

# THIS WEEK IN Science

edited by Phil Szuromi

## Our Fair Share?

A study by Vitousek *et al.*, 15 years ago, based largely on extrapolations from limited field-based studies, estimated that humans co-opt about 42% of the global terrestrial production. Rojstaczer *et al.* (p. 2549; see the Perspective by Field) now provide an update based on recent, mainly satellite-based surveys and an error analysis. They reach a similar conclusion through this different methodology, but caution that the uncertainties are still very large for several key parameters, namely, the productivity of agricultural land and the biomass of secondary forests.

## Black Holes and Growth Spurts

The excessive luminosity of active galactic nuclei (AGNs) has been attributed to a period when black holes at their core were accreting the bulk of their mass. Page *et al.* (p. 2516) studied the x-ray flux of AGNs where their luminosity peaks (those with redshifts from about 1 to 3). They assign the emission to dust from starburst activity, which reflects star formation, in the bulges of the galaxies. Starburst activity and the period of major growth of the black holes appears to be coeval, which suggests that the source materials for rapid star formation and black hole growth should be similar. Thus, galaxy morphologies in the bulge and the center developed at the same time in a relatively hyperactive universe.

## Exciting Landings on Surfaces

When a molecule adsorbs on a surface, bond formation releases energy. Generally it has been assumed that for low-energy bonds (less than half an electron volt), this energy is dissipated as heat (vibrations in the surface, or phonons), and that electronic processes are unimportant. Gergen *et al.* (p. 2521; see the Perspective by Auerbach) now show that adsorption of water, nitric oxide (NO), nitrous oxide (NO<sub>2</sub>), and even xenon onto a polycrystalline silver film all produce electron-hole pairs that can be observed with a low-barrier Schottky diode. This finding not only revises the conventional model of chemisorption but also suggests new possibilities for sensors.

## Exotic Behavior with Sheets

Low-transition-temperature ( $T_c$ ) superconductors, in which the superconductivity is described by an electron-phonon coupling mechanism, generally display isotropic pairing of the electrons in momentum space—they are said to exhibit s-wave symmetry. However,

## 2524 Reasons to Transfer

The Marcus cross relation allows the rate of electron transfer between different species to be systematized in terms of equilibrium constants (ground-state energetics) and self-exchange rates. Hydrogen atom (H<sup>•</sup>) transfers (an electron plus a proton) are radical reactions that exhibit wide variations in rates for similar driving forces. Roth *et al.* (p. 2524) now show that the rates of a wide variety of H<sup>•</sup> transfers obey a Marcus cross relation, and compounds that show slow electron or proton transfer often undergo slow H<sup>•</sup> transfer.

## And in Brevia ...

A previously unknown species of large squid, up to 7 meters in length and with distinctive morphology, has been sited by Vecchione *et al.* (p. 2505) in four deep-ocean basins.



Analysis of the tiny marine organism *Oikopleura dioica* by Seo *et al.* (p. 2506) reveals the smallest genome found so far for a chordate, part of the lineage that gave rise to the vertebrates and ultimately humans.

er, like some of their high- $T_c$  cuprate cousins, a few low- $T_c$  superconductors have revealed a more complex pairing symmetry. One mechanism put forward to explain this apparent discrepancy has been additive contribution of several Fermi surface sheets. Yokoya *et al.* (p. 2518) used an ultrahigh-resolution angle-resolved photoemission technique that could resolve different Fermi-surface sheets in such a superconductor (2H-NbSe<sub>2</sub>) and confirmed that the underlying mechanism is s-wave pairing.

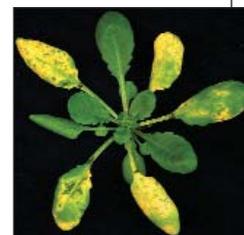
## A New Twist on Aromaticity

Thiamine diphosphate, a cofactor in many enzymatic reactions, contains a thiazole moiety that can yield a nucleophilic carbanion at the C-2 position. Chabrière *et al.* (p.

2559; see the Perspective by Frey) offer crystallographic evidence that the free-radical intermediate in the degradative reaction catalyzed by pyruvate:ferredoxin oxidoreductase contains a partially localized electron after decarboxylation of the pyruvate has occurred but before oxidation is complete. Twisting of the thiazole ring during catalysis greatly reduces its aromaticity and prevents complete delocalization of the lone electron.

