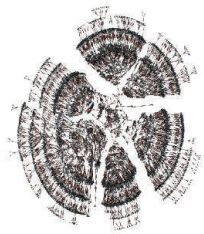
RESEARCH

Genetic architecture of human longevity and migration

Kaplanis et al., *p. 171*



IN *SCIENCE* JOURNALS

Edited by **Caroline Ash**

CARBON CYCLE

Microbes eat rocks and leave carbon dioxide

The reaction of atmospheric carbon dioxide (CO_2) with silicate rocks provides a carbon sink that helps counterbalance the release of CO_2 by volcanic degassing. However, some types of rocks contain petrogenic organic carbon, the oxidation of which adds CO_2 to the atmosphere, counteracting the drawdown by silicates. Hemingway *et al.* present evidence from the rapidly eroding Central Range of Taiwan showing that microbes oxidize roughly two-thirds of the petrogenic organic carbon there and that the rate of oxidation increases with the rate of erosion. —HJS

Science, this issue p. 209

Microbes oxidize most of the petrogenic organic carbon in Taiwan's fast-eroding Central Range.

QUANTUM INFORMATION

Scaling up to supremacy

Quantum information scientists are getting closer to building a quantum computer that can perform calculations that a classical computer cannot. It has been estimated that such a computer would need around 50 qubits, but scaling up existing architectures to this number is tricky. Neill *et al.* explore how increasing the number of qubits from five to nine affects the quality of the output of their superconducting qubit device. If, as the number of qubits grows further, the error continues to increase at the same rate, a quantum computer with about 60 qubits and reasonable fidelity might be achievable with current technologies. —JS

Science, this issue p. 195

ORGANIC CHEMISTRY

A guide for catalyst choice in the forest

Chemists often discover reactions by applying catalysts to a series of simple compounds. Tweaking those reactions to tolerate more structural complexity in pharmaceutical research is time-consuming. Ahneman *et al.* report that machine learning can help. Using a high-throughput data set, they trained a random forest algorithm to predict which specific palladium catalysts would best tolerate isoxazoles (cyclic structures with an N–O bond) during C–N bond formation. The predictions also helped to guide analysis of the catalyst inhibition mechanism. —JSY

Science, this issue p. 186

PLANT SCIENCE

Dormancy by communication shutdown

Trees become dormant in winter, with encapsulated buds protected against harsh conditions. Tylewicz *et al.* found that, as the days get shorter, communication channels between cells in aspen trees shut down. The blocked plasmodesmata sequester the dormant meristems from growth signals. Growth-promoting signals can be turned on and off relatively rapidly, but the closed plasmodesmata are not so nimble. Thus, despite the occasional sunny day, the trees stay dormant until spring. —PJH

Science, this issue p. 212

NOROVIRUS

Aiding and abetting norovirus disease

Norovirus is highly infectious and usually causes transient, acute disease. In some individuals, norovirus persists and is associated with inflammatory bowel disorders. While investigating the cell tropism for murine norovirus, Wilen *et al.* discovered that a rare cell type,

CREDITS: (TOP TO BOTTOM) J. KAPLANIS *ET AL.*; WENLILOU/SHUTTERSTOCK

tuft cells, carrying the CD300lf receptor were the virus's specific target. Tuft cells proliferate in response to the type 2 cytokines interleukin-4 and interleukin-25, which thereby amplify norovirus infection. Moreover, infected tuft cells are resistant to immune clearance. This effect may explain the associated persistent disease symptoms that humans can suffer. —CA

Science, this issue p. 204

METROLOGY

Refining the fine-structure constant

The fine-structure constant, α, is a dimensionless constant that characterizes the strength of the electromagnetic interaction between charged elementary particles. Related by four fundamental constants, a precise determination of α allows for a test of the Standard Model of particle physics. Parker *et al.* used matter-wave interferometry with a cloud of cesium atoms to make the most accurate measurement of α to date. Determining the value of α to an accuracy of better than 1 part per billion provides an independent method for testing the accuracy of quantum electrodynamics and the Standard Model. It may also enable searches of the so-called "dark sector" for explanations of dark matter. —ISO

Science, this issue p. 191

STRUCTURAL BIOLOGY

The RNA exosome captured in action

The RNA exosome, a major RNA degradation machine, processes ribosomal RNA (rRNA) precursors and is directly coupled to the protein synthesis machine, the ribosome. Using cryo–electron microscopy, Schuller *et al.* investigated the structure of the precursor large ribosomal subunit from yeast with unprocessed rRNA in complex with the RNA exosome. The structure captures a snapshot of two molecular machines transiently interacting and explains how the RNA exosome acts on an authentic physiological substrate and remodels the large subunit during ribosome maturation. —SYM

Science, this issue p. 219

PALEONTOLOGY

Early evolution of insect scales

Organisms use tiny structures on their surfaces to produce striking optical effects. The wing scales of butterflies and moths exhibit some of the most diverse physical colors produced by insects, but whether they have always been equipped with photonic structures is unknown. Zhang *et al.* used fossil evidence to establish that these insects possessed color-eliciting structures at least 130 million years earlier than previously thought. They determined the ultrastructure of wing scales from Jurassic Lepidoptera and mid-Cretaceous Tarachoptera. They then used optical modeling to reconstruct the colors that these features would produce. —PJB

Sci. Adv. 10.1126/sciadv.1700988 (2018).

