

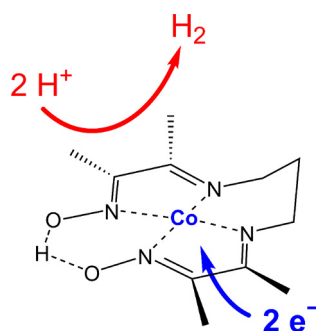
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CHEMISTRY

Hydrogen generated by a synthetic catalyst

The need for clean, renewable energy has focused research efforts on finding efficient ways to produce hydrogen, a molecular gas that can fuel engines and reduce carbon emissions. Industrial-



Renewable generation of hydrogen.

scale hydrogen production, however, currently relies on scarce, expensive, and unsustainable platinum catalysts. Other production methods rely on macrocyclic cobalt complexes called cobaloxime catalysts that have structures similar to some vitamins and protein cofactors. These complexes degrade quickly in the acidic environment required for hydrogen production.

Pierre-André Jacques et al.

modified macrocyclic cobalt complexes to create efficient molecular catalysts that can withstand acidic conditions. The authors created the catalysts by providing the metal center, cobalt or nickel, with a diimine-dioxime environment that contained a proton-exchange site, mimicking the structure of naturally occurring enzymes that produce molecular hydrogen. In addition to greater stability, the catalyst exhibited lower overvoltages and better turnover frequencies than previous cobaloxime catalysts. Because cobalt and nickel are abundant in the earth's crust, this research may pave the way for efficient hydrogen engines and cells for photochemical water-splitting, according to the authors. — F.A.

“Cobalt and nickel diimine-dioxime complexes as molecular electrocatalysts for hydrogen evolution with low overvoltages” by Pierre-André Jacques, Vincent Artero, Jacques Pécaut, and Marc Fontecave (see pages 20627–20632)

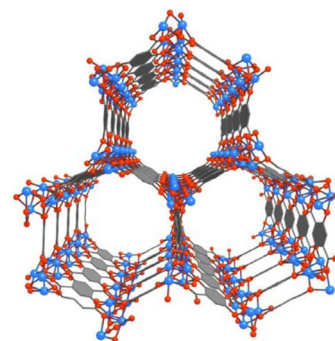
CHEMISTRY

Chemical filter catches CO₂

Capturing carbon dioxide is critical for purifying natural gas and for reducing CO₂ emissions in the atmosphere. Any viable filter must effectively capture CO₂ and then release it in an

energy-efficient manner so the filter can be reused. David Britt et al. tested whether Mg-MOF-74, one of a class of materials called metal-organic frameworks (MOFs), could be a useful CO₂ filter. The authors

flushed a 20% mixture of CO₂ in methane through their chemical trap and used mass spectrometry to monitor the effluent. Mg-MOF-74, which is replete with open magnesium sites, separated the CO₂ from the methane and did not significantly adsorb methane itself. The filter captured 89 g of CO₂ per kilogram of adsorbent before breakthrough, a value more than twice that



Single crystal structure of Mg-MOF-74.

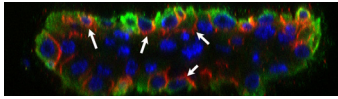
seen in any other MOF and higher than zeolites, another candidate for capturing CO₂. Mg-MOF-74 also released 87% of the CO₂ at room temperature and the rest after heating to 80 °C, using significantly less energy than other processes. The authors say that Mg-MOF-74 represents a candidate for energy-efficient CO₂ capture and could lead to a class of materials with potential for improvement in carbon capture and sequestration. — B.A.

“Highly efficient separation of carbon dioxide by a metal-organic framework replete with open metal sites” by David Britt, Hiroyasu Furukawa, Bo Wang, T. Grant Glover, and Omar M. Yaghi (see pages 20637–20640)

MICROBIOLOGY

Bacterial infection linked to gastrointestinal dysplasia

In animals, the intestines aid in key physiological processes such as digestion and pathogen clearance. As a result, this tissue regenerates quickly, but the combination of pathogen infection and intestinal self-renewal can lead to chronic gastrointestinal diseases. Yiorgos Apidianakis et al. report a molecular connection between bacterial infection and cellular intestinal dysplasias in genetically predisposed populations. The authors infected



Genetically predisposed infected midguts.

