**QUANTUM SYSTEMS**

**Quantum entanglement goes large**

Quantum entanglement occurs when two separate entities become strongly linked in a way that cannot be explained by classical physics; it is a powerful resource in quantum communication protocols and advanced technologies that aim to exploit the enhanced capabilities of quantum systems. To date, entanglement has generally been limited to microscopic quantum units such as pairs or multiples of single ions, atoms, photons, and so on. Kotler *et al.* and Mercier de Lépinay *et al.* demonstrate the ability to extend quantum entanglement to massive macroscopic systems (see the Perspective by Lau and Clerk). Entanglement of two mechanical oscillators on such a large length and mass scale is expected to find widespread use in both applications and fundamental physics to probe the boundary between the classical and quantum worlds. —ISO

*Science*, this issue p. 622, p. 625; see also p. 570

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**CORONAVIRUS**

**A large-scale screen to target SARS-CoV-2**

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) genome is initially expressed as two large polyproteins. Its main protease, M, is essential to yield functional viral proteins, making it a key drug target. Günther *et al.* used x-ray crystallography to screen more than 5000 compounds that are either approved drugs or drugs in clinical trials. The screen identified 37 compounds that bind to M. High-resolution structures showed that most compounds bind at the active site but also revealed two allosteric sites where binding of...
a drug causes conformational changes that affect the active site. In cell-based assays, seven compounds had antiviral activity without toxicity. The most potent, calpeptin, binds covalently in the active site, whereas the second most potent, pelitinib, binds at an allosteric site. —VV

**Paleontology**

*Revealing behavioral secrets in extinct species*

Extinct species had complex behaviors, just like modern species, but fossils generally reveal little of these details. New approaches that allow for the study of structures that relate directly to behavior are greatly improving our understanding of the lifestyles of extinct animals (see the Perspective by Witmer). Hanson et al. looked at inner ears and scleral eye rings and found clear patterns relating these bones to complex movement, including flight. Choiniere et al. looked at inner ears and scleral eye rings and found a clear emergence of patterns relating to nocturnality in early theropod evolution. Together, these papers reveal behavioral complexity and evolutionary patterns in these groups. —SNV

*Science, this issue p. 601; p. 610; see also p. 575

**Archaeology**

*Human impact on landscapes in early Africa*

Although fire has been used by many cultures to improve the availability of subsistence resources, the antiquity of this practice is poorly understood. Thompson et al. investigated the northern basin of Lake Malawi in southern-central Africa using archaeological, geomorphological, and palaeoecological data and reconstructed the environmental context of the Middle Stone Age hunters and gatherers who lived in this region around 92,000 years ago. These peoples used fire to clear forests and thin understory growth. The signature of these fires differs from those created by natural phenomena and signals an abrupt transformation of regional ecology when compared with earlier periods. This record of anthropogenic burning is much earlier than similar practices in prehistory. —MSA

*Sci. Adv. 10.1126/sciadv.abf9776 (2021).*

**Sustainability**

*Pollinator-focused solar arrays*

Although the power generated from the sun is “green,” the deployment of large receiving arrays is often less so. At their worst, these are large swaths of solar panels that sit above dry and dead fields. Large-scale solar production can be improved if panels are combined with native or other flowering plants. Graham et al. show that such “agrivoltaic” combinations provide a variety of microclimates with different light, temperature, and moisture

**Cancer Imaging**

*Through a shrimp eye brightly*

A camera for intraoperative imaging of tumors could improve surgical outcomes, but some imaging technologies have been difficult to translate to clinical practice. Blair et al. designed an imaging system based on the eye of the mantis shrimp. This system detected multiple near-infrared fluorescent signals simultaneously and was tested in a mouse model of human prostate cancer. In support of clinical feasibility, the authors show that the sensor can detect fluorescently labeled sentinel lymph nodes in patients with breast cancer who are undergoing surgical resection. This bioinspired imaging sensor could offer a flexible tool for image-guided surgical removal of tumors. —OMS

*Sci. Transl. Med. 13, eaaw7067 (2021).*

**Restoration Ecology**

*Fill-up for the forest*

The restoration of degraded and disturbed habitats has become a major focus of applied ecology because of the benefits it brings to ecosystem functioning and biodiversity. Cole and Zahawi show how nutrients from agricultural waste can contribute to the recovery of tropical forest on postagricultural land. In an experiment in Costa Rica, a 0.5-meter-deep layer of coffee pulp applied to the land raised nutrient levels and inhibited the growth of ground cover, especially of pasture grasses. This input promoted a succession of forest trees and shrubs, which reached substantially greater biomass and canopy height after 2 years than vegetation in a control plot. —AMS

