



SUN1 (purple) resides at the ends of chromosomes at various stages of synapsis (SYCP3, green; SYCP1, red).

DEVELOPMENT

Starting at the End

As sex cells divide during meiosis, homologous chromosomes pair up, form a synaptonemal complex with the aid of the lateral element SYCP3 and the transverse element SYCP1, and exchange genetic material. This recombination takes place before chromosome segregation and results in increased genetic diversity. Before pairing, however, the telomeric regions (the ends) of chromosomes can be observed to localize and cluster at the nuclear envelope. By generating knockout mice, Ding *et al.* show that the protein SUN1 participates in attaching telomeres to the nuclear membrane. When SUN1 is eliminated, telomeres no longer adhere to the nuclear envelope, and chromosomes are defective in synapsis and recombination. This results in mice that are infertile because of a failure to produce male and female gametes. Hence, telomeric clustering is necessary for successful meiosis in mice and is required for proper spermatogenesis and oogenesis. — BAP

Dev. Cell **12**, 10.1016/j.devcel.2007.03.018 (2007).

APPLIED PHYSICS

Quantum Dots Heated into Harmony

The cavity quantum electrodynamics framework, in which an atom in a cavity is coupled to the cavity's optical modes, is being explored as a potential building block for quantum information-processing architectures. However, atom mobility within the cavity can hinder control of the process. The use of artificial atoms, or quantum dots, confined to a high-quality optical cavity is one possible solid-state solution to the dynamics issue. Despite being designed to be identical, though, the dots can differ slightly from one another in size and atomic composition, thereby giving rise to distinct excitation spectra for each dot. This spectral variability is expected to cause a problem for communication between dots in an ensemble. By heating individual quantum dots through the laser excitation of a nearby connected heat pad, Faraon *et al.* show that the spectra of individual dots can be tweaked by up to 1.8 nm, thus providing the possibility of tuning the excitation spectra of an ensemble of quantum dots. — ISO

Appl. Phys. Lett. **90**, 213110 (2007).

SURFACE SCIENCE

Long Intervals in the Islands

Interactions between adsorbates on metal surfaces are often direct and short-range in nature; repulsions, for example, can lead to lower cover-

ages than steric packing would predict. Longer-range interactions can arise indirectly, such as through interactions with the surface states of the metal. Nanayakkara *et al.* explored these longer-range effects for adsorbed Br atoms on the close-packed Cu(111) surface. They deposited phenyl bromide on the surface and heated it to 600 K in vacuum. Biphenyl molecules desorbed and the Br atoms had sufficient mobility to form islands on the surface (shown at right).

Scanning tunneling microscopy at 4 K revealed that the nearest-neighbor island separations were half-multiples of the Fermi wavelength of this surface. The strong interaction of the Br atoms with the surface potential affected the island spacing even at distances of more than 50 Å. — PDS

Phys. Rev. Lett. **98**, 206108 (2007).

GEOCHEMISTRY

Mantle Melting Mechanisms

During Earth's history, heavy metals gradually decoupled from silicate rocks and sank toward the core, which became differentiated from the overlying mantle. Signatures of this process can be traced in the distribution of highly siderophile elements (Re and the platinum group elements Os, Ir, Ru, Pt, and Pd) that are chemically associ-

ated with iron. These elements tend to concentrate in base metal sulfides rather than in silicate-based minerals. Over time, they then fractionate and particular elements become sequestered in different types of sulfides, depending on the ways in which they melt. In low-sulfur rocks, their distributions are less well understood.

Luguet *et al.* have analyzed the distribution of highly siderophile elements in four rock samples from the low-sulfur harzburgite lenses in the Lherz massif in the French Pyrenees.

The platinum group elements were found to concentrate in rare, micrometer-sized minerals (sulfides and alloys) in the intergranular spaces. These are thought to be the residues of base metal sulfides that were lost from these rocks after a high degree (up to 25%) of partial melting. Because of their high melting temperatures and high Os content, these minerals may preserve Os isotope compositions after several rounds of mantle melting, possibly explaining the patchy Os distribution of the connecting upper mantle. — JB

Geochim. Cosmochim. Acta
10.1016/j.gca.2007.04.011 (2007).

