RESEARCH

IN *SCIENCE* JOURNALS

Edited by **Michael Funk**

HERBIVORY

Unequal impacts

Herbivory is a major selection pressure on plants, which have evolved many different physical and chemical adaptations to prevent animals from eating their tissues. However, herbivory pressure can be highly variable, even between plants in the same population. The Herbivory Variability Network consortium used standardized surveys to compare herbivory variability within populations at 790 sites across five continents. They found that the weak increase in mean herbivory at lower latitudes was accompanied by lower variation between individuals. Smaller plant species had higher herbivory variability, which also showed a phylogenetic signal. These findings highlight how variation in species interactions can influence eco-evolutionary outcomes. —BEL

Science, adh8830, this issue p. 679

The impact of herbivores, such as these birch sawfly larvae, varies largely within plant populations.

PHOTO: PAUL HOBSON/MINDEN PICTURES

MACHINE LEARNING

More confidence in machine learning

Over the past decade, there has been rapid progress in the development of large-scale machine learning (ML) systems that provide predictions related to various scientific phenomena. Unfortunately, the standard statistical approaches used to calculate confidence intervals and *P* values from gold standard data lose their statistical validity for ML-derived data. Angelopoulos *et al*. introduced "prediction-powered inference," a standardized protocol for constructing valid confidence intervals and *P* values that enables the power and scale of ML systems to be used as predictors while ensuring responsible and reliable scientific inferences. The method has been demonstrated on a broad range of real datasets and offers a promising statistical approach for using ML to derive scientific conclusions responsibly. —YS

Science, adi6000, this issue p. 669

ATMOSPHERIC SCIENCE

Aerosols' effect on low cloud coverage

Aerosols cool the climate indirectly by increasing low cloud brightness and coverage, partly offsetting anthropogenic greenhouse warming. However, the magnitude of the effect is uncertain, especially with cloud coverage. Yuan *et al.* used global ship tracks and remote sensing data to quantify aerosol-induced changes to marine low cloud properties through contrasting ship-polluted clouds to nearby background clouds, finding a strong observed aerosol effect on low cloud coverage. They conclude that low cloud coverage adjustments to aerosols adds between 52 and 300% additional forcing to that from low cloud brightness adjustments over the ocean. —JCHC

Sci. Adv. (2023) 10.1126/sciadv.adh7716

PHYSICS

Harnessing polyatomic molecules

Cold molecules hold much promise as a platform for investigating fundamental problems in physics such as matter-antimatter asymmetry through precise measurements of the electron's electric dipole moment (eEDM). Researchers have used diatomic molecules for this purpose. Polyatomic molecules have even more favorable properties but are more difficult to control. Anderegg *et al*. demonstrate coherent control of individual quantum states in the polyatomic molecule calcium monohydroxide. Their findings enable the measurement of eEDM in this and related systems, which is expected to lead to improved precision. —JS

Science, adg8155, this issue p. 665

PHOTONICS

Integrated mode-locked laser

Mode-locked lasers are an enabling technology in the ultrafast sciences, providing a platform to generate extremely short pulses of coherent light

and precisely spaced frequency combs of light. These lasers are typically bulky, with components sitting on an optical bench. Guo *et al*. shrunk a mode-locked laser down to the size of an optical chip. Combing a III-V gain medium with a lithium-niobate phase modulator, they demonstrated the operation of a mode-locked laser with good performance metrics. The results show promise for developing photonic chip–based frequency combs for precision measurements and spectroscopy. —ISO

Science, adj5438, this issue p. 708

ANTHROPOLOGY

Range expansion of *Homo erectus*

In 1981, the mandible of an infant hominin was discovered in the highlands of Ethiopia. Since then, its affinities have been debated, limiting our understanding of its importance. Using synchrotron x-ray imaging, Mussi *et al*. identified it as *Homo erectus*. This fossil is dated to 2 million years ago, and it is associated with both Oldowan and Early Archeulean tools, confirming that *H. erectus* used both types. This finding also reveals the use of high-elevation environments in this species, providing insight about the movement of hominins out of Africa. —SNV

