

## EVOLUTION

## Putting Off Growing Old

In a classic 1957 paper on the evolution of senescence, Williams argued that when extrinsic mortality (death due to predation, infectious disease, or accident) is high, natural selection favors investment in early reproduction. When it is low, the increased return from allocating resources to maintain and repair the soma should lead to longer life spans. In the absence of precise information on causes of death, researchers have used hazard models to partition mortality into age-independent (interpreted as extrinsic) and age-dependent components.

Taking this approach, Gurven and Fenelon analyze mortality data from 13 remote, small-scale societies and in historical cohorts from Sweden and England over the past 250 years. They explore two statistical models (Weibull and Gompertz-Makeham) of adult mortality patterns and consider three measures of actuarial aging (mortality rate doubling time, Ricklefs's  $\omega$ , and slope of the mortality function between ages 60 and 70). The variation in results across these two estimation procedures and three measures complicates the interpretation of the data. Nonetheless, some patterns are robust: The subsistence groups and the early Swedish cohorts exhibit similar actuarial aging, but more recent European cohorts show progressively slower aging. In the longitudinal samples, slower aging and reduced extrinsic mortality are linked. Women have lower rates of senescence than men, a difference that has increased over time. These "modest but nontrivial" changes support Williams's claims, and the authors discuss individual-level mechanisms that could underlie them. — SJS

*Evolution* 63, 1017 (2009).

## SIGNAL TRANSDUCTION

## Adaptable Transducers

The  $\alpha$  subunits of heterotrimeric guanine nucleotide-binding proteins (G proteins) associate with G protein-coupled receptors (GPCRs) at the cell membrane and transduce signals that affect a range of physiological processes. Yet there have been hints that G $\alpha$  subunits may have other signaling roles as well. Cao *et al.* found that mouse fibroblasts lacking the G $\alpha_{11}$  and G $\alpha_{13}$  proteins had impaired signaling through the epidermal growth factor receptor

(EGFR), a receptor with a signaling mechanism distinct from that of GPCRs. The protein Gab1 binds to activated EGFR and links it to activation of downstream proteins. The authors show that G $\alpha_{11}$  is required for this association and that in cells stimulated with EGF, G $\alpha_{11}$  and G $\alpha_{13}$  are present in a complex with Gab1 and EGFR. The effects of EGF on cell survival, proliferation, and migration were all dependent on signaling through G $\alpha$  proteins, suggesting that G $\alpha_i$  proteins might become the targets of therapies aimed at squelching cancer cells. — LBR

*Sci. Signal.* 2, ra17 (2009).

## CHEMISTRY

## Put On a Platinum Face

Precious metals such as platinum are widely used in industrial catalysts. One way to reduce the amount of precious metal used—and hence the cost of the catalyst—is to create core-shell particles in which a core consisting of a cheaper, nonprecious metal is surrounded by a precious-metal shell. Methods for creating such particles, such as high-temperature treatment and chemical leaching, commonly lead to the loss of active surface area as a result of reduced particle sizes. Mayrhofer *et al.* report a method in which carbon monoxide (CO) adsorption causes surface segregation of platinum in a platinum-cobalt catalyst. The authors explored both gas-phase and electrochemical treatments, both of which lead to particles with an alloy core and a platinum shell, as evidenced by cyclic voltammetry and CO stripping measurements. The modified catalysts have higher activity than the untreated system in the oxygen reduction reaction. Particle sizes remain unaltered, without the loss of active surface area. — JFU

*Angew. Chem. Int. Ed.* 48, 3529 (2009).

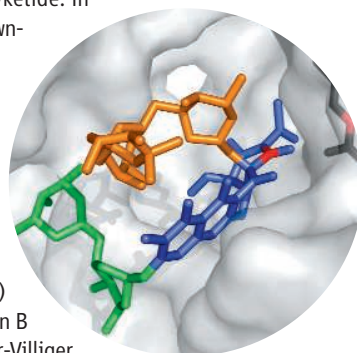
## BIOCHEMISTRY

## Burning Off a Carbon

Streptomycetes are bacterial drug designers, synthesizing a cornucopia of natural products that have found their way onto pharmacists' shelves worldwide. The precursor to one such compound, mithramycin, contains di- and tri-saccharide chains (green and yellow) linked to a tetracyclic polyketide. In

a subsequent down-sizing reaction, dioxygen is activated by attaching it to FADH (black) at C4a (red), and the resulting peroxy-flavin attacks the ketone at C1 (red) of premithramycin B (blue) in a Baeyer-Villiger oxidation. The consequences are

that one of the rings can then be opened by hydrolysis of the lactone, and one of the carbon atoms can be removed via decarboxylation. Beam *et al.* describe the crystal structure of the Baeyer-



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Villiger monooxygenase MtmOIV (gray) and the binding of FAD and premithramycin in the active site. Of particular interest are the residues that allow the enzyme to accommodate the saccharide chains, as these are prime targets for modifications aimed at enhancing the activity of mithramycin as a DNA cross-linking agent and at decreasing its toxicity. — GJC

*Biochemistry* **48**, 10.1021/bi8023509 (2009).

