

RESEARCH

IN SCIENCE JOURNALS

Edited by Michael Funk



PLANT SCIENCE

Potato pathogen resistance

The oomycete *Phytophthora infestans* devastates potato crops, most famously during the Great Irish Famine of the mid-1800s. Torres Ascurra *et al.* examined wild potato variants from across the Americas and identified a pattern recognition receptor called PERU, which recognizes a *P. infestans* peptide. When PERU binds a protein fragment from *P. infestans*, the potato

plant can mount an immune response. The authors established that different alleles of PERU from wild Andean potato relatives have different sensitivities to the *P. infestans* peptide. Their work provides mechanistic insight into *P. infestans* immunity, thus paving the way for improved crop resilience to a disease that has been challenging to control. —MRS *Science*, adg5261, this issue p. 891

Wild ancestors of potatoes are able to sense and resist oomycete pathogens that cause late blight, pictured here on a domesticated potato leaf.

CATALYSIS

Cooling down methane pyrolysis

Very high temperatures are needed to convert methane to hydrogen and solid carbon. A known liquid metal nickel–bis-muth catalyst for this pyrolysis reaction resists deactivation but requires reaction temperatures above 1000°C. Chen *et al.* added molybdenum to improve nickel reactivity, which could enable lower operating temperatures. Molybdenum appears to decrease the negative charge on nickel atoms in the molten state and to increase atom mobility and interaction with methane,

which enables efficient long-term pyrolysis at 800°C. —PDS *Science*, adh8872, this issue p. 857

ORGANIC CHEMISTRY

Displacing olefins with nitrogen

Reactions that form carbon–nitrogen bonds most often target carbon centers that are either single bonded to a halogen or double bonded to oxygen or another carbon. He *et al.* present an alternative sequence that targets a carbon–carbon single bond adjacent to an olefin. Treatment of the allylic carbon compound with ozone followed

by copper catalysis formally displaces the pendant olefin with an amine. The reaction can introduce nitrogen into a wide variety of complex terpenes, among other compounds. —JSY *Science*, adi4758, this issue p. 877

CHEMICAL TECHNOLOGY

Indirect oxidative propylene synthesis

The conversion of propane to propylene by oxidation is less energy intensive than direct dehydrogenation but must be controlled to avoid overoxidation, which limits selectivity and conversion. Wang *et al.*

show that a chemical looping process in which the feed gas switched between propane and oxygen achieved 81.3% propylene selectivity at 42.7% propane conversion at 550°C. Well-dispersed vanadium dioxide on alumina performed the dehydrogenation reaction, and adjacent iron vanadate particles acted as the oxygen carrier. Propylene selectivity increased with nanoscale proximity of the catalyst sites so that the hydrogen generated at the vanadium dioxide could migrate readily to the adjacent iron vanadate side for combustion. —PDS *Science*, adi3416, this issue p. 886

METABOLISM

Long noncoding RNA for slim mice

The gut microbiota of mice influences their host's metabolism by mechanisms mediated by small intestinal epithelial cells. During whole-transcriptome sequencing of epithelial cells, Wang *et al.* found several genes that encode long noncoding RNAs (lncRNAs). One of these genes, called *Shhg9*, varied in abundance in animals depending on the presence or absence of gut microbiota mediated by immune effectors. The authors found that the lncRNA interacted with and bound to cell cycle and apoptosis protein 2, which in turn bound to and inhibited sirtuin, a regulator of lipid metabolism. High levels of *Shhg9* seen in germ-free mice may be the reason that they stay slim, whereas animals with intact microbiota have lower levels of the lncRNA and are fatter. —CA

Science, ade0522, this issue p.851

HEART DISEASE

Aging gets on the heart's nerves

Changes in innervation of the heart can contribute to arrhythmias, and the risk of arrhythmias greatly increases with age. Wagner *et al.* uncovered a mechanism connecting these two phenomena. The authors studied young and aging mice and demonstrated that innervation of the heart decreases with age. Age-related accumulation of senescent cells promotes the release of semaphorin-3A, which reduces the density of neuronal axons in the heart. At the same time, aging is associated with a decrease in a microRNA that counteracts the effects of semaphorin-3A, further tipping the balance toward decreased innervation. These age-related losses in innervation could be reversed by treating the mice with senolytic drugs,

suggesting a potential therapeutic approach. —YN

Science, ade4961, this issue p. 897

MATERIALS SCIENCE

Curved structures from flat sheets

Transforming a flat sheet into a curved object or vice versa usually leads to distortions such as wrinkles or cuts unless the Gaussian curvature is conserved, such as when turning a piece of paper into a cylinder or a cone. Drawing inspiration from bulliform cells in plants, which are believed to control the curvature in leaves to regulate water loss, Gao *et al.* designed thin panels with inflatable pneumatic cells that allow for pure in-plane contraction or bending or combinations of the two. Thus, the authors were able to transform a flat surface into a shape with a different Gaussian curvature, with implications for the design of soft robotics. —MSL

