EDITORS' CHOICE

edited by Gilbert Chin

ASTRONOMY

The Fading Firmament

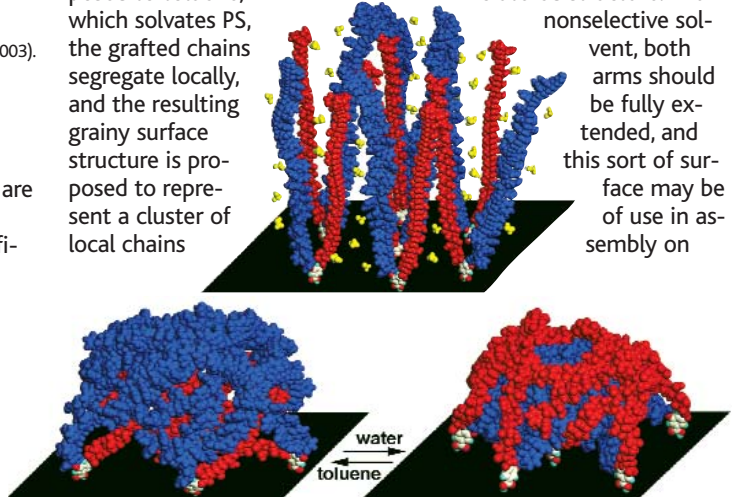
You may not have noticed it, especially if you live in an urban area, but the skies are getting darker. Using spectra from the Sloan Digital Sky Survey and an agile data compression algorithm called MOPED (Multiple Optimized Parameter Estimation and Data compression), Panter *et al.* have determined that the rate of star formation has been decreasing for the past 6 billion years. About 30% of the stars formed more than 8 billion years ago, and a similar percentage of stars are observed in elliptical galaxies, which is consistent with the theory that most elliptical galaxies formed early and contain the oldest stars. In addition, the computed average metallicity (abundance of elements heavier than He) of the gas in which the stars formed started increasing about 8 billion years ago, peaked at about the solar value, and then decreased to about half the solar value about 2 billion years ago. The rise and fall of metallicity favors star formation models in which infall of relatively unprocessed gases onto galaxies was prevalent in the universe from 4 to 0.1 billion years ago. — LR

Mon. Not. R. Astron. Soc. **343**, 1145 (2003).

MATERIALS SCIENCE

Flip-Flops

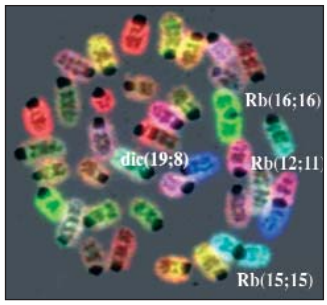
Most mixtures of polymers are unstable and form separate phases if the chains are sufficiently mobile. Separation can be hindered by linking the two polymers chemically or by grafting the chains to a common surface; even so, segregation can occur over the length of the polymer chain. Julthongpiput *et al.* combine these two restraints by connecting polystyrene (PS), which is hydrophobic, and polyacrylic acid (PAA) to a common stem that is then grafted to a silicon surface. Under dry conditions, the arms collapse to give a generally smooth surface with intermingled chain segments. When exposed to toluene, which solvates PS, the grafted chains segregate locally, and the resulting grainy surface structure is proposed to represent a cluster of local chains coming together to form a micelle with a PAA core enveloped by PS arms. On exposure to water, the chains reorganize, and the micelle turns inside out. As there is a higher volume fraction of PS, the PS core is not quite covered by PAA segments, and the micelles take on a dimpled or cratered structure. In a nonselective solvent, both arms should be fully extended, and this sort of surface may be of use in assembly on nanometer-sized objects and in microfluidics. — MSL



The arrangements of PS (blue) and PAA (red) arms.

Langmuir 10.1021/la035007j (2003).

CREDITS: (TOP) CELESTE *ET AL.*, *CELL* **114**, 371 (2003); (BOTTOM) JULTHONGPIPUT *ET AL.*, *LANGMUIR* 10.1021/LA035007J (2003)



Robertsonian (Rb) translocations and dicentric (dic) chromosomes in the absence of H2AX and p53.

MOLECULAR BIOLOGY

The Perils of Histone Loss

Left unattended, the many types of damage that afflict genomic DNA can have dire consequences for the mammalian cell. Double-strand breaks, for example, are potent substrates for chromosomal rearrangements that can push a cell toward malignancy. Among the molecular players implicated in the cellular response to these breaks is a histone variant called H2AX, which—together with DNA repair enzymes and signaling proteins—accumulates nearby in the chromatin.

Two studies of genetically manipulated mice by Bassing *et al.* and Celeste *et al.* reinforce previous evidence that H2AX is essential for genome stability and show further that even partial loss of the protein can accelerate tumorigenesis. Mice deficient in H2AX and the tumor suppressor protein p53 were found to develop tumors earlier and at a higher rate than did mice deficient in p53 alone, and these tumors were characterized by frequent chromosomal rearrangements. Thus, this histone can no longer be regarded solely as a structural component of chromatin, and researchers face the challenge of establishing precisely how it helps the cell keep its genome whole. — PAK

Cell **114**, 359; 371 (2003).

MICROBIOLOGY

Desperately Seeking *Salmonella*

Salmonella bacteria infect humans via contaminated food. They invade cells lining the gut wall and cause horrible dysenteric symptoms. Typhoid fever may occur when *S. enterica* serovar typhi escapes the gut to establish itself systemically.

