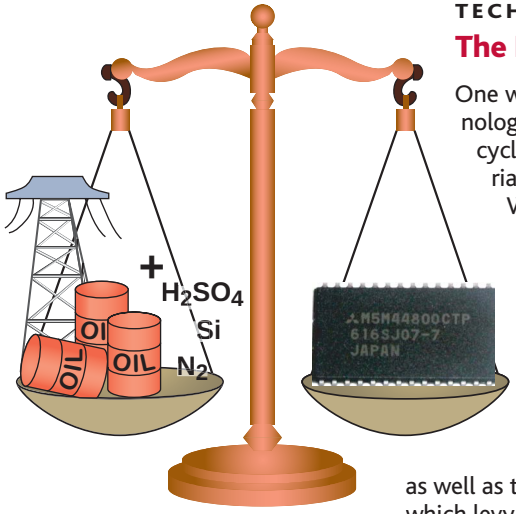
EDITORS' CHOICE

edited by Gilbert Chin



The black box with silver legs.

TECHNOLOGY

The Macro Side of Microchips

One way to assess the environmental impact of a technology is to perform materials flow analysis and life cycle assessment, which account for all of the materials needed to make the final product and to use it. Williams *et al*. present their findings for microchip manufacturing, which expand on previous efforts, in part, by comparing process data from different sources. A 2-g, 32-megabyte dynamic random access memory (DRAM) chip requires 1.6 kg of secondary fossil fuels and 72 g of chemical inputs for production and use, as well as 32 kg of water during the production phase. This extraordinary ratio of input to output reflects the high degree of materials purity needed as well as the complex organization within the chip, both of which levy entropic tariffs. — PDS

Environ. Sci. Technol. 10.1021/es205643o (2002).

GENETICS

A Genome to Chew On

As the leading cause of tooth decay, *Streptococcus mutans* may be held in high esteem by dentists, but to the rest of us the bacterium is an annoying source of pain and expense. The 2–million–base pair genome of *S. mutans*, recently sequenced by Ajdić *et al*., has shed some light on why this oral pathogen is so successful.

Perhaps not surprisingly, the sequence indicates that *S. mutans* can metabolize a wider range of carbohydrates than any other Gram-positive organism. Whereas the products of carbohydrate metabolism create an acidic microenvironment that inhibits competing oral bacteria (and causes tooth decay), *S. mutans* itself appears to survive because it encodes an acid-stable proton-translocating F_0F_1 ATPase that helps maintain intracellular pH. The sequence also revealed that (i) the bacterium can synthesize all of its required amino acids; (ii) it devotes 15% of its coding potential to transport proteins; and (iii) it encodes many virulence factors, such as adhesins, exoenzymes, and proteases, which likely enable it to escape host defenses and to degrade host tissue. Further analysis of the genes identified in this study may ultimately provide new leads for preventing and treating tooth decay. — PAK

Proc. Natl. Acad. Sci. U.S.A. **99**, 14434 (2002).

GEOCHEMISTRY

Oxidative Trigger

Most recent evidence implies that Earth's atmosphere was reducing for nearly the first half of the planet's history—lacking abundant free oxygen—and became oxidizing fairly abruptly about 2.3 billion years ago. What caused this change, which determined the subsequent geologic (by initiating oxidative weathering) and biologic (by allowing higher life in the oceans and on land) history of the planet?

One idea is that this change was biologically driven by the appearance of cyanobacteria, which produce oxygen during photosynthesis, but recent data imply that cyanobacteria evolved many hundreds of million years earlier. Another idea is that the oxygen fugacity of gases emitted from Earth's mantle via volcanoes and vents increased, but other data have shown that the fugacity of Earth's mantle has not changed much during its history. Holland reanalyzes this second proposal and shows that only a small change in the composition of gases is needed, related to the escape of hydrogen to space by about 2.3 billion years ago, to trigger a sudden increase in atmospheric oxygen content. — BH

Geochim. Cosmochim. Acta **66**, 3811 (2002).

MOLECULAR BIOLOGY

Suppressing Expression of X

BRCA1 is a tumor suppressor protein intimately associated with breast and ovarian cancer and has been implicated in a wide range of nuclear functions, including genomic integrity, transcription regulation, chromatin remodeling, and cell cycle checkpoint control. It has been noted previously that in female somatic cells containing a pair of X chromosomes, BRCA1 is associated with the inactive one (Xi). The inactive X chromosome is coated with RNA from the noncoding, Xi-specific transcript (XIST) gene as well as the variant histone MH2A1.

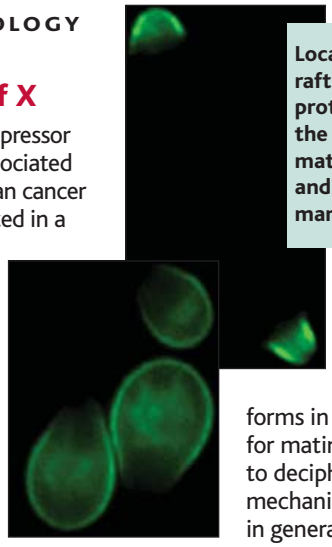
Ganesan *et al*. show that BRCA1 colocalizes with XIST RNA and that loss of BRCA1 results in loss of XIST from Xi, as well as loss of methylation at lysine 9 of histone H3, both of which are important for the suppression of gene expression. As a result, at least one formerly silenced gene on the inactive X is reactivated. Although BRCA1 and its heterodimeric partner protein BARD1 interact with XIST RNA, these proteins do not affect the level of the RNA; rather, they seem to direct its localization to Xi. — GR

Cell **111**, 393 (2002).