HIV

Zooming in on human lymph nodes

Follicular helper T cells (T_{FH}) play an essential role in shaping B cell–mediated antibody responses. Wendel *et al.* used mass cytometry and T cell receptor sequencing to examine the T_{FH} response in lymph node tissue collected from HIV$^+$ individuals. HIV infection altered the clonality of T_{FH} cells, with severe infections associating with pronounced oligoclonal T_{FH} responses. T_{FH} cells in the lymph nodes of HIV$^+$ individuals secreted interleukin-21 but were less polyfunctional than T_{FH} cells from healthy individuals. The lack of polyfunctionality correlated with impaired isotype switching of B cells in the lymph nodes. —AB

Sci. Immunol. **3**, eaan8884 (2018).

IN OTHER JOURNALS

Edited by **Caroline Ash** *and* **Jesse Smith**

Bill color in waxbills changes with external temperature.

SOCIAL SIGNALS

Sexual signals not so strict

Sexual signals in animals, such as bright plumage, are thought to be predetermined or to be badges of quality that can reflect an animal's current condition. Direct and immediate effects of the environment in which an animal lives are rarely considered to shape these phenotypes. Funghi *et al.*, however, found that in waxbills, bill color—a trait that can change quickly—is not the result of predetermined sexual differences, aggression, or sexual selection, but rather appears to be influenced by changes in the abiotic environment. Bill brightness was reduced in females after a series of lower-temperature nights. The authors suggest that this indicates that environmental conditions place constraints on these types of traits, limiting the degree to which they can reflect quality or be used for social interaction. —SNV

Behav. Ecol. Sociobiol. 10.1007/s00265-018-2486-6 (2018).

MATERIALS SCIENCE

Silicon sheds its harmonicity

The widespread technological uses for silicon make understanding this element's physical properties very important. Kim *et al.* performed inelastic neutron scattering experiments on single crystals of silicon to measure the vibrational properties up to 1500 K. Silicon has some odd thermal properties at certain temperatures, and these experiments show the need to account for a number of factors to explain the unusual thermal expansion

PHOTO: MARTIN MECNAROWSKI/SHUTTERSTOCK

ALSO IN *SCIENCE* JOURNALS

Edited by **Caroline Ash**

SYNTHETIC BIOLOGY

Writing a cell's history in its DNA

Recording cellular events could advance our understanding of cellular history and responses to stimuli. The construction of intracellular memory devices, however, is challenging. Tang and Liu used Cas9 nucleases and base editors to record amplitude, duration, and order of stimuli as stable changes in both genomic and extrachromosomal DNA content (see the Perspective by Ho and Bennett). The recording of multiple stimuli—including exposure to antibiotics, nutrients, viruses, and light, as well as Wnt signaling—was achieved in living bacterial and human cells. Recorded memories could be erased and re-recorded over multiple cycles. —SYM

Science, this issue p. 169; see also p. 150

CELL BIOLOGY

The mitoCPR unclogs mitochondria

The import of proteins into mitochondria is essential for cell viability. How cells respond when mitochondrial protein import is impaired is poorly understood. Weidberg and Amon showed that upon mitochondrial import stress, yeast cells mounted a response known as the mitoCPR. mitoCPR was activated when mitochondrial protein import was impaired and unimported precursors accumulated on the organelle's surface. mitoCPR restored mitochondrial functions by clearing stalled proteins from the import channels. It did this by inducing expression of Cis1, which recruited the adenosine triphosphatase Msp1 to import channels to remove unimported precursors and target them for degradation by the proteasome. —SMH

Science, this issue p. 170

POPULATION BIOLOGY

Quantitative analysis of millions of relatives

Human relationships, as documented by family trees, can elucidate the heritability of a host of medical and biological parameters. Kaplanis *et al*. collected 86 million publicly available profiles from a crowdsourced genealogy website and used them to examine the genetic architecture of human longevity and migration patterns (see the Perspective by Lussier and Keinan). Various models of inheritance suggested that life span is predominantly attributable to additive genetic effects, with a smaller component from dominant genetic inheritance. The data also suggested that relatedness between individuals is less attributable to advances in human transportation than to cultural changes. —LMZ

Science, this issue p. 171; see also p. 153

TOPOLOGICAL MATTER

A topological superconductor

A promising path toward topological quantum computing involves exotic quasiparticles called the Majorana bound states (MBSs). MBSs have been observed in heterostructures that require careful nanofabrication, but the complexity of such systems makes further progress tricky. Zhang *et al*. identified a topological superconductor in which MBSs may be observed in a simpler way by looking into the cores of vortices induced by an external magnetic field. Using angle-resolved photoemission, the researchers found that the surface of the iron superconductor $FeTe_{0.55}Se_{0.45}$ satisfies the required conditions for topological superconductivity. —JS

