# THIS WEEK IN Science

edited by Stella Hurtley and Phil Szuromi

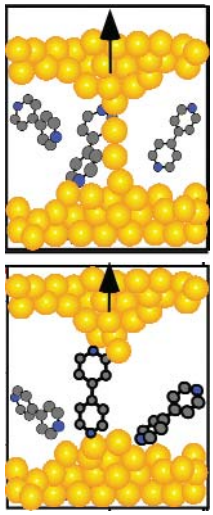
## Really Large Mergers

Our galaxy contains an interesting stream of stars that may represent the disruption of a previous small satellite galaxy as it merged with the Milky Way. **Forbes *et al.*** (p. 1217) used the Keck 10-meter telescope and the Hubble Space telescope to obtain direct evidence for such merger processes in the Tadpole Galaxy UGC 10214. They observed the stretching of the colliding dwarf galaxy into a characteristic ellipse and the formation of tidal tails on the rotating galaxy arising from the gravitational forces induced from the dark-matter halo of the larger galaxy. These observations imply that this process is ongoing and likely happens fairly quickly in the universe, and may also explain the high abundance of small elliptical galaxies.

## Earning Their Striped Phase

The formation of chiral liquid crystalline phases normally requires chiral molecules, but achiral "bow-shaped" or "bent-core" molecules are known to separate into macroscopic chiral domains. These molecules have given rise to a rich array of phases with unusual structure and dipolar ordering. **Coleman *et al.*** (p. 1204; see the cover) now show that in one of these phases, the so-called B7 phase, a local spontaneous ordering of molecular polarity and chirality drives the formation of larger scale stripes that undulate in their packing and dipole arrangement. They base their structure on results from x-ray diffraction, optical texture, and freeze-fracture transmission electron microscopy, as well as theoretical arguments.

## Breaking Down Molecular Conductivity



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One approach for studying the electrical conductance of single molecules is to form an extremely narrow "break junction" between gold electrodes and then introduce the molecule into the gap. Another is to probe molecules assembled on a surface with a gold nanoparticle attached to a scanning probe tip. **Xu and Tao** (p. 1221) combine both approaches by using a gold scanning tunneling microscope tip to create break junctions on a gold surface covered with molecules that can bond to gold on both ends (4,4′-dipyridine and *n*-alkanedithiols). This method is simple enough that thousands of measurements can be made. Histograms of conductivity data show characteristic peaks at integral multiples of a base conductivity value than reflects bridging by one or more molecules. Clean surfaces show no such conductivity peaks.

## Grabbed by the Tail

Cavitands are water-soluble organic compounds in which charged groups (typically carboxylates) line a hydrophobic pocket. The charged interactions usually dominate, but **Trembleau and Rebek** (p. 1219) report that a cavitand that typically binds amines (bearing a positive charge) also binds surfactants (sodium dodecyl sulfate and dodecyl phosphocholine) that are amphiphilic. Nuclear magnetic resonance studies show that the long alkyl tails of the surfactants escape their aqueous environment and wind themselves into the cavitand's hydrophilic pocket.

## Pulling Aluminum Parts Together

Rapid prototyping has changed the way many industries operate by allowing for the fabrication of parts or a complete assembly directly from the blueprints. Steels, ceramics, and polymers have been processed this way, but it is still very difficult to manufacture parts from aluminum because of its tendency to rapidly form an oxide coating. **Sercombe and Schaffer** (p. 1225) show that by heating a resin-bonded "preform" (a mixture of aluminum and magnesium powders in nylon binder) in a low oxygen environment, they can form an aluminum nitride skeleton. The skeleton then gives the part sufficient strength and dimensional stability that it can be infiltrated with a second aluminum alloy.

## Aligned Against the Flow

Seismic anisotropy, where the sound speed is faster in one direction, may be caused by mantle flow at mid-ocean ridges. The faster speed has been attributed to the alignment of the *a* crystal axes of olivine crystals parallel to the flow direction. **Holtzman *et al.*** (p. 1227; see the Perspective by **Bystricky**) performed simple shear experiments on olivine, basaltic melt, and molten sulfide or solid chromite. Melt-rich and melt-poor bands formed, and the *a* axes of the olivine grains in the melt-poor bands aligned perpendicular to the applied simple shear (a proxy for the mantle flow direction). Thus, in a more complex system of segregated liquid and solid phases, the fast direction of the seismic anisotropy may be perpendicular to mantle flow.

