EDITORS' CHOICE

edited by Stella Hurtley

The Sun's heliosphere and heliopause.

Image not available for online use.

ASTROPHYSICS

To an Instability and Beyond

Just like Buzz Lightyear speeding through the atmosphere in his own bubble, the Sun creates a Buzz-like bubble of supersonic solar wind that rams into the interstellar medium. This tapering bubble is called the heliosphere and essentially defines the edge of the solar system. The gas and particles in the solar upwind are supersonic until they reach the termination shock at about 90 astronomical units (AU, where 1 AU is the mean distance between the Sun and Earth). The wind then travels subsonically and starts to flow in the direction of the interstellar medium in the heliosheath until it reaches the heliopause, where the interstellar and solar winds meet at about 110 AU.

Opher *et al*. developed a three-dimensional magnetohydrodynamic code, BATS-R-US, to discover that a shear velocity instability forms just beyond the termination shock, causing a jet and sheetlike feature to oscillate up and down in the heliosheath. Such an instability could alter the entry of interstellar particles and the mixing between the interstellar and solar winds, which might alter the make-up of the solar system. Voyager 1 is approaching the termination shock at a rate of about 3 AU per year and may soon be able to observe this instability. — LR

Astrophys. J. **591**, L61 (2003).

BIOCHEMISTRY

Extending a Helping Hand

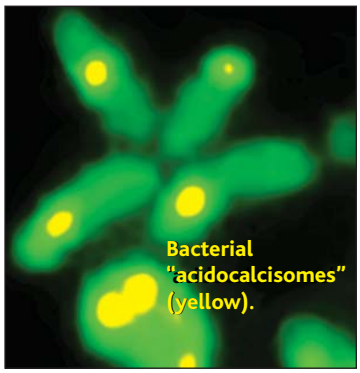
The cell wall and plasma membrane glycoproteins and glycolipids of plant cells are carbohydrate-based outer layers that serve structural and defensive purposes. It can be challenging to move through this thicket of carbohydrates, either for microbes in the act of feeding on cell wall constituents or for viruses seeking to effect entry into the host cell. Polysaccharide-degrading enzymes often incorporate a carbohydrate-binding module (CBM) alongside the hydrolytic domain. Boraston *et al*. use the crystal structure of one such domain, called CBM27, and thermodynamic measurements to describe its interaction with an oligosaccharide of the mannan type. The individual binding sites not only manage to discriminate among various combinations of axial and equatorial hydroxyls, but succeed in accommodating side branches so as to afford virtually complete coverage of the heterogeneous polymer of glucose, galactose, and mannose residues. Thobhani *et al*. show that the multivalency conferred by linked sialidase and CBM introduces a remarkable gain in catalytic efficiency, up to 50-fold. This tethering enables the low-affinity sialidase to clip off terminal sialic acid residues. The difficulty in targeting an enzyme that displays low substrate affinity might thus be overcome by developing an inhibitor that makes use of the adjoining CBM. — GJC

Structure **11**, 665 (2003); *J. Am. Chem. Soc.* 10.1021/ja029759w (2003).

CELL BIOLOGY

How Different Are We?

Subcellular organelles—membrane-bound intracellular compartments—have been thought to be an invention of eukaryotes. Now Seufferheld *et al*. challenge this dogma by the discovery of subcellular organelles within bacteria. Within the cytoplasm of *Agrobacterium tumefaciens* the so-called volutin granules displayed all the hallmarks of acidocalcisomes, an organelle found in unicellular eukaryotes. The granules were surrounded by a membrane and contained large concentrations of P, Mg, K, and Ca. The membrane, which had a distinct composition from the plasma membrane, contained a proton pump. The lumen of the granules was acidic and could accumulate externally added calcium. Thus, this organelle seems to be of very ancient origin, having appeared before the separation of prokaryotes and eukaryotes. — SMH



Bacterial "acidocalcisomes" (yellow).

J. Biol. Chem. 10.1074/jbc.M304548200 (2003).

MEDICINE

Bloody Virus

The mosquito-born flavivirus that causes dengue fever threatens 50 million people a year. A first infection can be shrugged off after a febrile illness, but subsequent infection with one of the other four serotypes can result in dengue hemorrhagic fever, which in 20% of cases proves fatal. This double jeopardy is a major obstacle to vaccine design. In secondary infections, preexisting antibodies, which do not neutralize the virus, bind to virus particles and promote their uptake into macrophages where they replicate and amplify viremia and hence disease severity, which correlates with viral load. Mongkolsapaya *et al*. have made the connection to pathophysiology in studies on hospitalized Thai children. In these patients, instead of killing virus, the cytotoxic $CD8^+$ cells become "stunned" and cease to produce protective interferon gamma. In severely affected children with a history of serial dengue infections, the frequency of antigen-specific T cells for the current serotype was unexpectedly low, but a high frequency of apoptotic T cells was found. Somehow secondary infection sees an expansion of low-affinity, cross-reacting T cells, possibly because the high viral load drives high-affinity T cells into apoptosis, releasing large amounts of cytokines into the blood system. It is the flood of cytokines that causes the cell damage and hemorrhagic symptoms. — CA

Nature Medicine 10.1038/nm887 (2003).

