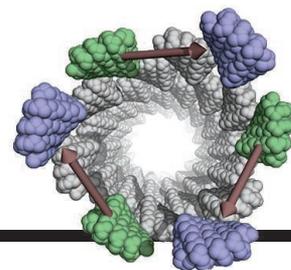


# RESEARCH

## Self-assembling helical fragments by design

Shen et al., p. 705



## IN SCIENCE JOURNALS

Edited by Stella Hurtley



### NEONICOTINOIDS

#### Trouble at the hive

**N**eonicotinoid pesticides cause mortality and decline in insect pollinators. One repeatedly noted effect is a reduction in bee colony size. However, the mechanism behind this reduction is unclear. Crall *et al.* performed complex real-time monitoring of bumblebee behavior within their nests (see the Perspective by Raine). Neonicotinoid exposure reduced nurse and care-taking behaviors, which affected productivity and harmed colony thermoregulation. These changes in behavior acted together to decrease colony viability, even when exposure was nonlethal. —SNV

*Science*, this issue p. 683; see also p. 643

Bumblebee (*Bombus impatiens*) worker foraging outdoors, fitted with a tracking device

### QUANTUM OPTICS

#### Inducing interactions between quantum emitters

The development of scalable quantum systems will require the ability to control the interactions between the individual quantum building blocks of the system. Evans *et al.* used a pair of silicon vacancy centers embedded in a diamond nanocavity to show that interactions between the quantum emitters can be mediated optically (see the Perspective by Lodahl). Such optical control provides a speed advantage as well as the potential to develop an integrated platform for future quantum communication and quantum networking. —ISO

*Science*, this issue p. 662; see also p. 646

### NEUROSCIENCE

#### Theta rhythm protects sleep replay

Hippocampal replay of place cell sequences during sleep is critical for memory consolidation in target cortical areas. How is the sequential organization of place cell assemblies maintained across different time scales? Drieu *et al.* compared periods when a rat either sat passively on a moving train or ran actively on a treadmill on the same train. During the passive movement, the slow behavioral sequence of place cells was still present, but the rapid generation of theta sequences was lost. Active running on the treadmill, however, maintained the theta rhythm. After passive transport,

sequence replay during sleep was destroyed, whereas active running protected replay. —PRS  
*Science*, this issue p. 675

### ORGANIC CHEMISTRY

#### The staying power of electron-poor ligands

The venerable Suzuki coupling reaction originally used palladium to pair up unsaturated carbon centers. The protocol has been widely extended to chiral saturated alkyl carbons, but control over product stereochemistry is a pressing challenge. Zhao *et al.* systematically studied how the properties of the phosphine ligands that are coordinated to the catalyst influence the stereochemical

outcome. Certain electron-withdrawing phosphines favored retention of the initial configuration in chiral alkyltrifluoroborate reactants. Conversely, bulky electron-rich phosphines lead to inverted configurations in the products. —JSY

*Science*, this issue p. 670

### GENETIC PRIVACY

#### Detecting familial matches

Recent advances in DNA technology and companies that provide array-based testing have led to services that collect, share, and analyze volunteered genomic information. Privacy concerns have been raised, especially in light of the use of

these services by law enforcement to identify suspects in criminal cases. Testing models of relatedness, Erlich *et al.* show that many individuals of European ancestry in the United States—even those that have not undergone genetic testing—can be identified on the basis of available genetic information. These results indicate a need for procedures to help maintain genetic privacy for individuals. —LMZ

*Science*, this issue p. 690

## BATTERIES

### Oil when not in use

For primary or nonrechargeable batteries, the overall energy density will be limited by any discharge or open-circuit corrosion that occurs during storage. For batteries based on aluminum and air, this long-standing problem has prevented their widespread use and has been challenging to overcome. Hopkins *et al.* used commercially available components to construct aluminum-air batteries. During standby periods, the electrolyte in the batteries was replaced with oil to protect the electrodes from corrosion, thus preventing energy loss. —MSL

*Science*, this issue p. 658



Photo of aluminum-air prototype battery

## OSTEOPOROSIS

### Building and rebuilding bone

WNT signaling is important for proper embryonic development, shaping cell fate and migration, stem cell renewal, and organ and tissue formation. Luther *et al.* investigated the role of WNT1 in osteoporosis.

