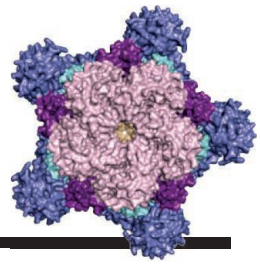
RESEARCH

A complex in plants that triggers immune response

Wang et al., *p. 43, p. 44*



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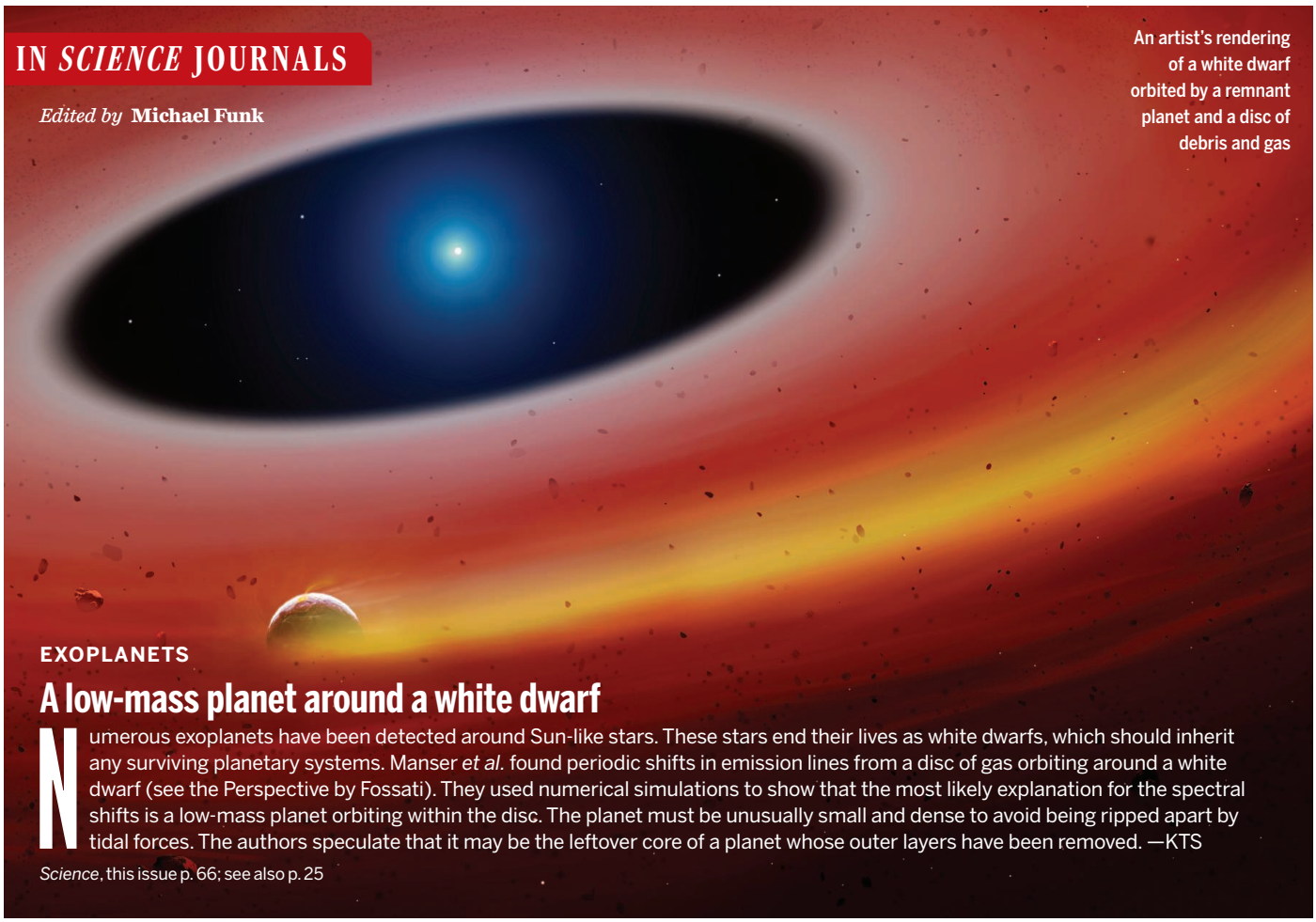
Edited by **Michael Funk**