GEOPHYSICS

Tearing Down Deep

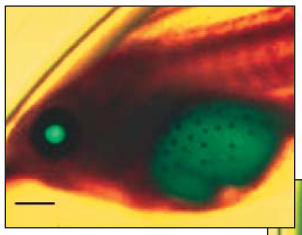
The greatest depth of the ocean, more than 11 km, is at the Marianas Trench in the western Pacific. One reason is that here some of the oldest, and thus coolest, ocean crust is subducted westward beneath Guam, and the trench is not filled with sediment. But the deepest part of the Marianas Trench, the Challenger Deep, is

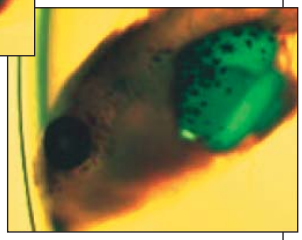
CONTINUED ON PAGE 2007

CREDITS: (TOP) P. FRISCH/UNIVERSITY OF CHICAGO, A. HANSON/INDIANA UNIVERSITY, PHILIP FU, TIMUR LINDE; (BOTTOM) SEUFFERHELD *ET AL., J. BIOL. CHEM.* 10.1074/JBC.M304548200 (2003)

not southwest of Guam but southeast, where the trench bends to the west and much younger ocean crust is being subducted. Fryer *et al.* provide new geophysical data to explain why the Challenger Deep is so deep. Their data imply that the subducting ocean crust is torn here, not that there is a large strike-slip fault, as was previously thought. This tear has further influenced the deformation and dynamics of the overriding plate, and together these features have deepened what is already a deep subduction zone. — BH

Earth Planet. Sci. Lett. **211**, 259 (2003).



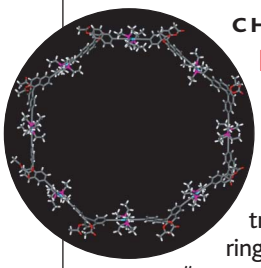


Transgenic (left) tadpoles express fluorescently tagged rhodopsin (green) in their eye, control (right).

CREDITS: (LEFT) JIANG AND LIN, *J. AM. CHEM. SOC.* 10.1021/JA034402T (2003); (RIGHT) JIN *ET AL.*, *NATURE NEUROSCIENCE* 10.1038/NN1070 (2003)

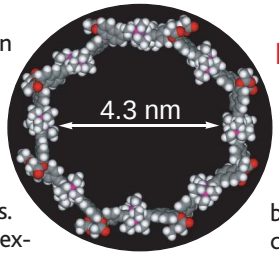
CHEMISTRY

Rings with A Twist



The formation of large macrocyclic rings during solution synthesis is often hindered by the entropy costs of closing the ring. Jiang and Lin report a "one-pot" synthesis that creates large chiral rings with three to eight units by catalytically coupling a flexible organic group bearing two ethyne linkages with *trans*-$Pt(PEt_3)_2Cl_2$ (where Et is ethyl). The mix of products can be separated by column chromatography into the various size fractions as well as into their right- and left-handed components. The chiral fractions exhibit strong circular dichroism bands that arise from the arrangement of the PEt_3 groups. Such chiral cavities may prove useful as artificial receptors in host-guest chemistry. — PDS

Energy-minimized model structures (*S* isomer) of the molecular octagon.



J. Am. Chem. Soc. 10.1021/ja034402t (2003).

NEUROSCIENCE

The Eyes Have It

Congenital night blindness (CNB) occurs when retinal rod photoreceptor cells are inappropriately stimulated so that their sensitivity to dim light is reduced. Three rhodopsin mutants are known to cause CNB in humans, but it has been unclear whether desensitization is caused by constitutive activation of the apoprotein (opsin) or activation of the holoprotein by thermal isomerization of the 11-cis-retinal chromophore to all-trans retinal. Jin *et al.* resolved this by isolating photoreceptor cells containing each of the three rhodopsin mutants from transgenic frogs, and measuring their photoresponse before and after incubation with 11-cis-retinal. Intensity response curves and dim flash kinetics showed that all mutants were desensitized initially but recovered wild-type photoresponses after incubation with 11-cis-retinal. The addition of 11-cis-retinal would not be expected to have any effect on active rhodopsin; however, it could convert active opsin to inactive rhodopsin. Thus it appears that rhodopsin mutations cause CNB by constitutively activating opsin and not by increasing thermal isomerization of the retinal chromophore. — VV

Nature Neurosci. 10.1038/nn1070 (2003).

ASTROCHEMISTRY

Phenyl Radicals Over the Radio

The polyaromatic hydrocarbons (PAHs) found in space are thought to form through reaction pathways that include the phenyl radical C_6H_5. This radical has been well characterized by a variety of optical and infrared spectroscopic techniques, but unfortunately not in the frequency range needed for radio astronomy, which probes signatures of molecular rotation. One difficulty is the preparation of this unstable radical species for spectral analysis. McMahon *et al.* have now detected phenyl radical in a benzene glow discharge using Fourier-transform microwave spectroscopy and millimeter-wave absorption spectroscopy. By optimizing the discharge conditions, they minimized the formation of other species, such as *o*-benzyne, and obtained rotational constants for the phenyl radical, in part by identifying more than 50 rotational transitions between 150 and 330 Ghz. Encouragingly, some of these lines are sufficiently intense to be observable in millimeter-wave spectroscopy. — PDS

Astrophys. J. **590**, L61 (2003).

Phenyl Radicals Over the Radio

Phil D. Szuromi

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