

GEOCHEMISTRY

## Lost N Found

Humans are adding new reactive forms of nitrogen (N) into the environment, which has the potential to cause a range of problems, including eutrophication and the formation of dead zones in lakes and coastal waters. The microorganisms responsible for these “N loss” pathways, known as denitrification or anaerobic ammonium oxidation (anammox), often reside in sediments, but a variable and limiting supply of organic matter makes it difficult to determine which reaction dominates. Babbin and Ward set out to address this problem in the lab by constructing a series of mesocosms out of sediments from the Chesapeake Bay, United States, with large amounts of organic matter added to some of the columns. Over 7 weeks of incubation and monitoring, the proportion of each pathway was dictated more by the relative N content of the organic matter than by the total organic matter content. Moreover, the microbial communities in the sediments were able to quickly adjust to high N loading, such as sewage effluent or fertilizer runoff, so that most of the reactive N would be removed from the ecosystem and potentially released back to the atmosphere. — NW

*Environ. Sci. Technol.* 10.1021/es304842r (2013).

IMMUNOLOGY

## SREBPs for T Cell Expansion

Responding to infections is energetically demanding, especially for cytotoxic CD8<sup>+</sup> T cells. Once these cells recognize an infection, they blast, which requires lipid biosynthesis, and then undergo metabolic reprogramming so that they rely primarily on glycolysis to meet their high energetic demands. The specific mechanisms that allow for this transition are not well elucidated. Kidani *et al.* identify a role for the sterol regulatory element-binding proteins SREBP1 and SREBP2, transcription factors that regulate lipid homeostasis, in this process. The expression of SREBPs is up-regulated in response to T cell activation and is required for the induction of a lipid synthesis program. CD8<sup>+</sup> T cells from

mice with a T cell-specific deficiency in SREBPs exhibited poor blastogenesis and proliferation upon activation, altered lipid homeostasis, and did not undergo the typical activation-induced metabolic reprogramming. Impaired responses of SREBP-deficient mice to infection with lymphocytic choriomeningitis virus underscored the physiological relevance of this pathway. — KLM

*Nat. Immunol.* 14, 10.1038/ni.2570 (2013).

CELL BIOLOGY

## Haste Makes Waste

mTORC1 is a protein kinase complex that regulates many biological processes, including cell growth and proliferation, and that has a primary role in the control of protein synthesis. Inhibition of mTORC1 increases life span, and partial

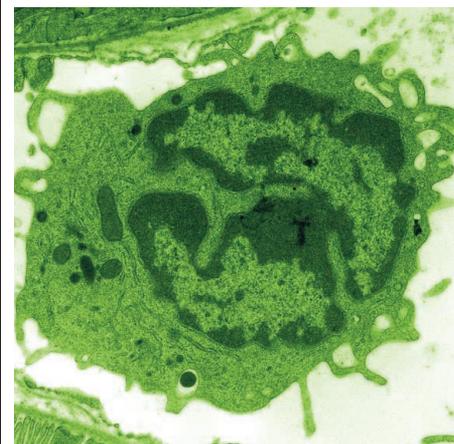
inhibition of translation mimics the effect on life span, indicating that effects of mTORC1 on life span might be related to effects on protein synthesis. Conn and Qian present a mechanism by which reduced rates of protein synthesis might extend life span. They found essentially that haste makes waste. When mTORC1 activity was high and cells synthesized polypeptides rapidly, the stability of a newly synthesized fluorescent reporter protein was diminished. Inhibition of mTORC1, on the other hand, slowed protein synthesis through effects on translation initiation and elongation, and improved the fidelity of the process. Slower translation may allow more time for correct tRNA pairing or for cotranslational processes that promote proper folding and may thus result in fewer misincorporated amino acids or misfolded proteins, either of which would tend to reduce protein stability. — LBR

*Sci. Signal.* 6, ra24 (2013).

CELL BIOLOGY

## Monocytes on the Prowl

Monocytes, macrophages, and dendritic cells are a family of cells collectively referred to as the “mononuclear phagocyte system” (MPS) that mediates and regulates inflammation. Cells of the MPS scavenge dead cells and toxic molecules, and kill or contain infectious agents. They are a critical mediator of the inflammatory response, which controls proliferation of microorganisms but they can also damage host tissues. Carlin *et al.* examined the role of a subset of monocytes, the Ly6C<sup>low</sup> population, in mice. Ly6C<sup>low</sup> monocytes, which continuously patrol the endothelium of capillaries, were shown to remove cellular debris and microparticles. In kidney tissues that bore the hallmarks of viral infection or cell death, the Ly6C<sup>low</sup> cells were retained by the endothelial cells within the capillaries and recruited neutrophils, which mediated necrosis of the endothelial cells, and



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then the monocytes cleaned up cellular remnants. Thus, these monocytes appear to serve as "intravascular housekeepers," orchestrating and cleaning up the damage caused by neutrophil-dependent necrosis of endothelial cells lining the capillaries. — SMH

*Cell* **153**, 362 (2013).

