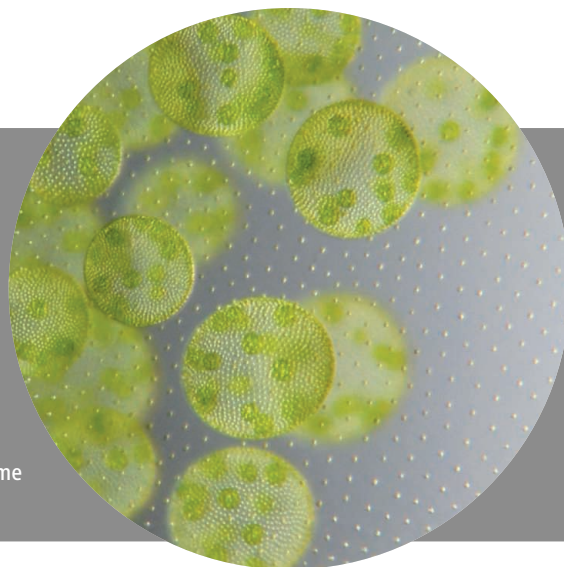


## Going Multicellular >>

The volvocine algae include both the unicellular *Chlamydomonas* and the multicellular *Volvox*, which diverged from one another 50 to 200 million years ago. Prochnik *et al.* (p. 223) compared the *Volvox* genome with that of *Chlamydomonas* to identify any genomic innovations that might have been associated with the transition to multicellularity. Size changes were observed in several protein families in *Volvox*, but, overall, the *Volvox* genome and predicted proteome were highly similar to those of *Chlamydomonas*. Thus, biological complexity can arise without major changes in genome content or protein domains.

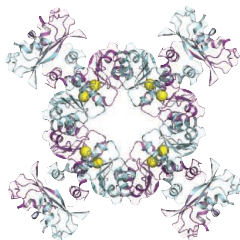


## Out of the Oort Cloud

Long-period comets originate from the Oort cloud, a vast reservoir of icy bodies that surrounds the solar system. These bodies are thought to be remnants from the formation of the solar system. But did they all form in the Sun's protoplanetary disk, or could they have been generated in the protoplanetary disks of other stars in the cluster where the Sun probably formed? Levison *et al.* (p. 187, published online 10 June) used detailed numerical simulations to investigate what fraction of comets might transfer from the outer reaches of one stellar system to another. The simulations suggest that a substantial number of comets can be captured through this mechanism, which may explain why the number of bodies in the Oort cloud is larger than models predict.

## BK Channel Cytoplasmic Domain

BK channels are potassium ion channels found on the surface of a variety of cell types that are essential for the regulation of several key physiological processes, including smooth muscle tone and neuronal excitability. BK channels are regulated by both membrane voltage and intracellular  $\text{Ca}^{2+}$ . The channel comprises an integral membrane pore, an integral membrane voltage sensor domain, and a large cytoplasmic region that confers  $\text{Ca}^{2+}$  sensitivity. Now Yuan *et al.* (p. 182, published online 27 May; see the Perspective Weyand and Iwata) have determined the crystal structure of the cytoplasmic domain



of the human BK channel. Four cytoplasmic regions form a gating ring at the intracellular membrane surface with four  $\text{Ca}^{2+}$  binding sites on the outer perimeter.

## Elucidating Turbulent Flow

When needing to mix two fluids rapidly, turbulent flow can be beneficial. However, in most cases, the churning and tumbling motions of a fluid during turbulent flow reduce the efficiency of a device or process. When fluid flows past a solid object, the bulk of the turbulent motion is concentrated at the surface boundary, but it is unclear to what extent these inner motions are influenced by flow far from the boundary. Marusic *et al.* (p. 193; see the Perspective by Adrian) demonstrate a nonlinear connection between inner-layer motions and the large-scale outer-layer motions in wind tunnel experiments. A simple model was able to describe the relationship mathematically while accurately mapping the experimental data.

## Switching Basins

Most of the densest, deepest water at the bottom of the oceans comes from two regions, the North Atlantic and the circum-Antarctic. Have other regions been able to produce significant quantities of deep water in the past? For decades, researchers have looked, with limited success, for evidence of deepwater formation in the North Pacific since the time of the Last Glacial Maximum, about 23,000 years ago. Okazaki *et al.* (p. 200) combine published observational evidence from the North Pacific with model simulations to suggest that deep water did form in the North Pacific during the early part of the Last Glacial Termination, between about 17,500 and 15,000 years ago. The switch between deep-water formation in the North Atlantic and the North Pacific is likely to

have had an important effect on heat transport and climate.

## Nanorod Polymers

Nanoparticles and colloids have been used to model crystallization and melting phenomena. Liu *et al.* (p. 197) studied the polymerization kinetics of nanoparticles. Functionalized arrowhead nanorods acted as linkable units that joined together in solvent-tuned assembly. The results resembled common processes of chemical polymerization: Growth was controlled kinetically and could be interpreted by formulas for step-growth polymerization and branching. Furthermore, some isomerization phenomena were observed, as was the formation of cyclic "macromolecules."

