## A REVISED PICTURE OF DEEP-EARTH SULFUR

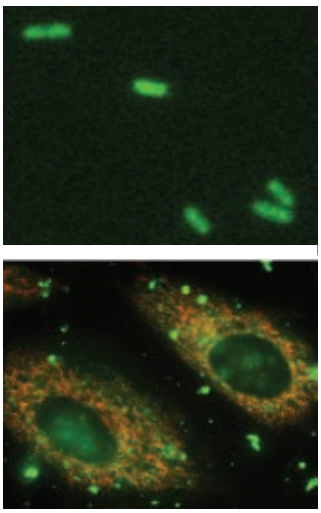
A study of sulfur in fluids at high temperatures and pressures suggests that this geochemically ubiquitous element may exist deep in Earth in the form $S_3^-$, rather than the presumed sulfide ($H_2S$, $HS^-$, and $S^{2-}$) and sulfate ($HSO_4^-$ and $SO_4^{2-}$) species (*Science,* DOI: 10.1126/science.1199911). If true, this finding would change the picture of sulfur-rich fluid chemistry that drives the migration of elements such as gold, copper, and platinum from deep fluids to the surface to form ore deposits. It also implies that sulfur isotopic fractionation models used to date geologic samples, which are based on the assumption that sulfides and sulfates are the dominant species, may need to be revised. Gleb S. Pokrovski of France's Paul Sabatier University and Leonid S. Dubrovinsky of Germany's University of Bayreuth used a diamond anvil cell to subject sulfur-water solutions to a range of temperature and pressure conditions—up to 450 °C and 3.5 gigapascals. They found that at moderate temperatures sulfides and sulfates do predominate. However, at higher temperatures, like those encountered in Earth's magma, $S_3^-$ emerges as the dominant species.—EKW

## PICKING PRION INFECTIVITY APART

Prion disorders such as Creutzfeldt–Jakob disease and bovine spongiform encephalopathy have long kept researchers guessing about exactly how the diseases' characteristically misfolded proteins lead to infectivity and toxicity. Research from John Collinge and colleagues at UCL Institute of Neurology, in London, suggests that the infectious refolding of normal proteins into misfolded versions and prion diseases' neurological toxicity are independent processes (*Nature,* DOI: 10.1038/nature09768). The researchers note that "prions themselves are not neurotoxic but catalyze the formation of such species." Working with mouse models, Collinge's team showed that infectious prion proteins catalyze the increase in concentration of misfolded proteins, but that during this phase no clinically relevant toxicity occurs. Only after the misfolded prion proteins reach a saturation concentration does neurotoxicity initiate. In a commentary about the work, Reed B. Wickner of the U.S.'s National Institute of Diabetes & Digestive & Kidney Diseases notes that this "simple experiment [shows] that the infectious and toxic particles are not the same." Wickner adds that "this is unexpected and raises issues central to our understanding of prion diseases."—SE

# SEQUESTERED ANTIBIOTICS

Shuttling drugs away from their intended targets can transform compounds that might otherwise be too toxic for people into good antimicrobials, according to researchers at the University of Toronto. Shana O. Kelley and Mark P. Pereira attached a mitochondria-targeting peptide to the cancer drug methotrexate and demonstrated the drug's antimicrobial abilities (*J. Am. Chem. Soc.,* DOI: 10.1021/ja110246u). The researchers show that the conjugate accumulates in mitochondria in human cells, where it can't reach its enzyme target, but in the cytoplasm in bacteria. In cell culture, the conjugate killed a broad range of bacteria, including methicillin-resistant *Staphylococcus aureus,* a microbe resistant to most drugs. Kelley's group is starting to study animals to see whether the drug retains its activity and reduced toxicity. The approach could be general for other drugs, provided they have a convenient "synthetic handle to tinker with," Kelley says. The demonstration with methotrexate "opens the door to using similar strategies to revisit or repurpose old molecules that may have been discarded at early stages of antibiotic development," says infectious disease expert Gerard D. Wright of McMaster University, in Hamilton, Ontario.—CHA



