# THIS WEEK IN Science

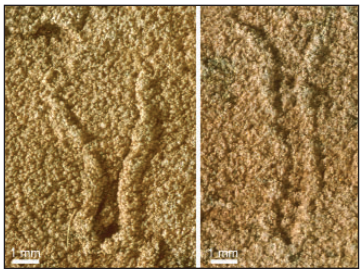
edited by Phil Szuromi

## Three Ways with Light

Light can be used in a variety of ways to fabricate materials or provide power to devices, as illustrated in three reports. Manipulation of particles with light has been generally limited to trapping and rotation. MacDonald *et al.* (p. 1101) have developed a range of techniques based on optical interference for forming and manipulating three-dimensional structures of microscopic particles. The interference pattern generated by Laguerre-Gaussian optical beams results in a spiral type structure of optical traps that can be used to trap, rotate, and translate the microscopic particles over macroscopic distances and in three dimensions. A challenge for nanotechnology is powering small devices, and one may be to feed in the energy in the form of light. Hugel *et al.* (p. 1103) show that the light-driven cis-trans isomerization in individual chains of an azobenzene polymer can generate force and thus perform mechanical work. A common approach to three-dimensional fabrication is to use pairs of lasers beams to define a point in space where photoprocesses can be used to initiate reactions in polymer precursors, such as through the generation of acids. Nonlinear two-photon excitation (in which two infrared photons combine to produce ultraviolet excitation) can reduce unwanted background polymerization. Zhou *et al.* (p. 1106) now report the design of a much more efficient two-photon acid generator, as well as initial results for positive-tone microfabrication.

## First Impressions Count

Metazoans are generally thought to have arisen in the latest Precambrian (less than about 600 million years ago) and then diversified greatly during the Cambrian explosion. However, there have been some hints, including clues from molecular genetics studies, pointing to a much earlier evolution. Rasmussen *et al.* (p. 1112) have dated and reexamined rocks from the Stirling Range Formation, Australia, that were provisionally assigned an edicaran age (latest Precambrian), based in part on the presence of discoidal impressions that were analogous to some accepted edicaran fauna. However, uranium-thorium-lead dating places the age of the rocks to be older than 1.215 billion years. Although these discoidal impressions may have a nonbiological origin, they also see what appears to be fossilized trackways of a motile organism, either a metazoan or lineage that went extinct.



CREDIT: RASMUSSEN *ET AL.*

## 1087 Comet Flyby

The nuclei of comets may contain frozen primordial remnants from the formation of our solar system. However, only the nucleus of 1P/Halley, a comet derived from the Oort cloud, has been imaged. Soderblom *et al.* (p. 1087) provide images and spectra of the nucleus of 19P/Borrelly, a comet derived from the Kuiper Belt, that were collected during a close flyby (as close as 2171 kilometers) by the Deep Space 1 ion-propulsion spacecraft in September 2001. The nucleus of Borrelly is extremely dark, with an albedo similar to C-type asteroids, and its surface is mottled and rough. Spectra indicate that the nucleus is very dry, with no evidence for water or hydrated minerals. Several collimated jets of dust and gas show that the comet is still actively sublimating, and the main jet accounts for the sunward asymmetry of Borrelly's coma. ✗

### And in Brevia ...

Bearing sons was associated with a reduction in human maternal life-span after menopause, whereas bearing daughters was associated with an increase, according to an analysis of preindustrial demographic records by Helle *et al.* (p. 1085).

## The Wheres of Electrons

Although transport measurements on quantum dots have revealed single-electron charging effects and Coulomb repulsion, they do not provide information on where the electrons are within the dot. Scanning probes provide spatial resolution but generally provide very limited electronic information. Using a metallized tip in an atomic force microscope, Woodside and McEuen (p. 1098) now extend scanning probe microscopy to imaging single electrons within the quantum dot.

## A Big South American Hit?

Tektites are glass fragments attributed to melt ejecta from an impact event, and several areas in Indonesia, Australia, and the Czech Republic are concentrated in glass fragments and thought to be strewn fields from an impact. Bland *et al.* (p. 1109; see the Perspective by Melosh) have found a tektite-strewn field on the Pampean plain of Argentina, and their observations suggest that a 0.5-kilometer-diameter bolide may have hit the plain about 0.5 million years ago.

