Polymer Production
Organic chemists have developed a wide range of techniques for linking and functionalizing small molecules that polymer chemists have exploited for creating larger molecules with controlled architectures and chain lengths. A rich toolbox is now available for making macromolecules that could not be made using standard polymerization techniques. **Hawker and Wooley** (p. 1200) review a number of key advances, and show how these new polymeric systems are showing promise for applications including encapsulation, drug delivery, and thin-film patterning, as well as for the study of fundamental polymer properties.

Tracking a Proton Propeller
Discovery of superacids revealed that, with a weak enough counterion, even a molecule as inert as methane could bind an extra proton. The product when methane is acidified, the CH₅⁺ ion, has long puzzled theorists and spectroscopists alike. The hydrogen atoms seem to change places with one another too rapidly to assign the geometry and bonding mode reliably. **Asvany et al.** (p. 1219, published online 30 June 2005) have now measured the vibrational spectrum of CH₅⁺ by detecting its infrared-induced reaction with CO₂. Comparison with simulations supports a structure in which a CH₃ tripod binds an H₂ fragment through a three-centered, two-electron bond, with a barrier for exchange between these different sites of 0.3 kilocalorie per mole.

Melting and Freezing
Melting and crystallization are often easier to study in colloids, where the particles are readily visualized (see the Perspective by **Pusey**). Premelting can occur at the crystal surfaces below the bulk melting temperature, but this phenomenon has not been observed in the bulk itself. **Alsayed et al.** (p. 1207, published online 30 June 2005) studied the melting of colloidal crystals composed of microgel particles that undergo large volume changes with small changes in temperature. Premelting can occur in the bulk at grain boundaries and dislocations and depends on the interfacial free energy associated with each type of defect. The addition of impurities to a melt can stop, slow down, or accelerate the crystallization of the bulk material. The interactions between impurity and bulk are complex, because one needs to consider differences in shape and size, as well as the nature of the chemical interactions between the two materials. **De Villeneuve et al.** (p. 1231) examine the role of curvature in which the impurities were large colloidal particles embedded in a sea of smaller ones. The presence of impurities did not necessarily slow down crystallization, but the relative curvature did play a role in pinning grain boundaries that formed. Each impurity was surrounded by a mobile layer of small particles.

Snapshots in Solution
X-ray diffraction has long permitted chemists to map out the molecular structure of solids. Recently, short and intense x-ray pulses from synchrotrons have produced time-resolved pictures of structural rearrangements, but the samples, such as proteins, first had to be immobilized. **Ihee et al.** (p. 1233, published online 14 July 2005; see the Perspective by **Anfinrud and Schotte**) used intense 100-picosecond x-ray pulses to probe a reaction in solution. The sensitivity of x-rays for heavy atoms allowed them to follow an iodine atom in the photodissociation of diiodoethane to I₂ and C₂H₄. Over a large solvent background, the data offer direct structural evidence for a long-hypothesized I-bridged C₂H₄I intermediate.

Grainy Signatures
Grains from other stars were incorporated into our solar nebula when it formed. **Brandon et al.** (p. 1233) obtained osmium isotope data from such grains in primitive meteorites which indicate that elements such as rhenium and osmium were derived from small stars with a higher neutron density than that which formed our solar system. Furthermore, the data require that these and other grains produced in our solar system were extremely well mixed in our solar nebula when solids started forming.

Strong Thin Sheets
Exploiting the strength of carbon nanotubes in most applications will require their assembly into macroscopic films and fibers. **Zhang et al.** (p. 1215) show that by attaching a sticky sheet of paper to a forest of vertically oriented nanotubes, they can draw them into sheets that are centimeters wide and meters in length. The sheets initially take the form of a highly anisotropic electrically conducting aerogel, and can be compressed into dense, strong sheets that are only tens of nanometers thick.

**CONTINUED ON PAGE 1151**
Why Large Size Increases Extinction Risk

A statistical analysis of extinction risk patterns for about 4000 mammal species by Cardillo et al. (p. 1239, published online 21 July 2005; see the 22 July news story by Stokstad) has provided an explanation for why species of large body size suffer the highest risk of extinction. Sensitivity to a variety of risk-promoting factors, such as low reproductive rate and low population density, increases sharply above a threshold of around 3 kilograms. For species below this threshold, extinction risk reflects simply where species live; above it, extinction risk also reflects biological traits, so that larger species are more likely to be predisposed to decline. The disproportionate disadvantages of large size might accelerate the loss of large-mammal biodiversity in the face of environmental threats.

Controlled Mobilization

Tissue stem cells have the capacity to self-renew and generate differentiated cells that replace lost cells as an organism ages. Quiescent stem cells typically reside in specific microenvironments or “niches.” When needed, they begin proliferating and exit the niche, a process thought to be controlled by extracellular cues from the niche and by intrinsic genetic programs. Studying mouse models, Flores et al. (p. 1253, published online 21 July 2005) now show that epidermal stem cell mobilization is regulated by telomeres, the nucleoprotein structures at the ends of chromosomes. Short telomeres impaired mobilization, whereas overexpression of telomerase, the enzyme that synthesizes telomeres, promoted mobilization. The effect of telomeres on stem cell function could potentially explain, at least in part, their role in aging and cancer.

The Smaller the Better

Small α-proteobacteria account for about a quarter of all bacteria in the oceans. Giovannoni et al. (p. 1242) reveal that Pelagibacter, the first isolate from this clade, has the smallest genome yet observed in a free-living organism. Unlike many parasites and symbionts, Pelagibacter retains a nearly full suite of biosynthetic genes, but it shows no trace of “junk” DNA. Because of the extremely large population size, it seems that selection can act on the very small fitness costs of replicating functionless DNA. In contrast to Pelagibacter, other heterotrophic marine bacteria for which genome sequences are available have relatively large genomes.

Host Factors Required for Microbial Residence

The host cells characteristics that allow for microbial invasion and residence are less well defined than the virulence factors that allow microbe entry. Using a genome-wide screening approach, Philips et al. (p. 1251, published online 14 July 2005) identified host factors required for infection by Mycobacterium fortuitum, which divides within vacuoles. Factors fell into two main categories: those that generally affect phagocytosis (the process by which cells engulf extracellular particles) and those that cause a specific defect in mycobacterial uptake or growth. A Drosophila member of the CD36 family of scavenger receptors was specifically required for the uptake of mycobacteria. Using a similar approach, Agaisse et al. (p. 1248, published online 14 July 2005) identified host factors that affect intracellular infection by Listeria monocytogenes, a bacterial pathogen that escapes from phagocytic vacuoles and replicates within the cytosol of host cells. Several phenotypes were observed, including decreases in the percentage of host cells infected, alterations of intracellular growth rates, and changes in subcellular location of bacteria. The identified host factors spanned a wide range of cellular functions. Comparing the two studies revealed host factors that specifically affect access to the cytosol by L. monocytogenes and host pathways that are differentially required for intracellular infection by a cytosolic versus a vacuolar intracellular bacterial pathogen.