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SUSTAINABILITY SCIENCE

Future of metal resources

Analyses of metal cycles reported by Robert Gordon *et al.* show that the stocks of copper, zinc, and related metals in use by each person in the United States continue to increase, in contrast to a popular theory that the economies of developed countries are becoming less materials-intensive. Newly extracted metals provide both new levels of service and replace the metal in end-of-life products, which are then either recycled or enter waste streams. Of the copper mined in the United States since 1900, approximately half remains in use or is being recycled, whereas the remainder has been dissipated into the environment or placed in wastes where future recovery is problematic. If the current level of services in the United States were applied worldwide with current technology, the entire copper ore content of Earth's lithosphere would have to be mined and placed in sustained use without losses, the authors calculate. They say only increased recycling, more efficient product designs, or acceptance of less desirable substitutes can sustain essential services from copper, as well as zinc, platinum, silver, tin, and nickel, beyond the next few decades. — P.D.

16th century brass astrolabe.

"Metal stocks and sustainability" by R. B. Gordon, M. Bertram, and T. E. Graedel (see pages 1209–1214)

BIOCHEMISTRY, CHEMISTRY

Gold nanoparticle and phage networks

Glauco Souza *et al.* have developed a method for targeting and manipulating mammalian cells with direct-assembled gold nanoparticles and filamentous bacteriophage. The technique may give researchers unique ways to image and manipulate cells. In the authors' method, gold nanoparticles are able to attach to phages and then assemble into nanoparticle networks. In solution, the nanoparticles and phages direct-assemble and can behave as a hydrogel, a matrix in which cells can grow. For example, the phage can be genetically engineered to display short peptides, allowing it to bind to and be taken in by specific types of normal or cancer cells. In the networks, the engineered phage retained the ability to bind to mammalian cells and to multiply in their usual bacterial hosts. Souza *et al.* also found that adding imidazole groups to the phage nanoparticles altered the networks' fractal properties and changed their near-infrared optical properties. Thus, the technique could be useful for fluorescence and dark-field microscopy, nondestructive radiological imaging, surface-enhanced Raman scattering detection, and near-infrared photon-to-heat conversion. Combining features may also make the technique useful for the development of biological sensors. — P.D.

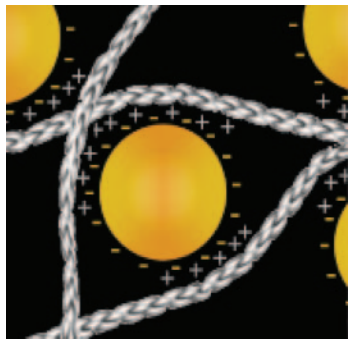


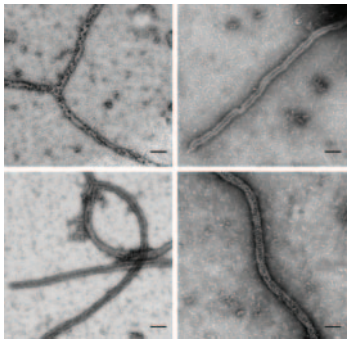
Illustration of electrostatic interaction of gold (yellow spheres) with phage (elongated structures).

"Networks of gold nanoparticles and bacteriophage as biological sensors and cell-targeting agents" by Glauco R. Souza, Dawn R. Christianson, Fernanda I. Staquicini, Michael G. Ozawa, Evan Y. Snyder, Richard L. Sidman, J. Houston Miller, Wadih Arap, and Renata Pasqualini (see pages 1215–1220)

CELL BIOLOGY

Nitric oxide role in regulating endocytosis

Gaofeng Wang *et al.* report that nitric oxide synthase (NOS) nitrosylates the GTPase dynamin, regulating its assembly, enzymatic activity, and membrane localization, in response to stimulation of the β_2 adrenergic receptor (β_2AR). *S*-nitrosylated dynamin stimulates endocytosis from the plasma membrane, and such endocytosis plays an important role in cell entry by microbes. Previous research has shown that dynamin can bind endothelial NOS (eNOS), but the molecular mechanisms involved and the significance of this interaction have not been



Dynamin proteins.

