

RESEARCH

An epigenetic switch controls caste behavior in carpenter ants

Simola et al., p. 42



IN SCIENCE JOURNALS

Edited by Stella Hurtley



Polymer-derived ceramic lattices exhibit high thermal shock resistance and low thermal conductivity

THREE-DIMENSIONAL PRINTING

Printing ceramics into complex shapes

Some materials, such as thermoplastics and metals, are naturally suited to being 3D printed because the individual particles can be fused together by applying heat. In contrast, ceramics do not fuse together the same way. Eckel *et al.* developed a way to pattern specific preceramic monomers using either 3D printing or stereolithography into complex, curved, and porous shapes. Upon heating, they observed almost no shrinkage, and the formed parts showed exceptional thermal stability. — MSL

Science, this issue p. 58

VIROLOGY

Coronaviruses in the Middle East

Middle East respiratory syndrome coronavirus (MERS-CoV) causes severe acute respiratory illness and kills about a third of people infected. The virus is common in dromedary camels, which can be a source of human infections. In a survey for MERS-CoV in over 1300 Saudi Arabian

camels, Sabir *et al.* found that dromedaries share three coronavirus species with humans. Diverse MERS lineages in camels have caused human infections, which suggests that transfer among host species occurs quite easily. Haagmans *et al.* made a MERS-CoV vaccine for use in camels, using poxvirus as a vehicle. The vaccine significantly reduced virus excretion, which should help reduce the potential

for transmission to humans, and conferred cross-immunity to camelpox infections. — CA

Science, this issue p. 81, p. 77

GENOME EDITING

Making the correct cut

The CRISPR/Cas system is a prokaryotic immune system that targets and cuts out foreign DNA in bacteria. It has

been adopted for gene editing because it can be designed to recognize and cut specific locations in the genome. A challenge in developing clinical applications is the potential for off-target effects that could result in DNA cleavage at the wrong locations. Slaymaker *et al.* used structure-guided engineering to improve the specificity of *Streptococcus pyogenes* Cas9 (SpCas9). They identified enhanced-specificity variants (eSpCas9) that display reduced off-target cleavage while maintaining robust on-target activity — VV

Science, this issue p. 84

PROTEIN TRANSLOCATION

Seeing the signal sequence in action

Protein translocation across the endoplasmic reticulum (ER) involves the interaction of a signal sequence with the protein translocation channel. Although much work has looked at the details of protein translocation, questions remain. Voorhees and Hegde present a single-particle cryoelectron microscopy study of the mammalian ER translocation apparatus at the point in which the signal sequence is engaging the translocation pore. — SMH

Science, this issue p. 88

ORGANIC CHEMISTRY

A two-for-one twist on Suzuki coupling

The Suzuki-Miyaura coupling reaction is one of the most widely used ways of making carbon-carbon bonds. Essentially,

a palladium catalyst activates one carbon fragment and then links it to a second fragment pulled from boron. Zhang *et al.* now demonstrate a twist on the conventional pathway (see the Perspective by Fyfe and Watson). In their system, the palladium initially coaxes together two carbon fragments on one boron center. Then the catalyst stitches a second C-C bond to a third, external fragment. A chiral ligand renders the reaction highly enantioselective. — JSY

Science, this issue p. 70;
see also p. 26

PHOTOVOLTAICS

Efficient luminescent solar cells

Shine on! Bi *et al.* fabricated a perovskite-based solar cell that can create extraordinarily high solar-to-electric power conversion and intense electroluminescence. The new-fangled cells should help to produce solar technologies that approach the upper limit for open-circuit voltage. These devices are likely to be competitive with “state-of-the-art” conventional solar technologies and may be used in tandem with more traditional solar cells. — ZHK

Sci. Adv. 10.1126/sciadv.011170 (2016).

CARDIOLOGY

Disruptive technology

Healthy hearts beat synchronously; failing hearts often lose this coordination. Normally, pacemakers are used to reset the heart's rhythm. Kirk *et al.* used pacemakers to restore synchrony by inducing periods of abnormal rhythm—called pacemaker-induced transient asynchrony (PITA). In dogs with heart failure, PITA halted heart chamber dilation and negative remodeling of heart tissue. It also improved cell signaling and force generation, and supported normal muscle fiber structure and function. Some people with pacemakers do not respond to

standard resynchronization protocols; PITA could offer them the possibility of restoring rhythm. — MLF

Sci. Transl. Med. 7, 319ra207 (2015).