Science, add9115, this issue p. 713

PHAGE ECOLOGY

Microcosm at multiscale

Real communities are characterized by complex interaction networks among species. The interaction is described as "nested" if there are specialist species interacting with subsets of species and "modular" if species interact within a group but not between different groups. A mixed pattern is known as a "multiscale" network. Borin *et al*. examined if and how a multiscale interaction network can develop through rapid evolution in a simple community with one type of bacteria and one type of phage. The authors were able to recapitulate the range of host interactions using receptor knock-out experiments. This means that phage-host interactions in a laboratory setting are sufficient to form complex ecological patterns and could be a valuable model system for informing phage therapy. —CA

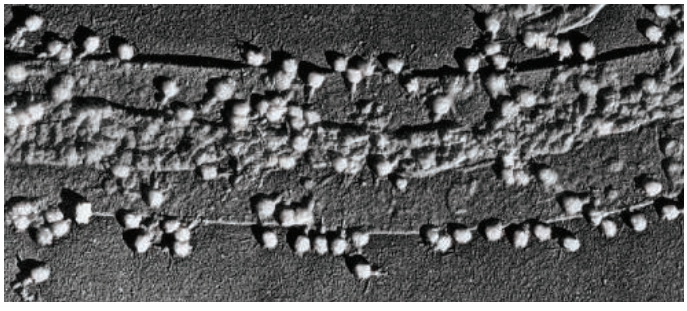
Science, adi5536, this issue p. 674

IMMUNE REGULATION

T cells protect muscle during exercise

Regulatory T cells (T_{regs}) support repair of injured muscle, but whether they participate in the response of healthy muscle to exercise training remains unclear. Using acute and chronic models of exercise in mice, Langston *et al.* found that T_{regs} suppress exercise-induced skeletal muscle inflammation that is counterproductive for performance enhancement. T_{regs} were required for gains in exercise capacity and promoted muscle metabolic reprogramming by protecting mitochondria from interferon-γ–driven damage. These results identify T_{regs} as a key regulatory element that is activated in response to exercise and needed to support performance-enhancing muscle adaptations. —CO

Sci. Immunol. (2023)
10.1126/sciimmunoladi5377



Electron microscopy image showing bacteriophages infecting an *Escherichia coli* cell

IN OTHER JOURNALS

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

STEM EDUCATION

Reimagining graduate handbooks

Graduate STEM education programs contain the same elements: research, coursework, and a candidacy examination. However, recent shifts in higher education research suggest that it is time to reconsider the goals of graduate programs. Donkor and Harshman approached this reframing through the lens of the graduate handbook. Using a backward design paired with document and thematic analysis, graduate handbooks from 60 chemistry departments were investigated for evidence of explicit alignment among the goals, objectives, and activities of the program. The results showed that most handbooks do not explicitly state learning goals, indicating missed opportunities for helping students value programmatic elements, identifying students' weaknesses, and helping faculty align their assessment tools with the learning goals. Including explicit learning goals and outcomes in graduate handbooks could improve student experiences and outcomes. —MMc

J. Chem. Educ. (2023)
10.1021/acs.jchemed.3c00062

VIROLOGY

Getting out of the nucleus

During infection, herpes simplex virus (HSV-1) assembles new viruses inside the host cell nucleus. To reach the nuclear envelope for viral exit, newly formed viral capsids must cross dense peripheral host heterochromatin. Lewis *et al.* observed increases in the levels of the epigenetic markers H3K27me3 and macroH2A1 on host cell chromatin during HSV-1 infection. Loss of these markers correlated with lower viral titers, reduced capsid mobility, and trapping of viral capsids in the nucleus. On infection, broad host genomic regions showed redistribution of macroH2A1 and H3K27me3 and decreased host transcription. Thus, virus-stimulated changes to host cell heterochromatin

PHOTOS: (LEFT TO RIGHT) NASA; OLIVIER MORIN/AFP/GETTY IMAGES

ALSO IN *SCIENCE* JOURNALS

Edited by **Michael Funk**

HYPOTHESIS

How do molecular motors loop DNA?