## The Dynamics of Digesting DNA

Recombination in bacteriophage λ requires an exonuclease that digests one strand of DNA in a 5′ to 3′ direction. The enzyme is highly processive, and the energy for translocation comes from the hydrolysis of the phosphodiester bond. **Van Oijen *et al.*** (p. 1235) studied the kinetics of single exonuclease molecules moving along DNA. The catalytic rate depended upon the base sequence of the substrate DNA and fluctuated in response to differences in the energy required to break Watson-Crick hydrogen bonds and disrupt base stacking. Sequence-independent rate fluctuations were also observed that likely reflect conformational changes of the enzyme-DNA complex.

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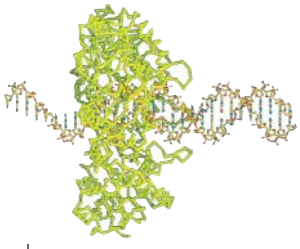


## Substitution Reactions of Carbenes

Carbene compounds bear a carbon atom with six rather than the normal eight valence electrons. Long viewed as fleeting intermediates, stable carbenes have been synthesized and even used as ligands in transition metal complexes. **Merceron-Saffron *et al.*** (p. 1223) now show that carbenes can undergo nucleophilic substitution reactions that should enable the synthesis of libraries of carbene compounds needed for the optimization of their applications, such as in catalysis.

CREDITS: (TOP TO BOTTOM) XU AND TAO; VAN OIJEN *ET AL.*

## Generating Diversity

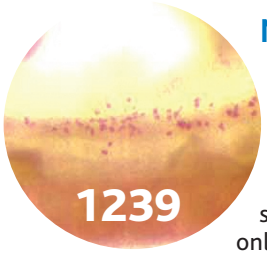
Hybridization might speed the pace of evolution by generating new gene combinations that promote the development of novel adaptations, but the reduced fitness of hybrids might also create an evolutionary dead-end. **Rieseberg *et al.*** (p. 1211; see the Perspective by **Abbott**) tested whether major ecological transitions in sunflowers are facilitated by hybridization. Three species of sunflowers found in three extreme habitats (sand dunes, desert floor, and salt marshes) represent ancient hybrid derivatives of two parental species. Thus, ecological divergence through hybridization is feasible and has facilitated the origin and divergence of sunflower species. By generating variation at many genes simultaneously, hybridization can provide a mechanism for large and rapid adaptive evolutionary transitions that might otherwise be difficult.

## Plant Pathogen Target

Many pathogens of mammals and plants use a conserved delivery system, the type III secretion system, to inject virulence factors into their hosts. However, few of the host targets are known, and how the plant surveillance system works is not well understood. **Shao *et al.*** (p. 1230) show in *Arabidopsis* that a protein kinase, PBS1, is the host target for a *Pseudomonas syringae* virulence protein AvrPphB, a cysteine protease that cleaves PBS1. The resulting fragment of PBS1 autophosphorylates, and, possibly in conjunction with AvrPphB, is then recognized by the plant resistance protein RPS5.

## Fast Folding of Single-Protein Molecules

Single-molecule protein-folding experiments have provided valuable information on the conformational states that are significantly populated at equilibrium for a particular denaturant condition. Now **Lipman *et al.*** (p. 1233) combine single-molecule and mixing techniques to monitor the folding of the cold shock protein under nonequilibrium conditions. After triggering folding by an abrupt change in denaturant concentration, they monitor Förster resonance energy transfer to follow the distributions of protein structures during folding.




## Making Germ Cells

The development of germ cells in mammals can differ significantly from that in other species. The gene *Nanos* promotes germ cell development in *Drosophila*. **Tsuda *et al.*** (p. 1239) have found two conserved *nanos* genes in mice that are also required for germ cell development. Intriguingly, *nanos3* was required for both spermatogenesis and oogenesis, but the related gene, *nanos2*, was only required for spermatogenesis. Thus, there is conservation of function within the germ cell development pathways from fly to mouse.

## A Persistent Mutation

Persistence is a key factor in the spread and reactivation of many parasitic diseases including leishmaniasis. Previous work has concentrated exclusively on host factors involved in persistence. **Späth *et al.*** (p. 1241) describe a mutant form of the parasite *Leishmania major* that is specifically defective in its ability to cause acute pathology because of the loss of a key glycoconjugate pathway. However, the mutant parasite can persist in the infected mammalian host indefinitely. This mutant may now be used to help in the elucidation of mechanisms of persistence, and in the development of effective vaccines and chemotherapy.

## Sugar Coatings

The production of glycoproteins with appropriate glycosyl side chains within a fermentable organism would be an important advance for biotechnology. **Hamilton *et al.*** (p. 1244; see the news story by **Service**) describe the genetic engineering of the secretory pathway in the yeast *Pichia pastoris* and show the production of complex human *N*-glycans in this fungal system. The uniform glycan modifications should aid in the study of structure-function relations of glycoproteins.

CREDIT: TSUDA *ET AL.*