

Neandertal Refugees? >>>

Paleohuman populations occupied high latitudes in Eurasia after about 50,000 years ago, even as Earth's climate seesawed toward a full glaciation. These sites, in part, represent the expansion of modern humans, which led to the contraction and elimination of Neandertals. **Slimak *et al.*** (p. 841) now describe a site in the Northern Urals that is dated to about 33,000 years ago but that contains an older, Middle Paleolithic set of tools. This tool set is typical of those associated with Neandertals at older European sites, but the site lacks human fossils and so the exact makers are uncertain. The site may thus represent a northern refuge of a Middle Paleolithic population, possibly Neandertals.

Heads or Tails?

Planarian flatworms are famous for their ability to regenerate any missing body part (see the Perspective by **Slack**). **Petersen and Reddien** (p. 852) studied the mechanism by which planaria know what body part to regenerate, whether head or tail. The secreted Wnt inhibitor *notum* was selectively activated at anterior-facing wounds to throw a regeneration polarity switch. When *notum* was inhibited using RNA interference, a two-tailed planarian was produced. Thus, local responses to tissue orientation at wounds can determine the regeneration outcome. **Wagner *et al.*** (p. 811; see the cover) examined whether regeneration is made possible by neoblasts (adult proliferative cells) that are pluripotent or whether multiple, lineage-restricted cells are needed. Pluripotent clonogenic neoblasts were able to regenerate lethally irradiated animals otherwise lacking dividing cells, ultimately transforming host animals into genetic clones of the donor. Thus, the remarkable regenerative abilities of planarians require persistence of pluripotent cells into adulthood.

Partners by Design

Proteins such as antibodies that bind with high affinity to targets are valuable in diagnostics and therapeutics. Computational design could complement high-throughput screening methods; however, designing high-affinity interaction partners to chosen targets remains a challenge. **Fleishman *et al.*** (p. 816; see the Perspective by **Der and Kuhlman**) engineered proteins that target a conserved region on the influenza hemagglutinin (HA) protein from the 1918 H1N1 virus, using a computational method aimed to design high shape complementarity and core residue interactions. Two designed proteins exhibited low-nanomolar

affinity binding to HA after affinity maturation and the actual binding interface was confirmed by structural analysis to be nearly identical to the designed model.

Nanoimaging Nanocrystals

Analysis of the three-dimensional grain structure in a nanocrystalline metal usually requires destruction of the specimen through repeated removal of the surface layers, or through slicing into multiple specimens. While x-ray techniques can be used nondestructively, the resolution is limited to features larger than 100 nanometers in size. **Liu *et al.*** (p. 833) acquired a series of dark-field electron microscopy images over all beam and sample tilt positions, and determined the grain orientation in each voxel. Analysis of over 100,000 images provided a resolution down to 1 nanometer in a specimen of nanocrystalline aluminum.

He Not So Super After All

Lowering the temperature of a rotating ring of frozen helium to temperatures below 250 millikelvin gives rise to an increase of the rotational frequency. One interpretation of the effect was the formation of an exotic supersolid quantum phase, whereby the atoms within the frozen sample decouple and "flow" akin to that seen for a normal to superfluid transition. Since the initial report, however, the interpretation has been controversial. **Pratt *et al.*** (p. 821) revisited the effect using an ultrasensitive torsional oscillator to comprehensively map out the temperature and mechanical dependence of the frozen helium's behavior. The results favor a scenario involving the shearing of the frozen helium at impurity and defect sites and did not reveal a phase transition associated with a quantum supersolid.

Enhancing Capacitance

Typically, the capacitance of a flat interface is limited by geometrical properties, but electron correlation effects can allow more electrons to be confined. These enhancements are often on the order of a few percent, but **Li *et al.*** (p. 825) observed enhancements of up to 40% at the interface between LaAlO_3 and SrTiO_3 that arise from a "negative compressibility" effect. These enhancements, which occur at low electron densities when top-gate electrodes deplete most of the electrons from the interface, could prove useful in increasing the speed and power consumption of field-effect transistors.

Rapid Heating

Metallic glasses need very high cooling rates to prevent crystallization. If one wants to process a supercooled metallic glass, even faster heating rates are needed. **Johnson *et al.*** (p. 828) used the discharge of a critically damped capacitor to induce an intense millisecond current pulse to achieve uniform, quantifiable, Ohmic heating, which could be used to measure the temperature-dependent enthalpy of the metallic systems.



