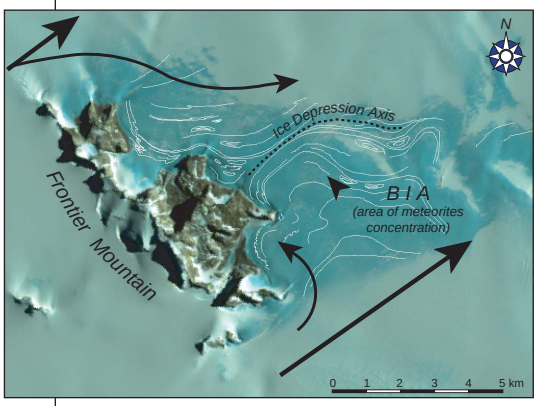
EDITORS' CHOICE

edited by Gilbert Chin



Ice flow (arrows) around Frontier Mountain.

GEOPHYSICS

Putting Meteorites on Ice

Every year, scientists put on their mittens and collect meteorites in Antarctica. Of the roughly 37,000 meteorites listed as of 2002, about 30,000 come from Antarctica or, to be precise, the ice sheets covering that continent. Antarctica is the best place to collect meteorites because they accumulate on blue ice fields, upstream of topographic barriers. Meteorites fall and become buried in the ice; the ice flows; the ice slows and is lifted up near a barrier; finally, wind ablation exhumes and concentrates the meteorites.

Corti *et al.* explain how meteorites may also become trapped downstream of a barrier—specifically, Frontier Mountain, an 8-km-long granitic ridge in Northern Victoria Land. Geodetic data and laboratory simulations (using polydimethylsiloxane in place of ice) show that the ice flow slows down and converges behind the mountain. Although katabatic winds do ablate the ice and expose the meteorites, the influence of the barrier on ice flow is crucial for corraling them in one place. Behind Frontier Mountain, the residence time of trapped meteorites would be as long as 60,000 years if there were no scientists (about 600 meteorites have been collected there in 12 years), and it is possible that downstream ice traps may be more effective than upstream ones in storing meteorites for long periods. — LR

Earth Planet. Sci. Lett. **215**, 371 (2003).

EVOLUTION

Small, Hot, and Old

When a new and apparently primitive organism is discovered, how can we decide if it truly reflects an ancient organism that evolved slowly over many millions of years or if it arrived at its present compact state by jettisoning pieces of its genome, having developed a relationship with another living being (that is, living as a parasite or symbiote)? Phylogenetic analysis of the ribosomal RNA from *Nanoarchaeum equitans* indicated that its ancestors might have been amongst the first archaeons, dating back to just after the split between Archaea and Eukaryota. This symbiont is only about 400 nm in diameter and lives in physical contact with the 2-μm archaeon *Ignicoccus*.

Waters *et al.* have sequenced and analyzed the *Nanoarchaeum* genome (~490 kilobases). It contains many if not all of the components for handling genetic information (replication, transcription, translation, and repair) but lacks many of the biosynthetic enzymes to make building blocks such as amino acids and nucleotides; these are presumably acquired from its partner, either via membrane transporters, which are encoded in its genome, or by vesicular transfer from *Ignicoccus*, which would explain the need for physical contact. Unlike other cases of evolution by reduction, only about 5% of the genome does not code for proteins or RNAs, and few pseudogenes are present. Furthermore, the hot and anerobic environment (a submarine vent north of Iceland) in which *Nanoarchaeum* lives is similar to early life conditions. Taken together, this evidence is consistent with the proposal that this unusual organism is indeed primitive. — GJC

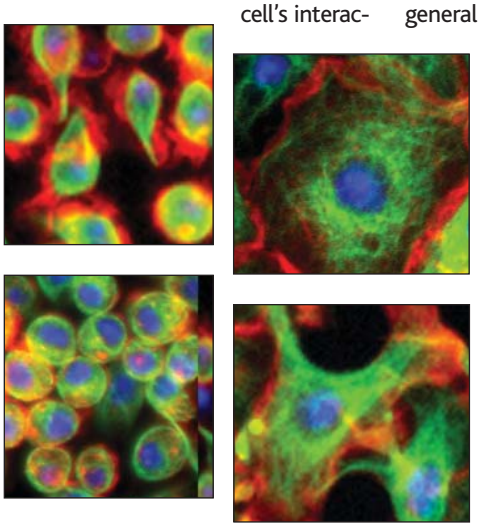
Proc. Natl. Acad. Sci. U.S.A. **100**, 12984 (2003).

CELL BIOLOGY

A Kaleidoscope of Cell Shapes

Animal cells adopt a variety of shapes—small and rounded, flat and polygonal, and even spindle-like. These characteristic morphologies are generated and maintained by the intracellular cytoskeleton and by the cell's interactions with the extracellular matrix and with neighboring cells. Kiger *et al.* have classified the morphological effects of interfering with a whole variety of proteins. They set up an automated screen that systematically targeted genes involved in cell ultrastructure and in processes that depend on changes in structure. Using RNA interference technology and two distinct *Drosophila* cell lines, they identified many genes that influenced cell shape, cell division, and cell-cell interactions; some were known components that regulate the cytoskeleton, but many had not been characterized previously. This type of mapping will be important in helping to define the pathways and the genetic and protein interactions responsible for cell structure and function. — SMH

J. Biol. **2**, 27 (2003).



Gallery of cells displaying various morphologies (actin, red; tubulin, green; DNA, blue).

