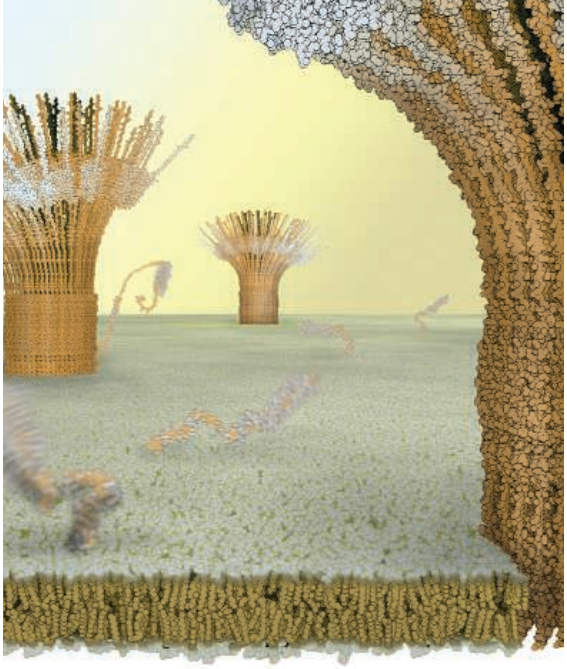
EDITED BY STELLA HURTLEY AND PHIL SZUROMI



<< Let's Get Together

Proteins in the eukaryotic plasma membrane mediate many different functions and are largely partitioned into clusters. Using the SNARE protein syntaxin 1 as an example **Sieber *et al.*** (p. 1072; see the Perspective by **White**) investigate the mechanism of clustering using high-resolution optical imaging, quantitative biochemistry, and molecular dynamics simulations. Weak protein-protein interactions are balanced by steric repulsion to give densely crowded clusters containing about 75 syntaxins. Proteins within the cluster are immobile, but can exchange with freely diffusing molecules. This conceptual framework likely applies to many other membrane proteins.

A Clean Break at Tantalum

Bacteria have evolved the remarkably efficient nitrogenase enzyme to metabolize N_2 to ammonia, whereas the fertilizer industry has long relied on heterogeneous iron catalysts at high temperature to perform the same reaction. Both systems appear to require the cooperation of multiple metal centers to cut the strong N_2 triple bond. **Avenier *et al.*** (p. 1056) have found that tantalum hydride complexes bound to a silica surface can cleave N_2 in the presence of H_2 at isolated metal centers, yielding Ta-NH and Ta-NH_2 products. Infrared spectroscopy reveals that the reaction mechanism is distinct from those in the enzymatic and iron-catalyzed reactions and in homogeneous organometallic systems.

A Lot from a Little

Sea-level rise from future melting of the Greenland and Antarctic ice sheets has received much attention because these harbor most of Earth's ice, but melting of the other glaciers and ice caps will also contribute, particularly over the next century, as they are melting rapidly. **Meier *et al.*** (p. 1064, published online 19 July; see the cover) survey these glaciers and ice caps and show that they are likely to contribute as much as 10 to 25 centimeters to sea-level rise during the next 100 years, perhaps up to 60% of the estimated total increase.

Capturing a Surface Crossing

Computer simulations of chemical reaction dynamics tend to rely on the simplifying Born-Oppenheimer approximation, which assumes that electron rearrangement is complete before the nuclei move about. However, experiments have shown that certain triatomic reactions violate the approximation; for example, in the abstraction of one deuterium atom from D_2, an electronically excited fluorine atom can form a ground-state DF product. **Che *et al.*** (p. 1061) undertook a more exact theoretical treatment of this reaction, encompassing multiple electronic potential energy surfaces, and also measured product distributions experimentally at different collision energies. They found strong agreement between theory and experiment in capturing the precise quantum-mechanical factors underlying chemical reactivity.

Fertilizing the Southern Ocean

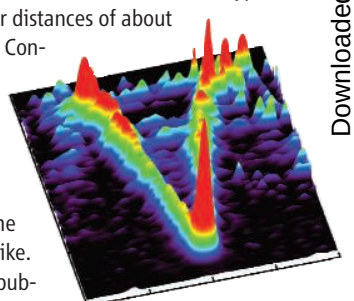
Experiments have shown that adding iron to surface waters in some parts of the world, can stimulate biological production. By analyzing compiled data and conducting additional experiments, **Cassar *et al.*** (p. 1067) show that gross primary production and net community production in large regions of the Southern Ocean is proportional to the input of soluble iron from aerosols. They conclude that iron addition increases export production and that windblown dust enhances gross primary production across large parts of the Southern Ocean.

