EDITED BY KRISTEN MUELLER AND MARIA CRUZ

ECOLOGY

Poor Replacements

The loss of large herbivore species can have very noticeable ecological impacts. Replacement of lost species with similar species expected to perform the ecological roles of those lost may temper some of these changes. Caution is needed, however: History is full of biological introductions that have not turned out as planned. Hunter *et al.* tested the effectiveness of ecological equivalency in the Galapagos, where extinctions of giant tortoises have had significant ecological impacts. Sterilized tortoises with two distinct shell morphologies, domed and saddleback, were introduced to Pinta Island. The now-extinct native species had saddleback-shaped shells and were dispersers of prickly pear cactus. Introduced saddleback tortoises also selected prickly pear–rich habitats and thus have the potential to fill the same ecological role. Tortoises with dome-shaped shells, on the other hand, migrated to high elevations and showed no inclination toward prickly pear habitat. This was somewhat surprising, because despite differences in shell shape, domed-shell tortoises are more closely related to the extinct saddleback tortoises. Controlled experimentation, therefore, may be essential when considering ecological replacement strategies. — SNV

Conserv. Biol. 10.1111/cobi.12038 (2013).

BIOCHEMISTRY

Transport by the Numbers

Twelve is a useful number when it comes to protein design. Why? Because divisibility by 2 and by 3 means that subunits or intraprotein domains can be assembled combinatorially while structural homologies insure stability. Madej *et al.* document a striking example of this flexibility in design by comparing the tertiary structures of two members of the major facilitator superfamily (MFS) of secondary transporters. MFS transporters carry small molecules across the cell membrane, often in tandem with an ion; the movement of the small-molecule substrate, such as lactose or fucose, is driven by the electrochemical gradient of the ion, which is in turn established by active transporters. Both sugar permeases LacY and FucP consist of 12 transmembrane helices, and both of their secondary structures adhere to the canonical pattern of a quartet of three helix bundles. Biochemical analysis of mutant forms has identified the aromatic residues Trp^{151} and Phe^{308}, respectively, as the platforms where the sugar substrates bind, but as is evident from their numbering, these functionally homologous residues are found in entirely different locations in the primary structure. Madej *et al.* discovered that LacY and FucP are inverted permutations of each other, with bundles A through D in LacY corresponding to bundles D through A in FucP. — GJC

Proc. Natl. Acad. Sci. U.S.A. **110**, 10.1073/pnas.1303538110 (2013).

GENOMICS

All-Seeing Mystery

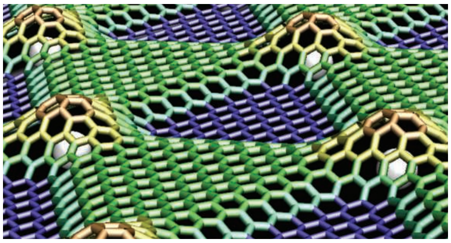
Nematode worms can infect a variety of tissues in humans; for example, apart from disconcertingly migrating across the eyeball on occasion, the African eyeworm *Loa loa* can cause neurological and heart pathologies. *L. loa* is a filarial worm, vectored by a biting fly and related to the worms that cause river blindness and elephantiasis. Unlike those species, *L. loa* does not possess the endosymbiont bacterium *Wolbachia*, which is the target of the antibiotics that are important treatments for these other parasites. Desjardins *et al.* have redressed a genome sequence gap and in a comparative study explored the nature of the apparently obligatory relationship between those filarial worms that have the endosymbiont and *L. loa,* which does not. It seems the eyeworm is very similar to other filariae to the extent that it (and they) possesses the metabolic pathways that previously were thought to be contributed by the endosymbiont. Contrarily, this new genome sequence is less revelatory than expected, instead restoring the symbiotic role played by *Wolbachia* in filarial nematodes to one of subtle mystery. — CA

Nat. Genet. **45**, 10.1038/ng.2585 (2013).

MATERIALS SCIENCE

Implanted Atoms as Implements

Ion implantation can be used to remove a thin layer of a crystal. For example, in the fabrication of silicon-on-insulator chips, a layer of heteroatoms that can form a gas (e.g., hydrogen atoms) are implanted as a subsurface layer. Upon heating, the formation of the gas dislodges the thin film from the bulk crystal. Cun *et al.* examined such effects at the level of a single monolayer; in this case, a boron nitride (BN) overlayer grown on the (111) surface of rhodium that forms a "nanomesh" superstructure of wires and holes with a lattice constant of 3.2 nm. After implantation of low-energy argon ions, scanning tunneling microscopy revealed protrusions along the wires created by subsurface argon atoms trapped at two different sites. These structures were stable in air, but annealing to 900 K caused a "can-opener" effect; that is, the formation of well-defined 2-nm



holes in the perturbed overlayer along with the corresponding removed flakes of BN. Similar effects were seen with neon ions and for graphene layers on ruthenium surfaces. — PDS

Nano Lett. 10.1021/nl400449y (2013).

