EDITORS' CHOICE

edited by Gilbert Chin

PHYSICS

Counting Teeth on a Comb

Accurate determination of optical frequencies with high precision usually relies on a colossal experimental setup involving the microwave input of a cesium atomic clock, subsequent frequency doubling and tripling through a chain of stable lasers, all the while comparing and locking frequencies along the chain. The optical frequency of interest is then determined by comparison to the output from this chain.

To bridge the six orders of magnitude between the microwave and optical frequencies in a single step, Diddams *et al.* used a train of femtosecond pulses generated at a rate of 100 MHz to form an optical comb that serves as a precise frequency grid for making relative comparisons (see also Jones *et al.*, Reports, 28 April, p. 635). To get an absolute map of the frequency spectrum, they couple part of this comb into a microstructured optic fiber, which then generates a broad continuum that covers most of the visible spectrum. Overlaying the precise grid onto this spectrum then allows them to determine other unknown frequencies by counting the number of teeth on the comb between the frequency of interest and its second harmonic with the accuracy and precision otherwise reserved for national laboratories. — ISO

Phys. Rev. Lett. **84**, 5102 (2000).

CELL BIOLOGY

Making a Commitment

Intracellular membrane fusion events are mediated by the interaction between so-called SNARE proteins. Detailed analysis of the interaction between these proteins has led to a model in which four coiled-coils from two SNARE proteins in different membranes intertwine to form a SNAREpin, which brings together the membranes for subsequent fusion. However, the *N*-ethylmaleimide sensitive fusion protein (NSF) is known to disrupt SNARE complexes.

Weber *et al.* examined these competing reactions in a reconstituted system and found that SNAREpins that are committed to causing a fusion event become functionally resistant to disruption by NSF. The molecular details of commitment to fusion and resistance to NSF-mediated disruption remain obscure, but may involve the cooperation between multiple SNAREpins to form a fusion pore or the steric sequestration of the SNAREpins due to tight membrane apposition. — SMH

J. Cell Biol. **149**, 1063 (2000).

MICROBIOLOGY

One for All and All for One

Remarkably, it appears that the ubiquitous soil-living bacterium and occasional food-poisoning culprit *Bacillus cereus,* the widely used insect biocontrol pathogen *Bacillus thuringiensis,* and the life-threatening biological warfare agent *Bacillus anthracis* are the same species, despite the striking differences in phenotype. The secret appears to lie in the plasmids harboured by *B. anthracis* and *B. thuringiensis.*

When ten *B. cereus*–like strains were isolated for biochemical and genetic analysis from soil taken from anthrax outbreak sites, they were found by Helgason *et al.* to have the same chromosomal marker as the implicated *B. anthracis* strains, but no plasmids. In their natural environments these species have a relatively low rate of clone formation, and it is known that all three *Bacillus* species are naturally able to take up plasmids. Indeed, plasmid exchange between *B. cereus* and *B. anthracis* has been verified experimentally. However, before sounding a general alarm, it cannot be ruled out that there is some other special, but as yet undetected, feature of the *B. anthracis* genome that makes it alone of the three species particularly adept at retrieving and retaining virulence plasmids. — CA

Appl. Environ. Microbiol. **66**, 2627 (2000).

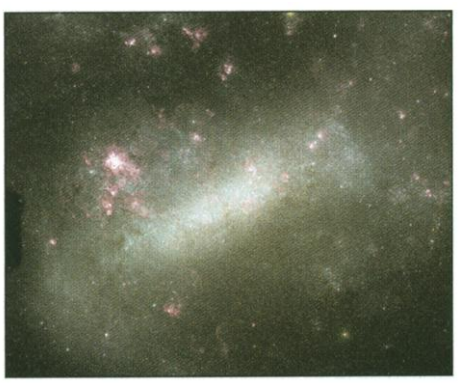
PALEONTOLOGY

Evidence for Early Land Life

When did microbial life move from the oceans into more hostile terrestrial environments, such as on land or in lakes and ponds? In comparison to the marine realm, depositional environments on land are fewer and preservation is more difficult, so most of the evidence for biogenic activity has been obtained through isotopic studies of organic matter in soils.

Rye and Holland have studied paleosols preserved in rocks in Western Australia dated to 2.76 billion years ago. Organic carbon in the soil horizon has extremely negative carbon isotope ratios, which suggests that methanotrophs were present; the presence of methanotrophs is consistent with the notion that Earth's atmosphere was richer in methane at this time and relatively poor in oxygen. These organisms may have inhabited nearby ephemeral lakes, and some of the dessicated microbial mats may have been washed or blown into the soil as it formed nearby. — BH

Geology **28**, 483 (2000).



The LMC—older than it looked.

ASTRONOMY

Telling a Neighbor's Age

The Large Magellanic Cloud (LMC), one of the largest and closest galaxies to our Milky Way, is an irregular barred galaxy with one spiral arm that has only about one tenth the mass of the Milky Way. The bar is thought to have formed only 1 to 5 billion years ago, which would help to explain the differences between the LMC and the Milky Way, which is 9 billion years old.