An artist's rendering of a white dwarf orbited by a remnant planet and a disc of debris and gas

EXOPLANETS

A low-mass planet around a white dwarf

Numerous exoplanets have been detected around Sun-like stars. These stars end their lives as white dwarfs, which should inherit any surviving planetary systems. Manser *et al.* found periodic shifts in emission lines from a disc of gas orbiting around a white dwarf (see the Perspective by Fossati). They used numerical simulations to show that the most likely explanation for the spectral shifts is a low-mass planet orbiting within the disc. The planet must be unusually small and dense to avoid being ripped apart by tidal forces. The authors speculate that it may be the leftover core of a planet whose outer layers have been removed. —KTS

Science, this issue p. 66; see also p. 25

PLANT SCIENCE

Following meiosis in maize

Plants do not set aside a germ-cell lineage from early development as animals do, but instead generate germ cells on demand. Nelms and Walbot, working in maize, took advantage of a size differential between somatic and developing germ cells in the anthers at the top of the maize plant to isolate individual germ cells during the meiotic progression to pollen development. They used single-cell RNA sequencing to study changes in the transcriptome through meiosis. These studies revealed increasing specialization as meiosis progressed, with a reorganization of the transcriptome in a transition during the leptotene stage of meiosis. —PJH

Science, this issue p. 52

QUANTUM OPTICS

An exercise in spin control

Semiconductor quantum dots offer the highest rate and quality of single photons among all other solid-state quantum light sources. However, they lack access to a long-lived quantum memory, such as a proximal nuclear spin, that would make them competitive for large-scale quantum architectures. Gangloff *et al*. used the spin of a single electron and light to cool an ensemble of about 30,000 nuclei within semiconductor quantum dots (see the Perspective by Bayer). They then extended this approach to manipulate individual nuclear spins. The ability to manipulate the ensemble of nuclei coherently, down to the single nuclear spin, could lead to the realization of a quantum dot network where each node has its own dedicated quantum memory. —ISO

Science, this issue p. 62; see also p. 30

PSYCHIATRY

Where does trauma hide in the brain?

Posttraumatic stress disorder (PTSD) is a severe psychiatric illness that is best treated with psychotherapy. However, not all PTSD patients respond to psychotherapy. Etkin *et al*. found that nonresponsive patients had impairment in connectivity in the brain's ventral attention network accompanied by a deficit on a word list learning task. Neuroimaging during noninvasive brain stimulation identified a brain location where network connectivity correlated with

PHOTO: UNIVERSITY OF WARWICK/MARK GARLICK; GRAPHIC: WANG *ET AL.*

Published by AAAS

the effects of stimulation. This work suggests a target for future noninvasive brain stimulation approaches for treating patients with PTSD who do not respond to psychotherapy. —OMS

Sci. Transl. Med. **11**, eaal3236 (2019).

ACTIVE MATTER

Seeing whom you interact with

Schools of fish and flocks of birds are familiar examples of biological active matter. The motion of individuals is guided by the collective, but without obvious neighbor-to-neighbor interactions. This behavior can be designed into synthetic particles with the right shape or surface properties. Lavergne *et al*. made Janus particles that become active upon light irradiation, but only when they can "see" their neighbors. This property led to the formation of groups of particles that flock together in particular ways without specific pairwise or flow-generated interactions. —MSL

