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EDUCATION

Self-Efficacy Is the Key

The natural response to the shift toward inquiry-based science education is an increase in faculty-mentored undergraduate research experiences (UREs). Large amounts of data describe the impact of UREs on student gains in performing research-related procedures, thinking and working like a scientist, and interest in graduate school. Much less is known about the processes through which student gains are achieved and the organization and dynamics of specific URE programs. Adedokun *et al.* used structural equation modeling to explore a URE program with a specific focus on exploring the relationships among three key outcomes: research skills, research self-efficacy, and aspiration for research careers. A post-participation survey was given to 156 students who typically spent 4 to 10 hours per week in their faculty mentor's laboratory and attended a seminar class on research conduct. Modeling data showed significant direct relationships between research skills and research self-efficacy, and between research skills and aspirations. Additionally, positive relationships between self-efficacy and aspirations and an indirect effect of research skills on aspirations via self-efficacy were shown. Research self-efficacy thus partially mediates the relationship between research skills and student aspirations for research careers. — MM

J. Res. Sci. Teach. 10.1002/tea.21102 (2013).

NEUROSCIENCE

Stroke Recovery

Astrocytes are the most numerous cells in the mammalian brain, providing metabolic support for neurons and modulating synaptic transmission. They can also help to repair neuronal injuries, replacing central nervous system cells that cannot regenerate. Because they are believed to protect neurons from injury and death, there is interest in exploring their therapeutic potential, in particular to promote recovery after stroke. Although astroglia have been derived in vitro from human embryonic stem cells, it is not clear whether a subpopulation of astroglia might better promote repair. Jiang *et al.* generated highly pure populations of astroglia progenitors from human embryonic stem cells and observed that those expressing the transcription factor Olig2 showed strong neuroprotective effects against oxidative stress and glutamate toxicity in vitro. Further, rats that received hippocampal transplants of human $Olig2^+$ astroglia soon after being subjected to global cerebral ischemia showed increased synaptogenesis and improved learning and memory in water maze trials. The observed differential expression of growth factors, neurotrophic factors, cytokines, and chemokines related to synaptic function may account for differences in the ability of this astroglia population to promote recovery. — LDC

Nat. Comm. **4**, 10.1038/ncomms3196 (2013).

CANCER

Highway Deconstruction

Because most cancer patients die of metastatic disease, there is substantial interest in understanding—and pharmacologically thwarting—the molecular events that drive or facilitate metastasis. Early in the process within the primary tumor, cells attach to and migrate along collagen networks, which take them to blood vessels that carry them to distant organs they ultimately colonize. A new study suggests that these collagen highways are particularly important for an aggressive soft-tissue sarcoma that frequently and fatally metastasizes to the lung. Using mouse models, Eisinger-Mathason *et al*. show that when primary sarcomas become deprived of oxygen, a transcription factor called HIF1α (hypoxia-inducible factor 1α) is induced, which in turn enhances the expression of PLOD2 (procollagen-lysine, 2-oxoglutarate 5-dioxygenase 2), an enzyme that creates dense and highly disorganized networks of collagen by adding hydroxyl groups to collagen monomers. Sarcomas in mice treated with a drug known to inhibit PLOD2 expression (minoxidil, which is commonly used for hair restoration) exhibited more-organized patterns of collagen and had a reduced propensity to metastasize to the lung. — PAK

Cancer Discov. **3**, 10.1158/2159-8290.CD-13-0118 (2013).

NEUROSCIENCE

Finding Parallels

The transcription factor nuclear factor I-A (NFIA) controls genetic programs implicated in cellular metabolism and the migration of normal glial cells. NFIA is overexpressed in some gliomas: tumors of the central nervous system that contain cells resembling glial cells. In the hematopoietic system, NFIA is regulated by the microRNA miR-223. Glasgow *et al.* now document a similar relationship of NFIA and miR-223 in glial cells and in gliomas. Their results show that during normal development, miR-223 represses NFIA and blocks the proliferation of glial precurors; the cells are then left to switch into differentiation pathways. In gliomas, miR-223, which may be expressed in only some gliomas, can repress NFIA and thus suppress glioma cell growth. These results pave the way to understanding what is and is not parallel between normal development and cancer. — PJH