Alcock *et al.* have completed a photometric survey of about 9 million stars in the LMC as part of the massive astrophysical compact halo object (MACHO) project that takes advantage of microlensing events to boost the brightness of background stars. Billions of photometric measurements were collected and used to create a color versus magnitude diagram that distinguishes the age, distribution, and population of different types of stars. This massive survey indicates that there is a discrete population of stars about 9 billion years old in the LMC bar, thus requiring revisions to models of the LMC's evolution. — LR

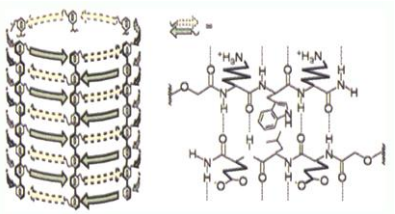
Astron. J. **119**, 2194 (2000).

CONTINUED ON PAGE 1935

CHEMISTRY

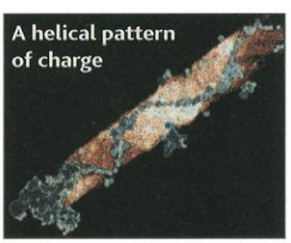
Expanding Barrels, Twisting Tubules

Barrel-like protein architectures support a wide range of biological functions, from transport across membranes to catalysis of metabolic reactions. Previously, Baumeister and Matile synthesized tetrameric barrels that self-assemble from solution and that are stable in detergent-free water. The two types of component molecules consist of chains of benzene rings (rigid rods) with complementary tripeptide ligands that adhere to form small β-sheets. These authors have now expanded these structures to form hexameric barrels by replacing half of the leucine residues with bulkier tryptophans. The hexamers have an interior diameter of about 2 nanometers, which may be useful for encapsulating molecules such as biological chromophores.



Self-assembling β-barrel

One strategy for synthesizing nanostructures is to assemble layers of oppositely charged particles. Lvov *et al.* have imaged subtle charge patterns in microtubules formed from lipids containing diacetylenic groups by attaching charged particles (silica nanospheres) that then can be imaged by transmission electron microscopy. For microtubules containing only a neutral zwitterionic lipid, particles attached to the ends of the tubules. However, adding a small fraction (2%) of anionic lipid allowed the helical twist of the microtubules to be seen readily. This approach could be used to assemble more intricate structures that take advantage of the microtubule helicity. — JU; PDS



Chem. Commun. **2000**, 913 (2000); *Langmuir*, in press.

BIOCHEMISTRY

Of Stems and Pseudoknots

For proteins, α-helices and β-sheets are the two main secondary structural elements to consider when relating amino acid sequence to three-dimensional structure. For RNA, there are stems (double-stranded regions) and pseudoknots—where bases within the loop of a stem-loop region are paired with those outside of the stem.

Isambert and Siggia offer a computationally feasible approach to predicting the energetics of stem-loop and pseudoknot structures and apply it to the folding of a well-studied molecule, the 87-nucleotide human delta virus (HDV) ribozyme. They observe the formation and disappearance of nonnative stem interactions as well as a kinetic bifurcation (if both P1 and P5 stems exist, then correct folding is likely to ensue) that occurs at the time when about 40 nucleotides have been synthesized. They describe two stems as "folding guides" whose transient existence might be assessed experimentally with single-molecule techniques (see Zhuang *et al.*, Reports, this issue, p. 2048). — GJC

Proc. Natl. Acad. Sci. U.S.A. **97**, 6515 (2000).

HIGHLIGHTED IN *SCIENCE*'S SIGNAL TRANSDUCTION KNOWLEDGE ENVIRONMENT

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Irreversibly Instructed to Become Glia

Stem cells in the mammalian neural crest (NCSCs) can differentiate into neurons, glia, or smooth muscle cells. As the peripheral nervous system is formed, migrating NCSCs first differentiate into neurons in response to neurogenic factors like the BMPs (bone morphogenetic proteins); later, in spite of continued exposure to BMPs, the NCSCs form glial cells (which surround the cell bodies of the neurons). Morrison *et al.* used rat NCSCs to show that exposure to a soluble form of the Notch receptor ligand, Delta-1, could inhibit neurogenesis induced by BMP2 and promote formation of glial cells. This activation was irreversible and cell-heritable, unlike in *Drosophila* and *Xenopus* where Notch appears to work transiently and reversibly, leaving stem cells competent to assume multiple fates. In the mammalian system, it seems that the initial differentiation of neurons can trigger the sequential formation of glia by activating Notch signals in neighboring stem cells. These signals appear to inhibit the capacity of the NCSCs to form neurons while instructing them to adopt a glial cell fate. — LBR

Cell **101**, 499 (2000).

CREDITS: (TOP TO BOTTOM) BAUMEISTER AND MATILE, *CHEM. COMMUN.* **2000**, 913 (2000); LVOV *ET AL.*, *LANGMUIR*, IN PRESS.