

edited by Gilbert Chin

ECOLOGY/EVOLUTION

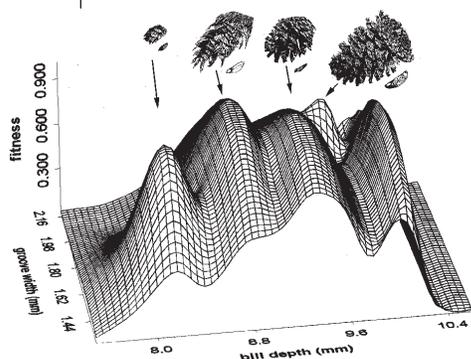
Surveying a Rugged Landscape

Adaptive radiation is the evolutionary process by which populations of organisms diverge and ultimately form new species. These radiations can be mapped as fitness surfaces that contain peaks of adaptation, occupied by populations or species, separated by unoccupied valleys and plains. In theory, these surfaces capture how natural selection contributes to the process of radiation. In practice, however, it has proved difficult to construct such surfaces with accuracy

due to the numbers of confounding variables and the obstacles to obtaining enough information about all of the relevant species.

Benkman has quantified how natural selection acts on red crossbills in Idaho. These birds are a model system for studying radiation because of the clearcut link between their bill morphologies and conifer cones (their food resource), and because the divergence in the populations is recent. Fitness in these birds closely matches feeding efficiency, which in turn is a function of the precision of the match between bill shape and cone shape. The results provide a detailed adaptive surface for crossbills and give strong support to the theory of adaptive radiation via specialization on alternative resources. — AMS

Evolution 57, 1176 (2003).



Fitness landscape of red crossbills specialized for feeding on five conifers, with four sets of cones/seeds drawn to scale.



BIOCHEMISTRY

Searching Adaptive Space

A common goal in drug design (whether by humans or microbes) is to target the foreign protein without interfering with any host proteins. One way of achieving the desired specificity is to design an inhibitor that is perfectly complementary to an enzyme active site. Unfortunately, such an inhibitor may be more vulnerable to a resistance-conferring mutation in the infectious agent or even in a population of transformed cells (compare Gleevec).

Nezami *et al.* have pursued the design of what they call adaptive inhibitors of the family of aspartyl proteases of *Plasmodium falciparum*. This parasite resides in blood cells and feeds on hemoglobin by digesting it with four structurally similar proteases, the plasmepsins, which display both conserved and distinctive amino acid residues in the substrate-binding site. An allophenylnorstatine-dimethylthiopropine scaffold was derivatized at four positions with rotationally versatile groups in a search of an all-purpose anti-malarial, and this resulted in a single compound, KNI-10006, that inhibited all four proteases at submicromolar concentrations. This versatility did not extend to inhibition of the mammalian aspartyl protease pepsin, against which KNI-10006 was several orders of magnitude less active. — GJC

Biochemistry 10.1021/bi034131z (2003).

APPLIED PHYSICS

Switching on to Ferroelectric Transistors

The ability to maintain an electronic device (a transistor) in the On or Off state without the need for an applied bias is a particularly desirable feature in

CHEMISTRY

Following Formation

High-throughput screening is increasingly being used to evaluate the performance of many catalysts. Such screening would be facilitated if the desired reaction could be tracked via a spectroscopic signal, such as fluorescence. For monitoring carbon-carbon bond cleavage, there are several probes whose fluorescence increases, but it is more difficult to follow the formation of carbon-carbon bonds in the same fashion.

Using a compound previously used to detect carbon-sulfur bond formation as one of the reactants, Tanaka *et al.* show that for Michael and Diels-Alder synthetic reactions, fluorescence increases by a factor of 20 to 100 upon carbon-carbon bond formation. The fluorescence signal allows the relative reaction rates for different catalysts to be deter-

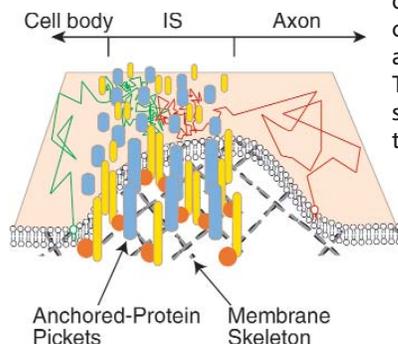
mined quickly. This class of compound (amides of α,β -unsaturated carbonyls) can be used to optimize solvent conditions and to screen protein, peptide, and small-molecule catalysts. — JFU

J. Am. Chem. Soc. 10.1021/ja034069t (2003).

CELL BIOLOGY

Picket Fences

Neurons represent an exquisitely complex type of polarized cell. They possess three radically different domains—dendrites, cell body, and axon



—and each of these has a distinctive surface composition. How the neuron maintains this polarized distribution has been the focus of many studies, sometimes with conflicting results.

