EDITED BY GILBERT CHIN AND JAKE YESTON

CHEMISTRY

Holding U Tight

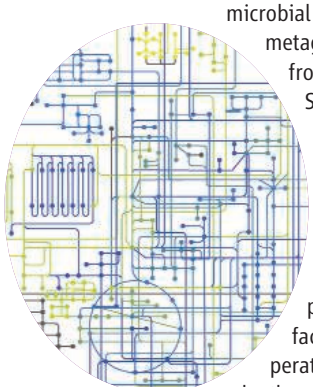
Sensitive and selective detection of uranium is a prerequisite for both effective bioremediation and the treatment of radiation poisoning. Wegner *et al*. show that such detection may be possible with a reengineered metal protein that binds to DNA only in the presence of uranyl cations (UO_2^{2+}), the most stable form of uranium in oxygen- and water-containing environments. The authors use the *E. coli* nickel-responsive repressor protein, which binds nickel (Ni^{2+}) in a square-planar geometry. By changing just two amino acids, they shift this binding environment to one in which the uranium center binds to six ligands in the equatorial plane (as supported by x-ray absorption spectroscopy); one of the two oxygens of the uranyl cation is poised to be held in place through coordination to a third mutated amino acid. Whereas the wild-type nickel-binding protein binds to other metal cations commonly found in the environment, such as copper (Cu^{2+}) and zinc (Zn^{2+}), the mutated protein is selective for uranyl. — JFU

Angew. Chem. Int. Ed. **48**, 10.1002/anie.200805262 (2009).

SYSTEMS BIOLOGY

Footprints in the Oceans

Laboratory research works well in identifying the responses of individual organisms to a series of environmental changes; it is rather more difficult, however, to carry out analogous studies of how community structure and function are influenced by the environment and by interactions among ecosystem residents. Gianoulis *et al*. have documented the metabolic adaptations of microbial communities using metagenomic data culled from the Global Ocean Survey, which has sampled sites in the Atlantic and Pacific Oceans. Analytical approaches enabled them to examine the effects of multiple environmental factors (including temperature, salinity, sample depth, and average chlorophyll content) on metabolic pathways. Some pathways were associated with particular environments, providing what could be called a metabolic footprint. In contrast, some amino acid biosynthetic pathways varied with the environment, yet others did not. Rather than reflecting the energetic potential of the environment, this variation may indicate the presence or absence of valuable metals, such as cobalt, that are used to make catalytic cofactors. Potentially, metabolic footprints might be used as sensitive detectors of environmental change. — BJ



Metabolic pathway covariation (yellow, high; blue, low).

Proc. Natl. Acad. Sci. U.S.A. **106**, 1374 (2009).

MICROBIOLOGY

Nab a Niche

Salmonella species live in a diverse range of hosts and environments and transfer readily between them. This lineage has evolved in a stepwise manner into multiple strains of pathogens as a result of the snatch and grab of mobile elements called pathogenicity islands from other bacterial species. A sensor kinase and response regulator pair of components on one of the islands acts as an antenna for environmental changes. Depending on the signals it receives, this antenna orchestrates expression across virulence genes by binding to their respective cis-regulatory elements, wherever they are in the genome. Thus, environmental cues can be matched to niche-specific gene expression. Osborne *et al*. confirmed the evo-

ECOLOGY

Underground Engineering

Prairie dogs are keystone species (meaning that many taxa are affected by their presence) and also ecosystem engineers (that is, they sculpt the physical aspects of their environment). Prairie dog colonies crop nonwoody vegetation, disturb soil surfaces, and dig extensive networks of burrows. To determine how these activities affect the local biota, VanNimwegen *et al*. censused rodents and measured vegetation structure either directly on black-tailed prairie dog (*Cynomys ludovicianus*) colonies at the Cimarron National Grassland or at sites roughly 1 km distant. The authors plotted separate ordinations of rodent counts and vegetation variables using nonmetric multidimensional scaling. They examined the effects of three categorical variables: colony (on or off), cover (shortgrass or sandsage), and habitat (factorial combination of colony and cover). Rodent communities differed in response to prairie dog colonies regardless of the cover, and the effect of colonies was not diminished by the uniform vegetation structure in the shortgrass prairie. These patterns indicate that the prairie dogs' cropping of vegetation has at most a minor effect on the rodent community structure; their impact is achieved through soil disturbance and burrowing. — SJS

Ecology **89**, 3298 (2008).

