EDITED BY KRISTEN MUELLER AND MARIA CRUZ

PLANT SCIENCE

A Productively Repellant Aura

The domesticated tomato has wild relatives which, although they may lack large juicy fruits, retain useful defenses against insect infestation. The reduced density of trichomes and absence of specific biosynthetic pathways leave the domesticated tomato more susceptible to insect infestation, which can cause devastating crop losses. Bleeker *et al*. have now identified key enzymes in the biosynthetic pathway for 7-epizingiberene, a terpene derivative exuded from leaf trichomes of the wild, but not domesticated, tomato that repels whiteflies and spider mites. Cross-breeding experiments showed that plants that expressed some 7-epzingiberene, even if it was less than the expression seen in wild tomato plants, were resistant to whitefly pests. Expression of 7-epizingiberene synthase (ShZIS) and *cis*-prenyltransferase (zFPS), both from wild tomato, in trichomes of domesticated tomato drove production of 7-epizingiberene. The consequent reduction of whitefly and spider mite infestations suggests routes to protect domesticated tomato crops. — PJH

Proc. Natl. Acad. Sci. U.S.A. **109**, 20124 (2012).

CELL BIOLOGY

Barrier Maintenance

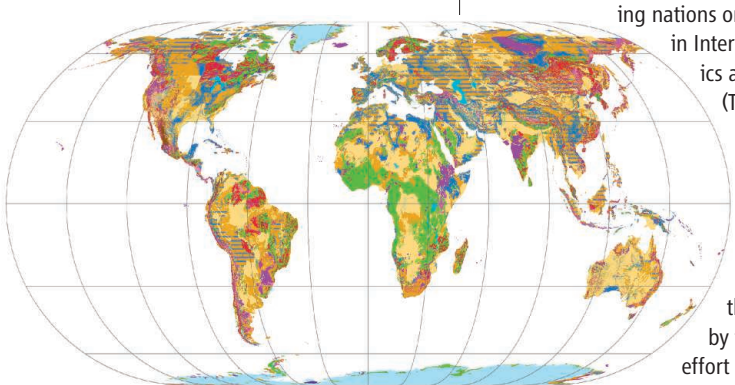
The central nervous system (CNS) and retina are privileged areas of blood vessel growth and function. For example, the specialized vasculature restricts the diffusion of toxic molecules and the entry of pathogens into these regions. Frizzled4, a protein expressed at the surface of vascular endothelial cells (ECs), and its activating ligand Norrin are important for the development of blood vessel networks. Wang *et al*. now report that in the mouse, Norrin-Frizzled4 signaling is required for early vascular development in the retina and also later in the CNS to maintain vascular integrity. In genetically engineered mice lacking either Norrin or Frizzled4, retinal blood vessel growth was slow, formed irregular, criss-crossed patterns, and failed to create a trilayer architecture. The authors could also visualize leakage of these blood vessels in regions of the brain, spinal cord, olfactory bulb, and retina, and show that Norrin-Frizzled4 signaling is needed for the expression of cell junction proteins. In mice engineered to lack Frizzled4 in only a few percent of the EC population, general vascular organization appeared normal, but was leaky only in regions of blood vessels where Frizzled4 was absent. The loss of either the blood-brain or blood-retina barrier occurs in many disorders, including stroke, diabetes, infections, and eye disease. The Norrin-Frizzled4 signaling pathway may thus be a new therapeutic target. — LC

Cell **151**, 1332 (2012).

GEOLOGY

A Map of Earth's Rocks

The distribution of rocks on Earth's continents reflects their geologic history spanning deposition, formation, deformation, metamorphism, uplift, and erosion. It also has important implications for engineering and resources, and the rocks exposed in areas of erosion influence global ocean chemistry and the composition of dust in the atmosphere. Hartmann and Moosdorf have compiled a global map of rock types exposed on Earth's continents using a variety of individual geologic maps and literature resources. Their high-resolution global map shows that most of the exposed rocks are sedimentary in origin, and most of these and about 20% of the total are carbonate rocks. Metamorphic rocks make up about 13%, as do igneous rocks, distributed roughly equally between volcanic and plutonic rocks. About 10% of Earth's continents are covered in ice or water. Rock types are distributed unequally over the continents;



Africa is covered by extensive metamorphic rocks, whereas siliciclastic rocks (e.g. sandstones, shales, and conglomerates) dominate in North America and northern Eurasia. — BH

Geochem. Geophys. Geosys. **13**, Q12004 (2012).