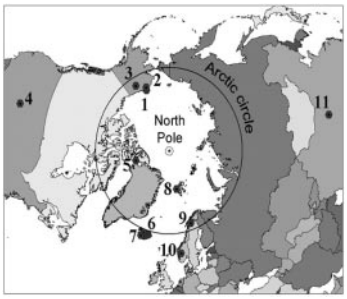
well understood. Wang *et al.* stimulated the internalization of β_2AR and epidermal growth factor receptor *in vitro* and found that the rate of receptor internalization was greater in cells expressing eNOS than in wild-type cells or in cells not expressing the synthase. Inhibition of NOS blocked receptor internalization, whereas stimulation increased the amount of dynamin bound to eNOS. Mutated dynamin proteins showed severely attenuated response to β_2AR internalization in NO-producing cells and were unable to be *S*-nitrosylated by NOS. Mutant dynamin also had reduced GTPase activity and a reduced ability to self-assemble in response to NO. Bladder epithelial cells that expressed the dynamin mutant were impaired in their ability to uptake bacteria. — F.A.

"Nitric oxide regulates endocytosis by S*-nitrosylation of dynamin" by Gaofeng Wang, Nader H. Moniri, Kentaro Ozawa, Jonathan S. Stamler, and Yehia Daaka* (see pages 1295–1300)

ECOLOGY

Tundra plants' response to warming

Marilyn Walker *et al*. report that the abundance and species diversity of plants found in northern tundra regions will change rapidly if climate change continues to raise temperatures. The International Tundra Experiment studied changes in plant populations in 11 tundra settings in northern, alpine, and Arctic regions. Small land plots were exposed to temperatures 1–3°C higher than normal, an amount consistent with climate projections. Walker *et al*. found that, in two growing seasons, graminoids and shrubs became the dominant plant types in their plots, whereas mosses and lichens diminished. The plants grew higher and covered more ground, reducing the abundance of shade-intolerant mosses and lichens. The effect was strongest at lower latitudes. A few species came to dominate their samples, decreasing diversity and evenness. Walker *et al*. suggest that this dominance could lead to the local extinction of other species. The results support previous observations but are unique in deriving from the same experimental protocols used in diverse locations. According to the researchers, biodiversity will initially decrease with warming, species could be lost, and shrubs will become the dominant plants in tundra. The increased cover of plants could also amplify warming, because they absorb more solar radiation. — P.D.



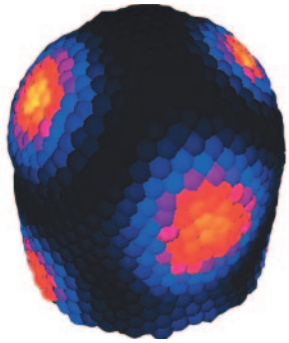
Tundra analysis sites.

"Plant community responses to experimental warming across the tundra biome" by Marilyn D. Walker, C. Henrik Wahren, Robert D. Hollister, Greg H. R. Henry, Lorraine E. Ahlquist, Juha M. Alatalo, M. Syndonia Bret-Harte, Monika P. Calef, Terry V. Callaghan, Amy B. Carroll, Howard E. Epstein, Ingibjörg S. Jónsdóttir, Julia A. Klein, Borgþór Magnússon, Ulf Molau, Steven F. Oberbauer, Steven P. Rewa, Clare H. Robinson, Gaius R. Shaver, Katharine N. Suding, Catharine C. Thompson, Anne Tolvanen, Ørjan Totland, P. Lee Turner, Craig E. Tweedie, Patrick J. Webber, and Philip A. Wookey (see pages 1342–1346)

PLANT BIOLOGY, APPLIED MATHEMATICS

Auxin polarization promotes plant patterning

Henrik Jönsson *et al.* suggest that the plant hormone auxin can influence its own efflux within the meristem to promote the patterning of developing primordia. In the growing plant shoot, new leaves and flower primordia emerge at defined positions. Previous research has shown that auxin activates primordia formation, creating complex phyllotactic patterns. In *Arabidopsis*, the pinformed (PIN) family of proteins transports auxin from the meristem to the forming primordia, and the PIN1 protein is expressed in the epidermal layer, polarized towards the young primordia. Jönsson *et al.* devised a mathematical auxin transport model using PIN1 localization data from confocal imaging. Using this model together with extracted data, predicted peaks of auxin concentration were found to be associated with new primordia positions. The authors developed a simplified, cell-based model that used only passive and active transport as parameters. This mathematical model revealed that an auxin feedback loop, in which the hormone regulates its own polarized transport, can support the regular spatial patterning of primordia. The simulations were able to generate the complex phyllotactic patterns seen in plants, and the cell-based model also recapitulated the reversal of PIN1 polarity, which is observed *in vivo* in *Arabidopsis* primordium development. — F.A.



Phyllotaxis model simulation.

"An auxin-driven polarized transport model for phyllotaxis" by Henrik Jönsson, Marcus G. Heisler, Bruce E. Shapiro, Elliot M. Meyerowitz, and Eric Mjolsness (see pages 1633–1638)