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In This Issue

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GEOLOGY, EVOLUTION

Sulfur cycling sustained Earth's "boring billion" years

Researchers have proposed a hypothesis that may help explain Earth's "boring billion" years, when the oceans remained in an intermediate oxidation state that prevented the development of complex multicellular life. David Johnston et al. propose that anoxygenic photosynthetic bacteria in the surface ocean used sulfide, rather than water, as an electron donor. The resulting chemical reaction reduced the rate at which oxygen was produced, which likely kept oxygen from accumulating in the sea and air. These sulfide-using bacteria perpetuated a worldwide zone within the ocean where only anaerobic species could live, which persisted from roughly 1.8 until 0.8 billion years ago. Sulfide binds to iron to produce insoluble pyrite. Over geological time scales, oceanic pyrite cycling controls oceanic sulfur levels; the same sulfur, when free in the ocean, is used as the primary energy source for the bacteria. Eventually this cycle was broken, freeing more iron, and in turn allowing more oxygen to be produced in the oceans. Oxygen-producing photosynthetic bacteria eventually took over the oceans, which indirectly led to the rise of multicellular life, first in the oceans and then on land, according to the authors. — P.D.

"Anoxygenic photosynthesis modulated Proterozoic oxygen and sustained Earth's middle age" by D. T. Johnston, F. Wolfe-Simon, A. Pearson, and A. H. Knoll (see pages 16925–16929)

GEOLOGY

How to build a meandering river

Researchers have created a meandering river in the laboratory, revealing the conditions that support river flow and dynamics found on Earth and other planets. Christian Braudrick et al. report that the most important factors are strong banks and the blocking of chutes that form between the floodplain and point bars. The authors formed a meandering river by creating a 40-cm-wide, 1.9-cm-deep channel along a 17-m-long flume filled with sand and seeded with alfalfa sprouts. The authors tested the effects of variable and constant flood discharge for 136 hours and observed the channel migrating across its floodplain and cutoffs forming behind bends. The laboratory river matched most of the characteristics of natural ones, but was less sinuous. The authors found that the sprouts strengthened riverbanks, providing time for a new floodplain to be created through bar growth. Fine sediment filled the chutes behind bars that maintained a single thread. The results may help create meandering channels in stream restoration projects and provide insight into river-flow mechanisms on Earth and elsewhere, according to the authors. — P.D.

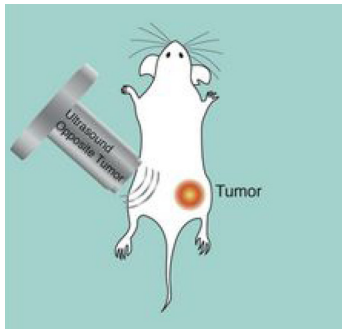
Sample river and cutoff channel.

"Experimental evidence for the conditions necessary to sustain meandering in coarse-bedded rivers" by Christian A. Braudrick, William E. Dietrich, Glen T. Leverich, and Leonard S. Sklar (see pages 16936–16941)

MEDICAL SCIENCES

Ultrasound amplifies blood biomarkers

Biomarkers for illnesses such as cancer have the potential to help clinicians diagnose and monitor disease. Blood concentrations of the markers are often low, are difficult to measure accurately, and provide no indication of disease location. Aloma D'Souza et al. applied ultrasound energy to determine whether tumor cells could amplify released biomarker signals. The authors used the human colon cancer tumor cell line LS174T and the colon cancer biomarker carcinoembryonic antigen (CEA) and found that low-frequency ultrasound caused tumor cells to release CEA in culture and in tumor-bearing mice infected with an LS174T tumor. Blood concentrations of CEA in the mice were significantly higher after ultrasound directed at the tumor than before ultrasound. In addition, CEA blood levels



Ultrasound applied to a non-tumor-bearing region of mice with tumors.

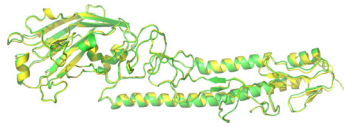
did not increase when the authors applied ultrasound to tumor-free mice or to tumor-free areas on infected mice, suggesting that the technique may be useful for localizing tumors. The authors say that this study supports the use of ultrasound to amplify biomarker release and to serve as a noninvasive way to analyze tumors in patients. — B.A.

"A strategy for blood biomarker amplification and localization using ultrasound," by Aloma L. D'Souza, Jeffrey R. Tseng, Kim Butts Pauly, Samira Guccione, Jarrett Rosenberg, Sanjiv S. Gambhir, and Gary M. Glazer (see pages 17152–17157)

MICROBIOLOGY

A clue to how avian flu jumps to humans

All three influenza pandemics of the 20th century derived from avian viruses that evolved to recognize and bind human cells. How those viruses migrated across species has been unclear because birds and humans have different receptors for hemagglutinin, the receptor-binding glycoprotein of influenza viruses. Junfeng Liu et al. used X-ray crystallography to determine the structure of hemagglutinin H2 from the 1957 "Asian" influenza pandemic, and compared it with the 1918 "Spanish" influenza hemagglutinin, H1, and the 1968 "Hong Kong" hemagglutinin, H3.



Human H2 hemagglutinins.

The authors also analyzed hemagglutinins from avian viruses that might represent precursors to the H2 pandemic virus, and showed that these H2 avian viruses bind human receptors by making unusual patterns of hydrogen bonds. Once inside humans, the fast-growing mutations can improve the viruses' ability to bind to human receptors. The mutations may also protect against mucins in the human respiratory tract that would otherwise block infection. The study suggests that research into which avian flu viruses have the propensity to bind human receptors may benefit pandemic planning, according to the authors. — B.A.

"Structures of receptor complexes formed by hemagglutinins from the Asian Influenza pandemic of 1957" by Junfeng Liu, David J. Stevens, Lesley F. Haire, Philip A. Walker, Peter J. Coombs, Rupert J. Russell, Steven J. Gamblin, and John J. Skehel (see pages 17175–17180)