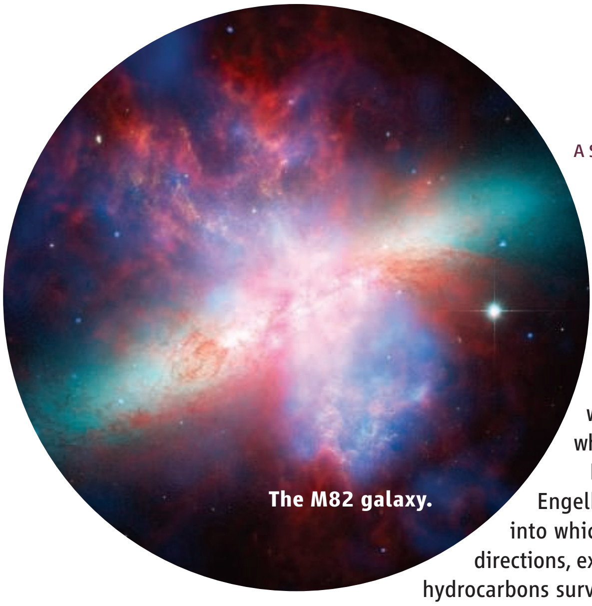


The M82 galaxy.

ASTROPHYSICS

Glowing in the Wind

Galactic winds, driven by violent bursts of star formation, are thought to spread elements heavier than hydrogen between galaxies and throughout the cosmos. The ashes of former stars thereby live on in later generations of stars and may affect galactic evolution. The loss of gas due to winds may starve galaxies of fuel and could affect the growth of different galaxy types. The nearby edge-on spiral galaxy M82 has the most thoroughly studied strong wind; this galaxy is undergoing a violent burst of star formation in its heart, which expels a bi-conical superwind of hot ionized gas.

By examining infrared images acquired with the Spitzer Space Telescope, Engelbracht *et al.* find that M82 is surrounded by a spherical halo of warm dust into which the hot wind penetrates. Spidery dust filaments emanate outward in all directions, extending well beyond the galaxy and its wind. The spectra reveal that aromatic hydrocarbons survive in the dust despite close proximity to the hot superwind. The unusually wide extent and spherical shape of the M82 dust cocoon suggest that the dust was driven out of the galaxy before the superwind commenced, and is thus more pervasive than previously thought; possible explanations include interactions with neighboring galaxies or alternative wind-related mechanisms. — JB

Astrophys. J. **642**, L127 (2006).

CREDITS (TOP TO BOTTOM): NASA/JPL-CALTECH/STSCI/CXC/UOFA/ESA/AURA/JHU; HOTULAINEN AND LAPPALAINEN, *J. CELL BIOL.* **173**, 10.1083/JCB.200511093 (2006)

BIOCHEMISTRY

Flipped Out

As a consequence of their competitive upbringing, microbes have refined the art of warfare, both in the synthesis of and resistance to small molecules, many of which are used by humans as antibiotic drugs. The modes whereby the microbes resist the action of drugs fall generally into three classes: (i) chemical modification of the small molecule into a harmless derivative (for instance, by hydrolysis); (ii) protection of the protein targeted by the drug (by mutation of the gene); (iii) sequestration or transport of the drug beyond the vicinity of the target (by pumping the drug out of the cell).

Siarheyeva *et al.* have taken a closer look at the last of these pathways and address a current controversy regarding the environment and mechanism used to load substrates into the multidrug-resistance transporters for removal. By applying nuclear magnetic resonance spectroscopy to detect the interactions between (the protons of) nine representative and structurally dissimilar drugs and (the protons of) dimyristoyl phosphatidylcholine, the authors find that all of these hydrophobic compounds reside predominantly in the portion of the lipid bilayer between the choline headgroup and the aliphatic tails. This location is consistent with the view that multidrug-resistance transporters may function primarily to flip drugs from the inner to the outer leaflet of the plasma membrane, from whence the drugs diffuse into the extracellular medium, thus reducing intracellular antibiotic concentrations. — GJC

Biochemistry **45**, 10.1021/bi0524870 (2006).

PHYSICS

Brane-Induced Inflation

Inflationary cosmology seeks to explain such puzzling features of the universe as the extreme flatness of spacetime and the mutual similarity of distant regions of space that are not causally connected. A universe experiencing breakneck inflationary expansion would exhibit these and other observed characteristics, but the standard model of particle physics lacks any identifiable quantum particle, or inflaton, that could underlie this phenomenon.

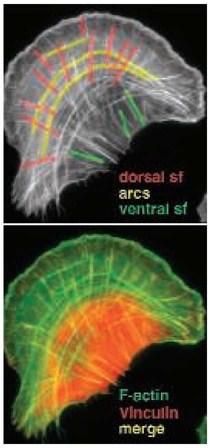
A brane is a spacetime structure that inhabits the higher dimensional spaces (the "bulk") required by "theories of everything," such as string theory and M theory, and some specific assemblage of branes might act as inflatons. Shuhmaher and Brandenberger offer a model of cosmological inflation in which a hot gas of branes drives expansion of the high-dimensional bulk spacetime. At first, all spatial dimensions are extremely compact, and extra dimensions above the usual three are tucked away into a topological space called an orbifold. As the brane gas expands, its energy density decreases until the three familiar spatial dimensions can undergo conventional inflationary expansion. — DV

Phys. Rev. Lett. **96**, 161301 (2006).