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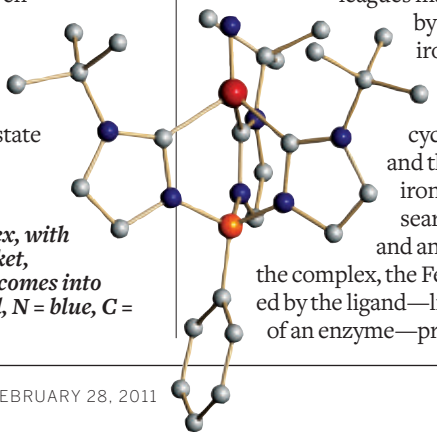
***Peptide-conjugated methotrexate (green) accumulates in the cytoplasm of bacteria (top) and the mitochondria (red) of human cells (bottom).***

## IRON(V) NITRIDE MIMICS NITROGENASE ACTIVITY

An international research team has isolated an iron(V) nitride (Fe≡N) complex that readily produces ammonia, mimicking one of the steps nitrogenase enzymes may use to reduce $N_2$ to $NH_3$ (*Science,* DOI: 10.1126/science.1198315). Chemists are on the lookout for high-oxidation-state iron complexes with metal-ligand multiple bonds as models to study nitrogenase and other enzyme catalytic cycles with the goal of developing efficient industrial catalysts. In these cycles, iron shifts into different oxidation states to bind nitrogen intermediates on the pathway between $N_2$ and $NH_3$. Iron(V) complexes proposed to participate in this process have been exceedingly hard to isolate and study, however. Jeremiah J. Scepaniak and Jeremy M. Smith of New Mexico State University and Karsten Meyer of Friedrich Alexander University, in Erlangen, Germany, and colleagues made their complex by synthesizing an iron(IV) complex containing a tripodal N-heterocyclic carbene ligand and then oxidizing it to iron(V). When the researchers added water and an electron source to the complex, the Fe≡N group protected by the ligand—like the active site of an enzyme—produced ammonia



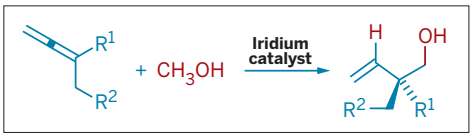
KARSTEN MEYER

***This iron(V) nitride complex, with the Fe≡N in a protected pocket, liberates ammonia when it comes into contact with water; Fe = red, N = blue, C = gray, B = orange.***

within seconds and formed an iron(II) complex. This reactivity is similar to nitrogenase chemistry in which water supplies hydrogen for ammonia synthesis, the researchers note.—SR

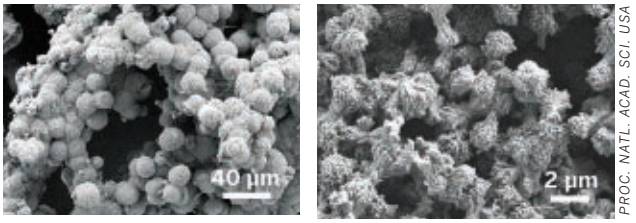
## CATALYTIC METHANOL COUPLING ACHIEVED

Methanol is a high-volume chemical feedstock and thus a readily available reagent. But its ability to react at carbon rather than oxygen in chemical synthesis is limited—it's restricted primarily to the Monsanto and Cativa processes for carbonylating methanol to form acetic acid. Michael J. Krische and coworkers of the University of Texas, Austin, have now developed iridium complexes that catalyze the direct C–H functionalization of methanol with allenes to form higher alcohols bearing a quaternary carbon center (*Nat. Chem.*, DOI: 10.1038/nchem.1001). The regioselective hydrohydroxymethylation process does not generate stoichiometric by-products. "Methanol is not an obvious choice of reagent for C–C bond formation, and it is a clever hydrogen-transfer sequence combined with a highly reactive catalyst that has allowed Krische and coworkers to make this significant advance," comments carbon-coupling expert Jonathan M. J. Williams of the University of Bath, in England. Krische notes that his group hopes to advance the work further by developing "related alcohol C–C couplings applicable to renewable feedstocks, such as the coupling of glycerol to α-olefins."—SB




