gain) at low power will help conserve power and extend battery life. Jiang *et al*. used inkjet printing to fabricate an organic transistor in which silver metal contacts form a low Schottky barrier (less than 0.2 electron volt) with an organic semiconductor. The transistor delivered gain near the theoretical limit at a power below 1 nanowatt and detected electrophysiological signals from the skin with a wearable device. —PDS

Science, this issue p. 719

QUANTUM OPTICS

An integrated route to quantum detection

The quantum properties of the nitrogen-vacancy (NV) center defect in diamond are being pursued as building blocks for quantum-enhanced technologies. Addressing and manipulating the defects, however, typically requires bulk optics, which could limit scalability. Siyushev *et al*. developed an on-chip technique in which the NV center is detected optoelectronically. Such a detection and manipulation method offers a route to develop an integrated platform for scalable quantum-based sensing technologies. —ISO

Science, this issue p. 728

STRUCTURAL BIOLOGY

Mechanism of ribosome rescue

Bacterial ribosomes that stall on truncated or cleaved messenger RNA (mRNA) are rescued by trans-translation. Two factors, transfer-messenger RNA (tmRNA) and small protein B (SmpB), resolve the stalled complex by tagging the nascent polypeptide for degradation and facilitating release of the ribosome. Rae *et al*. determined structures of key trans-translation intermediates. The structures reveal how SmpB identifies stalled ribosomes; how the large, circularized tmRNA molecule moves through the ribosome; and how translation is shifted from the truncated mRNA to tmRNA. —SYM

Science, this issue p. 740

STRUCTURAL BIOLOGY

To transport or not to transport

Therapeutic drug delivery into cells is complicated by membrane proteins like ABCB1 (also termed P-glycoprotein) that shuttle diverse compounds out of cells. Alam *et al*. determined high-resolution cryo–electron microscopy structures of ABCB1 bound either to a substrate, the cancer drug Taxol, or to the ABCB1 inhibitor zosuquidar. The conformational changes that facilitate drug transport are caused by hydrolysis of adenosine triphosphate (ATP). The structures show that, although Taxol and zosquidar bind to the same site, subtle structural differences lead to altered conformations of the nucleotide binding domains that are responsible for ATP hydrolysis. —VV