Science, this issue p. 70

ECOLOGICAL NETWORKS

Invasive birds spread native seeds

When humans introduce exotic species to sensitive ecosystems, invasion and extinction of native species often follow. The resulting ecological communities can develop unusual interactions between the survivors and newcomers. Vizentin-Bugoni *et al*. analyzed the structure of seed dispersal networks in Hawai'i, where native bird species have been mostly replaced by invaders. They found that the native plants now depend on the invasive birds for seed dispersal. The network of dispersal interactions is complex and stable, which are features of native seed-dispersal networks in other parts of the world. It appears that introduced species may, in some circumstances, become integrated into native ecosystems. —AMS

Science, this issue p. 78

Red-whiskered bulbul, *Pycnonotus jocosus*, a non-native species found on Oahu, Hawai'i

PHENOTYPIC EVOLUTION

All roads lead to regulation

Species from widely divergent taxa can experience similar changes in traits. What underlying genetic drivers cause these parallel changes remains an open question. Sackton *et al*. looked across groups of birds that have repeatedly lost flight, the ratites and tinamous, and found that there is convergence in the regulatory regions associated with genes related to flight, but not within the protein coding regions. Changes within these regulatory regions influenced limb development and may represent quick paths toward convergent change across taxa. —SNV

Science, this issue p. 74

PAIN

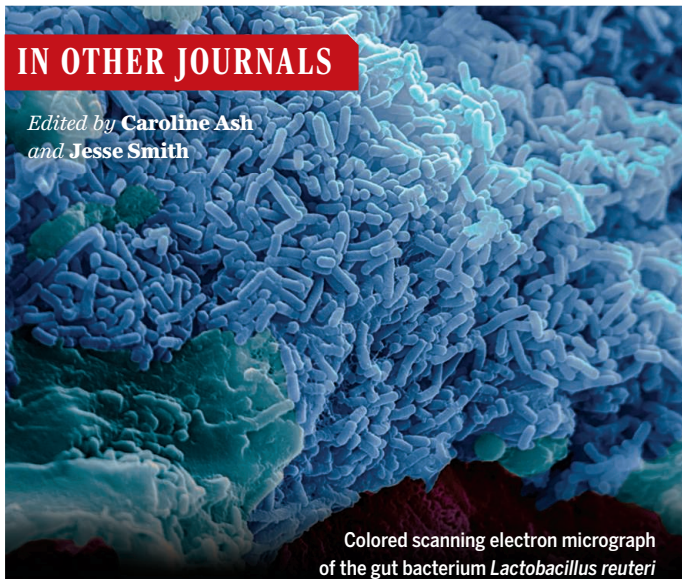
Better opiate analgesia with TRPV1

Patients often become desensitized to opiates and then require greater doses, which increases the risk of addiction. Inflammation, which is common with painful injuries, enhances the analgesic efficacy of opioids. Basso *et al*. found that inflammation-induced activation of the ion channel TRPV1 promoted opioid sensitivity and analgesia in mice by preventing the desensitization of μ-opioid receptors. This cross-talk between pathways may explain the analgesic effect of inflammation in patients taking opioids and might be useful for avoiding opiate dose escalation. —LKF

Sci. Signal. **12**, eaav0711 (2019).

IN OTHER JOURNALS

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



Colored scanning electron micrograph of the gut bacterium *Lactobacillus reuteri*

NEUROSCIENCE

Socialization by bacteria

The gut microbiome influences behavior through interactions with the brain. *Lactobacillus reuteri*—a bacterium that naturally inhabits the guts of mammals and birds—has previously been shown to restore social behavior in mice, but the mechanism behind this effect remains unknown. Sgritta et al. used a variety of autism spectrum disorder (ASD) mouse models (genetic, idiopathic, and environmental) to see whether and how *L. reuteri* can restore the deficient social behavior in these mice. To do so, the ASD mice were given either L. reuteri or a control vehicle and were tested on an array of social tasks (on which ASD mice consistently showed poorer performance). Not only did *L. reuteri* significantly improve the social behavior of the mice, but this happened via the vagus nerve and was found to be dependent on oxytocinergic and dopaminergic signaling. —EACP

Neuron 101, 246 (2019).

