

ECOLOGY

Diversity Down Below

Despite a surge of research efforts in recent years, the challenges faced by soil biologists remain daunting. Knowledge of even the basic elements of the biodiversity that is so visible above ground—in particular, species diversity and distribution—remains far more rudimentary where life below the soil surface is concerned. Soil fungi are a case in point. A key component of the soil ecosystem, its global species diversity, has tended to be estimated by various proxies. From a study of the fungi of boreal forest soils in Alaska, Taylor *et al.* suggest that previous estimates of fungal diversity, which hitherto hovered between 0.5 and 1.5 million, might need to be revised upward. Fungal DNA sequence data from their samples yielded just over 1000 discrete fungal taxa—many more than had been estimated from nonmolecular data. Within the soil, the fungal species communities were found to be highly structured and correlated with abiotic variables such as pH and soil horizon, and with the species composition of the understory plant community. The revealed fungus:plant ratio of 17:1, if reflected globally, would extrapolate to at least 6 million fungal species, suggesting in turn that 98% of fungi have yet to be described—a figure that remains to be corroborated by similarly detailed sampling across a range of other soil ecosystems. — AMS

Ecol. Monogr. 84, 3 (2014).

IMMUNOLOGY

Amplifying Immunity

Antigen-specific T cells are important for the control and clearance of many types of infection. T cells that do not recognize the specific pathogen, however, often participate in getting rid of infections, but the specific mechanisms that regulate the activation of these so-called “bystander” T cells are less well understood. O’Donnell *et al.* used mice infected with *Salmonella* to better understand this phenomenon and found that detection of microbe-associated molecular patterns by Toll-like receptor 4 and components of the inflammasome in a T cell extrinsic pathway led to the production of several cytokines, including interleukin 18 (IL-18). IL-18 in turn acted on bystander CD4⁺ T cells to amplify their antibacterial responses. In fact, mice in which the bystander activation of CD4⁺ T cells was inhibited were impaired in their ability to control *Salmonella* infection. Although not formally demonstrated, this may be a way for the immune system to avoid being overwhelmed

by a rapidly dividing pathogen and/or to protect the host against co-infection. — KLM

Immunity 10.1016/j.immuni.2013.12.013 (2014).

BIOMEDICINE

Counteracting Muscle Aging

Muscles tend to get weaker with age and also lose regenerative capacity. Studying young and old mice, Cosgrove *et al.* demonstrate that impaired muscle stem cell function is at least in part to blame. In aged mice, about two-thirds of the muscle stem cells were on their way to differentiation or senescence and thus

were individually less effective at regenerating muscle fibers. However, even in the aged mice, a subset of muscle stem cells existed that showed youthful, enthusiastic muscle regeneration. Analysis of the differences between the two stem cell populations pointed to differences in the p38 mitogen-activated protein kinase (MAPK) pathway. Muscle stem cell populations from aged mice that were cultured on soft substrates and treated with a p38 MAPK inhibitor proliferated to produce more of the robust-regeneration stem cells, even though the source was aged mice. When transplanted into the muscles of aged mice, stem cells derived from this *in vitro* treatment engrafted enthusiastically, contributed to repair of muscle fibers, and restored muscle strength measurements to youthful levels. — PJH

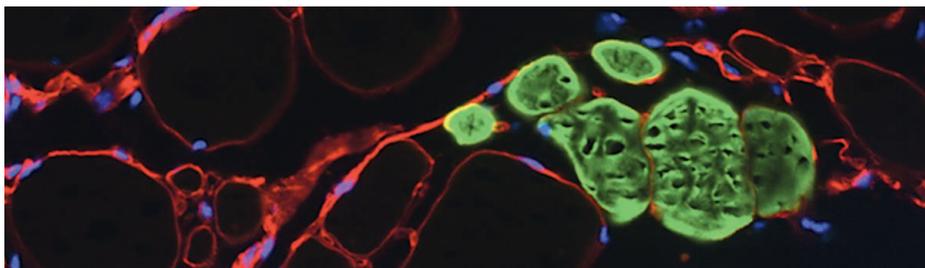
Nat. Med. 10.1038/nm.3464 (2014).