Science, this issue p. 753

PAIN MEDICATIONS

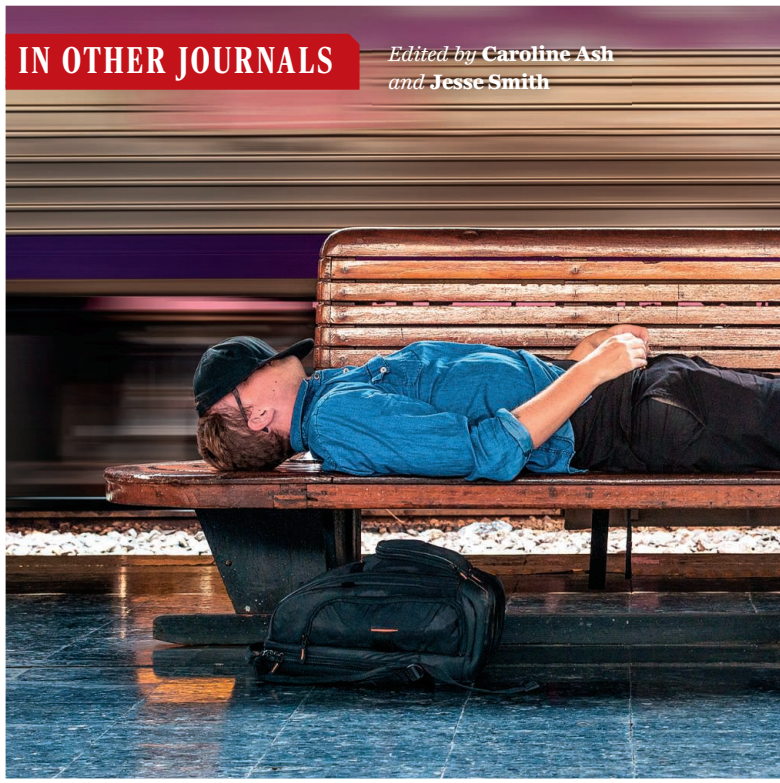
Toward a painkilling nanomedicine

America's opioid epidemic has resulted in large-scale initiatives to identify opioid substitutes. However, for many cases of chronic pain, no viable alternatives to opioids exist. In an effort to expand the arsenal of antipain treatments, Feng *et al*. bonded Leu-enkephalin with the lipid squalene. Enkephalins, like endorphins, are naturally occurring peptides in the human brain. They act on the opioid receptors to manage pain but have proved difficult to exploit therapeutically. When incorporated into nanoparticles with squalene, Leu-enkephalin exhibited a more controlled release that localized in inflamed tissue, which is promising news for nonopioid pain treatment. —KJP

Sci. Adv. 10.1126/sciadv.aau5148 (2019).

IN OTHER JOURNALS

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



CELL BIOLOGY

Chromosome axis organization

The chromosome axis is a meiosis-specific structure that is essential for proper chromosome pairing and meiotic recombination. It is conserved among all eukaryotes; however, the key axis protein components are evolutionarily divergent among different species. West *et al*. characterized axis proteins in baking yeast, a mustard plant, and human. Although these proteins have little sequence homology, they all form filaments from tetrameric units and recruit key players that mediate downstream meiotic recombination. This common assembly feature ensures that the architecture of the meiotic-chromosome axis is highly conserved across fungi, mammals, and plants. —SYM

eLife **8**, e40372 (2019).

CELL BIOLOGY

Tunneling nanotubes under the microscope

Long, actin-rich membranous protrusions called tunneling nanotubes (TNTs) allow the intercellular transport of various cargos, including viruses, organelles, and proteins. Sartori-Rupp *et al*. report the structural characterization of TNTs formed between neuronal cells in culture using correlative light- and cryo–electron microscopy approaches. They found that TNTs are distinct from other actin-rich cell protrusions like filopodia. TNTs are composed of a bundle of functional individual tunneling nanotubes containing membrane-bound compartments, including mitochondria. Bridging threads between the individual nanotubes contained the cell adhesion molecule N-cadherin. —SMH

Nat. Commun. **10**, 342 (2019).

ORGANIC CHEMISTRY

Illuminating a path uphill to open rings

When a chemical compound absorbs light directly, it gets a burst of energy that can propel an otherwise unfavorable reaction forward. In principle, light-absorbing catalysts can likewise channel energy to substrates to push reactions uphill

PHOTO: ISTOCK.COM/STEPHANE NOIRET

NEUROSCIENCE

Sleeping in standby mode

Sleep is essential, but it makes us unable to interact and vulnerable. Yet the sleeping brain continues to process stimuli from the environment. Legendre *et al*. presented awake and sleeping subjects with relevant and irrelevant stories via both ears while recording the neural responses in their brains with electroencephalography. Although sleepers seemed unresponsive, their brains clearly registered external stimuli to an extent that depended on specific brain rhythms and sleep depth. Thus, sleepers can process surrounding events sufficiently to know when it might be a good idea to rapidly wake up. —EACP

Nat. Hum. Behav. 10.1038/s41562-018-0502-5 (2019).

Even when asleep, humans remain alert to external stimuli.

thermodynamically. Nonetheless, the recent surge in photoredox catalysis has largely focused on accelerating favorable transformations. Ota *et al*. demonstrate that a catalyst system composed of an iridium photoredox chromophore, a phosphate base, and a thiol for hydrogen-atom transfer can isomerize cyclic alcohols to higher-energy linear aldehydes. The high-yielding protocol is compatible with a wide variety of complex substrates. —JSY