MICROBIOLOGY

Form Follows Function

Strains of *Prochlorococcus* cyanobacteria contribute nearly half of the photosynthesis in the open ocean. Different ecotypes have distinct

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morphologies. The tiny and spherical MED4 strain holds a 1.66-Mb genome and appears to prefer surface waters. In contrast, the larger (2.41-Mb genome) and ovoid MIT9313 ecotype is abundant in deeper (>50 m) subtropical and tropical waters.

By rapid freezing of hydrated cultured cells and cryoelectron microscopy, Ting *et al.* were able to document a substantially divergent cellular organization and structure in these bacterial strains. The MED4 strain possesses a thinner cell wall and a less extensive intracytoplasmic (photosynthetic) membrane system in comparison to MIT9313. The authors also find differences in key genes required for the biosynthesis of the cell wall peptidoglycan, where the greater similarity of these genes in MIT9313 and *Synechococcus* WH8102 correlates with their much thicker peptidoglycan layers. Overall, it seems that MIT9313 cells are better adapted for photosynthetic growth at low irradiance levels in deeper waters, although nutrient transport could also influence cell size and shape. — CA

J. Bacteriol. **189**, 10.1128/JB.01948-06 (2007).

BIOCHEMISTRY

Tinkering with Protein Structure

A few years ago, a new protein (Top7) was made from scratch. A computational algorithm provided a sequence of amino acids that had been designed to fold into a stable structure unlike any previously deposited in the public data-

bases; lo and behold, it did. Top7 consists of three substructures: a pair of two β -strand-one α -helix modules (A and C) separated in the sequence by a single β strand (module B), with the five β strands forming a hydrogen-bonded β sheet.

Using atomic force microscopy and steered molecular dynamics, Sharma *et al.* have assessed the mechanical resistance of Top7 to being pulled apart and compared these parameters to those of the canonical elastomeric module I27 of titin. They find that theory and experiment fit well, providing an average unfolding force of 155 pN that acts to strip off module A from B-C by breaking the hydrogen (and other) bonds between these substructures. Welding



Top7 (green) construct used in measuring unfolding forces.

β -strands 1 and 3 with a disulfide revealed that 170 pN was needed to lever module C away from the A-B assembly, whereas interrupting one of the hydrogen bonds linking β -strands 3 and 5 was sufficient to lower the unfolding force to 125 pN. These results together illustrate the power of combining computational and biochemical approaches to the design and refinement of protein structure. — GJC

Proc. Natl. Acad. Sci. U.S.A. **104**, 9278 (2007).



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<< NEMO: An Adaptive Regulator

Nuclear factor κ B (NF- κ B), a transcription factor critical in the immune response to pathogens, is maintained in the inactive state by an inhibitory protein (I κ B). The I κ B kinase (IKK) complex activates NF- κ B by dissociating I κ B, and NEMO, also known as IKK γ , is a regulatory subunit of this complex. Zhao *et al.* show that in addition to

this role in NF- κ B activation, NEMO helps to activate the interferon regulatory factors IRF3 and IRF7, which, in combination with NF- κ B and activator protein 1, stimulate the transcription of type I interferons (IFN- α and - β) in virally infected cells. Experiments with mouse embryo fibroblasts deficient in the gene encoding NEMO showed that the efficient production of IFN- α and the subsequent expression of signal transducer and activator of transcription 1 (STAT1) required NEMO, but not IKK β (a subunit required for NF- κ B activation), suggesting that NEMO was not acting through the NF- κ B pathway. Reporter gene assays also demonstrated the dependence of IRF3- and IRF7-mediated gene expression on NEMO. In the NEMO knockout cells, overexpression of TBK1 (an IKK-related kinase that is upstream of IRF3 and IRF7 activation) restored reporter gene activation, and NEMO was also required for activation of the kinase activity of TBK1, placing NEMO upstream of TBK1 in the path to IRF3 and IRF7 activation. However, NEMO did not interact directly with TBK1 (or the related kinase IKK ϵ); instead, immunoprecipitation studies with transfected cells showed that TANK (TRAF family member-associated NF- κ B activator) was required for the formation of a trimeric complex of TANK, NEMO, and either IKK ϵ or TBK1. Mutational and deletion analyses suggest that different regions of NEMO participate in NF- κ B versus IRF activation. — NRG

Nat. Immunol. **8**, 592 (2007).