Patients with early-onset osteoporosis and mutations in the *WNT1* gene had low bone turnover and high fracture rates, and loss of WNT1 activity caused fracture and osteoporosis in mice. Inducing WNT1 in bone-forming cells increased bone mass in aged mice, and this process did not require LRP5, a co-receptor involved in WNT signaling. Thus, WNT1 acts as an anabolic (bone building) factor and might represent a therapeutic target for osteoporosis. —CC

*Sci. Transl. Med.* **10**, eaau7137 (2018).

## SKIN BIOLOGY

### A basic way to tan

Darker-skinned individuals have more melanin in their skin and a lower risk for skin cancers. The production of melanin in organelles called melanosomes is pH sensitive. Zhou *et al.* found that the enzymatic activity of soluble adenylyl cyclase (sAC) resulted in decreases in both melanosome pH and melanin synthesis. sAC deficiency or inhibitors increased melanosome pH and pigmentation in mice. This mechanism for rapidly regulating melanin synthesis could potentially be exploited to reduce skin cancer risk for fair-skinned individuals. —WW

*Sci. Signal.* **11**, eaau7987 (2018).

## PREDATION

### No longer a safe haven

Many biological patterns have a latitudinal component. One long-recognized pattern is that predation rates are higher at lower latitudes. This may explain why many migratory birds travel thousands of miles from the tropics to the poles to breed. Looking across thousands of records, Kubelka *et al.* found that climate change seems to have altered this fundamental pattern. In shorebirds, at least, predation rates on nests are now higher in the Arctic than in the tropics. —SNV

*Science*, this issue p. 680

## IN OTHER JOURNALS

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

A handheld device should greatly expand the application of adaptive optics scanning laser ophthalmoscopy.

## NEUROSCIENCE

### Decisions and their future implications

We constantly make choices. It is often important to consider not only the short-term but also the longer-term implications of a choice, also known as its prospective value. In a combined decision-making and brain-scanning study, Kolling *et al.* found that when humans make sequential decisions, they do not only consider their immediately available options. Instead, they incorporate the average value of future options, their variability, and the time frame or search horizon, as well as search costs. Furthermore, humans even consider individual capacities and preferences for making decisions in the future. Brain activity in the dorsal anterior cingulate cortex represents prospective value, but when there is an increased need to overcome costs, activity in the ventral striatum and perigenual anterior cingulate cortex is more strongly coupled. —PRS

*Neuron* **99**, 1069 (2018).

## CELL BIOLOGY

### The intraflagellar transport train

Assembly of the cilium requires bidirectional intraflagellar transport (IFT) of building blocks along microtubules to and from the site of assembly at its tip. Dynein-1b motors are required to power retrograde transport and are believed to reach the ciliary tip by kinesin-2–driven anterograde IFT. It is unclear which mechanism prevents a tug-of-war between these oppositely directed microtubule motors. Jordan *et al.* used cryo-electron tomography to examine the architecture of IFT trains in *Chlamydomonas* cilia in situ. Their findings revealed the relative positions of IFT motors on anterograde versus retrograde trains. Dynein-1b in its autoinhibited form was an integral part of anterograde trains but is positioned to prevent premature engagement with the microtubules. Once at the cilia tip, the dynein converted into its activated form, engaged the microtubules, and then powered retrograde transport. —SMH

*Nat. Cell Biol.* **20**, 1250 (2018).