Structural maintenance of chromosomes complexes (SMCs) are molecular motors that fold DNA into the three-dimensional structures that are important for many genomic processes. However, the mechanism by which these motors act is unclear. In a Perspective, Dekker *et al.* draw on recent experimental findings to present a new model for the extrusion of loops of DNA by SMCs. Their "reel-and-seal" model integrates central features of previous hypotheses but explains how SMCs can pass large obstacles on the DNA. —SAL

Science, adi8308, this issue p. 646

BIOELECTRONICS

Removing limits on powering devices

Bioelectronic devices that can sense or manipulate biological signals, such as pacemakers that can detect and regulate irregular cardiac cycles, can dramatically improve the health and lifestyle of the patients who use them. However, these devices are often limited by the storage capacity of an onboard battery or are tethered to wires that can cause infection. Nair *et al*. reviewed advances in developing alternate methods to generate, transmit, and store electrical charge that enable wireless power transfer and energy harvesting safely through and within the human body. In addition to removing power limitations, these advances often also enable communication from a device or possibly even between devices. —MSL

Science, abn4732, this issue p. 660

CORONAVIRUS

Inspiring inhibitors

The COVID-19 pandemic prompted many groups to rethink how to perform and communicate science. Although their work has been freely available from the beginning, Boby *et al*. now formally report the results of the COVID Moonshot project, a fully open-science drug discovery campaign to identify, synthesize, and test inhibitors against the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) main protease, a key antiviral target (see the Perspective by Shoichet and Craik). Starting with data from a fragment-based screen, candidate inhibitor designs were crowdsourced from volunteer submitters using a variety of design approaches. An experienced team, aided by computational tools, evaluated proposals and designed synthetic routes. Noncovalent, nonpeptidomimetic inhibitors were identified and characterized functionally and structurally. Iterative medicinal chemistry and community input yielded a lead with promising bioavailability, safety, and antiviral activity. —MAF

Science, abo7201, this issue p. 663; see also adk5868, p. 649

METABOLISM

Absorb it with flowers

Intestinal absorption of dietary cholesterol has a major influence on blood cholesterol concentration, which plays an important role in cardiovascular and metabolic health. It was already known that this process starts with the Niemann-Pick C1 Like 1 protein, but now Ferrari *et al*. have identified subsequent steps involved in cholesterol uptake from the intestine. In particular, the authors determined that proteins called Aster-B and Aster-C are required for cholesterol to get from the exterior of intestinal cells to their endoplasmic reticulum, where it undergoes further processing. This pathway is targetable with a small-molecule inhibitor of Aster proteins, suggesting a potential pharmacological approach for lowering the intake of cholesterol. —YN

Science, adf0966, this issue p. 664

MAGNETISM

Vibrational route to large magnetic fields

The manipulation and control of the optoelectronic properties of a material finds application across a range of fields. However, doing so by applying electric or magnetic fields can be slow and not always practical. Luo *et al*. have shown that chiral phonons driven by ultrafast pulses of circularly polarized terahertz radiation can induce magnetic fields on the order of one tesla in the rare earth trihalide cerium fluoride (see the Perspective by Kaindl). Such control of spin-phonon coupling provides a route to on-demand ultrafast, large magnetic fields on an atomic scale that would be useful for both fundamental materials science and the development of energy-efficient spintronic devices. —ISO

Science, adi9601, this issue p. 698; see also adl3521, p. 642

WILDFIRES

Losing a home

Houses built near wildland vegetation are at greater risk of burning than those farther from the wildland-urban interface, a growing problem as housing developments expand and the climate becomes warmer. Radeloff *et al*. examined how the risk to houses within wildfire perimeters has changed in the US since 1990, finding that the number of homes within the wildland-urban interface and climate change are the most important factors controlling how many homes burn (see the Policy Forum by Boomhower). The number of homes destroyed by wildfires has doubled over the past 30 years, and most of them were in grasslands and shrublands, not near forests. —HJS

