



conformations. Discovery of structural elements associated with specific signaling pathways could lead to new strategies in therapeutic development. — VV

*Nature* 10.1038/nature10361 (2011);

*Nat. Chem.Biol.* 7, 10.1038/NCHEMBIO.634 (2011).

#### IMMUNOLOGY

### Prions May Do Good, Too

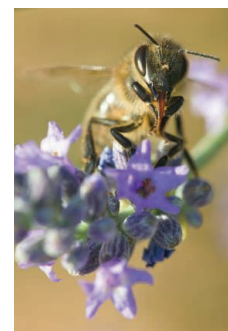
Prions are the causative agent in fatal neurological diseases affecting humans and animals. Prions are a native protein conformation's Mr. Hyde: They adopt a particular conformation that induces self-perpetuating protein aggregation, which can lead to devastating effects. Recent evidence suggests that not all prions are bad, however, and now Hou *et al.* show that effective antiviral immunity may depend on the formation of prion-like aggregates of the protein MAVS. MAVS functions downstream of RIG-I, an RNA helicase important for detecting viruses. RIG-I induced formation of MAVS prion-like fibrils in response to viral infection. These fibrils were resistant to detergent and protease and were able to "infect" endogenous MAVS proteins—that is, convert native MAVS into fibrils. These characteristics are all hallmarks of prions, which suggest that organisms can also use prions to their own advantage. — KLM

*Cell* 146, 448 (2011).

#### ECOLOGY

### Just a Few Make a Big Impact

Mutualism is the mutually beneficial ecological interaction between species. Traditionally, the biology of mutualisms has been studied in the context of two interacting species—plants and their pollinators being a prime example. Recently, attention has focused on wider networks of mutualists; for example, some pollinators are generalists that visit a wide range of plant species, and some plants attract a wide range of pollinators. Research on the ecology and evolution of these more complex systems has been facilitated by the recent explosion of interest in network theory. Guimaraes *et al.* studied patterns of coevolution in such



#### EPIDEMIOLOGY

### 1918 Flu in 2011

Analyses of historical data from the devastating influenza pandemic of 1918 have facilitated our understanding and preparations for controlling contemporary outbreaks. Fraser *et al.* accessed previously unpublished data from the fall of 1918, gathered during a household survey of over 7000 Maryland households conducted by Wade Hampton Frost, who led the U.S. Public Health Service's investigations into the Spanish flu. Frost made a mathematical model of disease transmission, which Fraser *et al.* have expanded on. The most important parameter in epidemic control is transmissibility, and the new analysis shows that rates of transmission within households were actually quite low and very variable. It appears that not only were roughly a fifth of the population immune before the fall wave of infection, but also that there appeared to have been very few asymptomatic infections. These revelations show that influenza is consistently only moderately transmissible and thus always potentially controllable, provided that the measures and tools available to us now remain available. — CA

*Am. J. Epidemiol.* 174, 10.1093/aje/kwr122 (2011).

#### STRUCTURAL BIOLOGY

### Many Ways of Conforming

G protein-coupled receptors (GPCRs) are activated by numerous extracellular stimuli and in turn activate diverse downstream pathways. Rather than ligand-dependent shifting of receptor equilibrium between single active and inactive conformations, with the relative activation of a particular pathway depending on the degree of coupling to that pathway, recent evidence suggests that multiple receptor conformations signal different pathways selectively. For example, the  $\beta_2$ -adrenergic receptor ( $\beta_2$ AR) signals through both G proteins and  $\beta$ -arrestins, and "biased ligands" were shown to

selectively activate only a subset of pathways. Crystal structures have provided insight into GPCR function and, in particular, Rasmussen *et al.* reported a structure of agonist-occupied  $\beta_2$ AR bound to a G protein that provides a high-resolution view of conformational changes associated with activation. Crystal structures, however, cannot capture the full dynamics of GPCRs. Kahsai *et al.* used a quantitative mass spectroscopy approach and focused on the reactivity of specific residues to investigate the effects of nine functionally distinct ligands on  $\beta_2$ AR conformation. Although some ligands induced reactivity that resembled classical receptor agonism, other ligands showed induced patterns suggestive of multiple ligand-specific

networks, exploring in particular the evolutionary influence of supergeneralists that provide mutualistic services to many other species in the ecological community. They find that supergeneralists play key roles in the evolution of their mutualistic partner species, particularly leading to the convergence of traits associated with the mutualism. Thus, the gain or loss of supergeneralists, as can occur when humans introduce species such as honeybees or cause the extinction of large seed dispersers, is likely to have important and in some cases rapid evolutionary consequences for their mutualistic partners. — AMS

*Ecol. Lett.* **14**, 10.1111/j.1461-0248.2011.01649.x (2011).

