Locust Heaven

Locust outbreaks have severe consequences for agriculture, but the conditions that promote an outbreak are unknown. Cease *et al.* (p. 467) investigated aspects of the locust diet and found that increased nitrogen content of cereal grasses reduced the size and viability of a herbivorous locust species. This locust prefers low N plants, which result from heavy grazing by livestock and erosion.

Natural Selection Caught in the Act

Understanding how new functions evolve has been of long-standing interest. However, the number of mutations needed to evolve a key innovation is rarely known, or whether other sets of mutations would also suffice, whether the intermediate steps are driven by natural selection, or how contingent the outcome is on steps along the way. **Meyer *et al.*** (p. 428; see the Perspective by **Thompson**) answer these questions for a case in which phage lambda evolved the ability to infect its host *Escherichia coli* through a novel receptor. This shift required four mutations, which accumulated under natural selection in concert with coevolution of the host. However, when **Tenaillon *et al.*** (p. 457) exposed 115 lines of *E. coli* to high temperature and sequenced them, adaptation occurred through many different genetic paths, showing parallelism at the level of genes and interacting protein complexes, but only rarely at the nucleotide level. Thus, epistasis—nonadditive genetic interaction—is likely to play an important part in the process of adaptation to this environment.

Potassium Permeation

Two–pore domain potassium (K2P) channels conduct K^+ ions across the plasma membrane of eukaryotic cells. They help to maintain the cellular resting potential and their modulation can tune cellular excitability (see the Perspective by **Poulsen and Nissen**). **Miller and Long** (p. 432) describe a high-resolution crystal structure of the human K2P channel K2P1 (TWIK-1) and **Brohawn *et al.*** (p. 436) present a high-resolution structure of the lipid and mechanosensitive human channel TRAAK. In both structures an extracellular domain constricts the channel entrance so that K^+ ions reach the selectivity filter through side portals. Openings in the transmembrane region expose the central cavity to the lipid bilayer and a helix is kinked so that its C-terminal part lies in the cytosol-membrane interface. The structural features explain K2P conductance and gating and give insight into how the channels are regulated by diverse stimuli.

Porous Membranes

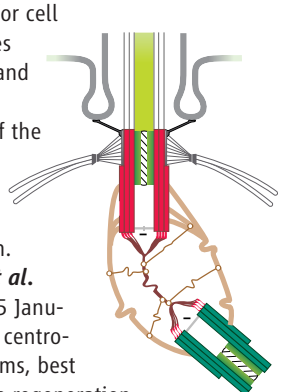
Thin semi-permeable membranes are commonly used as chemical barriers or for filtration purposes. While the size of the pores will influence which molecules are able to pass, other factors—including the surface chemistry of the pore walls, electrostatic interactions, and differences in solubility—can also affect the diffusion rates. There is also a trade-off between the thickness of the membrane regarding strength and permeation rates (see the Perspective by **Paul**). **Karan *et al.*** (p. 444) fabricated membranes from amorphous carbon, which showed excellent strength and could be used for filtrations involving organic solvents. **Nair *et al.*** (p. 442) observed unusual behavior in graphene-based membranes which were able to prevent the diffusion of many small-molecule gases, including helium, but showed almost barrier-free movement of water.

Boxing in Peroxide

Hydrogen peroxide (H_2O_2) is a powerful oxidant, and its reactivity is exploited in numerous biological, as well as synthetic, contexts. **Lopez *et al.*** (p. 450) have now managed to capture its dianion (O_2^{2-}) in a cryptand—essentially a molecular box assembled from benzamide derivatives—keeping the dianion stable in organic solution for days through a net of well-placed internal hydrogen-bond donors. The encapsulated dianion exhibited clean oxidative reactivity back to O_2 either by chemical or by electrochemical means.

Centrosome Center Stage?

The centrosome is a major organizer of the cytoskeleton in animal cells. The precise duplication of this organelle at each cell cycle ensures proper organization of the mitotic apparatus and chromosome segregation. However, centrosomes are dispensable for cell division during some stages of development in mouse and *Drosophila*. **Bornens** (p. 422) reviews the role of the centrosome in a variety of organisms and discusses how and why they can be dispensed with on occasion. In this vein, **Azimzadeh *et al.*** (p. 461, published online 5 January) now demonstrate that centrosomes in Planarian flatworms, best known for their remarkable regeneration abilities, are completely dispensable for both cell division and development.