J. Am. Chem. Soc. **141**, 1457 (2019).

ALZHEIMER'S DISEASE

Targeting Tau

Cholesterol metabolism is linked to Alzheimer's disease (AD) pathogenesis; however, the pathways involved are only partially understood. Van der Kant *et al*. associated cholesterol with the accumulation of phosphorylated Tau (pTau) protein in neurons, a hallmark of AD. The study screened compounds for the ability to block pTau accumulation in neurons that were derived from AD patients. Drugs that decreased cholesteryl esters (CEs) also reduced pTau. The effective drugs included statins, which block cholesterol synthesis, and drugs that alter the metabolism of cholesterol into CEs or 24-hydroxycholesterol. Reducing neuronal CEs was associated with increased proteasome-mediated degradation of pTau. —LC

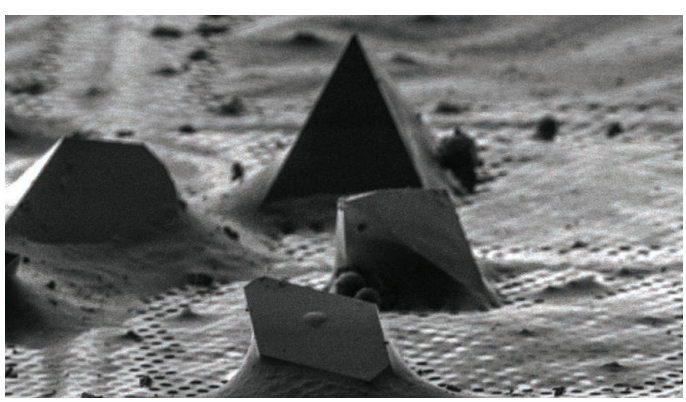
Cell Stem Cell 10.1016/j.stem.2018.12.013 (2018).

ELECTRON DIFFRACTION

Microsolution for macromolecules

Protein crystallographers who hope to use x-ray diffraction to determine structures have long struggled with growing large, uniform protein crystals. Crystals only a few micrometers thin are ideal for diffraction by electrons but are likewise hard to grow predictably. Focused ion beam milling can create thin slices from large protein crystals that are ideal for electron diffraction. Martynowycz *et al*. demonstrate that continuous rotation of a single crystal section with careful control of electron dose can yield a high-resolution structure of a model protein. Such a strategy should be generally applicable to otherwise intractable microcrystals, which are, as of now, a common dead end. —MAF

Structure 10.1016/j.str.2018.12.003 (2019).



Macromolecular protein crystals can be prepared for microcrystal electron diffraction by using focused ion beam milling.

IMAGE: M. MARTYNOWYCZ *ET AL*., *STRUCTURE*, 10.1016/J.STR.2018.12.003 (2019)

ASTROCHEMISTRY

Molecules in interstellar space

Chemistry in space occurs wherever gas is dense and cool enough for chemical bonds to form, producing a wide variety of molecules. These are particularly common in the gas clouds that provide the raw material for star and planet formation. McGuire has cataloged all molecules detected in the interstellar and circumstellar medium. More than 200 distinct molecules have been found, increasing at an average rate of four or five per year. The inventory of known molecules is heavily biased toward those that are easy to observe with radio telescopes. Thousands of astronomically observed molecular lines remain unassigned, often because of a lack of laboratory spectroscopy for comparison. —KTS

Astrophys. J. Suppl. Ser. **239**, 17 (2018).

PLANT SCIENCE

Optimizing agricultural fertilization

Although potassium (K) is the seventh-most-abundant element in Earth's crust, mineable resources of bioavailable K are finite. Plants depend on K for growth and development, but most K in soil is inaccessible to them. Dhillon *et al*. calculated the K use efficiency for cereal crops worldwide over a 55-year span and found that yields in recent decades have increased faster than the addition of new land for cultivation. This is due in part to the increased use of fertilizers that include K; however, K use efficiency has not improved. What is needed is fin=e-scale analysis of bioavailable K in agricultural fields, attention to the soil microbiome, and avoiding oversupply of K. —PJH

Agron. J. 10.2134/agronj2018.07.0462 (2018).