BIOCHEMISTRY

Two Steps Toward Resistance

Bacteria, notably *Staphylococcus aureus*, have fought back against the clinical use of β-lactam antibiotics, such as penicillin and methicillin, by acquiring resistance cassettes. These fall into two general categories: one that relies on an alternative transpeptidase (needed for bacterial cell wall synthesis) that is less sensitive to β-lactams and a second that activates synthesis of a β-lactam hydrolase. The latter pathway uses as its front-end sensor a membrane-bound receptor (BlaR in *Bacillus licheniformis*); binding of β-lactam to its extracellular domain triggers autoproteolysis of an intracellular loop, which leads eventually to inactivation of BlaI, the repressor of β-lactamase.

Kerff *et al.* provide the structure of the sensor domain of BlaR, and Van Melckebeke *et al.* provide the structure of the

CONTINUED ON PAGE 749

CREDITS: (LEFT) CORTI *ET AL.*, *EARTH PLANET. SCI. LETT.* **215**, 371 (2003); (RIGHT) KIGER *ET AL.*, *J. BIOL.* **2**, 27 (2003)

DNA binding domain of BlaI. Comparison of BlaR to the known structures of β-lactamases suggests that the former lacks an active site residue capable of acting as the general base in the deacylation step, explaining why it becomes stably modified by the β-lactam, a longevity that may be needed for communication with the cytoplasmic loop. BlaI belongs to the winged-helix family of DNA binding proteins, and identification of the residues contacting the major groove enabled modeling of this complex as well as that of MecI, the structurally similar repressor of the transpeptidase. — GJC

Biochemistry 10.1021/bi034976a (2003); *J. Mol. Biol.* **333**, 711 (2003).

PHYSICS

A Nanotube Story with a Twist

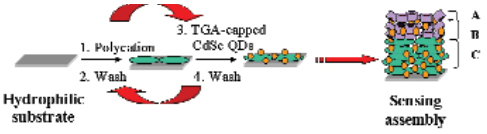
Singlewalled and multiwalled carbon nanotubes exhibit a variety of electronic and mechanical properties, which have earmarked them as strong candidates for potential applications in the fields of nanoelectronics and nanoactuators. For example, recent work has shown that when the nanotubes are in contact with a substrate, the electronic properties of the junction are dependent on the registry between the atomic structure of the nanotubes and that of the underlying substrate. Gartstein *et al*. have carried out calculations showing that as carbon nanotubes are stretched, compressed, or injected with charge carriers, they twist around, the extent of twisting depending on their chirality. It is therefore possible to envisage structures in which adding this degree of torsional control could lead to the development of novel devices and sensors. — ISO

Phys. Rev. B **68**, 115415 (2003).

CHEMISTRY

Detecting Potential Toxins

Organophosphorus compounds, such as paraoxon, are widely used in pesticides and insecticides, but they are an environmental concern because of their structural similarity to some nerve agents. Hence, there is a need to monitor these compounds in food and groundwater. Constantine *et al*. have used layer-by-layer assembly techniques to fabricate a biosensor that can detect paraoxon at nanomolar concentrations. The sensor is initially made from alternating layers of chitosan and thioglycolic acid–capped CdSe quantum dots (QDs). The chitosan strongly absorbs onto negatively charged surfaces and tends to forms films, giving the sensor its physical stability. Alternating layers of the enzyme organophosphorus hydrolase and QDs are then added to the film. When exposed to a solution containing paraoxon, the hydrolase cleaves it to form *p*-nitrophenol, which is readily detected by spectroscopy. The exposure to paraoxon also changes the QD photoluminescent intensity, which is enhanced by their confinement to the layered assembly, thus giving the biosensor two methods for measuring chemical exposure. — MSL



Multilayered sensing assembly (enzyme, purple; QD, orange; chitosan, green).

Langmuir 10.1021/la035237y (2003).

HIGHLIGHTED IN *SCIENCE'S* SIGNAL TRANSDUCTION KNOWLEDGE ENVIRONMENT

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Prions Stress Out the ER

A conformational change in the normal form of the prion protein (PrP^C) yields the neurotoxic form PrP^{Sc}, which is implicated in transmissible spongiform encephalopathies. Hetz *et al*. determined that application of PrP^{Sc} to N2A neuroblastoma cells initiated an increase in intracellular calcium concentration, because of release from the endoplasmic reticulum (ER). Application of PrP^{Sc} also activated the ER-resident caspase-12, one of a family of proteases that mediate programmed cell death, and increased expression of the ER chaperones, consistent with induction of the ER stress response. In mice infected with prion (139A-scrapie), active caspase-12 was detected in the brain, and regions of the brain with the highest caspase-12 activity showed the most neuronal death. Postmortem analysis of brain tissue from several patients with Creutzfeldt-Jakob disease revealed the presence of ER chaperones and active caspase-12. Thus, the ER stress response may play a critical role in the toxicity of prions. — NG

EMBO J. **22**, 5435 (2003).