Science, ade9223, this issue p. 702; see also adk7118, p. 638

PLANT SCIENCE

Monitoring cell wall structure

Plant cells are surrounded by a polysaccharide cell wall that withstands internal cellular pressure but adapts and restructures as the cell expands. In growing pollen tubes, the proteins RALF4 and LRX8 are required to monitor integrity of the cell wall. Moussu *et al*. demonstrated that these proteins form a complex with pectic polysaccharides, the gel-like component of the cell wall (see the Perspective by Mohnen). In addition to the roles of RALF4 and LRX8 in signaling to the intracellular environment, the protein-polysaccharide complex performs a structural role in patterning the cell wall. This work contributes to our understanding of how signaling proteins can react to changes in the physical state of the extracellular structure. —MRS

Science, adi4720, this issue p. 719; see also adl1198, p. 648

MOLECULAR BIOLOGY

Male chromosomes' secret protector

Ultracompaction of sperm DNA in many species is often associated with genome-wide replacement of histones with protamines, but the actual role of this radical change in chromatin organization remains largely enigmatic. Looking at a multidecade-old *Drosophila* mutant, Dubruille *et al*. found that histones were massively retained in sperm without affecting its ability to fertilize (see the Perspective by Levine). However, at fertilization, male chromosomes were aberrantly recognized by maternal factors that control female meiotic progression, leading to a deleterious premature division and early loss of male chromosomes. This work highlights the role of sperm chromatin in protecting male chromosomes in the egg. —DJ

Science, adh0037, this issue p. 725; see also adl0365, p. 643

RADIATIVE COOLING

Cooling the hard way

Passive radiative cooling materials emit heat through the atmospheric window and into outer space, providing an attractive way to reduce temperatures in buildings. Zhao *et al*. created a passive cooling glass and Lin *et al*. developed a passive cooling ceramic, both of which are mechanically strong and relatively easy to scale (see the Perspective by Zhao and Tang). Unlike strategies that rely on polymers, these hard materials should be more robust to long-term weathering, which may make them far more useful for outdoor applications. —BG

Science, adi4725, adi2224, this issue p. 691, 684; see also adk9614, p. 644

BRAIN DEVELOPMENT

A window into cerebellum maturation

The human cerebellum undergoes a long maturation during early childhood and is especially susceptible to perturbations that contribute to the risk of developing neurodevelopmental disorders such as autism spectrum disorder. Ament *et al*. performed single-cell genomics on postmortem cerebellar samples from 1- to 5-year-old children who died from sudden accidental death or who experienced inflammation at the time of death. Gene expression changes were identified in Purkinje and Golgi inhibitory neurons in the samples from children with inflammation, including premature downregulation of the developmental genes required for cerebellar maturation. —OMS

Sci. Transl. Med. (2023) 10.1126/scitranslmed.ade1283

IMMUNOLOGY

Selectively GAGging chemokines

Chemokines induce the migration of immune cells by stimulating cognate chemokine receptors on the cell surface. Ridley *et al*. demonstrated how specificity is achieved in a system in which different chemokines can recruit the same immune cell types. The genes encoding the three ligands for the chemokine receptor CXCR3 were all expressed in the same context. Specificity was provided by the differential interactions of these chemokines with glycosaminoglycans, which regulated their localization and availability for signaling. —JFF

Sci. Signal. (2023) 10.1126/scisignal.adf2357

In Science Journals

Michael Funk, Bianca Lopez, Yury Suleymanov, John C. H. Chiang, Jelena Stajic, Ian S. Osborne, Sacha Vignieri, Caroline Ash, Claire Olingy, Sarah A. Lempriere, Marc S. Lavine, Michael A. Funk, Yevgeniya Nusinovich, H. Jesse Smith, Madeleine Seale, Di Jiang, Brent Grocholski, Orla Smith, and John F. Foley

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