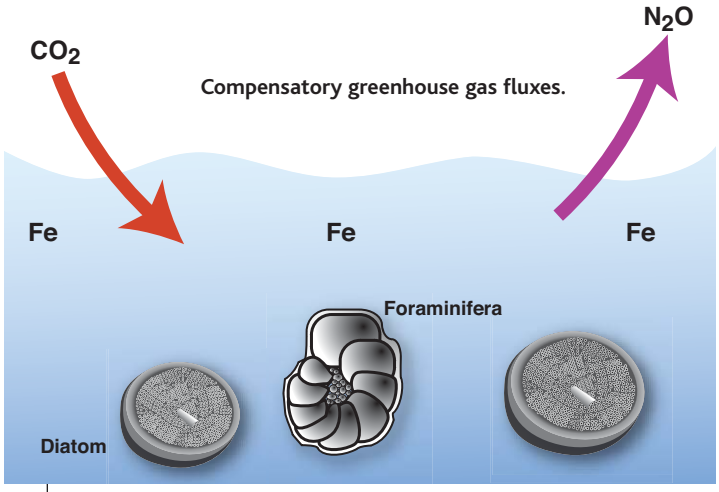
EDITORS' CHOICE

edited by Gilbert Chin



CREDITS: (LEFT) DEBRA J. MORGENEGG/*SCIENCE*; (RIGHT) S. GRUENHEID, C. ROSENBERGER, AND B. B. FINLAY

CLIMATE SCIENCE

Testing the Waters

Iron fertilization of the surface ocean layer has been considered as a possible strategy for reducing the burden of atmospheric CO_2; this would mitigate greenhouse gas buildup and global warming. The idea is that CO_2 would be removed from the atmosphere by sequestering it as new ocean production in "high nutrient—low chlorophyll" regions, where biological production is limited by the scarcity of iron. This approach might have other consequences, however, including the increased production and atmospheric concentration of N_2O, another powerful greenhouse gas.

Using a suite of three-dimensional, coupled physical-biogeochemical models and an oceanic N_2O cycle module, Jin and Gruber assess how excess production caused by iron fertilization would affect atmospheric N_2O. They find that additional N_2O production could offset 100% of the effect of CO_2 removal when fertilization of limited duration and size is undertaken in the tropics, and that smaller but still substantial offsets can be expected when fertilization is undertaken elsewhere over longer periods. These results indicate that ocean fertilization with iron, in order to reduce atmospheric CO_2, may be less efficacious than has been hoped. — HJS

Geophys. Res. Lett. **30**, 10.1029/2003GL018458 (2003).

APPLIED PHYSICS

Transistors Turn On the Light

The field of optoelectronics usually requires the integration of separate devices with optical and electronic functionalities. The extra masking, patterning, and wiring processes involved in the integration add significantly to the fabrication time and therefore to the cost of the end product. Furthermore, as these "separates" need to talk to each other, there may also be a reduction in the device performance. Feng *et al.* have fabricated a heterojunction bipolar transistor based on an InGaP/GaAs structure that combines both functions—three-terminal electronic control and optical function—in one device. They demonstrate that as their transistor is turned on, it also emits light as the injected carriers recombine in the vicinity of the base layer contact. By modulating the current of the base layer contact, they also demonstrate the ability to switch the light emission at rates up to 1 MHz. Although this modulation rate is rather slow, but perfectly sufficient for display purposes, present wide-bandgap heterojunction transistors can now achieve switching rates of 450 GHz, indicating a possible use for these light-emitting transistors in optical communication networks. — ISO

Appl. Phys. Lett. **84**, 151 (2004).

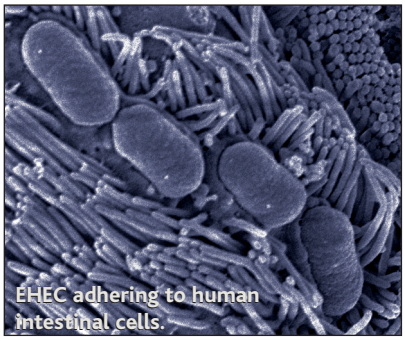
MICROBIOLOGY

Vaccinating Cattle

Contaminated food—hamburgers are a notorious example—is the primary source of dangerous enteric infections by *Escherichia coli* O157:H7 (EHEC), which in humans can cause bloody diarrhea and, in some cases, hemolytic uremic syndrome. Because EHEC has been found in almost 50% of beef carcasses in North America, an important commercial aim is to reduce exposure to the bacteria by reducing the extent to which EHEC colonizes the cattle intestine.

EHEC virulence is attributed to the ability to secrete determinants, via a type III secretion system, that include the adhesins Tir and EspA and the pore-forming protein EspB, which together promote bacterial attachment to host cells. Potter *et al.* have chosen these molecules as constituents of a trial vaccine for calves. The trial was carried out under commercial livestock-rearing conditions, and the trial animals were then exposed to the O157:H7 strain. Vaccination increased specific antibody titer 45-fold after a single booster and reduced the duration and quantity of EHEC shedding. As well as being economical to prepare, a livestock vaccine must be effective enough to minimize the number of times an animal has to be handled, which would add to rearing cost. Plus, developing a livestock vaccine might be a useful route to a human vaccine against EHEC. — CA

Vaccine **22**, 362 (2004).


EHEC adhering to human intestinal cells.