*Ecol. Solut. Evid. 2, e12054 (2021).*

Forest restoration in Costa Rica is accelerated (top section of image) by the application of coffee-processing waste as a deep mulch.
HYPOTHESIS
Rethinking insulin in obesity
The causes of obesity remain unclear, and several models have been proposed to help prevent or reverse weight gain. The carbohydrate-insulin model centers on the role of insulin in driving adiposity and limiting satiety in response to consumed carbohydrates. It has thus been proposed that low-carbohydrate, high-fat diets (a ketogenic diet) could be used to limit the postprandial effects of insulin. In a Perspective, Speakman and Hall discuss the accumulating evidence that this role of insulin may not be the key factor in regulating weight gain. Instead, they propose that the basal level of insulin in response to the balance of energy intake and expenditure, rather than diet composition per se, is more important. —GKA
Science, this issue p. 577

BACTERIAL PHYLOGENY
Reconstructing ancestral bacteria
The origin of the eubacteria and phylogenetic relationships between subgroups have been difficult to resolve. Applying a phylogenetic analysis and recent computational methods to the expanded diversity of bacterial sequences from metagonomic analyses, Coleman et al. infer the root of the eubacterial tree (see the Perspective by Katz). The root was determined without using the Archaea as an outgroup, to avoid the possibility of a false result due to long branch attraction. This method places the eubacterial root in the neighborhood of Fusobacteriota. Using this information, the authors reconstructed the eubacterial ancestor, identifying that this organism likely had a double-membrane cell envelope, flagellum-mediated motility, antiphage defense mechanisms, and diverse metabolic pathways. —LMZ
Science, this issue p. 588; see also p. 574

PRIMATE EVOLUTION
A distinctive ancestor
There has been much focus on the evolution of primates and especially where and how humans diverged in this process. It has often been suggested that the last common ancestor between humans and other apes, especially our closest relative, the chimpanzee, was ape- or chimp-like. Almécija et al. review this area and conclude that the morphology of fossil apes was varied and that it is likely that the last shared ape ancestor had its own set of traits, different from those of modern humans and modern apes, both of which have been undergoing separate suites of selection pressures. —SNV
Science, this issue p. 587

PALEOGENOMICS
The value of dirty DNA
Environmental DNA can identify the presence of species, even from the distant past. Surveying three cave sites in western Europe and southern Siberia, Vernot et al. identified nuclear DNA and confirmed that it is from the close relatives of anatomically modern humans—Neanderthal and Denisovan individuals. A phylogenetic analysis and modeling show that the DNA in sediment samples from several layers corresponds to previously studied skeletal remains. These results demonstrate that environmental data can be applied to study the population genetics of the extinct Neanderthal and Denisovan lineages, identifying a turnover of Neanderthal populations ~100,000 years ago. —LMZ
Science, this issue p. 590

FERROELECTRICS
A role for vacancies
Hafnia-based materials are of interest because of their potential use in microelectronic components. Hafnia-oxide is a ferroelectric material, but whether the polarization switching comes from the polar crystal phases or the migration of oxygen vacancies has remained an open question. Nukala et al. attempted to resolve this controversy by conducting electron microscopy during the operation of a hafnium zirconium oxide capacitor. The authors found that vacancy migration is intertwined with the ferroelectric switching, which has implications for the use of these materials in a range of microelectronic applications. —BG
Science, this issue p. 630

MATERIALS SCIENCE
Reversible fiber fusion and fission
Materials that can cycle between states are of interest for actuators, soft robotics, or recoverable membranes for separations. Chang et al. show that a collection of graphene oxide fibers can fuse into a single stronger fiber function. In some taxa, this process occurs often. The XY system in mammals, however, has been evolutionarily stable across a wide array of species. Fifty years ago, a variation on this norm was described in the creeping vole (Microtus oregoni), but the details have remained mostly unknown. Couger et al. sequenced the sex chromosomes in this species and found that the Y chromosome has been lost, the male-determining chromosome is a second X that is largely homologous to the female X, and both the maternally inherited and male-specific sex chromosomes carry vestiges of the ancestral Y. —SNV
Science, this issue p. 592

