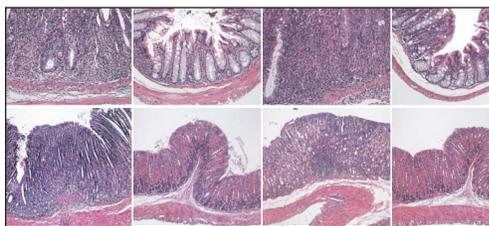


## A Nanotube Motion Sensor

When a conductive liquid flows along a carbon nanotube, a voltage is generated between the tube's ends. **Ghosh et al.** (p. 1042) also show that the effect depends logarithmically on the flow velocity for over six decades of velocity, indicating that the nanotubes may be useful as extremely small and sensitive flow sensors, or in the conversion of mechanical energy into an electrical signal. ✂

## Innate Restraint

Pathogen-specific immunity is shaped by the activation of innate immune receptors during the early stages of infection, most prominently the Toll-like receptors (TLRs). These receptors have evolved to scrutinize the molecular signatures of different classes of pathogen. They help tailor the most appropriate adaptive immune response, or, in pathological cases, allow autoimmune and allergic responses to develop (see the Perspective by **Powrie and Maloy**). **Pasare and Medzhitov** (p. 1033) show that the TLR sphere of influence extends to regulatory T ( $T_R$ ) cells, which are critical players in the management of T cell immunity. Accompanying the expected immune-response program initiated by activating TLR on dendritic cells, the potent suppressive effects of  $T_R$  cells were also blocked. This effect depended directly on production of the cytokine interleukin-6, which desensitized target T lymphocytes to the inhibitory effects of  $T_R$  cells. By lifting the suppression of  $T_R$  cells only in cases where the innate immune system has been activated, the immune system has come up with an elegant solution to the problem of maintaining control without compromising on efficiency. Naturally occurring mutations in the *FOXP3* gene in humans and mice have highlighted the role of this transcription factor in immune regulation. **Hori et al.** (p. 1057) provide direct evidence that this gene mediates principal control over  $T_R$  development. *FOXP3* was expressed preferentially in  $T_R$  cells, and transduction of *FOXP3*-negative T cells with a retroviral *FOXP3*-expressing vector caused these cells to suppress the proliferation of other T cells. The *FOXP3*-transduced cells also inhibited an aggressive form of T cell-driven inflammatory bowel disease in mice. ✂



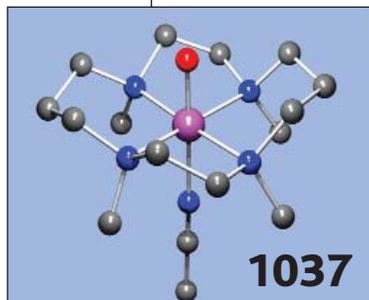
1057

## Southern Exposure

Determining the amount and distribution of volatile species, such as water and carbon dioxide, trapped at the martian polar caps is important for understanding the planet's climate. Mapping by the Thermal Emission Imaging System onboard Mars Odyssey has revealed an exposed layer of water ice on the surface of the south po-

## High-Valence Iron Without the Heme

Studies of  $O_2$  activation by iron-containing enzymes that bind iron with a heme group, such as the cytochromes, have found firm evidence for intermediate species such as iron-oxo groups. Two reports focus on  $O_2$  activation in nonheme mono-iron enzymes, where much of our information has been indirect (see the Perspective by **Kovacs**). Theoretical work has suggested that the formation of the high-valence  $Fe^{IV}=O$  would be disfavored in nonheme enzymes. **Rohde et al.** (p. 1037) present structural and spectroscopic evidence for an  $Fe^{IV}=O$  intermediate in a nonheme model compound that binds the iron through a macrocyclic ligand. **Karlsson et al.** (p. 1039) describe the x-ray structures of proposed intermediates in the catalytic pathway of naphthalene dioxygenase, a Rieske nonheme iron dioxygenase that catalyses a cis-dihydroxylation reaction. They find  $O_2$  bound side-on to the mononuclear iron in the active site. The molecule is positioned so that the two oxygen atoms could react with the carbon atoms of the substrate double bond in a concerted mechanism.



1037

lar cap. **Titus et al.** (p. 1048 ✂ ; see the 6 December news story by **Mackenzie**) suggest that the exposed water ice at the south pole may be more extensive than previously thought, and that some of this water will sublime in the summer to create atmospheric water vapor. **Byrne and Ingersoll** (p. 1051) provide further support for an extensive water-ice layer with models of the climatic processes that would lead to the pitted terrain at the south pole observed with the Mars Orbiter Camera onboard Odyssey.

