BIOTECHNOLOGY

Cutting Off Communication

Many bacteria communicate with one another through the secretion and uptake of small signaling molecules. If this process, known as quorum sensing, is disrupted, bacterial communities can no longer collectively respond to environmental stresses or cooperatively build complex structures such as biofilms. Yeon *et al.* have leveraged such a disruption to prevent biofouling—the clogging of membrane pores by accumulated particulate matter and bacteria—in wastewater treatment apparatus. The addition of a deactivating enzyme (acylase) quenched the quorum-sensing signal required for bacteria to form biofilms and thus increased the long-term performance of the filtration membrane. Furthermore, the use of a cell-sized magnetic carrier stabilized the acylase and facilitated its recovery and reuse over multiple operation cycles. Fortunately, the quenching process did not interfere with other beneficial bacterially driven processes in the bioreactor, such as the degradation of solid-phase organic matter. Although acylase is only specific to one type of signaling molecule, this procedure could eventually incorporate additional enzymes to quench the few other known quorum-sensing signals, effectively blocking all bacterial communication channels. — NW

Environ. Sci. Technol. **43**, 10.1021/es901323k (2009).

CHEMISTRY

Getting a Grip on Nitrogen

Chirality is associated more with carbon than with nitrogen centers, as the latter atoms tend to invert their configurations fairly rapidly on account of their unbonded electron pair. Recently, relatively slow nitrogen inversion was observed in cyclic oligomers of four or six aza-β^3–amino acids (β–amino acids in which nitrogen replaces the traditional carbon at the β position) on account of hydrogen bonding among the substituents. Mocquet *et al*. now show that swapping in a single analogous residue that is chiral at carbon disrupts the collective inversion mechanism and thereby dramatically stabilizes the chiral nitrogen conformations throughout the ring. A variety of nuclear magnetic resonance and x-ray diffraction studies revealed a stable syndiotactic arrangement of asymmetric nitrogen centers up to temperatures of 413 K. — PDS

J. Am. Chem. Soc. **131**, 10.1021/ja9058074 (2009).

EVOLUTION

Background Matters

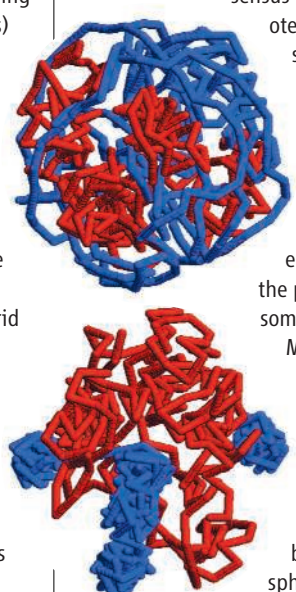
Species boundaries are often maintained because of reinforcement—where the male offspring of individuals of two different species are sterile. Although several candidate genes contributing to this reproductive barrier have been identified, the mechanisms by which sterility is conferred are still generally unknown. The dominance theory suggests that sterility is caused by interactions of X-linked loci from one species with dominant autosomal loci in the other species. Chang and Noor have investigated this phenomenon by introgressing putative sterility quantitative trait loci (QTLs) from one fruit fly species into another, individually and in combination. They found that no single allele of any of the QTLs resulted in hybrid sterility but that sterility increased in the presence of other QTLs, even when all genes were heterozygous. These data suggest that the genetic background is responsible for modifying the degree of dominance and demonstrate that epistasis is an important component of hybrid male sterility. — LMZ

Evolution **63**, 10.1111/j.1558-5646.2009.00823.x (2009).

BIOPHYSICS

Packing It All In

Though the double helix structure of DNA has been known for half a century, it is only the starting point for arranging genetic material. Exactly how the 3 billion base pairs of human DNA, which are distributed unevenly across 23 chromosomes, are organized within a micron-sized nucleus, while retaining the flexibility to open and close individual regions so that specific genes can be transcribed (which requires an unwinding of the double helix), is not entirely clear. The chromosomes are known to be spatially organized within the nucleus, in a function-dependent fashion; for instance, they each occupy distinct territories, and the general consensus is that in higher eukaryotes gene-poor chromosomes are found preferentially at the periphery, with gene-rich chromosomes more centrally located.



Cook and Marenduzzo suggest that entropy may influence the positioning of chromosomes within nuclei. Using Monte Carlo simulation methods, they analyzed the distribution of stiff (blue) and flexible (red) self-avoiding polymers composed of strings of beads within a confined sphere, representing compact heterochromatin (blue) and gene-rich chromatin (red) in the nucleus. The stiff polymers tended to localize to the periphery of the sphere, whereas the flexible ones moved to the center, analogous to the situ-

Continued on page 21

CREDITS (TOP TO BOTTOM): N. KEVITIYAGALA/*SCIENCE*; COOK AND MARENDUZZO, *EVOLUTION* **63**, 10.1111/J.1558-5646.2009.00823.X (2009)