## BIOMEDICINE

## A Delicate Balance in Fragile X

Endocannabinoids are lipids that modulate cognition, anxiety, mood, and pain sensation—all behaviors that are deficient in patients with fragile X syndrome (FXS). FXS is a genetic disorder in which fragile X mental retardation protein (FMRP), an RNA-binding protein that controls protein synthesis, is not expressed in neurons. Treatments for the condition are focused on alleviating the symptoms. Busquets-Garcia *et al.* suggest that targeting the endocannabinoid system could be a new therapeutic approach for FXS. When rimonabant, a drug that blocks endocannabinoid receptor CB1R, was injected into the hippocampus of FMRP-deficient mice (a good model for FXS), the animals showed improved memory and sensitivity to pain. In pyramidal neurons, activation of the receptor mGluR5 by excitatory glutaminergic neurons triggers the mTOR signaling pathway to control gene expression and synaptic plasticity. Activation of this pathway is elevated in FXS, and rimonabant normalized the phosphorylation of pathway components Akt and p70S6K in the FXS mouse model. Genetic deletion of CB1R blunted the therapeutic effects of the drug. Furthermore, an antagonist of the CB2R endocannabinoid receptor specifically normalized anxiety-like behavior in the FXS mouse model. These observations suggest that modulating endocannabinoids in FXS patients could improve cognitive abilities and anxiety, among other symptoms. — LC

*Nat. Med.* **19**, 10.1038/nm.3127 (2013).

## PHYSICS

## A Very Dilute Superconductor

Whether a given material conducts electricity, or even does so without any resistance (as in a superconductor below its transition temperature), depends sensitively on the density of electrical carriers. This density can be manipulated in several ways, the most straightforward one being chemical doping. For a semiconductor (such as Si) to start superconducting, doping with an element (such as B) at a level of a few percent is normally

needed. Lin *et al.* found that in the bulk material  $\text{SrTiO}_3$ , a tiny departure from the stoichiometric composition, achieved by removing 1 in  $10^5$  oxygen atoms, is sufficient to support superconductivity. Through thermoelectric measurements, they deduced that at this lowest carrier concentration the Fermi surface is almost spherical, with only a slight anisotropy, and that the Fermi temperature, a measure of the carrier concentration, is an order of magnitude lower than the Debye temperature, which reflects the lattice dynamics energy. This unusual hierarchy of scales, as well as the character of the Fermi surface, may present challenges to theoretical models of superconductivity in this compound. — JS

*Phys. Rev. X* **3**, 021002 (2013).

## MEDICINE

## Fugitive Fungi No More

Systemic fungal infections of the bloodstream or major organs, such as those caused by some species of *Candida*, can lead to fatalities, particularly in immunocompromised patients. The standard technique for detection requires culturing whole blood followed by morphological assessment, a process that can take several days. Neely *et al.* developed a whole-blood-compatible procedure that can detect certain strains down to one colony-forming unit per milliliter. After blood cell lysis and concentration of the *Candida* cells, polymerase chain reaction was used to selectively amplify the *Candida* DNA. This DNA was then captured with specific probes targeted toward one of five *Candida* species, which would

then agglomerate, giving clusters that could be detected with T2 magnetic resonance, using a custom-made bedside detector. For spiked samples, detection could be achieved within 3 hours, in contrast to the 1 to 2 days needed for the *C. krusei* and *C. albicans* species, respectively. Testing was also done on fully blinded specimens from patients who showed symptoms of septicemia, with excellent identification of both the *Candida*-positive and -negative cases. Three patients were also tracked in time, and in contrast to culture methods, which require viable fungal cells, the method could also detect nonviable cells after the treatment of patients with antifungal agents. — MSL

*Sci. Transl. Med.* **5**, 182ra54 (2013).



## AAAS *Travels*



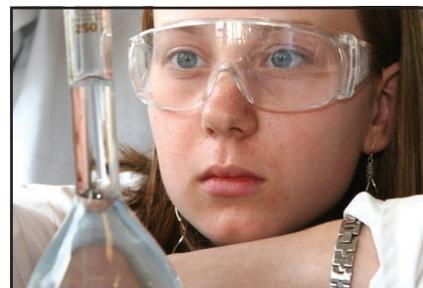
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