

## IN SCIENCE JOURNALS

Edited by **Stella Hurtley**

### PLANT SCIENCE

## Poppy genome reveals evolution of opiates

**T**he opium poppy has been a source of painkillers since Neolithic times. Attendant risks of addiction threaten many today. Guo *et al.* now deliver a draft of the opium poppy genome, which encompasses 2.72 gigabases assembled into 11 chromosomes and predicts more than 50,000 protein-coding genes. A particularly complex gene cluster contains many critical enzymes in the metabolic pathway that generates the alkaloid drugs noscapine and morphinan. —PJH

*Science*, this issue p. 343



*Papaver somniferum*, the opium poppy

### GRAPHENE

## Thickness matters in graphene stacks

If you stack graphene monolayers on top of each other, the number of layers will affect the properties of the material. Intuitively, one would expect that as the stack becomes thicker, the results will converge as the sample starts to resemble graphite. Nam *et al.* measured the conductance of graphene multilayers of increasing thickness. Studying

samples up to seven layers thick, they found that in all of them, electronic correlations caused a phase transition at a nonzero critical temperature. However, the critical temperature, as well as the nature of the low-temperature state, depended strongly on the number of layers. This unexpectedly persistent dependence showed no signs of slowing down and will motivate further theoretical and experimental work. —JS

*Science*, this issue p. 324

### GEOPHYSICS

## A solid and squishy inner core

Earth's inner core is thought to be solid, which means it should support shear waves. However, the small size of the inner core makes detecting shear waves very difficult. Tkalčić and Pham correlated different types of seismic phases to finally determine the speed of shear waves in Earth's inner core (see the Perspective by Irving). The detection of the waves closes

an 80-year quest to find them and confirms a solid, but soft, inner core. —BG

*Science*, this issue p. 329; see also p. 294

### SCIENCE AND SOCIETY

## Sharing pharmaceutical research

Increased collaboration will enhance our ability to predict new therapeutic drug candidates. Such data sharing is currently limited by concerns about intellectual property and competing commercial interests. Hie *et al.* introduce an end-to-end pipeline, using modern cryptographic tools, for secure pharmacological collaboration. Multiple entities can thus securely combine their private datasets to collectively obtain more accurate predictions of new drug-target interactions. The computational pipeline is practical, producing results with improved accuracy in a few days over a wide area network on a real dataset with more than a million interactions. —BJ and AMS

*Science*, this issue p. 347

### IMMUNOLOGY

## The absence of DNGR-1 is dangerous

Conventional type 1 dendritic cells (cDC1s) can sense tissue damage via DNGR-1, which binds F-actin exposed by necrotic cells. DNGR-1 activation favors cross-presentation, the process by which extracellular antigens are processed and presented to CD8<sup>+</sup> T cells via major histocompatibility complex class I molecules. Del Fresno *et al.* studied mice lacking DNGR-1

and found that DNGR-1 also has anti-inflammatory effects (see the Perspective by Salazar and Brown). It inhibits the secretion of the chemokine CXCL2 by cDC1s, which, in turn, limits neutrophil recruitment. Thus, DNGR-1 connects cell-death sensing with a mechanism of damage control. —STS

*Science*, this issue p. 351; see also p. 292

## MALARIA

### Prenatal *Plasmodium* reactivity

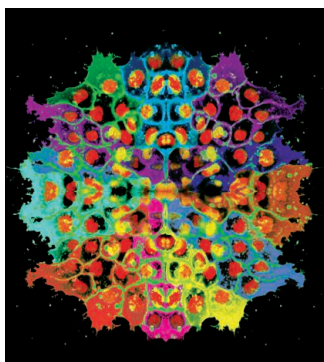
Fetal immunity is generally thought to be skewed toward tolerance. Odorizzi *et al.* used samples from a study in Uganda to determine if placental malaria infection modulated fetal immune responses to malaria. They stimulated cord blood cells in vitro and found that the fetal cells from cases of placental malaria were more reactive to *Plasmodium* antigens. Moreover, clinical follow-up revealed that this increased T cell response correlated with protection from childhood malaria. Thus, protective immune responses in humans can develop even before birth. —LP

*Sci. Transl. Med.* **10**, eaat6176 (2018).