Nakada *et al.* have examined the dynamics of lipids in developing hippocampal neurons. They observed the formation of a diffusion barrier for lipids at the axonal initial segment (IS)—the point at which the axon emerges from the cell body. The barrier appears to be imposed by the accumulation of membrane proteins anchored in a meshwork of actin below the membrane. These anchored proteins serve as a kind of picket fence to restrict the diffusion of membrane lipids. This mechanism may be important generally when cells need to establish connected but distinct membrane domains. — SMH

Nature Cell Biol. 5, 626 (2003).

the design of energy-efficient electronics. Ferroelectric materials, because of their remnant polarization, have two stable states and are thus being developed as the active layer in these sought-after, nonvolatile memory devices. Overcoming the short retention times that limited previous devices, Schrott *et al.* report the fabrication and characterization of a ferroelectric field-effect



transistor using $\text{SrRu}_x\text{Ti}_{1-x}\text{O}_3$ as the active channel layer and a zirconate titanate oxide as the gate layer. The transistor switched reliably over 10 billion read-write cycles, exhibited good retention times, and provides the opportunity to use conventional lithographic techniques to scale down the sizes and to improve the switching times. Taken together, these results offer the possibility of realizing high-performance electronics with low-power consumption. — ISO

Appl. Phys. Lett. **82**, 4770 (2003).

GEOLOGY

Large-scale Excavation

Humans have become the greatest global geomorphic agents. Some modifications of the terrain are intentional—for example, building roads and dams, or removing mountaintops in mining. Nevertheless, these and many other projects are often accompanied by unforeseen and un-



The Sri Lankan highlands.

desirable consequences, such as an increase in the number of floods in urban areas, that multiplies the impact of the original landscaping. Widespread deforestation, particularly in mountainous areas, is known to accelerate erosion, although the extent of the enhancement and the precise role of vegetation have been incompletely documented.

Hewawasam *et al.* have studied erosion in a river valley in Sri Lanka, where most of the mountains have been deforested in favor of agriculture. Using the sediment loads in rivers and cosmogenic nuclide levels, which mark the amount of time that a mineral is exposed on the Earth's surface (and hence bombarded by cosmic rays), they show that soil is being lost at a rate of up to several thousand metric tons per square kilometer per year. This rate is almost 100 times the natural background rate in still-forested regions; over some areas, 1 m of soil disappears in just 250 years. — BH

Geology **31**, 597 (2003).

HIGHLIGHTED IN SCIENCE'S SIGNAL TRANSDUCTION KNOWLEDGE ENVIRONMENT

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Maximizing Your Minis

Resting neurons release the contents of individual synaptic vesicles spontaneously and at random intervals. The ensuing miniature postsynaptic potentials (colloquially referred to as minis), which correspond to individual quanta of the postsynaptic response, are too small to initiate firing of an action potential in the postsynaptic cell.

Sharma and Vijayaraghavan recorded miniature excitatory postsynaptic currents (mEPSCs) from voltage-clamped pyramidal cells before, during, and after local application of nicotine. Nicotine increased the fraction of large mEPSCs (consistent with the concerted release of multiple quanta) and stimulated high-frequency bursts of mEPSCs. This increase in mEPSC amplitude and frequency depended on release of calcium from intracellular stores that was secondary to calcium influx through presynaptic nicotinic acetylcholine receptors (nAChRs). When the voltage clamp was removed, nicotine application initiated bursts of action potentials in the postsynaptic cells. Thus, calcium influx through presynaptic nAChRs supports a mechanism whereby impulses can be generated in the postsynaptic cell in the absence of firing in the presynaptic neuron. — EA

Neuron **38**, 929 (2003).