Magnetic Moon

It has long been suspected that the Moon once had a core-dynamo magnetic field. **Shea *et al.*** (p. 453) describe a lunar basalt brought back by Apollo 11 that records evidence for a strong dynamo on the Moon 3.7 billion years ago. This study, together with a previous study of different lunar rock, implies that a lunar core dynamo existed between 4.2 and 3.7 billion years ago, which extends the known lifetime of the lunar dynamo by 500 million years.

Continued on page 379

CREDITS (TOP TO BOTTOM): ARIANNE CEASE; BORNENS *ET AL.*

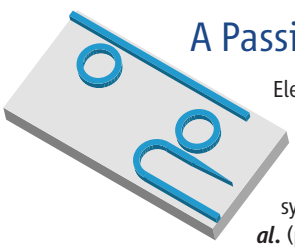
Continued from page 377

Forest Diversification

The relative role of neutral and deterministic processes in generating species richness in ecological communities (particularly tropical trees) has dominated recent discussions about patterns of diversity and abundance of species. **Ricklefs and Renner** (p. 464) present a test of random diversification and population change by comparing the numbers of individuals and species in plant families between forest plots on different continents that have diversified independently for millions of years. Stochastic theory, based on random events, predicts that there should be no correlation between the regions; however, the data reveal strong, statistically significant correlations. Thus, patterns of diversity appear to be dominated by deterministic processes.

A Good Judge of Distance

Jumping spiders actively pursue their prey, often jumping relatively long distances in order to catch them. Such feats require accurate depth perception. **Nagata *et al.*** (p. 469; see the Perspective by **Herberstein and Kemp**) show that jumping spiders use a process called image defocus, which allows depth perception to be obtained through the comparison of a nonfocused image to a focused image within the same eye. A single layer within the spider's eye that could not focus green light nevertheless contained a green sensitive pigment. Thus, this layer always receives an unfocused image, while other layers receive images in focus. Confirming this eye arrangement's role in depth perception, spiders unlucky enough to be bathed in green light nearly always jumped short of their target.



A Passive Optical Diode

Electrical diodes are at the core of microelectronics. The optical equivalent, however, has been difficult to realize owing to the time-reversal symmetry of Maxwell's equations that describe electromagnetic propagation. Usually, a control input in the form of a magnetic field is required that breaks that symmetry. Such inputs are not practical for optical integrated circuits. **Fan *et al.*** (p. 447, published online 22 December) developed a silicon-based microresonator device that could control the asymmetric transmission of light through it. The passive optical diode was compatible with current complementary metal-oxide semiconductor processing technology and thus should be readily integrated into optoelectronic circuitry.

Prion Problem

Prion disease, like "mad cow disease," has shown a frightening ability to cross the species transmission barrier, but, mercifully, with low efficiency. However, the role of different tissues in prion cross-species transmission is unclear. **Béringue *et al.*** (p. 472; see the cover; see the Perspective by **Collinge**) compared the ability of brain and lymphoid tissues from "ovinized" (sheeplike) and "humanized" transgenic mouse models to replicate prion transmission across a robust transmission barrier. Lymphoid tissue of these mice was consistently more permissive than brain tissue to prions such as those causing chronic wasting disease and bovine spongiform encephalopathy. Because previous measures of the transmission barrier have focused on the brain, this heightened susceptibility of lymphoid tissues could strongly impact estimates of the number of silent carriers of prion disease.

Antigen Polarity in B Cell Differentiation

Communication received through cell contact is critical for the differentiation of specialized effector cell populations during the immune response. For example, B lymphocytes acquire antigen that they present to helper T lymphocytes. T lymphocytes, in turn, provide key differentiation signals to B lymphocytes. In order to learn more about this process, **Thaunat *et al.*** (p. 475; see the Perspective by **Dustin and Meyer-Hermann**) used multiphoton microscopy and imaging flow cytometry to visualize the localization of antigen in B lymphocytes during an immune response. Antigen acquired by B lymphocytes exhibited a polarized distribution that was sustained over several rounds of cell division. This produced a population of activated B lymphocytes that contained very low levels of antigen. Daughter cells that received more antigen were better able to stimulate T cells. Because cues received through T lymphocyte interactions are likely to influence B lymphocyte fate decisions, unequal distribution of antigen in dividing B lymphocytes may influence their differentiation.

CREDIT: FAN *ET AL.*

Published by AAAS