## NEUROSCIENCE

**A framework for cognitive spaces**

Ever since Tolman's proposal of cognitive maps in the 1940s, the question of how spatial representations support flexible behavior has been a contentious topic. Bellmund *et al.* review and combine concepts from cognitive science and philosophy with findings from neurophysiology of spatial navigation in rodents to propose a framework for cognitive neuroscience. They argue that spatial-processing principles in the hippocampal-entorhinal region provide a geometric code to map information domains of cognitive spaces for high-level cognition and discuss recent evidence for this proposal. —PRS

*Science*, this issue p. 654

## EVOLUTION

**Replaying the tape of life**

The evolutionary biologist Stephen Jay Gould once dreamed about replaying the tape of life in order to identify whether evolution is more subject to deterministic or contingent forces. Greater influence of determinism would mean that outcomes are more repeatable and less subject to variations of history. Contingency, on the other hand, suggests that outcomes are contingent on specific events, making them less repeatable. Blount *et al.* review the numerous studies that have been done since Gould put forward this question, both experimental and observational, and find that many patterns of adaptation are convergent. Nevertheless, there is still much variation with regard to the mechanisms and forms that converge. —SNV

*Science*, this issue p. 655

## IMMUNOLOGY

**Dendritic cells give mast cells a nudge**

Anaphylaxis is a life-threatening allergic reaction triggered after antigen-specific immunoglobulin E (IgE) antibodies bind to target allergens. These antibodies then cross-link IgE-specific Fc receptors on the surface of mast cells. The mast cells rapidly release inflammatory mediators, including histamine, resulting in smooth muscle contraction, vasodilation, and blood vessel leakage. Because mast cells are usually found in the perivascular abluminal surface of blood vessels, it has been unclear how blood-borne allergens can interact with them. Choi *et al.* used live intravital imaging of the mouse vasculature to show that a specialized subset of dendritic cells sample blood-borne antigens and relay them to mast cells on the surface of microvesicles (see the Perspective by Levi-Schaffer and Scheffel). IgE-bound mast cells then vigorously degranulate after contact with these microvesicles. —STS

*Science*, this issue p. 656;

see also p. 640

## STRUCTURAL BIOLOGY

**Structures of eukaryotic ribonuclease P**

Ribonuclease P (RNase P) is a ribozyme that processes transfer RNA (tRNA) precursors and is found in all three kingdoms of life. Now, Lan *et al.* report the structures of yeast RNase P (see the Perspective by Scott and Nagai). The aporibozyme structure reveals how the protein components stabilize the RNA and explains how the structural roles of bacterial RNA elements have been delegated to the protein components in RNase P of higher organisms during evolution. The structure of yeast RNase P in complex with its natural substrate, a tRNA precursor, demonstrates the structural

basis for substrate recognition and provides insights into its catalytic mechanism. —SYM

*Science*, this issue p. 657;

see also p. 644

## NANOMATERIALS

**Cleaving with a metal handle**

Using adhesive tape to pull off monolayers of two-dimensional (2D) materials is now a well-established approach. However, the flakes tend to be micrometer scale, and the creation of multilayer stacks for device application can be challenging and time consuming. Shim *et al.* show that monolayers of a variety of 2D materials, including molybdenum disulfide and hexagonal boron nitride, can be cleaved from multilayers grown as 5-centimeter-diameter wafers. The multilayer is capped with a nickel layer, which can be used to pull off the entire grown stack. The bottom of the stack is again capped with nickel, and a second round of cleaving leaves the monolayer on the bottom nickel layer. The monolayers could be transferred to other surfaces, which allowed the authors to make field-effect transistors with high charge-carrier mobilities. —PDS

