Breathing Conductivity into Diamonds

Diamond is an excellent electrical insulator, but for nearly 20 years, researchers have puzzled over observations that the surface of hydrogen-terminated diamonds becomes conducting after exposure to air. The phenomenon has recently been applied to device design, but a compelling explanation of the underlying chemistry remained elusive. Through careful electrochemical measurements, Chakrapani et al. (p. 1424; see the Perspective by Nebel) show that the positive hole carriers responsible for conduction arise from electron transfer to oxygen dissolved in aqueous films on the surfaces. Similar interfacial charge transfer equilibria could be active in other semiconducting solids.

Controlling Spin Electrically

Manipulation of the spin of a single electron stored on a quantum dot is a strong contender as the basis for quantum information processing. Coherent manipulation of the spin has been demonstrated for a locally applied magnetic field, but scaling up to larger ensemble systems of spins and the individual manipulation of spin with magnetic field present significant experimental problems. Nowack et al. (p. 1430, published online 1 November) now show that coherent manipulation of the spin state can be achieved using a locally applied electric field to the quantum dot. They argue that the observation of coherent Rabi oscillations arises from electrical modulation of the spin-orbit interaction experienced by the confined electron.

Helium Tracing of Rising Mantle Fluids

Mantle helium has a high \(^{3}\)He/\(^{4}\)He ratio but is diluted by \(^{4}\)He from other crustal isotopic processes. Kennedy and van Soest (p. 1433; see the Perspective by Hilton) investigated the geographic distribution of helium isotopes across the Basin and Range province of North America. A gradient in \(^{3}\)He/\(^{4}\)He correlates with rates of active deformation of the crust, and the highest ratios occur where the extension and shear strain rates are greatest. This finding indicates that deformation enhances the permeability of the lithosphere and allows fluid from the mantle to penetrate even in the absence of local magmatism. Local spots with high isotope ratios may also pinpoint areas of high crustal permeability that maybe valuable for geothermal energy development.

Parsing Extinct Primate Dynamics

Inferring the social characteristics of early hominins is difficult, in part because fossils are few, scattered, and rarely reveal group dynamics. One more reliable indicator may be the development of methods based on sex and age differences. One more reliable indicator may be the development of patterns between males and females and, by inference with other primate species, what such findings might imply about social and reproductive strategies. Lockwood et al. (p. 1443) used a large sample of facial fossils from \(P\)aranthropus robustus to show that males of this species, extant about 2 million years ago, developed much more slowly than did females.

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To Fold or Not to Fold...

Molecular chaperones not only prevent misfolding of proteins but also play an active role in protein folding pathways. However, how protein folding pathways are affected by chaperones remains poorly understood. Bechtluft et al. (p. 1458) used a combination of experimental and computational approaches to study the effect of the chaperone SecB on the folding and unfolding pathways of maltose binding protein (MBP) at the single-molecule level. SecB retains MBP in a molten globule-like structure so that no energy will be needed to disrupt stable tertiary interactions during translocation across the cell membrane.
In primates, this pattern implies that social groups were mostly female (with only one or a few males), and that the mortality of most of the males was high.

**Defensins and Dog’s Coats**

Inheritance of “dominant black” coat color in domestic dogs involves a gene that is distinct from, but interacts with, genes encoding components of conventional pigmentation systems. Variation in this so-called K locus accounts for differences between yellow, black, and brindle colors in more than 38 dog breeds. Using genetic strategies that exploit the evolutionary history of dogs, Candille et al. (p. 1418, published online 18 October; see the Perspective by Dorin and Jackson) make the remarkable discovery that this locus encodes a member of the β-defensins, a protein family that in other species has been implicated in the defense against microbes. Mechanistic studies revealed that CBD103 is a ligand for melanocortin receptors, proteins that control pigment type-switching.

**Boron and Plants**

For reasons that remain unclear, boron is a key micronutrient for plants. However, boron toxicity is particularly apparent in agriculture of equatorial and arid regions. Sutton et al. (p. 1446) have cloned a boron transporter from barley and find that forms of barley that are unusually tolerant of boron have extra copies of this gene. Miwa et al. (p. 1417) find that Arabidopsis plants engineered to overexpress a related boron transporter are also more tolerant of boron. Thus, it may be possible to engineer boron tolerance into crops to improve growth on marginally suitable lands.

**Putting Weight on DNA Methylation State**

Recently, genome-wide association studies have identified genetic variants that affect one’s risk of developing common disorders. Among the most interesting are obesity-associated sequence variants in the FTO (fat mass and obesity associated) gene, whose functional role has been unknown. Gerken et al. (p. 1469, published online 8 November) now show that FTO encodes a 2-oxoglutarate–dependent nucleic acid demethylase, an enzyme that removes methyl groups from DNA. The subcellular and tissue expression patterns of FTO are consistent with the protein’s potential roles in DNA modification and in organismal energy balance, but precisely how these roles are linked mechanistically remains unclear.

**Neandertal Redheads**

The melanocortin 1 receptor is involved in the pathway that produces melanin and is a major determinant of skin color in humans. Lalueza-Fox et al. (p. 1453, published online 25 October; see the 26 October news story by Culotta) analyzed Neandertal DNA corresponding to the human gene and found evidence of a novel allele unknown in modern humans. Functional analyses of this variant showed reduced function at a level similar to that seen in humans of European descent. Thus, some Neandertals may have had reduced pigmentation levels, possibly leading to similar pale skin color or red hair in modern humans.

**Reducing When Wet**

In a puzzling case of structural economy, nature manages to use the same iron-sulfur cluster motif in proteins for both oxidative and reductive electron shuttling. Dey et al. (p. 1464) used x-ray absorption spectroscopy and theoretical modeling to explore the environmental factors that shift the oxidation potential of high-potential iron-sulfur proteins (HiPIPs) and the reduction potential of ferredoxins into physiological range. They found that hydration from exposure to water accounts for a large part of the change. Ferredoxins have more hydrated active sites, but a desiccated sample showed iron-sulfur covalency (which correlates with ease of oxidation) that approaches the level seen in HiPIPs. Similarly, HiPIPs evidenced reduced covalency upon exposure to water through denaturing.