EDUCATION

Teaching by Retraction

As funding for research grants becomes more competitive, the pressure to publish in top journals increases and may lead to an increase in ethical lapses. One way to overcome this may be through better education, but how best to teach it? Burnett *et al.* address this issue using research articles that have been retracted to highlight the types of ethical problems that can ultimately hinder scientific progress. Students in upper-level biology and chemistry courses were required to read a retracted research paper and the official retraction notice. Students then presented the ethical issues raised in the retraction and explained how these problems could have been avoided. This often led to class discussions, as the cause for retraction was not always clear. Instructors were able to take advantage of this process to teach about the scientific process and the importance of peer review, with students being able to see direct examples of how retractions alter scientific progress. Hopefully, by raising their awareness of ethical lapses that can derail research, the students can gain an appreciation for scientific ethics that they can carry with them throughout their careers. — MM

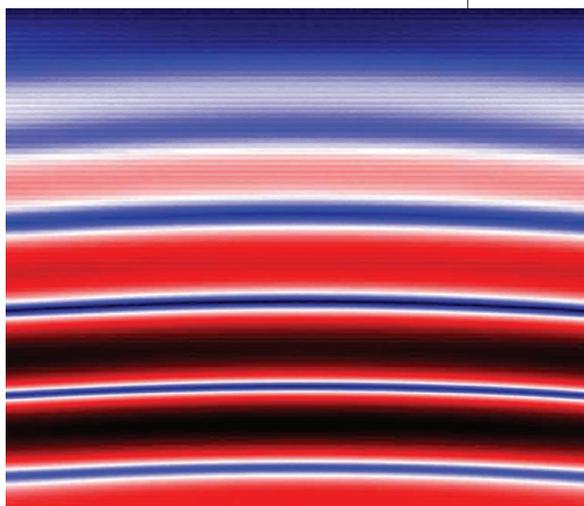
J. Coll. Sci. Teach. 43, 24 (2014).



APPLIED PHYSICS

A Nanomechanical Phase Shifter

Information can be encoded in optical signals with a variety of parameters, usually wavelength, polarization, or phase. However, as signals propagate down optic fibers or around optical circuits, they can disperse; that is, they can acquire a phase shift that can then compromise the integrity of the encoded information. In other circumstances, one might want to control the phase of a signal to do a sort of analog computing by interfering the signal with reference signal and then monitoring the output as the subsequent changes in interference fringes. In each case, the ability to reliably control the phase



is crucial. Poot and Tang describe a broadband phase shifter based on a nanoelectromechanical controlled waveguide composed of two parts. By electrically switching one side of the waveguide and varying the separation, they change the effective refractive index of the waveguide and can induce a controlled phase shift in the propagating light signal. Such a nanoelectromechanical approach should prove useful as optoelectronics shrink and move from bulk-optical to low-power on-chip components. — ISO

Appl. Phys. Lett. **104**, 61101 (2014).

ENGINEERING

Safe, Selective, & Specific siRNA

RNA interference (RNAi) via small interfering (si) RNAs offers potential as a therapeutic tool for the specific knockdown of disease-associated genes. One limiting factor in the use of siRNAs as drugs involves delivering highly charged RNA molecules across cell membranes and into cells of the tissue of interest. Dong *et al.* used natural lipoprotein particles—which consist

of apolipoprotein, phospholipid, cholesterol, and triglyceride and which have affinity for the liver—as a model for the design of an siRNA delivery system directed to the liver. They constructed lipopeptide nanoparticles (LPNs) by linking epoxide or aldehyde-derived lipid tails to amino acids or short peptides. Formulated with cholesterol, phospholipids, polyethylene glycol–lipid, and siRNA, the LPNs formed ~70-nm spheres, suspensions of which could be administered by injection. Lysine-based lipopeptides with tail lengths of 12 to 14 carbons proved highly effective at gene silencing specifically in liver hepatocytes. Furthermore, LPNs showed low toxicity and high gene-silencing activity in mice and cynomolgus monkeys. Apolipoprotein E facilitated both cell uptake and the escape of specific chemical classes of LPN-complexed siRNAs from endosomes into the cytoplasm. — GR

Proc. Natl. Acad. Sci. U.S.A. **10.1073/pnas.1322937111** (2014).

ASTROPHYSICS

Speedy Side-Kick

It is accepted that pulsars moving at high velocities through their surroundings received a kick at their birth from a core-collapse supernova, but details of this process remain under study. The presence of jets had been observed for rotation-powered pulsars either

moving subsonically or still embedded in their supernova remnant, but not for pulsars moving at supersonic speeds. Pavan *et al.* report on radio and x-ray observations of the supersonic pulsar IGR J11014-6103, in which they detect its wind nebula and a jet, whose nature is supported by a counterjet in the opposite direction. Pulsar jets are usually difficult to observe because the pulsar spin axis is typically aligned with the direction of motion, so that the jet is disrupted, or hidden by shocked material in the wind nebula. However, this pulsar is unusual in that its direction of motion, and thus its probable kick direction from the supernova explosion, lies nearly perpendicular to the observed jet. The authors identify the corkscrew-shaped jet as originating with the pulsar and as consistent with modulation by a precessing spin axis. These findings suggest that such jets may be common, and the evidence of an apparently misaligned velocity kick will enable improvements to the core-collapse supernova model. — MMM

Astron. Astrophys. **562**, 10.1051/0004-6361/201322588 (2014).

Science

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