



DEVELOPMENT

The Digital Divide

Programmed cell death is an important process in development, with mammalian digits being just one such example. The bone morphogenetic proteins (BMPs) and their downstream targets, the *Msx* genes, are known to participate in digit separation. If these components are absent, fingers and toes do not separate, resulting in soft tissue syndactyly. Suzuki *et al.* find that the small GTP-binding protein Rac1, which previously has been shown to function in cell adhesion, migration, and proliferation, also figures in digit development. When Rac1 was inactivated in the mesenchyme of the mouse limb bud, skeletal defects were apparent (such as the malformed sternum shown), yet a striking feature was soft tissue syndactyly due to webbing of the interdigital skin. Epistasis analysis revealed that *BMP* and *Msx* genes were not expressed in the limbs of Rac1-deficient mice; the elimination of Rac1 prevented programmed cell death from removing interdigital limb mesenchymal cells, primarily between the 2nd and 3rd, and the 3rd and 4th digits. — BAP

Dev. Biol. 335, 396 (2009).

MOLECULAR BIOLOGY

Domestic Tidying-Up

Ciliates, such as *Paramecium* and *Tetrahymena*, are single-celled eukaryotes that deal with the junk DNA infesting their genomes in a truly dramatic manner. They harbor complete copies of their genome within two separate nuclei. The micronucleus (or MIC) gives rise both to future progeny and to the macronucleus (or MAC), wherein the DNA is shredded, rearranged, and amplified, which allows the essential core of the genome—in some cases as little as 5% of it—to be expressed at high levels. The repetitive parasitic sequences that have been derived from transposable elements are trashed in the process.

Baudry *et al.* identify the enzyme (named PiggyMac) responsible for shredding the *Paramecium* MAC genome, and it turns out to have

arisen from the very sequences that it so ruthlessly eliminates. PiggyMac is derived from transposases, which are enzymes that normally promote the spread of selfish DNA through the genome that has been “domesticated” during ciliate evolution; although this enzyme can still excise transposon remnants from the host genome, it does not catalyze their reinsertion elsewhere, and instead the junk sequences are safely disposed of. PiggyMac is critical for *Paramecium* development, and the supercharged expression made feasible by abbreviating and amplifying the MAC genome probably facilitates rapid growth and division. Domestication of an enemy of the state has also occurred in our immune system, in which antibody diversification is driven by the recombination-activating gene *RAG*, another erstwhile transposase. — GR

Genes Dev. 23, 2478 (2009).

CHEMISTRY

Propping Up Cholesterol

Cholesterol is a key component of mammalian cell membranes, but where does it reside? Although it is usually thought to reside “upright” with its hydroxyl group at the water interface, neutron scattering studies have found it lying near the center of the bilayer when the membranes are composed of polyunsaturated fatty acid (PUFA) chains. Kučerka *et al.* used neutron scattering to examine whether the lipid composition of bilayers may play a role in orienting cholesterol. They compared the impacts of adding either monounsaturated or disaturated lipids to PUFA bilayers containing cholesterol. Whereas adding 50% of the monounsaturated lipid moved cholesterol back to the upright position, the same effect occurred on addition of only 5% of the disaturated lipid. — PDS

J. Am. Chem. Soc. 131, 16358 (2009).

BIOTECHNOLOGY

Paths of Least Resistance

Living cultures of bacteria may seem like unlikely candidates to help generate electricity. Yet microbial fuel cells are indeed intriguing complements to other alternative energy schemes, despite the need for improvements in scalability and power-generation efficiency before they can be used in certain environments (e.g., organic-rich marine sediments or wastewater treatment plants).

Advancements in efficiency may be achieved by identifying and then optimizing the important components of well-characterized species, or by identifying new bacteria that are inherently more efficient. On the first front, Newton *et al.* found that despite reducing environmental substrates such as Fe and Mn at a similar rate, two closely related species from the *Shewanella* genus produce very different current profiles over time. As mutants lacking certain proteins exhibited lower current generation, the mechanism of anode reduction—either through the production of mediator compounds or by direct attachment to the anode surface—emerged as a key efficiency determinant. On the second front, Fedorovich *et al.* isolated the dominant current-producing species from a mixed culture of bacteria from natural sediments. The new isolate is from a previously under-represented class of *Proteobacteria*. — NW

Appl. Environ. Microbiol. 75, 10.1128/AEM.01142-09; 10.1128/AEM.01345-09 (2009).



Shewanella.