Bacteria Seeing Blue

Phototropins, blue-light receptors in plants, are light-activated serine/threonine kinases with a flavoprotein LOV domain as their light-sensing module. In addition to the phototropins found in eukaryotes, gene-sequence analysis predicts that LOV domains should be present in prokaryotes, and archaea. **Swartz *et al.*** (p. 1090; see the Perspective by **Kennis and Crosson**) show that a subset of genes in prokaryotes encodes for proteins that function as light-activated LOV-histidine kinases. Light activation of the LOV domain leads to the formation of a flavin-cysteinyl adduct, which is the photoreceptor-signaling state that activates the kinase domain. Light-activated LOV-histidine kinases were found in two important plant and animal pathogens and in a marine photosynthetic bacterium and indicate that the LOV-histidine kinases are an important family of bacterial photosensory receptors.

Disordered but Coherent

When a magnet behaves classically, the spins on adjacent atoms are fixed and ordered and are typically correlated over distances of about 3 nanometers (nm). Confining the spins to a one-dimensional chain allows quantum fluctuations to become important, and the spins become disordered or fluid-like. **Xu *et al.*** (p. 1049, published online 26 July) now present inelastic neutron scattering measurements on the spin chain material Y_2BaNiO_5. Their data reveal that coherence between the spins, despite the quantum effects, extends to more than 20 nm, nearly an order of magnitude longer than the classical coherence length.



Threat, Distance, and Dread

Behavioral experiments suggest that the distance from a threat affects the state of fear in

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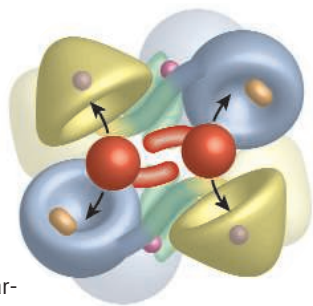
rodents. **Mobbs *et al.*** (p. 1079; see the Perspective by **Maren**) developed a computer program in which human subjects were chased by a virtual predator that could inflict real pain. As the virtual predator closed in, brain activity switched from the prefrontal cortex to the periaqueductal gray part of the midbrain. Higher-cortical systems thus control behavior when the degree of threat is perceived as low, while extreme levels of threat evoke phylogenetically older regions that control fast reflexive behaviors.

Astrocytes at Single Synapses

Astrocytes respond to synaptic activity and can release different gliotransmitters, which modulate neuronal activity and neurotransmission. **Perea and Araque** (p. 1083) examined the role of astrocytes on synaptic transmission at single hippocampal excitatory synapses. Ca^{2+} elevation in astrocytes led to a transient release of the neurotransmitter glutamate from astrocytes, which was mediated by metabotropic glutamate receptors. Potentiation became long-lasting when glial activation was paired with postsynaptic depolarization.

Metabolic Enzyme Nailed



Carboxylases transfer carboxyl groups in a number of essential metabolic reactions. The enzymes have distinct active sites to catalyze different steps of the overall reaction, and the covalently bound biotin cofactor is used to transfer activated carboxyl intermediates between the sites, but how this transfer is achieved has not been clear. Now **St. Maurice *et al.*** (p. 1076) report the complete structure of pyruvate carboxylase. Pyruvate carboxylase is active as a tetramer, and transfer of an activated carboxyl group occurs between active sites on separate polypeptide chains.

Motoring Chromatin Assembly

Molecular motor proteins, such as the chromodomain-containing factor CHD1, function in remodeling nucleosomes. In vitro analyses suggest that CHD1 acts as an ATP-utilizing chromatin assembly factor. **Konev *et al.*** (p. 1087) now examine the role of CHD1 in vivo in the fruit fly *Drosophila melanogaster*. Elimination of this factor results in infertile females because mutant embryos are unable to incorporate a histone variant into the paternal genome after protamine removal from the sperm. The *Chd1* null eggs cannot decondense sperm chromatin, resulting in the exclusion of paternal chromatin from the zygote and the generation of nonviable haploid embryos.

From Clone to Species

Because of widespread exchange of genes, bacteria do not fit easily into the conventional paradigm of species. **Retchless and Lawrence** (p. 1093) have devised a method to extract the time of divergence for different genes in different bacterial species. Using these data, they show genes that encode lineage-specific traits became genetically isolated long before recombination ceased at other loci. Thus, as bacterial lineages begin to separate, they can be considered different species at some genes, but the same species at other genes. This is quite different from any speciation process described for eukaryotes. Thus, ecologically distinct species must exist within traditionally named bacterial species, which may impact the use of microbial taxonomy to inform human decisions, such as medical diagnosis, epidemiology, or bioterrorism.

In Two Places at Once

The sense of being outside of one's physical body (an out-of-body experience) has generally fallen within the realms of neurological dysfunction, either organic or pharmacologically aided, or of paranormal phenomena. The advent of virtual reality has offered a noninvasive and reproducible approach to inducing out-of-body experiences in normal subjects, as shown by **Ehrsson** (p. 1048) and by **Lenggenhager *et al.*** (p. 1096; see the news story by **Miller**). Head-mounted displays were used to demonstrate that subjects would reliably report the sensation of inhabiting a virtual body, from which vantage point they would be looking at themselves. In addition, they reacted autonomically in response to harm directed at their virtual body and displaced their bodily sense of self toward their doppelganger and away from their physical body.

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