Drosophila with a virulent strain of *Pseudomonas aeruginosa* bacteria, which also infects humans, and report that the pathogen induced apoptosis in mature intestinal cells.

The cell death stimulated an increase in the production of intestinal stem cells in a homeostatic mechanism that replenishes injured tissue. In *Drosophila* with a latent form of the *Ras* oncogene, *P. aeruginosa* infection had a synergistic effect—it increased the number of new intestinal stem cells throughout the fruit fly gut, although many of these cells exhibited distorted cell polarity, a hallmark of cancer. The aberrant cells persisted after *P. aeruginosa* had been cleared from the fly gut. This research may aid the development of better diagnostic tools in the fight against cancer, according to the authors. — F.A.

“Synergy between bacterial infection and genetic predisposition in intestinal dysplasia” by Yiorgos Apidianakis, Chrysoula Pitsouli, Norbert Perrimon, and Laurence Rahme (see pages 20883–20888)

NEUROSCIENCE, PSYCHOLOGICAL AND COGNITIVE SCIENCES

Brain area crucial for reputation

In some cases, building a good reputation pits the immediate benefits of a socially unacceptable action, such as cutting in line, against the future benefits of a good reputation. Daria Knoch et al. report that disrupting the prefrontal cortex reduces humans’ ability to engage in the self-control vital to creating and maintaining a good reputation. The authors used noninvasive transcranial magnetic stimulation to temporarily disrupt areas of the prefrontal cortex in test subjects. The subjects engaged in several rounds of a bargaining game that involved two players dividing a hypothetical pool of money. One player could choose to keep all of the money, return a quarter, or return half of the amount he or she received from the other player. Subjects who chose equal payouts minimized their personal cache while building good reputations. When the authors disrupted the right side of the prefrontal cortex, subjects’ behavior showed that they maintained a sense of fairness—

knowledge of the appropriate social action—but lacked the self-control to act on it. Other subtleties of their choices revealed that, although subjects were able to think ahead to the increased gains of a good reputation, they still chose short-term gain, according to the authors. — T.H.D.

“Disrupting the prefrontal cortex diminishes the human ability to build a good reputation” by Daria Knoch, Frédéric Schneider, Daniel Schunk, Martin Hohmann, and Ernst Fehr (see pages 20895–20899)

NEUROSCIENCE

Physical fitness may boost cognitive performance and academic success

Studies in animals and humans have linked physical fitness with cognitive performance, leading to the “cardiovascular fitness” hypothesis that aerobic exercise may be the physiological mediator connecting exercise and cognition. However, most human studies have focused on children or older adults. The studies of young adulthood—a time when the brain changes rapidly and many cognitive traits are established—have been inconsistent. Maria Åberg et al. conducted a large-scale, population-wide study using data on physical fitness and intelligence performance collected from all Swedish men born from 1950–1976 who enlisted for military service at age 18. The sample of 1,221,727 men included 268,496 sibling pairs and 3,147 twin pairs, including 1,432 monozygotic twin pairs. The authors found that cardiovascular fitness, but not muscular strength, was associated with cognitive performance on many cognitive measures and that cardiovascular fitness at age 18 predicted socioeconomic status and educational attainment later in life. Based on analyses of twin and sibling data, the authors suggest that environment, not genetics, explained more than 80% of the fitness–cognitive associations. The findings support the notion that promoting physical exercise could serve as a public health strategy to optimize educational achievement, according to the authors. — B.A.

“Cardiovascular fitness is associated with cognition in young adulthood” by Maria A. I. Åberg, Nancy L. Pedersen, Kjell Torén, Magnus Svartengren, Björn Bäckstrand, Tommy Johnsson, Christiana M. Cooper-Kuhn, N. David Åberg, Michael Nilsson, and H. Georg Kuhn (see pages 20906–20911)