Science, adi2997 this issue p. 862

CANCER

Improving immune checkpoint inhibitors

Although immune checkpoint inhibitors have been beneficial for many patients, 40% fail to respond. Bennion *et al.* evaluated Fc γ receptor IIB (Fc γ RIIB), an inhibitory receptor that has recently been found on activated CD8⁺ T cells. They demonstrated that the Fc portion of the ligand antiprogrammed death 1 could bind to Fc γ RIIB on activated CD8⁺ T cells in mice and reduce the efficacy of immunotherapy, which was abrogated by adding an antibody against Fc γ RIIB to the treatment. These results elucidate an unappreciated mechanism of Fc γ RIIB-mediated, cell-autonomous suppression, suggesting that altering the Fc portion of these antibodies could better improve efficacy across patients. —DLH

Sci. Transl. Med. (2023) 10.1126/scitranslmed.add1868

IN OTHER JOURNALS

Edited by Caroline Ash and Jesse Smith

Ants transition between behavioral roles as they age, correlating with changes in gut microbiota and brain gene expression.

PLANT PATHOLOGY
Synthetic resistance promoters

Plant pathogens cause yield reduction of crops worldwide. Different pathogens elicit immune responses through divergent plant signaling pathways, for example, by either activating salicylic acid (SA) or jasmonic acid (JA) biosynthesis. To enhance immunity to a broad range of pathogens, Li *et al.* designed synthetic promoter sequences that respond to both SA and JA. Chimeric promoters integrating both SA- and JA-responsive elements were activated by diverse plant pathogens. The promoters were used to drive the expression of an antimicrobial peptide conferring plants with enhanced resistance. This approach allows the induction of immune responses in response to otherwise antagonistic signaling pathways. —MRS

Plant Commun. (2023) 10.1016/j.xplc.2023.100596

PALEOECOLOGY
Foliage feeding inferred from fossils

Plants are hosts for hundreds of thousands of herbivorous arthropods. This diversity is thought to be maintained by the diversity of plants, with many herbivores specializing on certain



Damage preserved in leaf fossils provides evolutionary evidence for functional diversity among herbivorous arthropods.

PHOTOS: (TOP TO BOTTOM) IRINA KOZDROG/ALAMY STOCK PHOTO; MARK A. SCHNEIDER/RESEARCH

ALSO IN *SCIENCE* JOURNALS

Edited by Michael Funk

CANCER GENETICS

Not just random chromosome changes

Aneuploidies, which are changes in the numbers of whole chromosomes or chromosome arms, are common in cancer, but their contributions to cancer cell survival have been difficult to pinpoint. Girish *et al.* developed a chromosome-engineering tool to orchestrate the targeted loss of aneuploid chromosome arms and thereby compare isogenic cancer cell lines with and without selected trisomies. The authors discovered that trisomy of chromosome 1q in particular is advantageous to cancer cells and phenocopies the loss of tumor suppressor *TP53* signaling. Tumors with this aneuploidy are sensitive to compounds activated by an enzyme encoded on chromosome 1q, suggesting a potential therapeutic approach. —YN

Science, adg4521, this issue p. 848

CELL BIOLOGY

How midnolin catches its substrates

Eukaryotic cells contain a macromolecular protease called the proteasome that degrades proteins modified by ubiquitin. The proteasome can also degrade proteins that are not ubiquitinated, but how this occurs mechanistically has remained mysterious. Gu *et al.* identified midnolin, an inducible protein that localizes within the nucleus to promote the proteasomal degradation of numerous transcriptional regulators independently of ubiquitination (see the Perspective by Schilling and Weber-Ban). Midnolin stably associates with the proteasome and uses a structural domain that incorporates a free β strand to “catch” substrates for destruction. Thus, the midnolin-proteasome pathway bypasses the canonical ubiquitination system to achieve selective

degradation of many nuclear proteins. —SMH

Science, adh5021, this issue p. 849;
see also adj8230, p. 834

STRUCTURAL BIOLOGY

Chromatin assembly by CAF-1

Chromosomal duplication involves the replication of DNA and the assembly of chromatin onto the replicated DNA. Chromatin assembly factor-1 (CAF-1) is a heterotrimeric protein complex responsible for the deposition of newly synthesized histones H3 and H4 onto DNA in replication-coupled nucleosome assembly. Liu *et al.* revealed that in the presence of histones H3 and H4, the two otherwise flexibly tethered globular domains of CAF-1 attach to opposite ends of an elongated H3-H4 heterodimer, and a flexible loop of the p150 subunit becomes ordered to secure H3-H4 binding. Formation of an H3-H4 tetramer is a prerequisite for nucleosome assembly, and DNA induces the juxtaposition of two CAF-1-H3-H4 complexes poised for H3-H4 tetramer formation. CAF-1 promotes right-handed DNA wrapping of H3-H4 tetramers in vitro, in contrast to the left-handed DNA wrapping in the nucleosome. —DJ