## A Superconducting Amplifier

Josephson junctions are simple structures comprising two superconductors separated by a thin insulating layer. Because of coupling between the two superconductors, application of a bias across the junction gives rise to an oscillatory current of superconducting Cooper pairs flowing through the junction at a well-defined frequency. Once characterized, these devices can be used as a voltage standard. **Delahaye et al.** (p. 1045) carefully tuned the coupling of the junction and constructed a device in which a small current of injected electrons controlled the flow of a larger supercurrent through the junction. Achieving gain in a superconducting device could open up new applications in metrology.

## Flexible Management

Scaffolding proteins contain binding sites for individual components of signal pathways and are thought to serve as grand organizing centers. **Park et al.** (p. 1061; see the Perspective by **Ptashne and Gann**) explored the basic physical requirements for a scaffold recruitment interaction using the yeast mitogen-activating protein (MAP) kinase signaling pathways as a model system. Replacing defective scaffold-kinase recruitment interactions with completely different protein-protein interactions restored proper signaling, thus demonstrating the tremendous plasticity of these organizing factors. Such flexibility likely underlies the evolution of new pathways and resembles that of binding sites in transcription factors. ✂

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## Squashing a Dry Hypothesis

The origins of agriculture in the New World have been thought to center in the dry highlands of Mexico and Central America. Evidence for domestication usually involves a noticeable increase in the size of seeds compared to those of local wild plants. **Piperno and Stothert** (p. 1054; see the Perspective by **Bryant**) present new radiocarbon dates from two sites in Ecuador that push the origins of domestication of a squash there back to perhaps 12,000 years ago. Such a date would be concurrent with, or even earlier than, those of sites in the dry highlands. Thus, agriculture may have arisen first or independently in the wet lowlands.

## Reversing Replication

DNA replication can be dangerous business, especially if damage to the DNA blocks replication before it has finished. The stalled replication fork is vulnerable to further mutations and rearrangements, and these can be lethal to the cell and potentially cause cancer. **Courcelle et al.** (p. 1064) examined the structure of the stalled replication fork and found how it is rescued—the stalled forks transiently reverse. The authors suggest that the reversed forks facilitate the repair of the initial DNA damage. Consistent with genetic analyses, RecA and RecFOR are required for the stable maintenance of the reversed forks and, in their absence, the forks are degraded by RecQ-RecJ.  $\otimes$

## Information Processing in the Auditory Cortex

The early processing circuits for auditory stimuli, like the auditory brainstem, contain multiple parallel pathways for both sound localization and general acoustic feature extraction. The analysis of sound features in higher centers, like the auditory cortex, is still not fully understood. **Barbour and Wang** (p. 1073) used parametric wideband acoustic stimuli to explore auditory cortical responses in a more realistic way. They could classify the neurons into two putatively important groups: High- and low-contrast-favoring cells. They also found that the effective bandwidth of the neuronal frequency response as measured with these stimuli is intensity invariant.

**1073**

## Poison Control Centers

Hydrogenases catalyze the separation of  $H_2$  into protons and electrons. At the heart of the enzyme resides a metal cluster containing nickel and iron, with multiple cyanide groups ( $CN^-$ ) serving as iron ligands. How are these groups synthesized while avoiding the suicidal liberation of free  $CN^-$ ? **Reissmann et al.** (p. 1067) describe the biochemical reactions that attach a carbamoyl group to a sulfhydryl side chain of the hydrogenase maturation protein HypE and subsequently convert it to a thiocyanate (HypE-SCN), which ultimately serves as a cyanide donor to the iron atom.

## The Basis of the fMRI Signal

Blood oxygen level-dependent (BOLD) functional magnetic resonance imaging (fMRI) allows the detection of minute fluctuations of deoxyhemoglobin in the central nervous system during the performance of a specific task. The nature of the signal and its correlation to the underlying neuronal activity has been controversial. **Thompson et al.** (p. 1070; see the Perspective by **Mayhew**) used single-cell recording and direct measurement of tissue oxygenation to determine the relation between neural activity and changes in oxygenation within the primary visual cortex of the cat. Neural activity was closely related to reduction in oxygenation, consistent with other reports that a period of hypoxemia precedes the hyperemia thought to underlie the BOLD response. Apart from their theoretical implications, these results suggest a number of ways in which the precision of fMRI could be further improved.