EDITED BY STELLA HURTLEY

<< Ancient Carbonate Minerals on Mars

The historical presence of liquid water on Mars together with a CO_2-rich atmosphere should have resulted in the accumulation of large deposits of carbonate minerals. Yet, evidence for the presence of carbonates on the surface of Mars has been scarce. Using data collected by the Mars Exploration Rover, Spirit, **Morris *et al.*** (p. 421, published online 3 June; see the Perspective by **Harvey**) now present evidence for carbonate-rich outcrops in the Comanche outcrops within the Gusev crater. The carbonate is a major outcrop component and may have formed in the Noachian era (~4 billion years ago) by precipitation from hydrothermal solutions that passed through buried carbonate deposits. Thus, it is likely that extensive aqueous activity under neutral pH conditions did occur on Mars.

Pulsar Clocks

Pulsars are rotating neutron stars whose rotation rates can be extremely stable, sometimes rivaling the precision atomic clock. Unfortunately, not all pulsars are this precise—most show irregularities in their rotation rates. Using a large data set collected over many years at Jodrell Bank in the United Kingdom, **Lyne *et al.*** (p. 408, published online 24 June) show that the rotation of pulsars is not modulated by a single spin-down rate but typically by two, each accompanied by a unique pulse profile. The irregularities are linked to abrupt quasiperiodic changes in the pulsar's magnetosphere, observed as changes in pulse shape and spin-down rate. Thus, it may be possible to use pulse-shape information to improve the precision of pulsars as stable clocks that can be used as probes of gravitational physics.

Let There Be Light

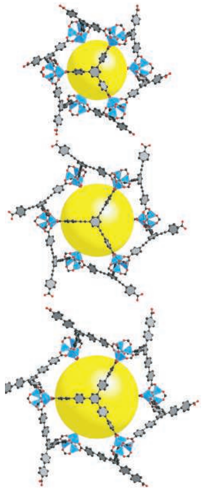
Retinitis pigmentosa, a disease that can result from a wide variety of genetic defects, causes degeneration of photoreceptor cells in the retina and leads to blindness. In the course of the disease, it is generally the rod photoreceptor cells that degenerate first. Cone photoreceptor cells may persist, but in a damaged and nonfunctional state. **Busskamp *et al.*** (p. 413, published online 24 June; see the cover; see the Perspective by **Cepko**) have now applied a gene therapy approach to mouse models of retinitis pigmentosa. Inducing expression of a bacterial light-activated ion pump, halorhodopsin, in the damaged cone cells improved visual responses in the diseased mouse retinas. Thus, it may be possible to rescue cone photoreceptors therapeutically, even after they have already been damaged.

Quantum Mechanics Born to Be Linear

Two pillars of modern physics, quantum mechanics and gravity, have so far resisted attempts to be reconciled into one grand theory. This has prompted suggestions that theories about either or both need to be modified at a fundamental level. **Sinha *et al.*** (p. 418; see the Perspective by **Franson**) looked at the interference pattern resulting from a number of slits, to test the "Born rule" of quantum mechanics. They verified that Born holds true—that the interference pattern is built up by the interference from two paths, and two paths only, with no higher-order paths interfering. The result rules out any nonlinear theories of quantum mechanics; thus, any modification of theory will need to take into account that quantum mechanics is linear.

Network Approaches to Highly Porous Materials

Metal-organic frameworks (MOFs), in which inorganic centers are bridged by organic linkers, can achieve very high porosity for gas absorption. However, as the materials develop larger void spaces, there is also more room for growing interpenetrating networks—filling the open spaces not with gas molecules but with more MOFs. **Furukawa *et al.*** (p. 424, published online 1 July) describe the synthesis of a MOF in which zinc centers are bridged with long, highly conjugated organic linkers, but in which the overall symmetry of the networks created prevents formation of interpenetrating networks. Extremely high surface areas and storage capacities for hydrogen, carbon dioxide, and methane were observed.