## CHEMISTRY

## N to the Rescue

In the war against infectious disease, bacteria are in the process of scoring a frightening tactical victory. Vancomycin is often used as the antibiotic to treat strains that have evolved resistance to other drugs, but it too is falling prey to resistant strains. A simple swap of oxygen for protonated nitrogen (more specifically, lactate for alanine) by the bacteria at vancomycin's binding site is remarkably effective at disarming the drug's mechanism of action. Xie *et al.* fight back by introducing a compensatory swap of their own—NH for O at the complementary site on the vancomycin framework. This modification leads not only to high-affinity binding with a model of the resistant target, it also conserves impressive binding affinity with a model of the native target (just a factor of 2 shy of vancomycin itself). In other words, the NH-substituted drug derivative appears to have the capacity to bind either to the lactate site or to the alanine site, which the authors rationalize by a flexible protonation equilibrium that would render the drug's nitrogen center an effective H-bond donor or acceptor. The authors furthermore observe promising results with the modified drug against vancomycin-resistant bacteria in culture. — JSY

*J. Am. Chem. Soc.* **133**, 10.1021/ja207142h (2011).

## MATERIALS SCIENCE

## Coming to Order

That cuprate superconductors are perfect conductors up to such high transition temperatures ( $T_c$ ) is all the more surprising in light of their origin as chemically doped insulators. In some layered cuprate families, such as  $\text{La}_2\text{CuO}_{4+y}$ , ordered oxygen dopants that intercalate between

the  $\text{CuO}_2$  layers are used to elicit superconductivity. When first introduced, however, these oxygen ions are mobile and disordered. Ordering takes place on a time scale of weeks, and little is known about the details of this process. Poccia *et al.* fast-forward the ordering dynamics by illuminating a disordered sample with x-rays, and use x-ray diffraction (XRD) to monitor the evolution of order, both parallel ( $a$  and  $b$  axes) and perpendicular ( $c$  axis) to the  $\text{CuO}_2$  layers. The XRD data reveal that the initial sample has small ( $\sim 2$  nm), almost isotropic islands of order, which act as nuclei for the final ordered state: They initially combine, then grow predominantly in the  $a$ - $b$  plane, and finally along the  $c$  axis. The authors use the x-ray switching to create simple patterns (a dot and a line) of order in a disordered sample, which can be erased by heating. Because  $T_c$  is found to grow with ordering, it is in principle possible to create more complicated circuits as well. — JS

*Nat. Mater.* **10**, 10.1038/NMAT3088 (2011).

## ENVIRONMENTAL SCIENCE

## Fresh Enough for the Farm?

As freshwater resources dwindle, purified wastewater is increasingly discussed as a supplement for such high-volume uses as crop irrigation. In a 15-year field-scale test of this prospect, Assouline and Narkis studied the soil properties of an irrigated avocado farm in Israel; one side of the farm received natural fresh water, while

the other received treated domestic wastewater that by most accounts was quite similar to the natural source but had increased dissolved organic matter, salinity, and suspended solids. Over the study period, several hydraulic proper-

ties of the clay-rich soil degraded in the plots that received treated wastewater, to the point that irrigation events created a smaller but more saturated volume of wetted soil. These conditions may have contributed to smaller root zones that ultimately led to lower crop yields. Because some soil horizons responded differently to the treated wastewater, it is not yet clear if treated wastewater will have this effect on other soil types or if precipitation patterns across different regions buffer against soil degradation. — NW

*Water Resour. Res.* **10.1029/2011WR010498** (2011).

