

edited by Stella Hurlley



Mars.

PLANETARY SCIENCE

Martian Magnetism Getting Hotter

While the world is focused on the rovers Spirit and Opportunity trundling across the surface, others are considering the structure and composition of the deep interior of Mars to determine if it ever had a magnetic field.

To generate a dynamo, Elkins-Tanton *et al.* assume a magma ocean on early Mars, a nearly completely molten planet caused by accretional heating. As the magma ocean crystallized, less dense layers would form beneath more dense layers, leading to an unstable

stratification. Overturn of the unstable layers would bring colder materials down, causing conductive heating and initiating a brief but strong magnetic field.

In contrast, Williams and Nimmo suggest that the early core was hotter than the mantle because of rapid core formation. The temperature difference would produce enough entropy to drive a brief and early dynamo and a magnetic field that would magnetize the crustal rocks. In addition, the hot core should remain molten.

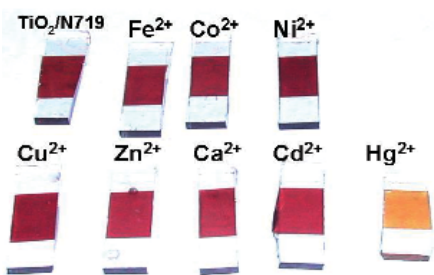
The molten mantle and molten core models are generally consistent with data from Martian meteorites. In time, data from the rovers may help to resolve these simmering debates. — LR

Meteorit. Planet. Sci. **38**, 1753 (2004); *Geology* **32**, 97 (2004).

CHEMISTRY

Sensing Mercury

One aspect of environmental monitoring is the detection of low levels of heavy metal ions. Of these, mercury is a particular concern because it is highly toxic, and it accumulates through the activity of microorganisms in the form of methyl mercury. Palomeres *et al.* have constructed a simple detector based on mesoporous nanocrystalline titanium dioxide films. These TiO₂ films have both a high surface area and excellent optical transparency in the visible region of the spectrum. A ruthenium-based dye (N719) was adsorbed onto the films to give a color signal detectable



Color changes in presence of metal ions.

by visual inspection (down to 20 μM concentrations) or by spectrophotometric means (down to 0.3 μM concentrations). Exposure of the sensor to mercury causes a shift in the absorption spectra toward the violet, but surprisingly no changes were observed for any of the other divalent metal ions that were tested. — MSL

Chem. Commun. **4**, 362 (2004).

MEDICINE

Mitochondria and Diabetes

Type 2 diabetes affects 150 million people worldwide. With new estimates that this number may double by the year 2025, efforts to understand the etiology of the disease have intensified. One of the earliest signs of type 2 diabetes is the development of insulin resistance in muscle, a condition often accompanied by the aberrant accumulation of intracellular fatty acids that are normally bro-

ken down by mitochondria. This and other evidence have led researchers to focus increasingly on mitochondrial dysfunction as a possible culprit in the disease.

Support for this hypothesis is provided by Petersen *et al.*, who used magnetic resonance spectroscopy to study skeletal muscle function in healthy young offspring of patients with type 2 diabetes. Compared with matched controls, the muscle of these individuals was severely insulin-resistant and showed an 80% increase in the level of intracellular fatty acids as well as a 30% reduction in mitochondrial ATP production. The authors speculate that the insulin resistance is caused by an inherited defect in mitochondrial oxidative phosphorylation. — PAK

N. Engl. J. Med. **350**, 664 (2004).

PHYSICS

Compensating for Atomic Dispersion

Applications, such as atom interferometers, exploit the ability to cool atoms to low enough temperatures that their quantum mechanical wave properties become ap-

parent. Clouds of cold atoms are split, sent down different paths, and brought together again, producing interference fringes on the scale of their de Broglie wavelength. However, movement and scattering of the atoms are also associated with dispersion, whereby the phases of the atom waves slip, leading to gradual loss of the contrast between fringes. Roberts *et al.* introduce a technique in which a specified phase shift is added to the atomic cloud in one part of the interferometer and then removed at another point. This manipulation can effectively compensate for the phase dispersion, re-establishing the contrast between the fringes, thus allowing more precise measurements to be made. — ISO

Phys. Rev. Lett. **92**, 0604405 (2004).