ECONOMICS

The Constraints of IP

Debates about intellectual property (IP) protections for genes remain unsettled. New analysis of landmark human genome sequencing efforts suggests that IP protections hindered use of some early findings in follow-on research and development (R&D). The publicly funded Human Genome Project (HGP) required that its results be immediately placed in the public domain. The private firm Celera, which published its draft genome at the same time as the HGP draft in 2001, maintained IP rights on its sequenced genes not yet sequenced by the HGP, allowing it to negotiate licensing agreements to sell data until those genes were made public by subsequent HGP resequencing, completed in 2003. Incorporating a range of counterfactuals and controls, Williams shows that scientific publications and the development of diagnostic tests based on genes covered by Celera's IP were reduced by 20 to 30%. Comparing Celera genes made public by the HGP in 2002 versus 2003, a gap remains in the overall stock of knowledge (measured by genes having a known phenotype), suggesting that even brief periods of IP can have persistent impacts on subsequent R&D. — BW

J. Polit. Econ. **121**, 1 (2013).

APPLIED PHYSICS

Falling into Traps

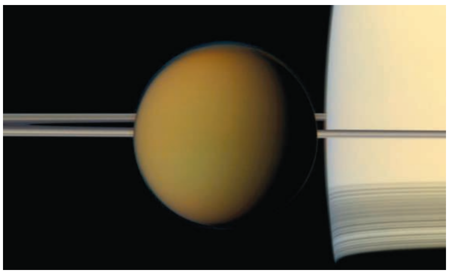
Semiconducting nanocrystals, or quantum dots, are promising materials for use in laser, light-emitting diode (LED), and solar cell applications, partly because of the tunability of their photophysical properties with size. One important size-dependent property in this context is the rate of Auger recombination, a process whereby one or more excited carriers relax through energy transfer to another carrier. Cohn *et al.* report that, in zinc oxide nanocrystals negatively photodoped under anaerobic conditions, a distinct sort of trap-assisted Auger recombination occurs at a rate that varies as the inverse square of the particle radius. Transient absorption and photoluminescence spectroscopy reveal the decay rates associated with relaxation of a conduction-band electron to a deep localized hole, through concomitant energy transfer to an extra conduction-band electron. Although the radial rate dependence is shallower than the inverse cube scaling of more widely studied biexciton recombination processes, the authors note that surface traps are common enough for the process to play a significant, and perhaps underappreciated, role in quantum dot photophysics. — JSY

Nano Lett. **13**, 1810 (2013).

PLANETARY SCIENCE

Simulating Titan's Atmosphere

Saturn's largest moon, Titan, has a thick atmosphere dominated by nitrogen (N_2) and methane (CH_4); the photochemistry of these two gases in the upper part of the atmosphere, initiated by solar wind particles and solar ultraviolet radiation, produces organics, including polymeric compounds called tholins that are thought to give Titan its distinctive orange-yellow color. Laboratory work by Gudipati *et al.* shows that tholin formation can continue at low altitudes, down to 200 km from the surface and below, through longer-wavelength photochemistry in condensed organic aerosols. They synthetized dicyanoacetylene (C_4N_2), a compound that has been detected on Titan and can be used as a model system for other larger unsaturated condensing compounds, cooled



it to 100 K, a temperature relevant to Titan's lower atmosphere, and irradiated it with laser-produced light at 532, 355, and 266 nm. Solar light at wavelengths longer than 200 nm is expected to penetrate through Titan's atmosphere and make it to low altitudes without much attenuation. In the simulations, irradiation of C_4N_2 ice with light at wavelengths as long as 355 nm induced the formation of tholins. These organic compounds, which do not occur naturally on Earth, can thus be produced on Titan by different photochemical processes at different atmospheric altitudes. — MJC

Nat. Comm. **4**, 1648 (2013).

CREDITS (TOP TO BOTTOM): H. CUN *ET AL.*, *NANO LETT.* (10.1021/NL40449Y 2013); NASA/JPL-CALTECH/SPACE SCIENCE INSTITUTE