## Quake Control

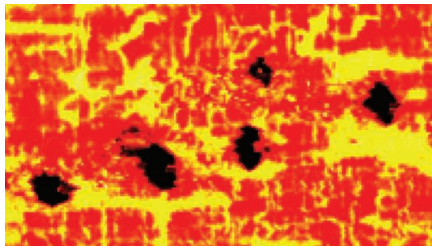
Large earthquakes occur at the margins of two colliding plates, where one plate subducts beneath the other at a shallow angle. These megathrust earthquakes often cause destructive tsunamis owing to the displacement of large volumes of water at the fault along the plate boundary. Two related studies of the seismic structure of subduction zones attempt to reveal the underlying mechanisms of megathrust earthquakes (see the Perspective by Wang). Kimura *et al.* (p. 210) compared seismic reflection images and microearthquake locations at the Philippine Sea plate where it subducts obliquely beneath Japan. The locations of repeating microearthquakes correspond to active transfer of material from the subducting plate to the continent—a process only previously assumed from exhumed metamorphic rocks. Dean *et al.* (p. 207) observe an expansive structure in the sea-floor sediment near the location of the 2004 and 2005 Sumatra earthquakes in Indonesia that suggests sediment properties may influence the magnitude of megathrust ruptures and their subsequent tsunamis.

## Offsetting the Cost of Parasitism

Fruit flies, like most animals, are vulnerable to infection by a range of organisms, which, in co-infections, can interact with sometimes surprising effects. **Jaenike *et al.*** (p. 212) discovered that a species of *Spiroplasma* bacterium that is sometimes found in flies, and that is transmitted from mother to offspring, protects its host from the effects of a nematode worm parasite, *Howardula aoronymphium*. The worm sterilizes the female flies and shortens their lives, but when flies were experimentally infected with *Spiroplasma*, their fertility was rescued. Similarly, in wild populations of fruit flies infected with worms, those also infected with *Spiroplasma* had more eggs in their ovaries. The bacterium inhibits the growth of the adult female worms, but such is the advantage of this bacterial infection in offsetting the burden of nematodes on reproductive fitness, *Spiroplasma* appears to be spreading rapidly through populations of fruit flies in North America.

## Separating Under Strain

Complex oxides, such as cuprate superconductors and perovskites, often exhibit microscopic phase separation, where two or more phases coexist on the macroscopic scale but are spatially separated on the microscopic scale. **Lai *et al.*** (p. 190) studied a configuration often found in technological applications, a strained manganite thin film placed on a substrate. Microwave impedance microscopy, which differentiates between conducting and insulating areas on the thin film, allowed visualization of the phase separation as the magnetic field was varied. A network of conducting domains was observed whose orientation and characteristic length scales suggest that the substrate-exerted strain was involved in network formation.



## Getting Gametes Together

Despite decades of research, the molecular basis of sperm-egg recognition in mammals remains unresolved. Models in which a glycan ligand in the zona pellucida (ZP) surrounding ovulated eggs binds to a sperm surface receptor have been widely embraced. A more recent model proposes that the cleavage status of a ZP protein, ZP2, renders the structure of the zona matrix either permissive or nonpermissive for sperm binding. **Gahlay *et al.*** (p. 216) tested predictions of each model by replacing endogenous zona proteins with either a mutant form of ZP2 that could not be cleaved or of ZP3 that lacked O glycan attachment sites. Sperm-egg recognition depended on the cleavage status of ZP2 rather than on glycan ligands released following fertilization.

## Righting Repair Pathways

The genetic disease Fanconi anemia (FA) results from mutations in a series of genes involved in a DNA repair pathway that helps process the damage caused by erroneous chemical cross-links between the two strands of the DNA double helix. The double-stranded breaks in DNA that arise from such cross-links can be repaired in an error-free manner or through an error-prone repair pathway. **Pace *et al.*** (p. 219, published online 10 June) show that the FA pathway can drive repair through the error-free pathway. The FA *FANCC* gene shows a genetic interaction with a component of the error-prone repair pathway, Ku70, inhibiting its action and thereby promoting the error-free pathway.

## Correcting a Liver Problem

The classical form of  $\alpha_1$ -antitrypsin (AT) deficiency is caused by a point mutation that alters the folding and causes intracellular aggregation of AT—an abundant liver-derived plasma glycoprotein. AT deficiency is the most common genetic cause of liver disease in childhood and can also lead to cirrhosis and/or hepatocellular carcinoma in adulthood. Carbamazepine is a drug known to be well tolerated in humans that enhances the intracellular degradation process known as autophagy. Now, **Hidvegi *et al.*** (p. 229, published online June 3; see the Perspective by **Sifers**) show that carbamazepine can reduce the severity of liver disease in a mouse model of AT deficiency by enhancing the degradation of misfolded accumulated AT.

CREDIT: LAI ET AL.