Science, this issue p. 182

SINGLE-CELL GENOMICS

Identifying single-cell types in the mouse brain

The recent development of single-cell genomic techniques allows us to profile gene expression at the single-cell level easily, although many of these methods have limited throughput. Rosenberg *et al*. describe a strategy called split-pool ligation-based transcriptome sequencing, or SPLiT-seq, which uses combinatorial barcoding to profile single-cell transcriptomes without requiring the physical isolation of each cell. The authors used their method to profile >100,000 single-cell transcriptomes from mouse brains and spinal cords at 2 and 11 days after birth. Comparisons with in situ hybridization data on RNA expression from Allen Institute atlases linked these transcriptomes with spatial mapping, from which developmental lineages could be identified. —LMZ

Science, this issue p. 176

STRUCTURAL BIOLOGY

A close-up view of oligosaccharyltransferase

Many secretory and membrane proteins are modified through the attachment of sugar chains by N-glycosylation. Such modification is required for correct protein folding, targeting, and functionality. In mammalian cells, N-glycosylation is catalyzed by the oligosaccharyltransferase (OST) complex via its STT3 subunit. OST forms a complex with the ribosome and the Sec61 protein translocation channel. Braunger *et al*. combined cryo–electron microscopy approaches to visualize mammalian ribosome-Sec61-OST complexes in order to build an initial molecular model for mammalian OST. —SMH

Science, this issue p. 215

IMMUNOLOGY

Autoantibody redemption through rapid mutations

Antibodies distinguish foreign epitopes from closely related self-antigens by poorly understood mechanisms. In mice, Burnett *et al*. found that a proportion of B cells could cross-react with similar foreign and self-antigens (see the Perspective by Kara and Nussenzweig). Challenge with self-antigen resulted in anergy (i.e., a lack of immune response), which was reversed by exposure to high-density foreign antigen. Mutations that decreased self-affinity were rapidly selected for, whereas selection for epistatic mutations that enhanced foreign reactivity took longer. Self-reactivity, rather than being an impediment to immunization, resulted in higher affinities against a foreign immunogen. —STS

Science, this issue p. 223; see also p. 152

CLIMATE

Climate effects of aerosol cleanup

Many aerosols emitted by human activities have a cooling effect on the climate and can also change precipitation patterns. In a Perspective, Samset highlights the magnitude of these influences at regional levels. Worldwide, aerosols have reduced the impacts of greenhouse gas emissions on air temperatures. Impacts on precipitation have also been substantial but more variable. Because of the negative impacts of aerosol emissions on health, efforts to reduce them are gathering pace, but this has important implications for future warming and precipitation patterns in many regions of the world. —JFU

Science, this issue p. 148

CANCER

Can wound healing worsen metastasis?

Early metastatic recurrence in breast cancer patients could be caused by tumor cells released into the circulation during primary resection or could be the result of existing metastatic outgrowth. To distinguish between these possibilities, Krall *et al*. used a common wound-healing model in mice harboring breast cancer cells in which the primary tumor bed was not disturbed by surgery. They found that T cells can keep tumor cells in check, but if wound healing is induced, inflammation disrupts this balance. Anti-inflammatory treatment reduced metastasis in the mice. Existing clinical data indicate that perioperative anti-inflammatories reduce early metastatic recurrence in breast cancer patients. By separating surgery from resection, these results may explain this curious clinical occurrence. —LP

Sci. Transl. Med. **10**, eaan3464 (2018).

STRUCTURAL BIOLOGY

Signaling for nitrogen fixation

The nitrogen-fixing bacterium *Bradyrhizobium japonicum* enables high-yield production of soybeans with little use of nitrogen fertilizers, a major source of nutrient pollution. Using structural and modeling techniques, Wright *et al*. generated a model by which a two-component system of this bacterium, comprising the histidine kinase sensor and response regulator, responds to low oxygen to stimulate the expression of genes required for nitrogen fixation. These results may help in the development of plant growth modulators that are unlikely to affect mammalian species, which do not signal through two-component systems. —AV

Sci. Signal. **11**, eaaq0825 (2018).

NANOMATERIALS

Synthesizing graphene nanopores

Nanosize pores in graphene can make its electronic properties more favorable for transistor applications and may also be useful for molecular separations. Moreno *et al.* used Ullmann coupling to polymerize a dibromo-substituted diphenylbianthracene on a gold surface (see the Perspective by Sinitskii). Cyclodehydrogenation of the resulting polymer produced graphene nanoribbons, and cross-coupling of these structures created a nanoporous graphene sheet with pore sizes of about 1 nanometer. Scanning tunneling spectroscopy revealed an electronic structure in which semiconductor bands with an energy gap of 1 electron volt coexist with localized states created by the pores. —PDS

Science, this issue p. 199; see also p. 154