## A Syringe in Action

Projections from bacteria have been predicted to play a role in the export of specific proteins and DNAs during conjugation and pathogenesis. However, a direct demonstration of such a role has been lacking. Jin and He (p. 2556) have now directly visualized the extrusion of a protein from the Hrp pilus of *Pseudomonas syringae*. The immunogold labeling protocol used will help to provide unambiguous answers in other systems where similar questions remain open.

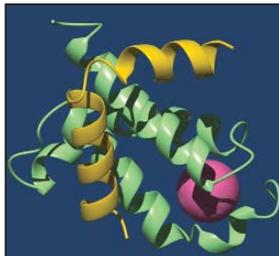


## Walk, Don't Walk

Signals from a circadian clock in a region of the mammalian brain called the suprachiasmatic nucleus (SCN) must somehow be translated into the rhythmic behavior of processes such as locomotion and rest. Kramer *et al.* (p. 2511; see the news story by Barinaga) show that neurons in the SCN secrete transforming growth factor- $\alpha$  (TGF- $\alpha$ ) that acts on cognate receptors in the hypothalamus to inhibit locomotion in hamsters. Expression of

TGF- $\alpha$  is correlated with cycles of locomotion and rest. Hence, secretion of factors that act locally in the brain is one mechanism by which the clock exerts its cyclic effects.

### Transcription and Cofactor Methylation



In order to access DNA that is packaged into nucleosomes, histone-modifying factors come into action to allow subsequent DNA transcription. Xu *et al.* (p. 2507; see the Perspective by Nishioka and Reinberg) now show that the histone methyltransferase CARM1 also has a nonchromatin substrate and acts in two separate but coordinated ways to influence gene expression. With *in vitro* chromatin templates, CARM1 acts positively to stimulate nuclear receptor transcription. However, the factor can block transcription by methylating the coactivator CBP at an amino acid that interferes with the action of CREB. Thus, CARM1 potentiates transcriptional activation by retinoid receptors whereas it can block cAMP (adenosine-3',5'-monophosphate) signaling and allow for cross-talk between the two signaling pathways. ✂

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### The End-Joining Justifies the Screen

A genome-wide screen in yeast for mutants defective in nonhomologous end-joining (NHEJ), a form of genetic recombination critical in immunoglobulin rearrangement, double-strand break repair, and yeast mating type-switching, has been performed by Ooi *et al.* (p. 2552). Thousands of these mutants were analyzed at one time with a functional assay in which cells were transformed by linear or circularized plasmids containing a selectable marker. One of the genes identified as being involved in NHEJ, *NEJ1*, interacts with the amino-terminal end of a homolog of a human protein that protects cells against cancer. ✂

### From Stem to Sperm

A pair of studies sheds light on the molecular mechanism and the spatial organization of a signaling pathway that regulates stem cell fate in the testis of fruit flies (see the Perspective by Wasserman and DiNardo). A group of somatic cells located at the testis apex (the hub) is surrounded by stem cells that can generate sperm. When needed by the fly, a stem cell can divide asymmetrically to yield a daughter stem cell and a cell that will subsequently differentiate into a mature sperm. Tulina and Matunis (p. 2546) and Kiger *et al.* (p. 2542) now show that the hub sends regulatory signals from the JAK-STAT signaling pathway in order to maintain these stem cells in an undifferentiated state. When this pathway is defective, cells begin to go through spermatogenesis. A better understanding of how stem cells are maintained and directed down different paths of differentiation should prove useful in medical applications.

### Genetic Clue to Prostate Cancer

Prostate cancer affects one in eight men and causes 32,000 deaths each year in the United States alone. About half of these cancers show allelic loss at chromosome 10p15. Narla *et al.* (p. 2563) find that one of the genes mapping to this region, *KLF6*, encoding a Kruppel-like putative transcription factor, is mutated at high frequency in sporadic prostate tumors. Transient expression of wild-type *KLF6*, but not *KLF6* containing tumor-associated mutations, slowed the growth of prostate cancer cells in culture, an effect mediated through the cell-cycle regulatory protein p21/WAF1. These features of *KLF6* suggest that it functions as a tumor suppressor gene in prostate cancer.

### Useful Information in the Neighborhood

How is information distributed over populations of neurons? Cortical neurons with selectivity for similar stimulus features can be found close to each other. Reich *et al.* (p. 2566; see the Perspective by Richmond) simultaneously recorded from single neurons in primary visual cortex and found that the responses of nearby neurons are only correlated to a relatively small degree. Simple averaging strategies, such as population histograms, imaging, or field potentials, are suboptimal and vastly underestimate the information processing that is occurring, even at such an early stage in sensory processing.