*Science*, this issue p. 665

## ANTIBIOTIC RESISTANCE

**Efflux pumps and mutation**

Antibiotic resistance is an alarming and growing challenge. Bacteria show great heterogeneity in growth and mutation rates. Such variability allows some cells to persist during transient antibiotic exposure. During this persistent phase, mutations accumulate, which can result in selection for full-blown antibiotic resistance. El Meouche and Dunlop found that increased expression of efflux pumps on some cells affords them some

relief from antibiotic toxicity. But up-regulating efflux pumps is costly for the bacteria, reducing growth rate and expression of MutS, a protein involved in DNA mismatch repair. These changes thus lift the lid on increased levels of bacterial mutation. —CA

*Science*, this issue p. 686

## IMMUNOLOGY

**An IgG1 SNP enhances autoimmunity**

One common feature of autoimmune diseases like systemic lupus erythematosus (SLE) is the presence of high titers of self-reactive antibodies. These result in immune complexes, inflammation, and tissue pathology. Consequently, the checkpoints that normally keep immunoglobulin G (IgG)-positive autoreactive B cells in check are of intense interest. Chen *et al.* report the presence of a common IgG1 single-nucleotide polymorphism (SNP) in East Asian populations (hIgG1-G396R). This SNP was enriched in SLE patients and associated with increased disease severity. Humans with this SNP, as well as knockin mice, showed enhanced plasma cell accumulation and antibody production. This SNP enhanced IgG1 immunoglobulin tail tyrosine motif phosphorylation, triggering longer adaptor protein Grb2 dwell times in immunological synapses and hyper-Grb2-Bruton's tyrosine kinase signaling after antigen binding. —STS

*Science*, this issue p. 700

## PROTEIN DESIGN

**Built to be reversible**

There has been some success in designing stable peptide filaments; however, mimicking the reversible assembly of many natural protein filaments is challenging. Dynamic filaments usually comprise independently folded and asymmetric proteins and using such building blocks

requires the design of multiple intermonomer interfaces. Shen *et al.* report the design of self-assembling helical filaments based on previously designed stable repeat proteins. The filaments are micron scale, and their diameter can be tuned by varying the number of repeats in the monomer. Anchor and capping units, built from monomers that lack an interaction interface, can be used to control assembly and disassembly. —VV

*Science*, this issue p. 705

## IMMUNOLOGY

### Adding to the cross-presentation family

Immune responses to viral or tumor antigens are typically initiated by the process of cross-presentation. Cross-presentation is believed to be the major way that innate immune cells, such as the classical dendritic cell 1 (cDC1) subset, activate and prime immunological T cells. Theisen *et al.* used CRISPR-based screening to identify regulators of cross-presentation by cDC1s (see the Perspective by Barbet and Blander). One such regulator that was identified, WDFY4 (WD repeat- and FYVE domain-containing protein 4), was required for cross-presentation of cell- and bacterial-associated antigens. WDFY4 played a critical role in cDC1-mediated viral and tumor immunity yet did not seem necessary for major histocompatibility complex class II presentation or for cross-presentation by monocyte-derived DCs. —PNK

*Science*, this issue p. 694;  
see also p. 641

## CANCER IMMUNOLOGY

### Tandem immunotherapy achieves synergy

Immune checkpoint-inhibitor therapies bolster the antitumor activity of CD8<sup>+</sup> T lymphocytes. Wang *et al.* performed single-cell analysis of tumor-infiltrating lymphocytes in mouse cancer

models in which inhibitory anti-PD-1 (programmed cell death protein 1) and stimulatory anti-GITR (glucocorticoid-induced tumor necrosis factor receptor-related protein) antibodies together enhanced tumor control. This combination immunotherapy led to a synergistic increase in tumor antigen-specific memory precursor effector T cells dependent on the CD226 costimulatory pathway. Biochemical studies in liposomes identified CD226 as an additional target of dephosphorylation mediated by the PD-1-SHP2 (Src homology region 2) complex. Thus, further clinical trials could usefully test the efficacy of combined anti-GITR and anti-PD-1 immunotherapy in human cancer. —IW

*Sci. Immunol.* **3**, eaat7061 (2018).