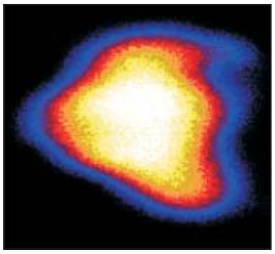
THIS WEEK IN Science

edited by Stella Hurtley and Phil Szuromi

Evolutionary Mountain Climbing

Evolutionary theory suggests that once a genotype has reached an adaptive peak, its potential to diversify further is reduced because small mutations are likely to reduce fitness. **Buckling *et al.*** (p. 2107; see the Perspective by **Elena and Sanjuán**) repeatedly allowed bacterial lines to diversify in laboratory microcosms. After 7 days' culture, the most abundant genotype in the focal niche, which would be assumed to be the best adapted genotype, was used to initiate a new culture, and subsequent diversification was measured. As predicted, increasingly well-adapted genotypes showed a decreasing ability to diversify into new niches.



2109

Brighter When Recognized

The orientation of rodlike liquid crystal (LC) molecules is easily influenced by the chemistry and topography of surfaces it is in contact with, and also by small changes in pressure or temperature. **Brake *et al.*** (p. 2094) show that they can exploit this tendency for the development of a simple "yes/no" biological sensor. A layer of phospholipids is initially adsorbed onto a nematic liquid crystalline film. The phospholipids induce a homeotropic anchoring of the LC molecules that appear dark when viewed between crossed polarized light. When specific proteins or other biomolecules are added, they interact with the phospholipids and alter the orientation of the LC molecules and make the film appear brighter. The reorganization of the LC molecules is dependent on the strength of the phospholipid-biomolecule interaction, thus giving the sensor its specificity.

Converting Molecules into Condensates

Since the demonstration of the Bose-Einstein Condensation of a cloud of bosonic atoms 8 years ago, efforts of the atom-cooling community have been trained on getting more complex systems, such as molecules and fermionic atoms, into the same degenerate quantum state. **Jochim *et al.*** (p. 2101) now provide compelling evidence for achieving such a state with an ensemble of a two-component Fermi gas. By tuning the interaction strength between the two fermionic atoms of the molecular dimer, they create an environment in which the molecules have long lifetimes (20 seconds). They then optically trap and cool the ensemble of molecules into a quantum-degenerate state. The ability to controllably tune the interaction strength between an ensemble of paired fermions opens the possibility to explore the exotic states of superfluidity and superconductivity with a tunable test system.

Randomizing Quantum Computation

As in classical communication networks and computation, where access to random number generators is a necessity for efficient information processing, error correction, and cryptography, so too will it be necessary to have access to random operators and states for the development of quantum information processing. However, as a quantum system grows in size, the resources required to provide a random set of operators grows exponentially. **Emerson *et al.*** (p. 2098; see the Perspective by **Paz**) introduce a generalized quantum circuit that can generate sets of pseudorandom operators that mimic the statistical features of the full quantum system, but with much lower resource cost. They then demonstrate the potential of the technique by implementing it in a nuclear magnetic resonance quantum processor.

Copper Melts

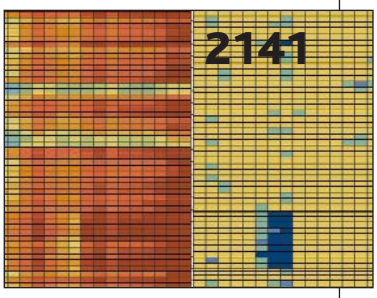
The formation of economic, porphyry metal-ore deposits is not well understood. **Harris *et al.*** (p. 2109; see the Perspective by **Cline**) have found quartz veins in a copper-gold deposit in Argentina that contain magmatic inclusions coexisting with early liquid and vapor inclusions. Using an in situ, high spatial resolution and nondestructive nuclear microscopy technique, they determined that the liquid and vapor inclusions have high copper concentrations. These fluids are thus carrying the Cu that will ultimately be concentrated in the ore deposits. This early association also implies that the metals do not necessarily separate from the magma because of immiscibility at a later stage. The rate of concentration of Cu into the ore deposit can be traced by using the partition coefficients determined from these inclusion measurements.

One Smell Per Cell

Each olfactory neuron in the mouse nasal epithelium expresses only one of more than 1000 olfactory receptor genes. Such limited expression is reminiscent of how antibody genes are selected in the immune system, but unlike antibody gene selection, the mechanism of olfactory receptor gene selection is unknown. **Serizawa *et al.*** (p. 2088; see the Perspective by **Lewcock and Reed**) now show that a DNA region upstream of an olfactory receptor gene cluster preferentially selects which olfactory receptor gene is expressed in a stochastic fashion. Once selected, the product of the expressed gene prevents expression of any of the other olfactory receptor genes in the cluster and ensures maintenance of the "one neuron, one receptor" rule.