EDUCATION

Summing Up Math Standards

Are the Common Core State Standards for Mathematics (CCSSM), which are about to be implemented in the United States, high-quality standards that are internationally competitive? Using data from standards of the highest-achieving nations on the 1995 Trends in International Mathematics and Science Study (TIMSS) and all 50 state standards in place in 2008, Schmidt and Houang analyzed the focus, coherence, and rigor of the content defined by the CCSSM in an effort to predict their impact on student achievement. Comparison of CCSSM with the international standards revealed an almost 90% degree of consistency, suggesting that the CCSSM are focused, rigorous, and worthy of being world-class standards. When applied to state standards, the same analysis showed a wide variation, suggesting that implementation of the CCSSM will be easier for some states than others. Implementing

Published by AAAS

the CCSSMM will be worth the effort, however, as further analysis revealed that states with existing standards most similar to the CCSSM had higher National Assessment of Educational Progress scores. Although the analyses from this study are an indication of correlation and not of causality, they do suggest that the CCSSM, once implemented, will improve the mathematics achievement of U.S. students. — MM

Educational Researcher **41**, 294 (2012).

PHYSICS

A Single-Atom Lasso

Optical tweezing is a powerful technique for trapping and manipulating particles and can be applied to a broad range of size scales—from single cells and viruses to glass beads several micrometers in diameter. Tweezing can also be used to trap single atoms. However, the interaction between photons in the trapping light beam and the atom generally results in atom jitter. This motion of the atom tends to prevent the atoms from being cooled to the lowest temperatures, where interesting quantum effects can then be probed. Kaufman *et al.* used an optical trapping beam and a suite of laser pulses to lasso a single rubidium atom and exploited Raman transitions of the atom to cool it to the quantum ground state. Once trapped and cooled to remove all vibrations from the atom, they also show that they could coherently manipulate its quantum spin and motion. The generality and flexibility of the optical tweezing approach may allow more complex systems comprising arrays of overlapping and interacting trapped atoms or molecules to be designed to form quantum simulators (i.e., well-controlled, engineered quantum systems that can be used to model other less-well-understood condensed-matter systems). — ISO

Phys. Rev. X **2**, 041014 (2012).

GENETICS

Crossovers and Cancer

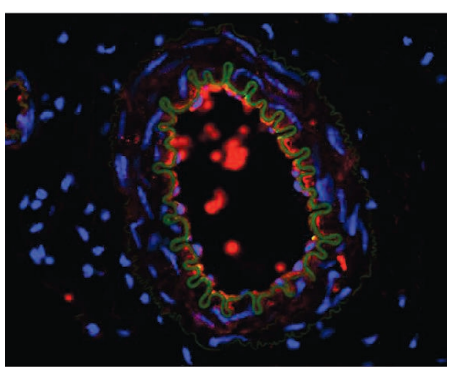
Many cancer-related genes involve variants of genes involved in DNA repair, which often also play a role in chromosomal recombination. Hussin *et al*. used exome sequencing to analyze a family with two siblings that have childhood B cell precursor acute lymphoblastic leukemia (B-ALL). They found that the mother carried a rare variant of PRDM9, a protein that regulates recombination hotspot usage in humans. Examination of the recombination profiles between the parents and offspring revealed an unusual maternal recombination profile in the two B-ALL–affected siblings. The authors then sequenced the exomes of a cohort of 44 parents whose children are affected by B-ALL and identified an excess of rare alleles relative to control populations. These findings were confirmed in an independent cohort of B-ALL–affected children and infants. Analysis of the motifs bound by the PRDM9 variants revealed that they were more likely to be found in segmental duplications within the genome in genes associated with ALL. On the basis of their investigations, the authors propose that PRDM9-mediated effects on meiotic recombination may contribute to the development of childhood leukemogenesis. — LMZ

Genome Res. 10.1101/gr.144188.112 (2012).

CELL BIOLOGY

Feeling the Stretch

Certain cells in the body, particularly those of the vasculature, need to respond appropriately when they are stretched. One way they do this is through the protein zyxin. In stretched cells, zyxin is released from focal adhesions (where cells are attached to their surroundings) and



goes to the nucleus, where it functions as a transcription factor to regulate gene expression. Suresh Babu *et al*. reveal a cellular signaling mechanism by which mechanical stretching is coupled to zyxin release. Using genetically modified mice, they found that zyxin release in response to stretching requires TRPC3 (transient receptor potential channel 3) protein, an ion channel from a family in which some members are regulated by mechanical stimuli. They showed that the channel activation appeared to cause release of endothelin-1 from mammalian endothelial cells, which then acted through its receptor to cause release of atrial natriuretic peptide, whose receptor is a guanylyl cyclase. Production of cyclic GMP (adenosine 3′-5′ monophosphate) would then activate protein kinase G, which phopshorylates zyxin, an event that appears to be necessary for its release from the focal adhesions. — LBR

Sci. Signal. **5**, ra91 (2012).

CREDIT: S. BABU *ET AL.*, *SCIENCE SIGNALING* **5**, 254 (11 DECEMBER 2012)