## FISH POOP ESTABLISHES A GEOLOGIC RECORD

By collecting and analyzing a lot of fish excrement, scientists have determined that the aquatic vertebrates generate a large portion of the carbonate mud that deposits on the ocean floor in tropical waters (*Proc. Natl. Acad. Sci. USA*, DOI: 10.1073/pnas.1015895108). Marine sediment contains information about past ocean chemistry, and the origins of a large fraction of the material have long been a mystery. On the basis of studies carried out with bony fish collected in the Bahamas, Chris T. Perry of England's Manchester Metropolitan University, Rod W. Wilson of England's University of Exeter, and coworkers estimate that on average 14% of the carbonate mud produced annually in the archipelago's waters comes from fish. The ocean dwellers produce carbonate by drinking seawater rich in calcium and magnesium ions, which then precipitate with bicarbonate ($HCO_3^-$) in their intestines. Using energy-dispersive X-ray microanalysis and scanning electron microscopy, the researchers found that different fish species excrete carbonate crystallites with widely varying magnesium content and different ellipsoid, spheroid, and dumbbell morphologies. The results, the team says, could help address "some of the major unknowns about the provenance of carbonate muds in the geologic record."—LKW

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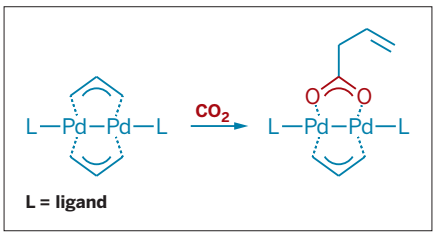
***SEM images of spheroid- (left) and dumbbell-shaped carbonate aggregates (right) produced by tropical bonefish and barracuda, respectively.***

## PALLADIUM-ALLYL BRIDGES SNATCH $CO_2$

Chemists at Yale University have developed a facile route to palladium(I)-bridging allyl dimers (*J. Am. Chem. Soc.*, DOI: 10.1021/ja110708k). Thanks to the synthetic methodology, which circumvents the use of reagents that tend to decompose, the team led by Nilay Hazari was able to study the reactivity of these unusual complexes, revealing their ability to insert carbon dioxide and form bridging carboxylates (shown). Although mononuclear palladium allyl complexes are well understood, relatively little is known about bridging metal-allyl complexes, in part because they are not trivial to prepare. Hazari and coworkers were able to create the complexes by combining commercially available allyl palladium complexes, free ligand, and an allyl Grignard reagent. With their ability to activate $CO_2$, the dimeric compounds behave like nucleophiles. In fact, when the researchers used a substituted N-heterocyclic carbene as the ligand, they found the dimer to be "one of the most active and stable catalysts reported to date for the carboxylation of allylstannanes and allylboranes with $CO_2$." Tin carboxylates are widely used industrially to stabilize polymers made from vinyl chlorides.—BH




## PEPTIDE INDUCES HAIR REGROWTH IN MICE

For people who suffer from hair loss due to chronic stress, help might be on the way, according to a research team led by Million Mulugeta of UCLA's David Geffen School of Medicine (*PLoS One*, DOI: 10.1371/journal.pone.0016377). The scientists recently stumbled upon a potential new treatment for alopecia while testing the effects of the 41-residue peptide astressin B on the gastrointestinal function of stressed mice. Engineered to overexpress stress-associated corticotropin-releasing factor (CRF) neuropeptides, the model rodents exhibit baldness and exaggerated responses to stress. Just two weeks after a five-day course of daily injections of astressin B, a known CRF protein receptor antagonist, the mice regained pigmentation on their pink skin and regrew nearly all their hair. In addition, the team administered astressin B to young model mice that had not yet lost their hair. Those rodents exhibited negligible hair loss for two months after treatment. "These new findings may well be clinically relevant," says Ralf Paus, a dermatologist at the University of Manchester, in England. "It now deserves to be systematically studied how CRF and CRF receptor antagonists affect human scalp hair follicles."—LKW

PLoS ONE

***Adult stressed mice three days after treatment with saline (control, top) and three days (center) and four weeks (bottom) after treatment with astressin B.***