## Culture for the Masses

A major challenge for microbiologists is that 99% of bacteria cannot be isolated from the wild and cultured in the laboratory. Kaeberlein *et al.* (p. 1127; see also the news story by Green and the special issue coverage starting on p. 1055) have developed a simple diffusion-chamber method for growing and passaging pure cultures of marine bacteria in contact with, but separated from, their natural sediments. They obtain sufficient quantities of pure organisms to satisfy the needs of most molecular biologists and ecologists. Their initial studies suggest that the primary barrier to cultivating naturally occurring bacteria is the characteristic interdependence for nutrients, or various diffusible signals, among species.

## The Third Way

A recurring problem in evolutionary biology and in human societies is how cooperative groups develop and survive. Cooperation among individuals can lead to greater goods, yet defectors within cooperative groups can reap greater benefits. Punishment only works in small groups where the culprits can be identified. Hauert *et al.* (p. 1129)

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leaven this mix of protagonists by adding a third type of agent, the loner. They show that the option to withdraw, or sit out, leads to dynamic coexistence of cooperators, defectors, and loners, with individuals rotating their behavior, as in the child's game of rock-paper-scissors.

## How Bacteria Get Their Vitamin $B_{12}$

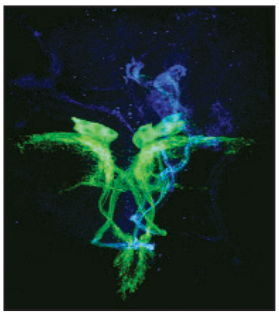
The largest class of membrane proteins that pump substances, either into or out of cells, are known as the ABC transporters for their common adenosine triphosphate (ATP)–binding cassette domains that couple the energy from ATP hydrolysis to active transport. The ABC transporter family includes members such as the cystic fibrosis transmembrane conductance regulator and multidrug resistance proteins. Locher *et al.* (p. 1091; see the Perspective by Davidson) provide a close-up at 3.2 angstroms of the transporter BtuCD, which enables bacteria to accumulate vitamin $B_{12}$. The arrangement of interfaces between the halves of the transmembrane chamber, formed by 20 helices, and between these halves and the cytoplasmic ABC domains leads to a proposal for how the transport pathway opens and closes.

## Insights into Aneuploidy

Errors in meiosis that lead to too many or too few copies of a chromosome (aneuploidy) are often lethal to the embryo. During the production of germline cells (meiosis), homologous chromosomes undergo extensive pairing and recombination via a synaptonemal complex (SC). Prior studies have shown that the SC filament protein SCP3 is necessary for male fertility. Yuan *et al.* (p. 1115) now analyze the functional role of SCP3 in the female germ cells of mice and find that SPC3-deficient female mice produce healthy offspring but have a greatly reduced litter size caused by chromosomal abnormalities. In addition, the incidence of chromosomal abnormalities increases with maternal age. This mouse model may serve to shed light on chromosomal nondisjunction and age-dependent aneuploidy in humans.

## Diabetic Fruit Flies?

The genome of the fruit fly *Drosophila* encodes several peptides with sequence homology to human insulin. Through cell ablation experiments, Rulifson *et al.* (p. 1118) show that the primary source of the systemic insulin required for larval growth is a small number of neurons in the dorsomedial brain. These neurons share several intriguing functional properties with pancreatic islet b cells in mammals, including the regulation of carbohydrate metabolism. This work raises the possibility that genetically tractable invertebrates like *Drosophila* may be useful models for studying insulin-dependent diabetes.



CREDIT: RULIFSON *ET AL.*

## A Matter of Timing

*Wolbachia* are bacteria that can infect various species of insect, and in so doing they alter the reproductive dynamics of the insects. Cytoplasmic incompatibility is one symptom of such infections such that when the sperm from infected males fertilizes eggs from uninfected females, embryonic lethality ensues. Matings between two infected individuals are fully fertile. Tram and Sullivan (p. 1124; see also the news story by Zimmer) examined the likely cause of cytoplasmic incompatibility and discovered an induced asynchrony between maternal and paternal pronuclei early after fertilization that prevents effective completion of the first cell division after fertilization.

## Cellular Stage Directions

As the cell progresses through the cell cycle, mechanisms must be present to allow the cell to exit one stage and progress to the next one. Ogawa *et al.* (p. 1132: see the Perspective by La Thangue) investigate the mechanism by which genes are turned off in the $G_0$ stage by the repressor protein E2F-6. They found that E2F-6 exists in a large complex with other proteins, including several DNA binding factors, a histone methyltransferase, the transcription repressor HP1, and polycomb proteins. This multiprotein complex is targeted to E2F-6–responsive promoters in quiescent, but not $G_1$, cells. As malignant tumor cells have lost the ability to enter the $G_0$ stage, the elucidation of the mechanisms governing cell cycle–dependent gene expression may reveal important information about cell regulation.