Martian CO₂ Store

Mars' CO₂-dominated atmosphere is believed to have been denser in the ancient past. Using radar measurements from the Mars Reconnaissance Orbiter, **Phillips *et al.*** (p. 838,

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published online 21 April; see the Perspective by **Thomas**) found that large quantities of the ancient atmospheric CO₂ could be stored in solid deposits within the Mars South Polar region. If released completely into the atmosphere, which might occur during a period of high obliquity, these deposits would almost double the atmospheric CO₂ content of Mars and could instigate major changes in the red planet's climate.

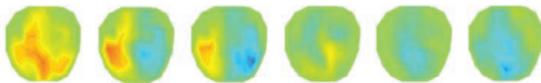
Light-Harvesting Benchmarks

Plants and a variety of autotrophic microbes use the energy in sunlight to oxidize water, ultimately channeling the electrons into carbon dioxide reduction to form sugars and more complex organic compounds. Artificial solar cells, or photovoltaics, also harvest the energy in sunlight to liberate electrons, but, rather than driving chemical transformations, these electrons often simply loop around a circuit before returning to their starting place. **Blankenship et al.** (p. 805) review the fundamental efficiency of photovoltaic-driven water splitting in an effort to make as clear a comparison as possible with the fundamental parameters of natural photosynthesis and assess the prospects for improving the efficiencies of each process, an endeavor crucial to ensuring a sustainable societal energy supply in the long term.

Consciousness and Feedback

The vegetative state is defined by preserved arousal, in the absence of any behavioral signs of awareness. Earlier investigations of patients and healthy volunteers suggested that, in addition to activity in low-level specialized brain regions, the conscious perception of external stimuli requires activation of fronto-parietal cortices. **Boly et al.** (p. 858) compared dynamic causal modeling of event-related potentials during auditory processing

in healthy subjects and in patients in a minimally conscious state or a vegetative state. Although the frontal cortex was still



involved in the generation of event-related potentials in the patients, recurrent processing between higher-order cortices was highly abnormal because of impaired backward connections from frontal to temporal cortices. Thus, the integrity of backward connections is required for conscious perception.

Mother's Curse

Because mitochondria, which contain their own genome, are primarily inherited from the mother, males are an evolutionary dead end for mitochondria. **Innocenti et al.** (p. 845; see the Perspective by **Parsch**) compared the genomic transcripts of male and female fruit fly with varying mitochondrial types but the same nuclear background. In females, exchanging mitochondrial genomes altered the expression of only a handful of nuclear genes; in contrast, in males, more than a thousand genes showed a significant change in expression and more than 10% of transcripts exhibited male-biased expression. Because changes in gene expression are generally deleterious, males will exhibit a much greater mutational load than females.

Mosquito Malaria Defenses

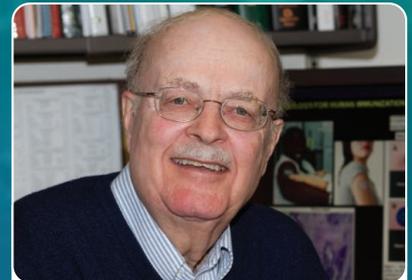
Despite the challenges of a complex life cycle, the malaria parasite is terrifyingly successful. Most parasites picked up by the blood-feeding insects fail to develop into transmission stages in the salivary glands because of both mosquito-immune responses and the effects of midgut microflora. **Cirimotich et al.** (p. 855) isolated bacteria from wild-caught Zambian *Anopheles arabiensis* and monitored their effect on *Plasmodium* oocyst development in several anopheline species. One enterobacter-like isolate, called *Esp_Z*, was able to almost eliminate the malaria parasite in vitro via the production of reactive oxygen species.

Active Learning

Teaching large groups of undergraduate students often involves lectures. **Deslauriers et al.** (p. 862) found that more active teaching formats improved student attention, engagement, and learning. Two sections of a large physics class, one taught by lecture, and one taught with active formats were compared. Students offered clicker response questions, small group tasks, and opportunities for student discussion within the class demonstrated better learning outcomes.

CREDIT: M. BOLY ET AL.

“A dream told me to do it.”



Carl R. Alving, M.D.
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