EDITORS' CHOICE

edited by Stella Hurtley

POLYMER SCIENCE

Smoothing out Spin-Cast Films

One way to apply thin polymer films to a substrate is spin casting. A solution containing dissolved polymer is sprayed onto a rotating substrate to ensure a full and even coating. Solution processing creates a polymer film with its chains in their relaxed state (which might not be the case if using melt-based processes). Controlling the surface roughness can be critical for the final optical and frictional properties of the film, which may be used as a barrier material or to modify the surface properties of a substrate. Strawhecker *et al.* examined glassy polymers spun from volatile solvents onto silicon substrates and found that two factors can increase surface roughness. At high evaporation rates, Marangoni instabilities, which are caused by local variations in surface tension, initiate the formation of surface roughness. The authors believe that this phenomenon terminates early on in the drying process, which raises the question of why the low-viscosity film does not heal itself to form a smooth and energetically favorable surface. They find that a second factor, the time it takes for the fluid to spread out and re-cover the surface, is greater than the evaporation time, which can be observed through large contact angles (>15°) for solvents that would normally fully wet the surface. Thus, by controlling the surface evaporation rate, it should be possible to obtain smooth films for most polymers cast from good solvents. — MSL

Macromolecules **34**, 4669 (2001).

GEOLOGY

Mediterranean Mud Pies

A mud volcano forms from the compression of fine-grained water-rich (usually clay) minerals, possibly mixed with hydrocarbon gases, producing a pressurized slurry that rises to the surface to create a bubbling mudflow. Over time, repeated eruptions can create a small edifice. These dome-shaped, meter-sized piles of mud can be found on the surfaces of accretionary prisms that develop at subduction zones.

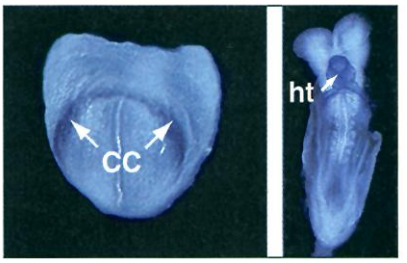
On the seafloor of the eastern Mediterranean, a large number of mud volcanoes and mud pies—flat areas of mud outflows that resemble cow pies, only larger—have been mapped. These mudflows occur on the accretionary prism that is being formed by the subduction of the African plate beneath the Eurasian plate. Kopf *et al.* estimated the volume and porosity of the mud volcanoes, which are abundant close to the Eurasian plate, where compressive stresses are higher, and of the mud pies, which are abundant close to the African plate, where stresses are lower. The fluid flux from the mud pies was higher than that from the mud volcanoes and from estimates on other accretionary prisms. Thus previous estimates of fluid flux from a subduction zone may have been too low, and revisions of the estimated global fluid mass balance between crust and mantle related to subduction may be needed. — LR

Earth Planet. Sci. Lett. **189**, 295 (2001).

DEVELOPMENT

Taking Gene Expression to Heart

The availability of large databases of expressed sequence tags and tissue-specific cDNA libraries has greatly facilitated the identification of novel factors regulating the development and function of individual tissues and organs. The power of this approach is illustrated by Wang *et al.*, who used a bioinformatics-based screen to find a previously elusive transcription factor that selectively turns on gene expression in heart muscle. The new protein, designated myocardin, potently activated transcription of heart and smooth muscle genes through its physical association with another, more widely expressed, transcription factor called serum response factor (SRF). Studies in developing mice and *Xenopus* embryos revealed that myocardin is expressed exclusively in the myocardium after birth and is required for myocardial cell differentiation. It remains to



Myocardin transcripts (dark blue) localize to the cardiac crescent (cc) and the heart tube (ht) in developing mouse embryos.

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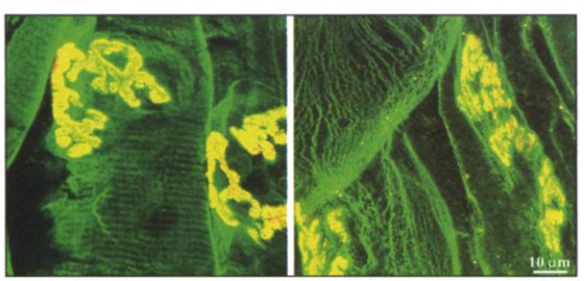
CELL BIOLOGY

More Power to Your Arm

At the neuromuscular junction, nerves and muscle interact and clusters of muscle acetylcholine receptors (AChRs) form in association with neuronal agrin. Using purified recombinant chick agrin derived either from muscle or from neurons, Bezakova *et al.* have demonstrated a specific ability of neural agrin to promote long-lived AchR clustering, when injected into rat soleus muscle. The injected agrin could be recovered from the muscles in association with the extracellular matrix protein laminin. In a separate study, Bezakova and Lømo went on to show that muscle agrin helped to preserve costameric structures (small riblike structures composed of dystrophin and β-dystroglycan across the muscle Z and M lines) in the absence of muscular stimulation. Usually these structures would reorient longitudinally after denervation. This unanticipated lability in costamere structure in response to stimuli, and the differential ability of muscle and nerve agrins to induce stable AChR clusters, may be important in the muscular dystrophies. — SMH



Distribution of AChR aggregates (yellow) and dystrophin (green) at innervated (left) and denervated (right) neuromuscular junctions.