## NEURODEVELOPMENT

### Supracellular cable drives collective cell movement

Neural crest cells migrate far and wide through a vertebrate embryo during development. Shellard *et al.* used *Xenopus*



Supracellular organization during collective migration

and zebrafish embryos to study how these clumps of mesenchymal cells migrate (see the Perspective by Adameyko). Movement was powered by a supracellular actomyosin cable that contracted around the rear of the clump. Similar supracellular contractility at the front was inhibited by a chemotactic signal. The imbalance in forces caused cells to rearrange so that the whole clump would be propelled forward. —PJH

*Science*, this issue p. 339; see also p. 290

## PAIN

### Channeling metastasis pain with VEGF

Metastatic cancer in the bone is painful. Yang *et al.* found that vascular endothelial growth factor (VEGF) promotes tumor angiogenesis and also contributes to this pain. In a rat model of bone-metastatic breast cancer, tumor-secreted VEGF repressed the expression of the potassium (K<sup>+</sup>) channel TRESK. Loss of K<sup>+</sup> current through TRESK increased the excitability of sensory neurons and made the animals hypersensitive to heat and touch near the bone lesion. Blocking this pathway restored channel activity and alleviated pain. —LKF

*Sci. Signal.* **11**, eaao5150 (2018).

## OPTICAL METAMATERIALS

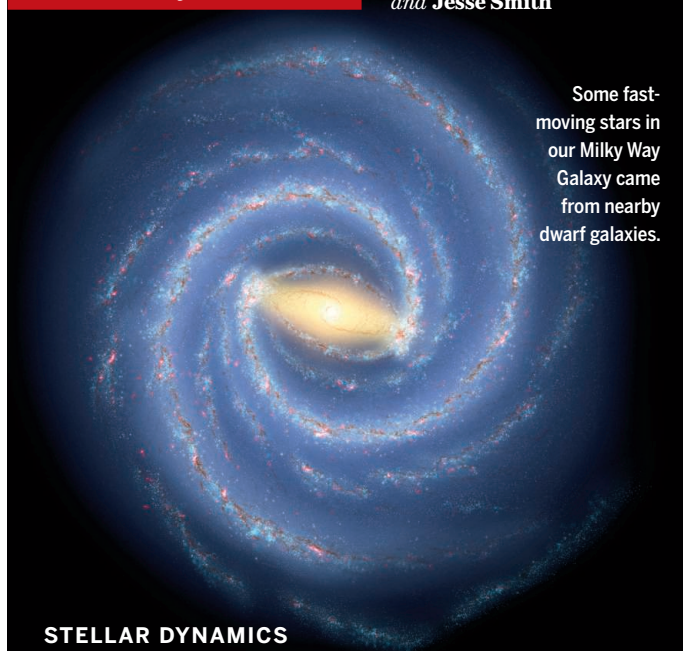
### Painting on the cool

Passive radiative cooling materials emit heat. They can reduce the need for air conditioning by providing daytime cooling but are often challenging to apply to rooftops and other building surfaces. Mandal *et al.* fabricated porous poly(vinylidene fluoride-co-hexafluoropropene) to create an excellent radiative cooling material. Better yet, the polymer is easy to paint or spray onto a wide range of surfaces, has good durability, and can even be dyed. This makes it a promising candidate for widespread use as a high-performance passive radiative cooling material. —BG

*Science*, this issue p. 315

## IN OTHER JOURNALS

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



Some fast-moving stars in our Milky Way Galaxy came from nearby dwarf galaxies.

## STELLAR DYNAMICS

### Fast-moving stars from other galaxies

**D**ynamical interactions and supernovae can accelerate stars to high velocities, sometimes even fast enough that they are no longer gravitationally bound to their host galaxy and escape from it. Marchetti *et al.* have combined astrometric data with radial velocity measurements to determine the three-dimensional motions of 7 million stars within the Milky Way Galaxy. Within that sample, they identify 20 stars that are not bound to the Galaxy. Only seven of them are moving away from the Milky Way's disc; 13 stars originated elsewhere. The authors postulate that these apparently extragalactic stars may have been ejected or tidally stripped from nearby dwarf galaxies. —KTS

*Mon. Not. R. Astron. Soc.* **10.1093/mnras/sty2592** (2018).

## VIRAL HOST RESPONSE

### Stressed out by influenza virus

Viral infection leads to cellular stress. This can act to the host's advantage to curb infection; however, the virus can also subvert stress responses for its own gain. Zhao *et al.* found that influenza A virus (IAV) infection leads to global deregulation of transcription. After IAV infection, RNA polymerase II runs through the transcription termination site of almost all active genes. This down-regulates gene expression by affecting the splicing of some transcripts and delaying the next rounds of

transcription initiation. The viral protein NS1 is responsible for this effect and can be modulated by SUMOylation. Although whether this stress response tilts in favor of host survival or facilitates viral replication is unknown, it might help explain the differences in pathogenicity seen in different IAV strains with divergent NS1. —SYM

*Nat. Struct. Mol. Biol.* **25**, 885 (2018).