ECOLOGY/EVOLUTION

Waiting for Nemo

In some animal societies, a group can consist of both breeding and nonbreeding adults. In such cases, non-



Clownfish among sea anemones.

breeders often achieve breeding status through sneak matings, through the demotion or demise of the dominant individual(s), or by dispersing to another group. Buston has documented a case of the "perfect queue," in which subordinate individuals replace successive domi-

CONTINUED ON PAGE 1441

nants without dispersal and without a fight. The clownfish *Amphiprion percula* inhabits the tentacles of sea anemones in small size-ranked groups of up to six individuals, with a single breeding pair. Newcomers to the group join as larval settlers and ascend toward breeding status as individuals die further up the dominance hierarchy; queue-jumping by dispersal or contest is never observed. This patient behavior appears to maximize an individual's probability of assuming the breeding territory; in other words, nonbreeding status is tolerated because it confers a potential to realize future benefits. — AMS

Proc. R. Soc. London Ser. B 10.1098/rsbl.2003.0156 (2004).

CELL BIOLOGY

Transcription in a Bind

The transcriptional activity of a nuclear receptor depends not only on its dimerization with another nuclear receptor but also on the functional communication between four distinct domains within its ligand-binding domain (LBD). For example, the retinoid X receptor (RXR) heterodimer is differentially responsive to

ligands through allosteric communication within the LBDs and across the dimerization interface. However, it is not clear how ligand binding propagates through the LBD to affect the sites that mediate cofactor, coregulator, and DNA binding; receptor dimerization; and transcription. Shulman *et al.* analyzed the LBD sequences of 250 nuclear receptors and identified a network of 27 residues that mediate allosteric communication. Certain residue pairs were energetically coupled and thus likely to have coevolved to maintain a specific function—global interaction between these pairs predicted the allosteric network.

Nettles *et al.* examined allostery in estrogen receptor subtypes that underlies their differential responses to ligands. Residues outside the ligand-binding pocket contributed to the subtype-specific positioning of bound ligands. The coactivator-binding pocket also affected ligand positioning through the conformation of a specific helix, suggesting that functional communication between these two regions of the LBD is bidirectional. — LDC

Cell 116, 417 (2004); *Mol. Cell* 13, 317 (2004).

HIGHLIGHTED IN SCIENCE'S SIGNAL TRANSDUCTION KNOWLEDGE ENVIRONMENT



Integrating Morphogenesis and Metamorphosis

One of the most dramatic signaling events in biology is the developmental transition from larval to adult form in organisms that undergo metamorphosis. In insects such as *Drosophila*, the destruction of larval tissues and their replacement with adult forms is triggered by the steroid hormone 20-hydroxyecdysone. What other factors help coordinate transcriptional regulation with the wholesale tissue restructuring?

Chen *et al.* found that signaling through LIM-kinase (a protein kinase regulated



Normal wings (top) compared with deformed wings from a mutant fly expressing a dominant negative LIM-kinase gene (bottom).

by the small guanosine triphosphatase Rho) is involved in these transitions. Rho modulates cell shape by regulating actin polymerization, and these changes affect transcription mediated by the serum response factor (SRF) transcription factor. Rho works through LIM-kinase to modulate expression of ecdysone-regulated genes, including *Stubble*, a gene encoding a protease involved in remodeling of the extracellular matrix. Cultured *Drosophila* SL2 cells required Rho signaling through SRF to allow proper ecdysone-dependent gene expression. Rho thus appears to be well placed to coordinate tissue remodeling and gene expression through its effects on the cytoskeleton, the extracellular matrix, and ecdysone-dependent gene expression. — LBR

Curr. Biol. 14, 309 (2004).