J. Neurosci. **33**, 13560 (2013).

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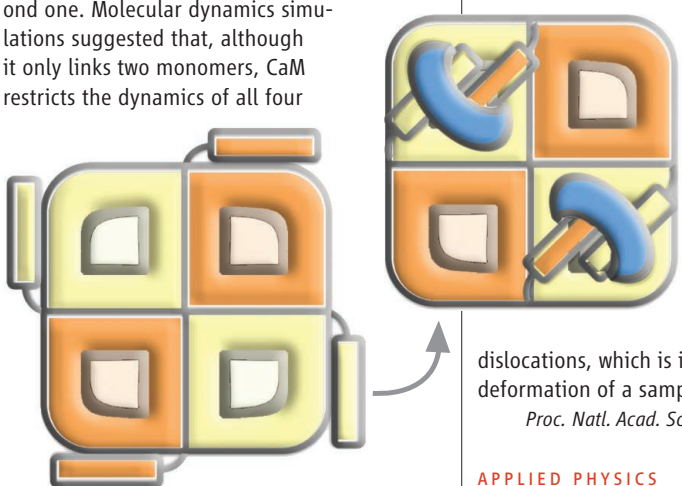
BIOCHEMISTRY

Four Closure

The Ca^{2+}-binding protein calmodulin (CaM) is involved in the regulation of many membrane channels, but how it modulates permeability remains unclear. Reichow *et al.* have combined electron microscopy, structural modeling, molecular dynamics, and mutagenesis to study the interaction of the aquaporin AQP0 and CaM. Each monomer in the tetrameric AQP0 contains a water-conducting pore. Fitting crystal structures of the AQP0 tetramer and CaM into a 25 Å electron microscopic reconstruction revealed that CaM bound to the C-terminal helices of adjacent AQP0 monomers. Initially, CaM binds to one helix, and its proximity to the neighboring monomer then allows it to capture the second one. Molecular dynamics simulations suggested that, although it only links two monomers, CaM restricts the dynamics of all four



monomers in the tetramer. The constriction site CSII at the cytoplasmic vestibule of the channel has been proposed to gate access. Interestingly, the AQP0 residues that were stabilized most by CaM mapped to the C-terminal helices, the base of the last transmembrane helix, and residues that form CSII. In AQP0, tetramerization is not required for water permeability; however, these results show that its quaternary structure facilitates cooperative regulation, and the regulation of other membrane channels by CaM may rely on similar mechanisms. — VV

Nat. Struct. Mol. Biol. **20,** 10.1038/nsmb.2630 (2013).

MATERIALS SCIENCE

Making Mg Magnificent

When crystalline materials are stressed, defects in the crystal planes become mobile once a critical stress is reached. The stress required for movement of these dislocations along different slip planes can vary considerably, leading to poor ductility. Magnesium is an example of a material with an extreme anisotropy: The critical stress required for deformation along nonbasal planes is 100 times larger than along basal ones. Yu *et al.* postulated that even though materials are known to be stronger when they are smaller, there are upper bounds to this enhancement, so that the critical anisotropy should decrease. They tested single-crystal Mg samples ranging from 850 to 80 nm in size inside a quantitative electron microscope. At sizes between 200 and 400 nm, significant strengthening of the samples was seen, but the ductility remained poor. Below 100 nm, there was a shift in the deformation behavior. As the local flow stresses approached 2 GPa, there was increasing activation of the nonbasal planes, leading to a large amount of plastic deformation. These size effects could be employed to make better use of other high plastically anisotropic materials. The use of grain boundaries could allow for larger overall samples, because the boundaries will act as stress concentrators and preferred sources for the nucleation and emission of dislocations, which is important during plastic deformation of a sample. — MSL

Proc. Natl. Acad. Sci. U.S.A. **110,** 13289 (2013).

APPLIED PHYSICS

Slowly Does It

The rise and fall of pitch of a passing police siren gives a familiar example of the Doppler effect. In such a case, the speed of the moving object is appreciable compared to the speed of sound, with fast-moving objects relatively easy to detect. The situation is somewhat more difficult for slow-moving objects, where the frequency shift can be very small. Detection typically requires complex interferometry. Bortolozzo *et al.* show that a slow light medium can be used to accentuate and detect tiny frequency shifts associated with slow-moving objects. Obviating the need for complex optics, they use a balanced detection scheme where they simply split a laser beam in two and measure the intensity difference between the two beams once they pass through the slow light medium. They can detect frequency shifts down to 1 μHz and suggest that the simple setup should allow for remote sensing of slow-moving objects. — ISO

Opt. Lett. **38**, 3107 (2013).