Acidification of the Ancient Oceans

Ocean acidification fueled by rising levels of atmospheric CO_2 is likely to become a major challenge for ocean ecosystems. Understanding how marine biota responded to similar events in Earth's history may provide clues as to what to expect—and what to prevent—in the future. To this end, **Erba *et al.*** (p. 428) present a detailed stratigraphic and geochemical characterization of 120-million-year-old marine sediments from a time when the oceans acidified because of a massive outgassing of volcanic CO_2. Microscopic fossils in the sediments, such as calcareous nannoplankton, show evidence of having responded to this major disruption through species-specific

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adaptations like deforming and shrinking their cells. These changes allowed these abundant and diverse organisms to avoid extinction, even through a subsequent global depletion of ocean oxygen levels.

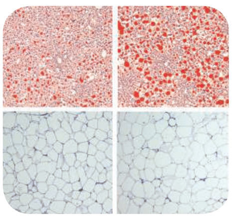
Staying in Place

The primary cilium is found on nearly all mammalian cells and is a key regulatory organelle for proper signal transduction throughout development and in adults. Extracellular signal transduction, such as that promoted by Sonic hedgehog (Shh), requires the enrichment of receptors and downstream signaling components in the ciliary membrane. Intraflagellar transport is involved in selective trafficking of proteins into the cilium, but it is not known how these proteins are retained in the cilium. It has been speculated that a diffusion barrier exists at the base of the ciliary membrane. Now, **Hu *et al.*** (p. 436, published online 17 June) demonstrate directly that a membrane diffusion barrier is indeed present at the base of the ciliary membrane. SEPT2, a member of the septin family that also forms a diffusion barrier in budding yeast and mammalian sperm membranes, localizes to the base of the ciliary membrane and is required for ciliogenesis, ciliary membrane protein localization, and cilium-dependent Shh signaling.

Location, Location, Location

The genome receives epigenetic marks throughout development that regulate the activity of multiple genes. One such mark is methylation, which usually represses gene transcription. Methylation has generally been studied in the promoters of genes, where many regulatory signals coordinate to control the expression of the gene. Studying neural stem cells from mice, **Wu *et al.*** (p. 444) now show that DNA methylation can be a double-edged sword. Although methylation of DNA sequences in promoters tends to be repressive, methylation of DNA sequences beyond the promoters can actually promote gene expression. Analysis of the methyltransferase Dnmt3a in mouse neural stem cells revealed that methylations around neurogenic genes—but outside their promoters—maintained the activity of these genes.

Fat's Mixed Messages



Certain metabolic disorders, such as type 2 diabetes, are more prone to arise in obese individuals, a link that has been attributed, in part, to the detrimental activities of adipokines—proteins secreted by fat cells. Most adipokines disrupt glucose homeostasis by promoting inflammation and insulin resistance. **Ouchi *et al.*** (p. 454, published online 17 June; see the Perspective by **Oh and Olefsky**) identify a new adipokine, secreted frizzled-related protein 5 (Sfrp5), which has the opposite effect: It is anti-inflammatory and appears to promote metabolic health. In obese mice, Sfrp5 suppresses the activation of key inflammatory cells (macrophages) residing within adipose tissue by inhibiting the c-Jun N-terminal kinase (JNK) signaling pathway. Further study of this Sfrp5-JNK1 regulatory axis in fat may offer therapeutic opportunities for obesity-linked metabolic disorders.

Complex I Under Scrutiny

Mitochondrial complex I is a large macromolecular membrane complex that couples electron transfer to proton pumping across the mitochondrial membrane and helps to drive adenosine 5′-triphosphate synthesis. **Hunte *et al.*** (p. 448, published online 1 July) now describe the structure of complex 1 from the aerobic yeast, *Yarrowia lipolytica*. The sites involved in redox chemistry are distant from those that pump protons, and the structure suggests that a 60-angstrom-long helix is involved in transducing energy to the proton-pumping elements.

Heme Communication Revealed by Asymmetry

An electronic bus bar is an electrical conductor that connects several circuits. **Świerczek *et al.*** (p. 451) now find that a similar strategy is used by the protein cytochrome bc_1 that plays a central role in cellular respiration and photosynthesis. Protein engineering was used to break the symmetry of a cytochrome bc_1 homodimer, which revealed that the dimer is bridged by electron transfer between two hemes. This allows electrons to move freely within and between dimers to distribute between four catalytic sites.

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