Until now, research has focused on host genes or on bacterial growth in tissue culture, but little is known about how *Salmonella* behaves within a natural host. Sheppard *et al.* looked at the distribution of bacteria within the livers of systemically infected mice and found salmonellae lodged in phagocytes. The invaders multiplied clonally in discrete focal lesions, growing at independent rates and forming new foci through the dissemination of bacteria into uninfected cells. Thus, unlike cell culture assays, there was no direct correlation between infection load and bacterial number per infected cell; rather, heavier infection signified more foci, highlighting the limitations of relying on cell culture to model pathogen infection. — CA

Cell. Microbiol. **5**, 593 (2003).

CHEMISTRY

Compartmental Production

Hydrogen peroxide is used as bleach, to treat waste, and in chemical synthesis. Hence, it would seem to be a prime candidate as a versatile, environmentally friendly oxidizing agent, but current production methods are energy-intensive and involve many steps. A catalytic method would be attractive, but mixtures of H_2 and O_2

CONTINUED ON PAGE 1161

are explosive, and the electrical efficiency on the basis of H_2 input is less than 30%.

Yamanaka *et al.* have modified their earlier fuel cell reactor in which low oxygen concentrations limited the production of hydrogen peroxide (which was further reduced to water) in order to increase the oxygen concentration and avoid losses. They introduced a porous membrane cathode, which allows a high O_2 concentration at the site where hydrogen peroxide is produced. Furthermore, they used a cation membrane to prevent diffusion of hydrogen peroxide to the anode, where it might be reduced. With these changes, they could achieve continuous hydrogen peroxide production at 6 weight % with an electrical efficiency of about 90%. —JFU

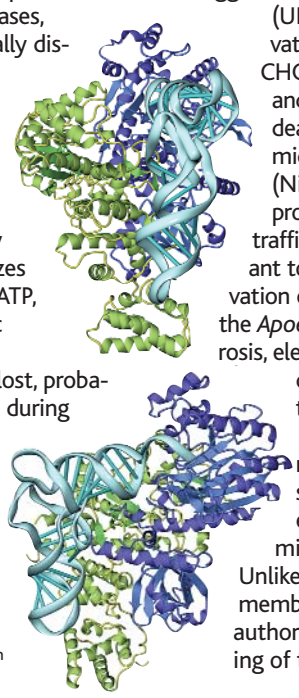
Angew. Chem. Int. Ed. **42**, 3653 (2003).

BIOCHEMISTRY

Two Many Synthetases

Aminoacyl transfer RNA (tRNA) synthetases (aaRSs) are at the heart of the transition from an ancient RNA-controlled economy to today's community of autonomous protein agents. These enzymes attach amino acids to their cognate tRNAs, and most organisms possess the canonical set of 20 synthetases, which fall into the structurally distinct classes I and II.

Roy *et al.* studied the archaeon *Pyrococcus abyssi*, which contains the full-length AsnRS as well as AsnRS2, which lacks the tRNA-binding domain. They show that AsnRS2 synthesizes asparagine from aspartate, ATP, and ammonia; phylogenetic analysis suggests that the tRNA-binding domain was lost, probably as a protective measure during the genesis of the free-standing biosynthetic enzyme from the ancestral AspRS. This path (AsnRS2 + AsnRS) to making Asn-tRNA^{asn} complements the indirect archaeal route of using a relaxed-specificity AspRS to make Asp-tRNA^{asn} followed by amido-transferase modification of the tRNA-bound amino acid.



Model of how LysRS1 (green) and LysRS2 (blue) bind to tRNA^{pyl} (light blue).

Polycarpo *et al.* examined one of the very few cases in which both class I and class II aaRSs are found in a single organism, the archaeon *Methanosarcina barkeri*. In addition to charging the usual suspects (tRNA$^{lys}_{CUU}$ and tRNA$^{lys}_{UUU}$), LysRS1 and LysRS2 cooperate to attach lysine to tRNA^{pyl}, a recently discovered component believed to insert the 22nd amino acid pyrrolysine cotranslationally. While LysRS2 carries out the chemical steps, LysRS1 may function as chaperone. These authors suggest that the aaRS-like PylS (which also seems to lack a tRNA-binding domain) may perform an in situ conversion of the attached lysine into pyrrolysine. — GJC

Proc. Natl. Acad. Sci. U.S.A. **100**, 9837 (2003); *Mol. Cell*, in press.

BIOMEDICINE

Cholesterol in Macrophages

The accumulation of dying macrophages in atherosclerotic lesions has been linked to rupture of plaques and subsequent thrombosis and ischemia. Studying how high cholesterol levels contribute to cell death, Feng *et al.* report that in mouse macrophages the toxicity of free cholesterol can be attributed to its transport to the endoplasmic reticulum (ER). Enrichment of this organelle in cholesterol triggered the unfolded protein response (UPR) stress pathway, which activated a transcription factor called CHOP (C/EBP homologous protein) and promoted programmed cell death. Macrophages derived from mice deficient in CHOP or in NPC1 (Niemann-Pick C), an endosomal protein required for intracellular trafficking of cholesterol, were resistant to free cholesterol–induced activation of UPR and cell death. Also, in the *Apoe*$^{-/-}$ mouse model of atherosclerosis, elevated plasma cholesterol increased CHOP expression in aortic lesions.

Feng *et al.* also report that macrophage apoptosis and lesional necrosis decreased in atherosclerotic lesions of *Apoe*$^{-/-}$ mice that were deficient in NPC1. Unlike the plasma membrane, the ER membrane is relatively fluid, and the authors propose that cholesterol loading of the ER membrane leads to depletion of lumenal calcium, perturbing membrane proteins involved in calcium homeostasis and triggering the UPR signaling pathway. — LDC

Nature Cell Biol. 10.1038/ncb1035 (2003); *Proc. Natl. Acad. Sci. U.S.A.* **100**, 10423 (2003).

CREDITS: POLYCARPO *ET AL. MOL. CELL*, IN PRESS (2003)