Published by AAAS

lutionary significance of cis regulation for *Salmonella enterica* by a series of in vivo competition experiments between mutants allowed to infect mice. Mutations in regulatory elements enable a bacterium to thrive opportunistically in multiple and contrasting niches without feeling too much pain from conflicting selection pressures on its genome. — CA

Proc. Natl. Acad. Sci. U.S.A. **106**, 10.1073/pnas.0811669106 (2009).

ASTROPHYSICS

Small but Young

Recent studies have shown that in the early universe, massive elliptical galaxies tended to be much smaller and denser than their present-day analogs, implying that most grew in size as they evolved through cosmic time. The mechanism by which they grew is not very well understood, but some theoretical models, involving collisions between galaxies, predict that a fraction of small dense galaxies could have survived intact up to the present universe. Using the Sloan Digital Sky Survey—a systematic map of a quarter of the sky, containing millions of galaxies—Trujillo *et al.* have found that small-sized high-mass galaxies, similar to those found in the early universe, are presently very scarce. Moreover, there are indications that their stellar populations are very young, contrary to what would be expected if they were relics of the early universe. If these galaxies are truly young and just recently formed, then explaining how massive galaxies swelled seems to demand a mechanism that acted in all massive elliptical galaxies and left none unaffected. Unfortunately, the available data are not sufficient to distinguish between different scenarios. — MJC

Astrophys. J. **692**, L118 (2009).

BIOCHEMISTRY

Phosphorylation Out of Order

When activated by ligand binding, the fibroblast growth factor receptor (FGFR), like others of its ilk being both a receptor and a tyrosine kinase, undergoes autophosphorylation, which leads not only to an increase in its kinase activity but also to its association with other signaling molecules that then serve as kinase substrates. Lew *et al*. have explored the mechanism by which five tyrosine residues in FGFR become phospshorylated in an ordered process in which the first phosphorylated tyrosine enhances the kinase activity, the next three provide docking sites for other signaling proteins, and the fifth increases catalytic activity even further. In vitro assays with the complete kinase domain and modified versions thereof showed that the order of phosphorylation depended on the nature of the amino acid sequences surrounding the sites and their location within the three-dimensional structure of the enzyme, and was limited by the rate of transfer of the terminal phosphate group from ATP. The potential biological impact of these carefully ordered events was emphasized by analysis of a mutant form of FGFR1 that has been implicated in the genesis of human glioblastomas. An altered order of modification of the sites led to an increased basal kinase activity of the mutant. The authors note that this and changes in the proper recruitment and regulation of substrate proteins may enable this mutant receptor to cause cell transformation. — LBR

Sci. Signal. **2**, ra6 (2009).

ENGINEERING

Solar for Less

The Sun provides far more energy to Earth each day than the worldwide population currently uses, but directing this energy toward a more useful purpose than heating the ground is a considerable challenge. Though silicon-based cells can effectively convert absorbed light into electricity, the costs associated with isolating and purifying the silicon toward this end remain substantially higher than those associated with fossil fuel–based processes for electricity generation. Wadia *et al*. have analyzed the relative costs and efficiencies of a wide range of alternative materials for eventual use in solar cells. Specifically, they examined 21 metal oxides, sulfides, selenides, and sundry other inorganic semiconductors in comparison with crystalline and amorphous silicon. Their model considered overall electricity consumption, and so evaluated power-conversion efficiencies of individual cells in the context of comparative fabrication costs for multiple cells. Iron pyrite emerged as an especially favorable option on the basis of its abundance and low extraction cost, with Zn_3P_2 and copper oxides also showing potential for economical efficiency. — JSY

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Environ. Sci. Technol. **43**, 10.1021/es8019534 (2009).

Phosphorylation Out of Order

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Science **323** (5918), 1149.
DOI: 10.1126/science.323.5918.1149b