BLACK HOLE PHYSICS

Transient radio jet from a black hole

When a star passes too close to a supermassive black hole, it gets ripped apart by the gravitational forces. This causes a tidal disruption flare as the material falls into the black hole. van Velzen *et al.* monitored one such flare with radio telescopes and found evidence for a transient relativistic jet launched by the black hole (see the Perspective by Bower). Larger jets are a feature of active galactic nuclei and have a profound effect on their host galaxy, but are poorly understood. The results will aid our understanding of how black holes “feed” and of the processes governing jet formation. — KTS

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

MICROBIAL ENGINEERING

Using light in the darkness

Solid-state devices can efficiently capture solar energy to produce chemicals and fuels from carbon dioxide. Yet biology has already developed a high-specificity, low-cost system to do just that through photosynthesis. Sakimoto *et al.* developed a biological-inorganic hybrid that combines the best of both worlds (see the Perspective by Müller). They precipitated semiconductor nanoparticles on the surface of a nonphotosynthetic bacterium to serve as a light harvester. The captured energy sustained cellular metabolism, producing acetic acid: a natural waste product of respiration. — NW

Science, this issue p. 74;
see also p. 34

IN OTHER JOURNALS

Edited by **Kristen Mueller**
and **Jesse Smith**

NEUROSCIENCE

How brains get the full picture

The visual system helps organisms make sense of their world. A network of brain areas called face patches helps monkeys identify other individuals and interpret their behavior. Fisher and Freiwald wanted to determine whether these regions only interpret face information or if they integrate body information, too. They scanned the brains of monkeys that were shown faces, bodies, faces on bodies, or faces on nonbody objects. Posterior face patches and adjacent body patches recognized faces and bodies, respectively. However, these networks could integrate face and body information to represent whole monkeys in the anterior face patches. Thus, the brain combines visual information from distinct but related objects to help organisms understand their social world. — PRS

Proc. Natl. Acad. Sci. U.S.A. 112, 14717 (2015).

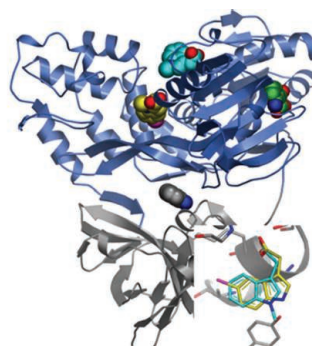
BIOCHEMISTRY

More than one way to target a protein

The primary function of many proteins involves binding to another protein or small molecule. In some cases, however, a second molecule interacting with a distinct site on the protein regulates this primary binding. To identify such functional secondary sites, Ludlow *et al.* used x-ray crystallography to screen a library of

molecules to detect binding to 24 protein targets. Two-thirds of the proteins had at least two binding sites. Sequence analysis of secondary sites showed that most were evolutionarily conserved, suggesting biological function. Moreover, their physicochemical properties indicated that secondary sites may be druggable. Targeting these sites could provide a way to increase protein activity in a therapeutically advantageous manner. — VV

Proc. Natl. Acad. Sci. U.S.A. 10.1073/pnas.1518946112 (2015).



Proteins have multiple binding sites that may contribute to their regulation

MITOCHONDRIA

The Drp, Drp, Drp of mitochondrial fission

Mitochondria are very dynamic organelles and undergo regular fusion and fission reactions. Fission involves the dynamin GTPase Drp1, a cytosolic enzyme that is recruited to mitochondria, where it oligomerizes and contracts to cause

ALSO IN SCIENCE JOURNALS

Edited by Stella Hurtley

ANTIBIOTIC RESISTANCE
Evolving antibiotic rescue stratagems

Antibiotic resistance threatens to put modern medicine into reverse. But we are not at the end of our options for currently available drugs. Baym *et al.* review what can be done by using combinations of antibiotics to circumvent bacteria's evolutionary strategies. For instance, resistance to one drug may cause sensitivity to another, the effectiveness of two drugs can be synergized by a resistance mutation, and some negative drug interactions may even be beneficial in selecting against resistance. Although not simple to assess, drug combinations still have something to offer for the development of sorely needed anti-infectives. — CA