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Continued from page 19

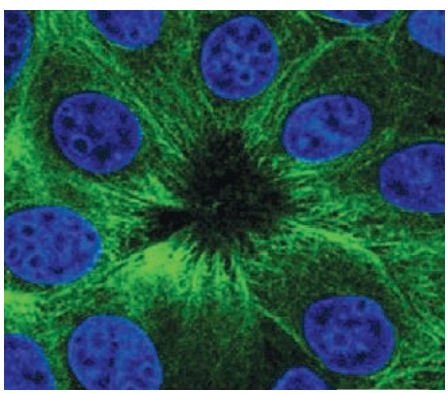
ation in vivo. Looping the polymers, which would represent the joining of distal regions of chromatin, promoted the formation of distinct territories, and flexible polymers were less likely to form contacts with other polymers, consistent with gene-rich regions being less frequently involved in chromosomal translocations. — HP

J. Cell Biol. **186**, 825 (2009).

CELL BIOLOGY

Squeezed Out by the Neighbors

Organs and tissues are surrounded by an epithelial layer of cells that serves as a physical barrier between, for instance, the blood and the vascular smooth muscle cells. If and when cells within



CREDIT: SLATTUM *ET AL.*, *J. CELL BIOL.* **186**, 693 (2009)

an epithelial layer die, they must be removed without breaching the integrity of the epithelial barrier. Slattum *et al.* have characterized the process by which apoptotic cells are actively extruded. There is a localized contraction of actin and myosin IIA within the cells (blue) that surround the dying cell—at their apical ends if the target cell is destined to exit into the tissue or, more commonly, at their basolateral surfaces if the cell is to be extruded into the luminal compartment. The latter requires microtubules (green) in the neighboring cells to reorient and to target a protein that controls actin and myosin activity, p115 RhoGEF, to the basolateral surface. In the whole organism, the direction of extrusion may figure in the subsequent fate of the ejected cell, particularly if, as may happen during tumorigenesis, the presumptive apoptotic cell does not in fact die. — SMH

J. Cell Biol. **186**, 693 (2009).

BIOMEDICINE

A Moving Target for Cancer Therapy

The primary cilium, an immotile structure found on many cells, is a critical site for regulating signaling by members of the Hedgehog family of ligands. Hedgehog proteins have major roles in development, but inappropriate signaling through this pathway can contribute to certain cancers. Wong *et al.* and Han *et al.* have studied primary cilia in two cancers, human basal cell carcinomas and medulloblastomas. In keeping with earlier indications that events at the primary cilium can have both positive and negative effects on Hedgehog signaling, they found that the loss of cilia could either prevent or promote the growth of cancer cells, depending on how the Hedgehog pathway had been activated. If the cells expressed a constitutively active form of Smoothened, the upstream component that is activated when Hedgehog binds to the receptor Patched, ablation of the cilium inhibited tumor cell growth in mice. However, if the downstream transcription factor Gli2 was made constitutively active, the loss of cilia promoted tumor growth. The mechanisms at work are not precisely understood, but the authors discuss the implications for targeting therapies to inhibit Hedgehog signaling, where in some cases, the inhibition of ciliogenesis could exacerbate cancer growth rather than curb it. — LBR

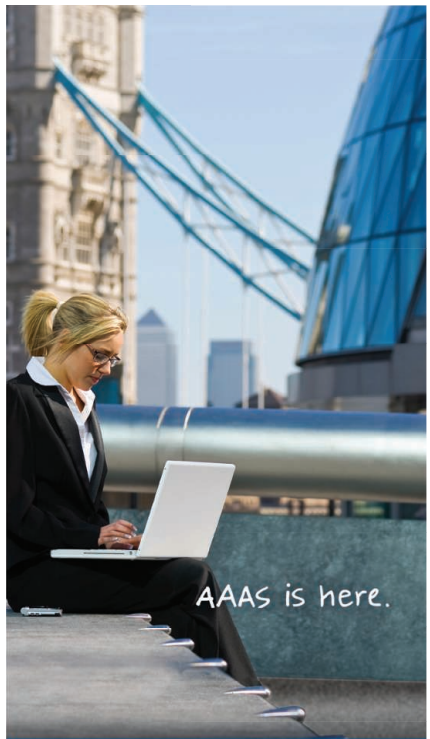
Nat. Med. **15**, 1055; 1062 (2009).

ATMOSPHERIC SCIENCE

Accounting for Delay

Earth's early atmosphere was lacking in oxygen for nearly 2 billion years; a variety of data imply that the concentration of the oxidizing gas began to rise abruptly about 2.4 billion years ago. The degree to which biological processes may have contributed to this rise remains subject to debate—some evidence suggests that cyanobacteria, which produce oxygen as a by-product of photosynthesis, appeared at least several hundred million years earlier, but why then the delay? Two isotopic studies from rocks several hundred million years older than the prominent oxidation event imply that some feedbacks may have been involved. Godfrey and Falkowski show that nitrogen isotopes record a type of nitrogen cycling in the oceans requiring the presence of free oxygen. In turn, this cycling would have depleted inorganic nitrogen required by cyanobacteria or plankton for growth, limiting their oxygen production. Frei *et al.* report a chromium isotope record, which traces oxidative weathering. Their data implicate small and transient amounts of oxygen in the atmosphere and ocean during this time. Together these and other data imply that the final abrupt oxidation of Earth's atmosphere reflected some fits and starts over the previous several hundred million years. — BH

Nat. Geosci. **2**, 10.1038/ngeo633 (2009); *Nature* **461**, 250 (2009).



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