Generating Diversity from Within

One pathway toward generating functional diversity is through alternative splicing of exons. Alternative pre-mRNA splicing is thought to play important roles in human development, physiology, and disease, and the majority of human genes are alternatively spliced. **Johnson *et al.*** (p. 2141) present a microarray analysis of exon-exon junctions for more than 10,000 human multi-exon genes in 52 tissues and cell lines. Novel isoforms and tissue specificity in the patterns of alternative splicing were observed, and more than 70% of the genes were alternatively spliced.



2141

Making Yeast Live Longer

Calorie restriction enhances longevity in many organisms. In yeast, this response involves Sir2, a histone deacetylase. It has not been clear if Sir2 is directly activated by nicotinamide adenine nucleotide (NAD^+), or if depletion of the Sir2 inhibitor nicotinamide is responsible for its apparent activation. By using in vivo nuclear magnetic resonance spectroscopy to quantify levels of total free NAD^+ in

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CREDITS: (TOP TO BOTTOM) HARRIS *ET AL.*; JOHNSON *ET AL.*

cells, **Anderson *et al.*** (p. 2124) observed that calorie restriction reduced cellular NAD^+ levels in yeast. These results suggest that food deprivation does not activate Sir2 by increasing the availability of this small molecule.

Sustainable Brazil Nut Harvesting?

The brazil nut is harvested entirely from natural populations of trees in the Amazon basin, and is often held up as an example of a resource that can be harvested sustainably from the tropical forest. **Peres *et al.*** (p. 2112; see the news story by **Stokstad**) gathered data on the size structure of Brazil nut tree populations from 23 sites in the Bolivian, Peruvian, and Brazilian Amazon. Contrary to expectations, the harvesting of nuts over many decades has reduced the recruitment of new seedlings, such that many populations are no longer sustainable.

Separating Maize Genes from the Chaff

Maize has a huge genome that impedes successful sequencing of the complete genome. **Whitelaw *et al.*** (p. 2118) and **Palmer *et al.*** (p. 2115) have generated maize genome sequences enriched in gene-coding regions. The maize genome is replete with repeated sequences, and nonrepeated sequences can be selected through melting and then reannealing the DNA. Methylation status can also be used to separate actively transcribed sequences from less active sequences. Application of either or both of these filters allowed sequencing efforts to concentrate on expressed gene sequences.

Generating Tubes During Development

In the animal world, the development of several organs involves tube formation: e.g., in the development of kidney, lung, and blood vessels. **Berry *et al.*** (p. 2134; see the Perspective by **Paul and Beitel**) examined genes required for proper tube formation and/or maintenance in the excretory system of the nematode, *Caenorhabditis elegans*. They identified and characterized a putative intracellular chloride channel that functions early in tube morphogenesis, at about the time the lumen begins to form. Mutations in this gene lead to the formation of cysts rather than a continuous luminal channel in the developing excretory system.

Separating Chromosomes and Separating Cells

How do cells coordinate the separation of chromosomes with the activities of the mitotic spindle and cytokinesis—the physical separation of two daughter cells? **Pereira and Schiebel** (p. 2120) examined this question in yeast cells and discovered a role for a protein complex known as INCENP. In metaphase, when the chromosomes align at the center of the mitotic spindle, INCENP associates with kinetochores—the central region of the chromosome that interacts with spindle microtubules during chromosome partitioning. During anaphase, the separation phase of mitosis, INCENP relocates to the spindle microtubules where it helps to define the midzone and so to define the position of the cytokinetic furrow. This transfer of INCENP is promoted by the cell cycle phosphatase, cdc14, which is stimulated to act by the chromosomal regulator separase. Thus, cdc14 coordinately regulates mitotic exit and spindle properties to ensure faithful cytokinesis.

How Kinesin Does the Two-Step

The double-headed motor protein kinesin moves along microtubules in 8-nanometer steps, and proposed mechanisms can be divided into two broad classes—hand-over-hand and inchworm. In hand-over-hand mechanisms, the heads exchange leading and trailing roles with each step, whereas in inchworm mechanisms, one head always leads. **Asbury *et al.*** (p. 2130) show that some kinesin molecules alternate between two different rates at each sequential step, effectively limping along the microtubule. Thus, stepping must be asymmetric, which excludes inchworm mechanisms and symmetric hand-over-hand mechanisms, but supports an asymmetric hand-over-hand mechanism. **Yildiz *et al.*** (, December 18) show that the average step is made up of alternating steps of 0 and 17 nanometers.

CREDIT: BERRY *ET AL.*