ECOLOGY

Diversity Takes Time

Like many groups of organisms in the Amazonian tropical rainforest, hylid tree frogs show very high diversity. Moreover, there is strong variation in local diversity, with some localities and regions having much higher density of species than others. Wiens *et al*. take a phylogenetic approach to the question of the cause of this local variation. Their analysis indicates that there is little or no relationship between variation in local species richness and climate variables such as temperature and precipitation. Nor are the rates of diversification or morphological variation correlated with local richness. Instead, diversity is related to the length of time that hylids have occupied a region. Even though diversification rates slow down when multiple clades occupy a region, species nonetheless continue to accumulate with the length of time that the region has been occupied: The highest diversity occurs where the largest number of clades have coexisted for longest. — AMS

Ecol. Lett. **14**, 10.1111/j.1461-0248.2011.01625.x (2011).

CHEMISTRY

Being in Touch

Cellular communication in three-dimensional (3D) tissues often requires contacts between neighboring cells. These events are mediated by the surrounding extracellular matrix, which influences cell positioning and signal transmission and receipt. Although techniques exist for creating 3D cell constructions, they often depend on artificial scaffolds or the manipulation of individual cells via external forces or tools. Dutta *et al.* use liposomes that incorporate cationic lipids to fuse orthogonal functional groups, in the form of ketone and oxyamine molecules, to cell membranes of different populations of cells, which can subsequently be coupled through selective oxime ligation. Techniques have previously been developed to generate protein tags on a cell's surface, but these tags have tended to be large and bulky, and thus interfered with other glycans and biomolecules or with the biochemical pathways or functioning of the cells. The authors explored a wide range of applications for their methodology, including the delivery of reagents to cell surfaces, formation of spheroid assemblies of cells with controlled interconnectivity, and patterning of multilayered cell tissues. When multilayers of human mesenchymal stem cells and fibroblasts were assembled together, differentiation led to tissue structures resembling adipocytes and fibroblasts. Liposome fusion could be performed on the same cells several times; thus, there is scope for giving cells multiple surface functionalities or for increasing the concentration of the functional groups at the surface. — MSL

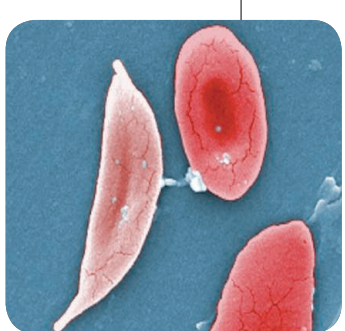
J. Am. Chem. Soc. **133**, 10.1021/ja2022569 (2011).

CELL BIOLOGY

Sickle Cells Protect

The genetic mutation that causes sickle cell anemia is a double-edged sword. Individuals who carry one copy of the mutant hemoglobin allele do not develop sickle cell disease but can show greater resistance to malaria. This may be because despite not developing full-blown disease, their blood still carries some consequences of the mutated allele. Ferreira *et al*. have now analyzed the chain of events that connect the pathology of one copy of mutant hemoglobin with defense against malaria. Mice that express a sickle variant of the human hemoglobin gene were less likely to develop cerebral malaria than normal mice, despite similar parasite loads. The protective effect was attributed to heme oxygenase-1 (HO-1), which metabolizes free heme, generating carbon monoxide as one of the derivatives. In mice with the sickle cell allele, there was a greater tendency for release of free heme, leading to increased induction of HO-1 to remove the heme, which generated more carbon monoxide, which in turn bound to and stabilized hemoglobin, with the overall effect being reduced immune pathology and oxidative stress. Unlike many defense strategies that reduce pathogen burden, this strategy allows the host to be more tolerant of the infection. — PJH

Cell **145**, 398 (2011).



CREDIT (TOP TO BOTTOM): DAN MOEN; JANICE HANEY CARR/CDC

GEOPHYSICS

Cool, Sink, and Thicken

The oceanic lithosphere, which includes the crust and some of the brittle underlying mantle, forms at mid-ocean ridges. As this material is pushed further away from a ridge, it slowly cools over millions of years and sinks, creating deep ocean basins with measurable depths. The evolution of lithosphere thickness with age or distance from the ridge, however, is more difficult to quantify, because seismic methods often fail to resolve its lower limits (over 100 km) across an oceanic plate. Using a method based on waveform modeling of seismic wave precursors, Rychert and Shearer mapped