Science, add8673, this issue p. 850

SENSATION

Intimate touch

It is well known that the genitals are unusually sensitive, and that genital touch is crucial for mating and associated pleasure, but the underlying basis is not completely understood. By studying mice and humans with a rare inherited mechanosensory syndrome, Lam *et al.* identified a mechanism involving the mechanoreceptor PIEZO2 that is responsible for determining genital sensitivity (see the Perspective by George and Abaira). Their results highlight

the importance of touch for driving physiological responses needed for sexual function. The identification of PIEZO2 and a specific type of touch neuron as key mediators might help in the development of therapeutic approaches for both hypo- and hypersensitivity that interfere with the enjoyment of sex. —MMA

Science, adg0144, this issue p. 906;
see also adj8674, p. 832

CARBON OFFSETS

A good idea in principle

Reducing emissions from deforestation and forest degradation (REDD) projects are intended to decrease carbon emissions from forests to offset other carbon emissions and are often claimed as credits to be used in calculating carbon emission budgets. West *et al.* compared the actual effects of these projects with measurable baseline values and found that most of them have not reduced deforestation significantly, and those that did had benefits substantially lower than claimed (see the Perspective by Jones and Lewis). Thus, most REDD projects are less beneficial than is often claimed. —HJS

Science, ade3535, this issue p. 873;
see also adj6951, p. 830

SOLAR PHYSICS

Numerous small-scale jets on the Sun

Plasma is constantly streaming away from the Sun, forming the solar wind. A likely source of this plasma is coronal holes, regions of the Sun's corona with magnetic field lines that open outward. Chitta *et al.* observed a coronal hole in the extreme ultraviolet using the Solar Orbiter spacecraft and identified several types of small-scale jets within it (see the Perspective by Ugarte-Urra and Wang). Large numbers of jets occurred during the observation, but each one lasted only a few dozen seconds.

The authors calculated that the jets provide enough energy and plasma to supply a large fraction of the solar wind, at least during quiet periods. —KTS

Science, ade5801, this issue p. 867;
see also adj8002, p. 833

THYMUS

Aire not so apparent

The T cell repertoire is formed from a series of intricate steps during which autoreactive thymocytes are eliminated. Glucocorticoids, produced locally, can promote thymocyte survival, counteracting the negative selection facilitated by the expression of tissue-restricted antigens in thymic medullary epithelial cells that is induced by the gene *autoimmune regulator* (*Aire*). Using genetically engineered mice, Taves *et al.* found that medullary, but not cortical, epithelial cells showed enriched expression of genes encoding enzymes required for all steps of glucocorticoid biosynthesis, including *Cyp11b1*, and that their expression and the abundance of glucocorticoids in the thymus were dependent on *Aire*. Although the importance of *Aire* in limiting autoimmunity by regulating negative selection is established, *Aire*-dependent expression of enzymes involved in lipid and steroid biosynthesis may modulate the process to refine T cell diversity. —SHR

Sci. Immunol. (2023)
10.1126/sciimmunol.abo7975

ION CHANNELS

A multitude of ways to activate TPCs

The second messenger nicotinic acid adenine dinucleotide phosphate (NAADP) indirectly stimulates the opening of two-pore channels (TPCs) on endosomes and lysosomes, thus triggering the release of calcium ions from these acidic organelles. Gunaratne *et al.* found that the NAADP-binding

proteins JPT2 and LSM12 were both required in a nonredundant fashion for NAADP-evoked calcium release. In a related paper, Saito *et al.* found that a synthetic compound mimicked the effect of NAADP on TPC2-mediated calcium release in a manner distinct from that of NAADP-binding proteins, suggesting strategies for restoring TPC2-dependent calcium release in pathological contexts. —AMV

Sci. Signal. (2023)
10.1126/scisignal.adg0485,
10.1126/scisignal.adg0661

LIQUIDS REDEFINED

Liquids reveal solid-like properties

Recent advances in theoretical and experimental research have led to a reevaluation of our understanding of liquids, revealing that they have properties akin to solids. Trachenko points out that the conventional Maxwell model that describes liquids as purely viscous is not universal. The interaction between the liquid and the substrate is key, and under total wetting conditions, liquids demonstrate a solid-like response, including shear elasticity, which challenges the very definition of what a liquid should be. This shear elasticity allows for the propagation of thermal waves, revealing a thermoelastic behavior similar to that of solids. These insights point to new applications for controlled fluid transport in the health sciences. —LSB

Sci. Adv. (2023)
10.1126/sciadv.adh9024

SOCIAL SCIENCES

Policy can both cause and reduce poverty

Researchers studying poverty in the United States often focus on individualized risks, such as a lack of college education, or other potential causes

of poverty, including cultural accounts. In a review of poverty research and a comparison of the US with other nations, Brady shows that the US has historically higher poverty than comparable nations, and this cannot be accounted for by a greater prevalence of expected risks or causes. Instead, policy decisions to penalize statuses thought of as risks (e.g., single motherhood), and to penalize them more severely than other nations, better explain the comparatively higher US poverty rate. However, policy change can reduce poverty, just as policy has generated it. —JSE

Sci. Adv. (2023)
10.1126/sciadv.adg1469



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