CHEMISTRY

Super Switcher

The extent to which water can wet a surface is dependent on a number of factors, including the chemistry and the roughness of the surface. Various methods have been used to change the extent of wetting dynamically, but they cover only a limited range of water contact angles. Sun *et al.* show that they can reversibly switch a surface from being superhydrophilic to being superhydrophobic with a very small change in temperature. On its own, poly(*N*-isopropylacrylamide) will switch from being hydrophilic to being mildly hydrophobic when the temperature is raised from 25° to 40°C. At the lower temperatures, the C=O and N-H groups are partnered by water molecules, and intermolecular hydrogen bonding dominates; when the temperature is raised, intramolecular hydrogen bonding takes over, ejecting the water molecules, and the chains adopt a more compact form. The authors enhanced this transition by depositing the polymer onto patterned silicon substrates. As the pattern size was decreased (finer grooves), they observed an increase in the range of contact angles achieved on switching. Detailed investi-

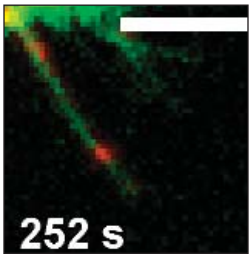
CONTINUED ON PAGE 289

gation of the substrate showed a large fraction of irregular nanoparticles produced by sputtering from neighboring regions and thus a very large surface area. — MSL

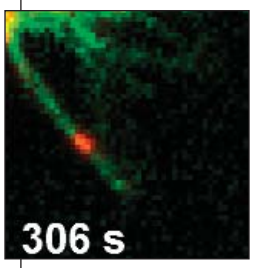
Angew. Chem. Int. Ed. **43**, 357 (2004).

BIOPHYSICS

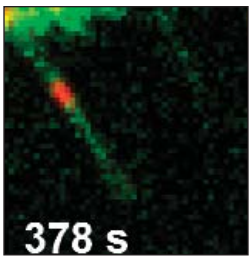
Small is Beautiful



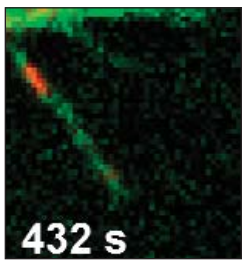
Although many biologists are interested in phenomena operating on micrometer-to-nanometer scales, they often rely on their physical science colleagues in adapting existing technology to new uses: for example, x-ray crystallography for structure determination of macromolecules and atomic force microscopy for probing single biomolecules.



Alivisatos reviews the recent crossover of quantum dots—clusters of roughly a few thousand inorganic atoms with favorable properties for biological imaging (intense stable fluorescence in the visible region). Lidke *et al*. illustrate their use with epidermal growth factor—quantum dot (EGF-QD) conjugates. EGF binds to members of the erbB family of receptor tyrosine kinases, and inappropriate expression of these receptors is implicated in some types of cancer. Fortunately, EGF-QDs also bind to these receptors, making it feasible to monitor endocytosis and intracellular trafficking of the growth factor. Coupling the use of these ligands to expression of various fluorescent pairs of erbB receptors suggested that heterodimerization of erbB1 and B2 (but not erbB1 and B3) is triggered by the interaction with EGF. — GJC



Nature Biotechnol. **22**, 47; 10.1038/nbt929 (2004).



Retrograde transport of EGF-QDs (red) in a filopodium (green).

CREDITS: LIDKE *ET AL.*, *NATURE BIOTECHNOL.* 10.1038/NBT929 (2004)

GEOCHEMISTRY

Selenospheres

Selenium is an important biological trace element: an essential part of some metalloenzymes and a nutrient at low concentrations, but a pollutant and a toxic species at high levels. Elemental selenium is used in many electronics applications, and recent efforts have focused on growing microscopic selenium wires and crystals with advantageous characteristics and optical properties for use in devices. Oremland *et al*. show that phylogenetically distinct groups of bacteria that live in a range of environments process selenium in ways that may bear on these aspects of selenium chemistry. These bacteria reduce selenium oxyanions in order to grow and deposit elemental selenium externally. Imaging and spectroscopy show that the selenium is precipitated as uniform crystalline nanospheres about 300 nm in diameter. Surprisingly, different bacteria produce spheres with different arrangements of the selenium atoms and hence different optical properties. — BH

Appl. Environ. Microbiol. **70**, 52 (2004).

BIOMEDICINE

The LO Road to Atherosclerosis

Lipoxygenases (LOs) are a family of enzymes that are attracting attention because of their role in the biosynthesis of lipids that mediate inflammatory and allergic reactions. Inhibitors of these enzymes are already in clinical use for treatment of asthma. Because lipid-mediated inflammatory circuits are also etiologic factors in atherosclerosis, Dwyer *et al*. investigated whether genetically determined variation in LOs might contribute to vascular disease. In a pilot study of 470 healthy individuals, they found that two variant alleles of the gene encoding 5-LO were associated with an increase in carotid artery intima-media thickness, an established indicator of systemic atherosclerosis. Notably, the effects of these variant alleles appeared to be modified by dietary intake of certain types of fatty acids, such as those in marine fish. This study and a recent mouse analysis linking a different LO gene to osteoporosis (see Reports, 9 January 2004, p. 229) broaden the scope of disorders that are potentially treatable with drugs targeting these enzymes. — PAK

N. Engl. J. Med. **350**, 29 (2004).

Small is Beautiful

Gilbert J. Chin

Science **303** (5656), 289.
DOI: 10.1126/science.303.5656.289a