Continued on page 1013

Continued from page 1011

the seismic discontinuity that defines the bottom of the lithosphere across the Pacific Ocean. Like depth, lithosphere thickness increases with distance from the ridge, in the direction that the convecting mantle below pulls it away. Moreover, the boundary layer is defined by a sharp velocity drop, signifying that the depth of the discontinuity is at least in part controlled by thermal variations between the lithosphere and the underlying viscous asthenosphere. Water or melting may also contribute to the sharpness of the discontinuity. — NW

J. Geophys. Res. **116**, 10.1029/2010JB008070 (2011).

MOLECULAR BIOLOGY

Demethylation DNA Dynamics

The methylation of DNA on cytosine (C) bases, most often at CpG sites, plays an important role in the epigenetic regulation of genomic imprinting, suppression of transposons and other parasitic DNA sequences, and X chromosome inactivation. Addition and removal of DNA methylation can be highly dynamic, but the means by which the methyl mark is removed in animals is unclear. One possible route involves the oxidation of 5-methylcytosine (5mC) to 5-hydroxymethylcytosine (5hmC) by the ten-eleven translocation (Tet) enzyme family.

Xu *et al*. map the binding of Tet1 across the genome of mouse embryonic stem cells and, along with Pastor *et al*., map the genome-wide occurrence of 5hmC. Tet1 bound to unmodified CpG, to 5mCpG, and to 5hmCpG. Tet1 was enriched at promoters and in gene bodies, and its binding correlated with high CpG levels. Besides being enriched in gene bodies (and particularly exons), 5hmC was found at transcription start sites and at silenced promoters and at poised (but inactive) promoters in particular. Its occurrence at some enhancers further reinforces the idea that the presence of 5hmC might prime some quiescent loci for rapid activation. — GR

Mol. Cell **42**, 1 (2011); *Nature* 10.1038/nature10102 (2011).

CELL BIOLOGY

Pass the Calcium, Please

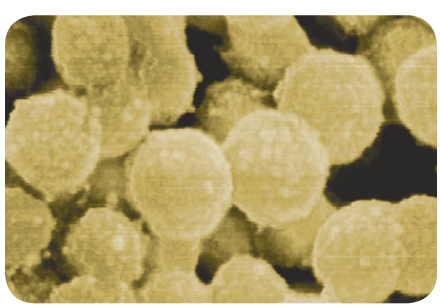
The prostate gets a lot of bad press as a source of problems for aging men, but now a new study suggests that it plays a key role in preparing sperm for successful fertilization. Prostate cells release prostasomes, vesicles that fuse with sperm cells during ejaculation. Park *et al*. found that fusion with prostasomes transfers a molecular "tool kit" to sperm that enables the dynamic calcium signaling events in sperm required for optimal motility and subsequent fertilization. In vitro analysis showed that sperm that had fused with prostasomes received components of the calcium signal transduction machinery, including progesterone receptors (which respond to progesterone released by cells surrounding the egg), ryanodine receptors (which are calcium-permeable channels), and an enzyme that produces cyclic adenosine diphosphoribose (which acts to open ryanodine receptor channels). The transfer of these various elements enhanced calcium signaling in the sperm, sperm motility, and fertilization efficiency in vitro. Thus, despite being stripped-down cells with little cytoplasm and few organelles, sperm are able to use a sophisticated calcium signaling mechanisms, thanks to the bits passed to them from the prostate. — LBR

Sci. Signal. **4**, ra31 (2011).

MATERIALS SCIENCE

A Bumpy Road to the Surface

Nanoparticles formed from mixtures of proteins and synthetic polymers are of interest for applications such as protein delivery. Ge *et al*. examined the surface evolution of particles comprising conjugates of bovine serum albumin (BSA) and poly(methyl methacrylate) (PMMA). They first added 51 acryloyl groups to each denatured BSA molecule and then initiated radical polymerization at each site. Nanoparticles varying in BSA content from 4 to 82% by



weight resulted from injection of an acetonitrile solution of these conjugates into phosphate-buffered saline. At the highest BSA content, the nanoparticles were well dispersed but the otherwise uniform surface of PMMA was covered with islands of BSA (as shown above). These islands grew over 2 weeks' time from surface patches to surface bumps in the buffered saline, but were unchanged if the nanoparticles remained in acetonitrile. The authors present a model in which PMMA, which is better solvated in acetonitrile, forms the main shell at the outset; over time in the aqueous medium, the more hydrophilic BSA then migrates to the surface. — PDS

Nano. Lett. **11**, 10.1021/nl201303q (2011).

CREDIT: GE *ET AL.*, *NANO. LETT.* **11**, 10.1021/NL201303Q (2011)