ACCELERATOR PHYSICS

An on-chip electron lens

Electron or particle accelerators are usually imagined only as large national or multinational facilities. However, efforts are under way to shrink the size of particle accelerators to table-top- or even chip-scale using powerful laser pulses. Confining and focusing an electron beam on the micrometer scale of a chip is a challenge. Black *et al*. developed a laser driven, tunable electron lens using a patterned microstructured array of silicon pillars. Laser illumination of the dielectric structures generate huge fields that confine and focus the electron beams between the pillars, effectively creating an electron lens with a focal length on the scale of around 50 micrometers. The ability to tune the energy of the electrons and focal length of the lens should prove useful in the further development of miniaturized electron accelerators. —ISO

Phys. Rev. Lett. **122**, 104801 (2019).

IMMUNOLOGY

Home away from dome

The germinal centers (GCs) of intestinal Peyer's patches form in

CREDITS (FROM LEFT): JEF VIZENTIN-BUGONI; STEPHANIE SCHULLER/ALISTAIR WALSHAM/SCIENCE SOURCE

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ALSO IN *SCIENCE* JOURNALS

Edited by **Michael Funk**

ANTIBIOTICS

Incentivizing restraint in drug use

The accelerating tide of antimicrobial resistance (AMR) is a major worldwide policy concern. Like climate change, the incentives for individual decision-makers do not take into account the costs to society at large. AMR represents an impending "tragedy of the commons," and there is an immediate need for collective action to prevent future harm. Roope *et al*. review the issues associated with AMR from an economics perspective and draw parallels with climate change. A major stumbling block for both challenges is to build consensus about the best way forward when faced with many uncertainties and inequities. —CA

Science, this issue p. 41

IMMUNOLOGY

Degradation triggers the alarm

Inflammasomes are multiprotein complexes that orchestrate proinflammatory cytokine secretion and cell death. Proteases such as anthrax lethal factor can activate an inflammasome known as NLRP1B, but the mechanism for this activation has been unclear. Chui *et al*. used genome-wide knockout screens to show that proteolysis of NLRP1B by lethal factor induces proteasomal degradation of the amino-terminal domains of NLRP1B and eventual cell death. Sandstrom *et al*. found that degradation of the amino-terminal domains of NLRP1B resulted in the release of a carboxyl-terminal fragment that activates caspase-1. This process, called "functional degradation," allows the immune system to detect pathogen-associated activities, much as it recognizes pathogen-associated antigens. —STS

Science, this issue p. 82, p. 42

PLANT SCIENCE

The plant resistosome comes into focus

Nucleotide-binding, leucine-rich repeat receptors (NLRs) initiate immune responses when they sense a pathogen-associated effector. In animals, oligomerization of NLRs upon binding their effectors is key to downstream activity, but plant systems differ in many ways and their activation mechanisms have been less clear. In two papers, Wang *et al*. studied the composition and structure of an NLR called ZAR1 in the small mustard plant *Arabidopsis* (see the Perspective by Dangl and Jones). They determined cryo–electron microscopy structures that illustrate differences between inactive and intermediate states. The active, intermediate state of ZAR1 forms a wheel-like pentamer, called the resistosome. In this activated complex, a set of helices come together to form a funnel-shaped structure required for immune responsiveness and association with the plasma membrane. —PJH

Science, this issue p. 43, p. 44; see also p. 31

ORGANIC CHEMISTRY

Amines emerge, as copper bides its time

Concurrent operation of two or more catalytic cycles requires a delicate balance of relative rates. Zhang *et al*. developed an amine synthesis in which allenes and nitriles are coupled under reductive conditions. A copper catalyst was charged with successively borylating the allene, coupling the intermediate to the nitrile, and then enantioselectively reducing that next intermediate to the amine. However, formation and reaction of the copper-boryl complex were too slow relative to a competing copper hydride. By adding an innovative delay cycle, the authors succeeded in keeping the fast-reacting hydride at bay until needed. —JSY