## MATERIALS SCIENCE

## Shrugging Off Grime

To prevent the accumulation of unwanted microorganisms, plants, and animals on surfaces exposed to a marine environment, coatings are applied to the submerged surface. One challenge in creating such a coating is that the critical length scales involved in organism attachment range from hundreds of nanometers to centimeters. Efimenko *et al.* have developed polymer coatings that possess a hierarchical wrinkled structure. They stretched and then cross-linked the surface of poly(dimethylsiloxane), after which they applied a fluorinated silane monolayer. On gentle relaxation of the stress, a rippled surface layer formed, wherein each wrinkle had smaller-scale wrinkles on top of it that themselves bore even smaller wrinkles, proceeding over five generations. In seawater tests, flat polymer films showed fouling after a few



Flat (top) and wrinkle-protected samples.

weeks, whereas the wrinkled polymers resisted barnacle accumulation over a period of 18 months. In tests on the adhesion of green algae zoospores, the wrinkled films performed less well, as the spores could nestle and be protected from shear flows and physical contacts within the wrinkles. However, a combination of topology and the right surface chemistry conferred improved resistance, pointing toward development of a nontoxic universal antifouling coating. — MSL

*ACS Appl. Mater. Interfaces* **1**, 10.1021/am9000562 (2009).

## EVOLUTION

## No Time for Rest

In the history of life, the Ediacaran Period is marked by an enigmatic collection of macroscopic fossils that record the appearance of animals that often took the form of discs, bags, or quilted sheets. Simultaneously, highly ornamented microfossils of an unusual size ( $>100\ \mu\text{m}$ ) appeared in the geological record. Like that of their macro brethren, the origin of these microfossils has remained something of a puzzle.

Using a process of elimination, Cohen *et al.* argue that many of these ornamented microfossils were in fact cysts—the resting stages of multicellular animals. Their large size and distinct lipid content exclude dinoflagellates as the culprits, and their size and spiny surfaces similarly argue against their being the remains of prasinophyte algae. The microfossils have complex and layered outer walls, distinct from various modern algal forms but similar to the diapause cysts of present-day brine shrimp. Encystment is a self-preservation response to an inconstant and potentially lethal environment, which may have been a chronic problem in the anoxic seas of the early- and mid-Ediacaran. This idea is reinforced by the disappearance of the microfossils roughly 560 million years ago, a period which corresponds to the oxygenation of the sea floor. So, instead of recording the loss of life, the disappearance of these microfossils would reflect a renaissance. — GR

*Proc. Natl. Acad. Sci. U.S.A.* **106**, 6519 (2009).

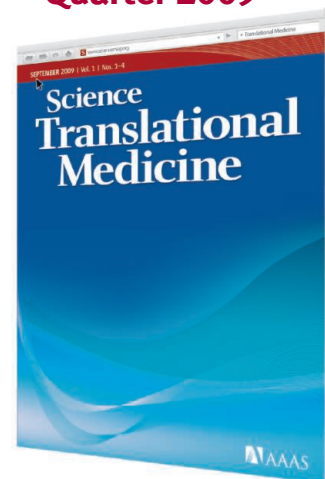
## CHEMISTRY

## Reaching Out to Zirconium

When alkyl chains bind to transition metals, the metal center can sometimes loosely attract electrons from the hydrogen bonds two carbons away. This attraction, termed an agostic interaction, plays an influential role in stereoselective olefin polymerizations at zirconocene centers, but it is typically too fleeting to characterize in a persistently stable complex. Forster *et al.* prepared an analog to an agostically coordinated ethyl ligand by replacing the two carbons ( $\text{CH}_2\text{-CH}_3$ ) with nitrogen and boron ( $\text{NH}_2\text{-BH}_3$ ). On coordinating through nitrogen to a zirconocene derivative, the ligand's boron hydride binds more stably to the metal center than the corresponding ethyl C-H. The authors characterized several such complexes in the solid state and in solution, and observed interconversion of isomers (which differed in the positions of N and B-H relative to a third substituent) on a time scale of tens of seconds. — JSY

*J. Am. Chem. Soc.* **131**, 10.1021/ja901460y (2009).

## Coming Fourth Quarter 2009



## Integrating medicine and science

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The journal's mission is to facilitate communication and cooperation among basic and preclinical researchers, physician scientists, regulators, policy makers, industry, and funding agencies in order to improve health around the world. It will present original, science-based peer-reviewed research that successfully moves the field closer to helping patients. Perspectives and reviews from basic and clinical viewpoints along with discussions about research funding and regulatory issues will be included.

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