GENETICS
Environmental impacts on gene networks
A phenotype can be affected by genes interacting with other genes, the environment, or both other genes and the environment (a differential interaction). To better understand how these interactions function in yeast, Costanzo et al. mapped gene–gene interactions using single- and double-mutant deletions and temperature-sensitive alleles under 14 environmental conditions. Many deleted or temperature-sensitive nonessential genes affected yeast fitness both positively and negatively under at least one of the environmental conditions tested. In these cases, up to 24% of yeast genes were affected. A minority of these differential interactions point to previously unknown genetic connections across functional networks, informing on how genetic architecture responds to environmental variation. —LMZ
Science, this issue p. 589

NEURODEVELOPMENT
Development of the human striatum revealed
Deep in the brain, the striatum receives and coordinates inputs from other parts of the brain. Bocchi et al. surveyed molecular features as the striatum develops in the human brain. Single-cell surveys of long intergenic noncoding RNAs revealed a progenitor for medium spiny neurons and provide insight into evolutionary divergence of this critical part of the brain. —PJH
Science, this issue p. 591

SEX DETERMINATION
Mystery solved?
Chromosomal sex determination arises when an autosomal locus acquires a sex-determining function. In some taxa, this process occurs often. The XY system in mammals, however, has been evolutionarily stable across a wide array of species. Fifty years ago, a variation on this norm was described in the creeping vole (Microtus oregoni), but the details have remained mostly unknown. Couger et al. sequenced the sex chromosomes in this species and found that the Y chromosome has been lost, the male-determining chromosome is a second X that is largely homologous to the female X, and both the maternally inherited and male-specific sex chromosomes carry vestiges of the ancestral Y. —SNV
Science, this issue p. 592

ECONOMIC SCIENCE JOURNALS
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RESEARCH

upon immersion in a solvent, extraction, and drying under tension (see the Perspective by Cruz-Silva and Elías). The geometrical deformation of the fibers during drying and swelling plays an important role in the reversible cycles, with a large volume change between the dried and swelled fibers. Moreover, fibers made from polymers, glass, metal, or silk can be given these abilities when coated with a micron-sized layer of graphene oxide. —MSL  
Science, this issue p. 644; see also p. 573

CORONAVIRUS

The Slovakian test case

Toward the end of 2020, Slovakia decided that it would test and then isolate positive severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) cases among its entire population of ~5.5 million, and more than 50,000 positive cases were found during a rapid antigen testing campaign. Pavelka et al. analyzed the data and found that in 41 counties before and after the two rounds of testing, infection prevalence declined by about 80% (see the Perspective by García-Fiñana and Buchan). They also used the data to test a microsimulation model for one county. Quarantine of the whole household after a positive test was essential to achieving a large reduction in prevalence. Since Autumn 2020, transmission in Slovakia has rebounded, despite other interventions, because high-intensity testing was not sustainable. —CA  
Science, this issue p. 635; see also p. 571

INFLAMMATION

DUBbing new inflammasome inhibitors

Inflammasome assembly and activation leading to mature interleukin-1β (IL-1β) release is dysregulated in a wide range of inflammatory diseases. Optimal activation of the NLRP3 inflammasome, a protein complex important for IL-1β release, requires the activity of BRISC, a deubiquitinating enzyme (DUB) complex composed of four protein subunits including the metalloprotease BRCC3. Ren et al. demonstrate that the compound thiolutin, a zinc chelator that inhibits BRCC3, can potently inhibit NLRP3 deubiquitination and inflammasome activation. Thiolutin was effective at inhibiting NLRP3 activation and preventing IL-1β production in multiple mouse models of inflammatory disease, including a model of diet-induced nonalcoholic fatty liver disease. Holomycin, a derivative of thiolutin with reduced toxicity, was also effective at inhibiting NLRP3, paving the way for the development of agents that selectively target deubiquitination of NLRP3 to regulate its activity. —CO  

NEUROSCIENCE

Stabilized by protein interactions

Neurons maintain stable excitability despite prolonged changes in synaptic input by adjusting the strength of connections between neurons. Heavner et al. found that in mice, associations between proteins in a postsynaptic protein interaction network were differentially altered by prolonged increases compared with prolonged decreases in activity. Some of these changes did not occur in mice lacking either Homer1 or Shank3B, genes that are mutated in some patients with autism spectrum disorder. Thus, these scaffolding proteins may serve as structural hubs for synaptic plasticity. —LKF  