Science, this issue p. 40**NEURAL CIRCUITS**
A way to modulate reward-seeking

Which brain regions are causally involved in reward-related behavior? Ferenczi *et al.* combined focal, cell type-specific, optogenetic manipulations with brain imaging, behavioral testing, and in vivo electrophysiology (see the Perspective by Robbins). Stimulation of midbrain dopamine neurons increased activity in a brain region called the striatum and was correlated with reward-seeking across individual animals. However, elevated excitability of an area called the medial prefrontal cortex reduced both striatal responses to the stimulation of dopamine neurons and the behavioral drive to seek the stimulation of dopamine neurons. Finally, modulating the excitability of medial prefrontal cortex pyramidal neurons drove changes in neural circuit synchrony, as well as corresponding anhedonic behavior. These observations

resemble imaging and clinical phenotypes observed in human depression, addiction, and schizophrenia. — PRS

Science, this issue p. 41;
see also p. 24**BEHAVIORAL GENETICS**
Epigenetic control of caste-specific foraging

In carpenter ants, separate behavioral classes, known as castes, are determined by the epigenetic regulation of genes. Simola *et al.* treated ants of different castes with drugs that affected histone acetylation. Reducing histone acetylation stimulated scouting and foraging behavior. The foraging and scouting behaviors of young ants were permanently changed by directly injecting their brains with histone acetylation inhibitors. — LMZ

Science, this issue p. 42**METABOLISM**
From sensing leucine to metabolic control

The mTORC1 protein kinase complex plays central roles in regulating cell growth and metabolism and is implicated in common human diseases such as diabetes and cancer. The level of the amino acid leucine tells an organism a lot about its physiological state, including how much food is available, how much insulin is going to be needed, and whether new muscle mass can be made (see the Perspective by Buel and Blenis). Wolfson *et al.* identified a biochemical sensor of leucine, Sestrin2, which connects the concentration of leucine to the control of organismal metabolism and growth. When leucine bound to Sestrin2, it was released from a complex with the mTORC1 regulatory factor GATOR2, activating the mTORC1 complex. Saxton *et al.* describe the crystal structure of Sestrin2 and show how it specifically

detects leucine. Aylett *et al.* determined the structure of human mTORC1 by cryoelectron microscopy and the crystal structure of a regulatory subunit, Raptor. The results reveal the structural basis for the function and intricate regulation of this important enzyme, which is also a strategic drug target. — LBR

Science, this issue p. 43, p. 48, p. 53;
see also p. 25**ASTROCHEMISTRY**
Water isomers hide their origin

H₂O exists in two spin isomers, ortho and para, in a ratio of 3:1 at room temperature. Some astronomical observations have found water with a ratio of less than 3, thought to be due to water being photodesorbed from ice that had been formed at very low temperatures (≤ 30 K). Hama *et al.* tested this idea in the laboratory, by forming water ice at low temperature and then photodesorbing it to measure the ortho:para ratio. They found a ratio of 3, even at 10 K. Thus, another explanation for the low ratios in some astronomical objects must be found. — KTS

Science, this issue p. 65**MEMBRANES**
Separating H⁺ from D⁺

In many respects, hydrogen and deuterium show similar properties because they share the same number of protons and electrons and only differ by one neutron. However, when you strip away the electron, a proton ends up having less than half the radius of a deuteron. Lozada-Hidalgo *et al.* used two-dimensional membranes of graphene or hexagonal boron nitride to separate these two charged isotopes, with a separation factor of about 10. — MSL

Science, this issue p. 68**COMPUTER SCIENCE**
Computing power of crowds

Every time a person transcribes distorted text to prove that they are human and gain access to a web page, they contribute to a massive effort to digitize books and newspapers. This is just one of many human computation systems that take advantage of the strengths of both humans and computers. In a Perspective, Michelucci and Dickinson chart recent progress in developing sophisticated human computation systems that can address complex economic, medical, and environmental problems. Human visual perception remains unmatched by machines, but humans are less predictable. Human computation developers must therefore take account of research into human cognition and decision-making. — JFU

Science, this issue p. 32**CANCER**
Pathway activity as a biomarker

Understanding signaling networks may enable the prediction of disease prognosis. Fey *et al.* constructed a computational model that reproduces the all-or-nothing, switch-like activation of the kinase JNK in neuroblastoma (see also the Focus by Kim and Schoeberl). Switch-like activation of JNK leads to cell death. The authors integrated patient data about the levels of JNK pathway components in neuroblastoma samples into the model, to simulate the activity of the pathway and accurately predict survival based on the dynamic properties of the pathway. Alterations in the network that prevented the switch-like activation of JNK were associated with poor survival of neuroblastoma patients. — NRG

Sci. Signal. **8**, ra130 and fs21 (2015).