J. Cell Biol. **153**, 1441;1453 (2001).

SOURCE: (RIGHT) WANG *ET AL.*, *CELL* **105**, 851 (2001); (LEFT) BEZAKOVA AND LØMO, *J. CELL BIOL.* **153**, 1453 (2001).

be established whether myocardin participates in signaling pathways that are disrupted in human heart disease. — PAK

Cell **105**, 851 (2001).

CLIMATOLOGY

Nearer Neighbors Have Greater Influence

Clouds help to control climate by reflecting or absorbing solar radiation, thereby affecting Earth's albedo. Cloud droplet formation depends on the presence of condensation nuclei, which can be produced by ionizing radiation. Is cloud cover modulated by changes in the intensity of ionizing galactic cosmic rays (GCRs)? Udelhofen and Cess analyzed cloud cover anomalies over the United States from 1900 to 1987, as well as the output of a model of cloud formation. They found a significant correlation, in both observations and model data, between cloud cover and the 11-year cycle of solar variability, and a strong time-series spectral peak at 11 years. The cloud cover variations were in phase with the solar cycle but not with GCRs, and the model did not reproduce these variations when a constant solar forcing was used. These observations indicate that variations in atmospheric heating caused by solar forcing, but not by GCR changes, are responsible for the recorded changes in cloudiness. — HJS

Geophys. Res. Lett. **28**, 2617 (2001).

EVOLUTION

Biological Model Generates Prime Numbers

Cicadas spend 7, 13, or 17 years, depending on the species, underground before emerging as adults for the final weeks of their lives.

Recently, Goles *et al.* investigated the selective forces that might have led to these prime-number life cycles. They produced spatiotemporal simulations of predator-prey cycles using cellular automata to yield periodicities of 13 and 17, indicating the selective optima for cicadas escaping predators. In this unexpected alliance of biology and number theory, the results suggest that these models have properties that favor the generation of prime numbers. — AMS

Complexity **6**, 33 (2001).

IMMUNOLOGY

Costimulating Rejection

Signaling through the cell surface protein CD28 is important in the initial stages of T cell activation. However, other pathways of costimulation appear to be required for maintaining the activated state of effector T cells. Unlike CD28, the recently characterized protein-inducible costimulator (ICOS) is up-regulated after T cell activation in order to sustain T helper 2 (T_H2)–type responses.

Özkaynak *et al.* studied the role of ICOS in T cell responses that lead to graft rejection. By preventing the interaction of ICOS with its ligand, either by use of an antibody directed against ICOS or by using an ICOS-immunoglobulin fusion protein, cardiac allograft survival in mice was prolonged. Different regimes of inhibition revealed that ICOS signaling, in addition to other pathways, was important in both the acute and chronic phases of graft rejection. Importantly, the transcription of several characteristic T_H1 and T_H2 genes within surviving grafts was strongly reduced, lending weight to the idea that ICOS may influence T_H-1 as well as T_H2 type immunity. — SJS

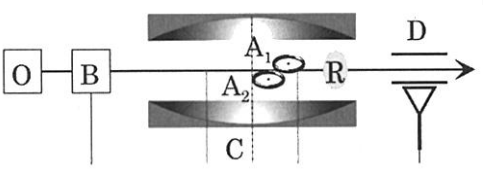
Nature Immunol. **2**, 591 (2001).

PHYSICS

Entangling Atomic Collisions

We usually think of collisions as destructive processes, but in the quantum world, collisions can be constructive and even desirable events. When quantum systems are brought into close contact and allowed to interact under the right conditions, the wave functions of the systems can become entangled so that the once separate systems effectively become one. Such entanglement could be used for logical operations in quantum computers. However, the entanglement process is rather inefficient for bare atom collisions, and methods are being explored that make the process more efficient. Osnaghi *et al.* collide two Rydberg atoms—atoms in an electronic excited state that give rise to a large interaction cross section—in a cavity. As the excited rubidium atoms cross the cavity to the point of collision, energy exchange mediated by the virtual emission and absorption of a microwave photon between the two atoms results in entanglement. They find that cavity-assisted entanglement is four orders of magnitude more efficient than free-space collisions, a promising feature for quantum information processing. — ISO

Phys. Rev. Lett. **87**, 037902 (2001).



Cavity-assisted entanglement and detection of rubidium Rydberg atoms.

CREDITS: OSNAGHI *ET AL.*, *PHYS. REV. LETT.* **87**, 037902 (2001).