CELL BIOLOGY

Stress Made Manifest

When cells attach to a surface, stress fibers (contractile actomyosin bundles) play a key role in adhesion itself and in the subsequent movements and morphology of these cells. Hotulainen and Lappalainen examined how stress fibers assemble in cultured human cells and document two pathways of formation. At the base of the cell, dorsal stress fiber assembly was driven by formin-stimulated actin assembly at focal adhesions, which are established adherent patches. In contrast, near the leading edge of the cell, unanchored ventral arcs of actin formed by means of the end-to-end assembly of bundles of the molecular motor myosin and with concomitant actin bundle assembly promoted by the Arp2/3 complex. Both dorsal stress fibers and ventral arcs were able to convert into ventral stress fibers, which are anchored to focal adhesions at the front and back of the cell.



Different types of stress fibers contain actin filaments in an osteosarcoma cell line.

Continued on page 817

Continued from page 815

Both dorsal stress fibers and transverse arcs continually undergo assembly and disassembly; and within stress fibers, actin cross-linking remained dynamic, allowing for extensive remodeling during cell movement. — SMH

J. Cell Biol. **173**, 10.1083/jcb.200511093 (2006).

DEVELOPMENT

A Bug's Life History

Direct-developing insects progress through nymphal and adult stages, where nymphs are similar to but smaller than adults, whereas other insects experience a dramatic transition—metamorphosis—with distinct larval and pupal stages giving rise to the adult form. The transcription factor *broad* is known to play a critical role in metamorphosis: Its expression is limited to the larval-pupal transition, where it activates pupal-specific genes and specifies pupal development. But what does *broad* do in direct-developing insects?

Erezyilmaz *et al.* have cloned the *broad* gene from the direct-developing milkweed bug *Oncopeltus fasciatus*, which passes through five nymphal instars before molting into the adult. The *broad* gene is expressed during embryogenesis and the nymphal stages; expression peaks during the nymphal molts, but *broad* RNA is not present in the latter part of the fifth and final nymphal instar or in the subsequently formed adult. RNAi knockdown of *broad* blocks the morphological transition from one nymphal instar to the next, although it does not alter the number of nymphal instars or the transition to the adult.

***Oncopeltus fasciatus*.**

Metamorphosis in insects is thought to have arisen in a direct-developing ancestor some 300 million years ago and may have been caused in part by changes in the expression of *broad*, from its temporally complex pattern in the milkweed bug, which directs differential growth between nymphal instars, to the highly restricted pattern during the last larval instar of insects that undergo metamorphosis. — GR

Proc. Natl. Acad. Sci. U.S.A. **103**, 6925 (2006).

CHEMISTRY

Stabilizing Ca-H

The *s*-block metals, whose valence electrons lie exclusively in *s* orbitals, are widely known for their ionic chemistry. Through careful ligand choice, metals such as sodium, magnesium, and calcium can also be coaxed into discrete coordination complexes. However, *s*-block molecular hydride complexes, which are of particular interest in light of the strong role of *p*- and *d*-block metal hydrides in organic reduction chemistry, have proven challenging to access, because they tend to decompose into insoluble aggregates.

Harder and Brettar have prepared a dimeric calcium hydride complex that is freely soluble in benzene and stable at 80°C. The solid-state structure, in which two hydride ligands bridge the two Ca centers, was characterized by x-ray crystallography. Key to the synthesis was the choice of a tightly coordinating β-diketiminate ancillary ligand on each Ca center. Surprisingly, the bulky tris(*tert*-butylpyrazolyl)borate (Tp^{tBu}) ligand failed to prevent disproportionation into $(Tp^{tBu})_2Ca$ and the insoluble CaH_2 oligomer, despite stabilizing a hydride complex of calcium's lighter congener beryllium. — JSY

Angew. Chem. Int. Ed. **45**, 10.1002/anie.200601013 (2006).

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<< Going for the Correct Orientation

Development of the *Drosophila* sensory organ depends on the polarization and subsequent asymmetric division of sensory organ precursor cells (SOPs), which give rise to the cell types that make up the mature structure. Although SOPs can become polarized and divide asymmetrically in the absence of external signals, achieving the correct orientation depends on extracellular signals transduced through the Frizzled (Fz) receptor. Fz is known to signal through heterotrimeric GTP–binding proteins containing G_o-type α subunits, and Katanaev and Tomlinson demonstrate that cells containing mutant G_o or overexpressing wild-type G_o show defects in both orientation and asymmetric division as well as in the localization of Numb, a protein whose polarized distribution in SOPs is key to cell fate determination. The phenotypic effects of overexpressing wild-type G_o depended on the expression of Fz and were enhanced by Fz overexpression. G_o thus appears to be involved both in the establishment of asymmetry and in specifying orientation, and the authors propose that it may act to integrate the two. — EMA

Proc. Natl. Acad. Sci. U.S.A. **103**, 6524 (2006).

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