CELL BIOLOGY

Getting It Right

When a haploid yeast cell senses mating pheromone released by a cell of the opposite type, it stops dividing and commences polarized growth toward its partner. A cellular projection (shmoo) that harbors a variety of proteins important for signaling, cell adhesion, and fusion forms in preparation for mating. In order to decipher the mechanisms involved in generating and



Localization of raft-associated protein (above) at the tip of the mating projection, and a non-raft marker (below).

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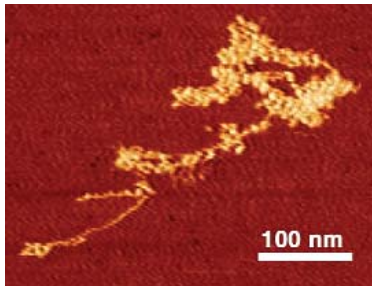
maintaining this polarized structure, Bagnat and Simons looked at the role of lipid rafts—domains composed of sphingolipids and sterols—in the yeast plasma membrane. In pheromone-treated cells, the lipid rafts collected at the tip of the projection, taking with them mating-specific proteins. In mutant yeast that could not synthesize sphingolipids or ergosterol, these proteins failed to concentrate in the projection, and mating was defective. — SMH

Proc. Natl. Acad. Sci. U.S.A. **99**, 14183 (2002).

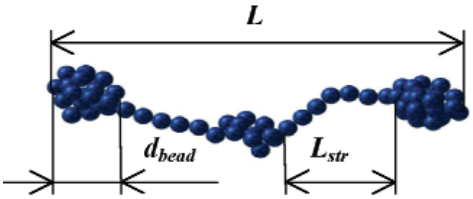
POLYMER SCIENCE

Charged Collapse

In dilute solution, a polymer chain in a good solvent exists as a random coil. If the solvent quality is lowered, the chain will collapse to form a globule. For stiffer molecules, the collapse will be an abrupt first-order transition, whereas for more flexible molecules, the collapse will be gradual and resemble a second-order transition. However, for stiff molecules, coils and globules can coexist, so that when an ensemble of chains is studied, the transition may appear to be continuous.



Kiriy *et al*. probed this transition for polyelectrolyte chains whose behavior is complicated by electrostatic interactions and by the tendency for chains to aggregate. They adsorbed the chains onto a mica surface, while preserving their radial configurations, and then measured the chain dimensions by atomic force microscopy. When salt was added, the chains collapsed to form "pearl necklaces," in which small globules are connected by extended segments. With increasing salt concentration, the pearls coalesced to form larger clusters. This type of transition is thus intermediate between that of flexible and stiff polymers, and can be described as occurring by a cascade of first-order transitions. — MSL



Schematic (above) and micrograph (top) of a pearl necklace.

J. Am. Chem. Soc. 10.1021/ja0261168 (2002).

CLIMATE SCIENCE

Beyond Natural Variation

In their efforts to determine whether physical processes provide any evidence that anthropogenic activity has begun to affect Earth's climate, researchers have long pointed out that the historical and geologic records of mountain glaciers show that they have receded substantially in the past few centuries. In order to ascertain whether this retreat lies within the range of natural variation, Reichert *et al*. have conducted calculations of mountain glacier (from Norway and Switzerland) fluctuations, using a mass balance model of intermediate complexity and a dynamic ice flow model. Fluctuations were produced exclusively by internal variations in the climate system. Their simulations indicate that the preindustrial fluctuations of these glaciers can be explained by internal climate variability, independently of external forcing factors such as solar irradiation changes or volcanic or anthropogenic effects. In contrast, the observed present-day retreat is too large to be due to natural causes alone and must result from external events, with anthropogenic climate forcing being a likely candidate. — HJS

J. Clim. **15**, 3069 (2002).

MICROBIOLOGY

Mark, Capture, and Release

Several bacteriophage that infect bacteria produce just a few copies of their genomes, which, during cell division of their host, are faithfully segregated into the daughter cells. Li and Austin marked the P1 plasmid of *Escherichia coli* with green fluorescent protein fused to the partition (*par*) proteins of the phage, and then watched to see what happened to the plasmids during the cell cycle. Foci containing one or a few copies of the plasmid were captured at the center of growing cells and remained in place until just before the septum between the new cells was completed. At this point, the plasmid focus divided and then flew apart along the long axis of the cell, releasing the plasmid copies into the newly partitioned daughter cells. Interestingly, the plasmid seems to exert considerable control over host cell division; if mutant plasmids were used that did not separate, cell division was significantly delayed and was often aberrant. — CA

Molec. Microbiol. **46**, 63 (2002).

Beyond Natural Variation

Science **298** (5596), 1139.
DOI: 10.1126/science.298.5596.1139b