Surface hydrogen enables catechol to "dance" from left to right across TiO_2 via successive rotational motions; Ti is blue, O is orange and gray, C is black, and H is pink.

Upon adsorption, catechol's OH groups dissociate, leaving the molecule to bind via its oxygen atoms in a bridging configuration to two titanium sites. The liberated hydrogen atoms bind to two surface oxygen atoms, but they can easily shuttle back and forth between TiO_2 and catechol. Hydrogen's shuttling actions make it energetically feasible for catechol to "lift one of its legs" by breaking an O–Ti bond, rotate 180° on the other oxygen leg, rebind to TiO_2, and thereby "dance" across the surface via repeated rotations, the team says.—MJ

HEALTHY OMEGA-3 FATTY ACID METABOLITES

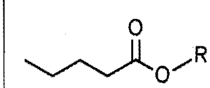
Omega-3 fatty acids found in seafood and nuts or taken as dietary supplements have health benefits that include preventing cardiovascular disease and reducing inflammation. But the biochemical basis for these benefits has not been well understood. Bruce A. Freeman and Francisco J. Schopfer of the University of Pittsburgh and coworkers have now identified omega-3 fatty acid metabolites that may be responsible for the favorable effects and show how drugs such as aspirin can boost levels of the compounds (*Nat. Chem. Biol.*, DOI: 10.1038/nchembio.367). The metabolites—a class of electrophilic oxo derivatives that the researchers call EFOXs—are produced by the action of the enzyme cyclooxygenase-2 (COX-2) on omega-3 fatty acids in macrophages. EFOXs bind to transcriptional regulatory proteins, and the resulting alterations in gene expression patterns have beneficial metabolic and anti-inflammatory effects. The COX-2 inhibitor aspirin induces the enzyme to produce greater than normal quantities of EFOXs, enhancing the effects. The findings suggest that EFOXs "are signaling mediators that transduce the beneficial clinical effects of omega-3 fatty acids, COX-2, and aspirin," the researchers write.—SB

One of several EFOXs identified in the University of Pittsburgh study.



VALERIC BIOFUELS MOVE FORWARD

Researchers continue to gain momentum in the effort to make practical the conversion of woody plant material into biofuels via levulinic acid derivatives. Jean-Paul Lange of Shell Global Solutions, in Amsterdam, and colleagues report a novel approach based on converting lignocellulose into valeric esters, which might be more ideal for augmenting diesel and gasoline supplies than other proposed levulinic acid derivatives (*Angew. Chem. Int. Ed.*, DOI: 10.1002/anie.201000655). Lignocellulose is considered an attractive renewable starting material for biofuels. But accessing and converting the sugars trapped in plants is complicated and expensive. Levulinic acid can be readily produced from lignocellulose via acid hydrolysis and then hydrogenated to γ-valerolactone, which has been considered a potential biofuel. Several research groups have been working to improve on γ-valerolactone, however. For Lange's group, optimizing one subsequent step—the hydrogenation of γ-valerolactone to valeric acid—had been a synthetic bottleneck. The Shell researchers solved the problem with brute force, testing 150 catalysts before settling on a platinum-loaded zeolite that does the trick. The team then esterified valeric acid to a set of valeric esters and diesters. They put these valeric esters to a number of fuel tests, including a 155,000-mile road trip powered by a blend of 15% ethyl valerate in regular gasoline.—EKW



Valerate esters