Science, this issue p. 45

PLANT SCIENCE

GTPase clustering in response to a hormone

Some lipid variants that are rare in plasma membranes function as signaling components. Studying root tip cells of the model plant *Arabidopsis*, Platre *et al*. found that phosphatidylserine, which is relatively abundant in plasma membranes, also modulates signaling pathways. Phosphatidylserine is required for the clustering of ROP6, a small guanosine triphosphatase (GTPase), in membranes in response to signals from the plant hormone auxin. Changes in phosphatidylserine concentration altered the clustering of ROP6 and thus the auxin signaling response. —PJH

Science, this issue p. 57

KIN RECOGNITION

Peptides let nematodes know family

To maximize fitness, organisms need to be able to recognize their own species, especially in the proximity of closely related individuals. Lightfoot *et al*. identified a hypervariable small peptide in the predatory nematode *Pristionchus pacificus* that is involved in species recognition to prevent predation of kin. They induced modifications in the carboxyl terminus of the peptide with a CRISPR-Cas9 system, which showed that this region is necessary for self-recognition. This molecular recognition system appears to prevent cannibalism and thus enables the worm to focus on appropriate prey species. —LMZ

Science, this issue p. 86

HUMAN GENOMICS

Spatiotemporal gene expression in ALS

Amyotrophic lateral sclerosis (ALS) is a progressive motor neuron disease that affects nerve cells in the brain and the spinal cord. It has proven difficult to identify the early stages of disease and where it spreads within the body. Maniatis *et al*. used RNA sequencing to define transcriptomic changes over the course of disease in different regions of the spinal cord of a mouse ALS model and a postmortem human ALS spinal cord. From changes in gene expression, they identified disease-associated pathways and established the key steps in motor neuron degeneration observed in ALS. —LMZ

Science, this issue p. 89

ARTIFICIAL INTELLIGENCE

What good is a black box?

Many scientists are uncomfortable using so-called black box algorithms, which provide answers without revealing how they have arrived at these answers. In a Perspective, Holm argues that there are some situations where black box algorithms are a valuable tool, even if they are not transparent. These include low-risk, high-reward situations, when the cost of a wrong answer is trivial relative to the value of a right answer or when the black box objectively outperforms all other means of data analysis, even the judgment of a trained human. Black box algorithms can also reveal new connections within datasets that are not intuitive from first principles. Although they must be used with care, black boxes have a clear role in advancing science and engineering. —JFU

Science, this issue p. 26

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LYMPHOCYTE HOMING

Splenic portal for lymphocyte entry

Lymphocytes are immune cells that travel through the body, alternating between periods of residence in lymphoid organs and periods of circulation in blood and lymphatic vessels. Tadayon *et al*. investigated where circulating lymphocytes first exit the vasculature of the mouse spleen to gain access to the lymphocyte-rich splenic white pulp. Minutes after adoptive transfer of labeled lymphocytes, the majority were found in the red pulp zone of the spleen. The Clever-1 adhesion and scavenger receptor on endothelial cells was an important facilitator of initial entry of B cells and $CD8^+$ T cells into the red pulp. Distinct molecular mechanisms apparently govern how lymphocytes traffic into the spleen compared with the lymph nodes. —IRW

Sci. Immunol. **4**, eaat0297 (2019).

COGNITIVE NEUROSCIENCE

Chimera states in neural networks

Chimera states occur when complex systems produce coexisting patterns of synchrony and desynchrony. The neurons that make up the human brain form just such an intricate system. Bansal *et al*. assembled digitized and personalized brain network models based on diffusion spectrum imaging of 30 healthy individuals, which could then be probed by in silico stimulation. More central and more connected regions produced greater synchrony when stimulated in the model, but chimera states were the most prevalent state overall. This pattern is likely due to the need for both segregated and integrated processing in many brain activities. These models captured fundamental patterns related to brain architecture but reveal individual variability, especially with regard to higher cognitive functions. —KSL and KJP

Sci. Adv. 10.1126/sciadv.aau8535 (2019).

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