## GENETIC DISEASE

### Impaired constriction

Duchenne muscular dystrophy (DMD) is a hereditary disease caused by mutations in the gene that encodes the protein

## ALSO IN SCIENCE JOURNALS

Edited by Stella Hurtley

## QUANTUM INFORMATION

**The stages of a quantum internet**

As indispensable as the internet has become in our daily lives, it still has many shortcomings, not least of which is that communication can be intercepted and information stolen. If, however, the internet attained the capability of transmitting quantum information—qubits—many of these security concerns would be addressed. Wehner *et al.* review what it will take to achieve this so-called quantum internet and propose stages of development that each correspond to increasingly powerful applications. Although a full-blown quantum internet, with functional quantum computers as nodes connected through quantum communication channels, is still some ways away, the first long-range quantum networks are already being planned. —JS

*Science*, this issue p. 303

## CONSERVATION

**A nature-friendly matrix**

As the human population has grown, we have taken and modified more and more land, leaving less and less for nonhuman species. This is clearly unsustainable, and the amount of land we protect for nature needs to be increased and preserved. However, this still leaves vast regions of the world unprotected and modified. Such landscapes do not have to be a lost cause. Kremen and Merenlender review how biodiversity-based techniques can be used to manage most human-modified lands as “working landscapes.” These can provide for human needs and maintain biodiversity not just for ecosystem services but also for maintenance and persistence of nonhuman species. —SNV

*Science*, this issue p. 304

## ION CHANNELS

**Structures of voltage-gated sodium channels**

In “excitable” cells, like neurons and muscle cells, a difference in electrical potential is used to transmit signals across the cell membrane. This difference is regulated by opening or closing ion channels in the cell membrane. For example, mutations in human voltage-gated sodium ( $\text{Na}_v$ ) channels are associated with disorders such as chronic pain, epilepsy, and cardiac arrhythmia. Pan *et al.* report the high-resolution structure of a human  $\text{Na}_v$  channel, and Shen *et al.* report the structures of an insect  $\text{Na}_v$  channel bound to the toxins that cause pufferfish and shellfish poisoning in humans. Together, the structures give insight into the molecular basis of sodium ion permeation and provide a path toward structure-based drug discovery. —VV

*Science*, this issue p. 305, p. 306

## SOCIAL SCIENCE

**Assessing gender differences**

What contributes to gender-associated differences in preferences such as the willingness to take risks, patience, altruism, positive and negative reciprocity, and trust? Falk and Hermle studied 80,000 individuals in 76 countries who participated in a Global Preference Survey and compared the data with country-level variables such as gross domestic product and indices of gender inequality. They observed that the more that women have equal opportunities, the more they differ from men in their preferences. —BJ

*Science*, this issue p. 307

## QUANTUM COMPUTING

**Quantum outperforms classical**

Quantum computers are expected to be better at solving certain computational problems than classical computers. This expectation is based on (well-founded) conjectures in computational complexity theory, but rigorous comparisons between the capabilities of quantum and classical algorithms are difficult to perform. Bravyi *et al.* proved theoretically that whereas the number of “steps” needed by parallel quantum circuits to solve certain linear algebra problems was independent of the problem size, this number grew logarithmically with size for analogous classical circuits (see the Perspective by Montanaro). This so-called quantum advantage stems from the quantum correlations present in quantum circuits that cannot be reproduced in analogous classical circuits. —JS

*Science*, this issue p. 308;

see also p. 289

## ORGANIC CHEMISTRY

**Carbon nanotubes help nickel work in water**

Most synthetic chemistry takes place in hydrocarbon-derived solvents. By contrast, enzymes manage to perform exquisitely selective reactions in water, often by surrounding reactants with hydrophobic pockets. Kitano *et al.* show that single-walled carbon nanotubes can similarly render simple nickel catalysts effective in water. Integration of the nickel ions with chiral ligands and surfactants at the nanotube surface produces a highly enantioselective catalyst for nitron formation from aldoximes and unsaturated ketones. Spectroscopy suggests that the nanotubes enhance electron density at the nickel center as well as provide a hydrophobic milieu. —JSY

*Science*, this issue p. 311

## CHEMICAL SENSING

**Transistor sensing in salt solutions**

Molecular binding to receptors on the surface of field-effect transistors (FETs) can be sensed through changes in transconductance. However, the saline solutions typically used with biomolecules create an electrical double layer that masks any events that occur within about 1 nanometer from the surface. Nakatsuka *et al.* overcame this limitation by using binding to large, negatively charged DNA stem loop structures that, upon ligand binding, cause conformational changes that can be sensed with an FET, even in solutions with high ionic strength. The authors demonstrate the sensing of charged molecules such as dopamine in artificial cerebrospinal fluid as well as neutral molecules such as glucose and zwitterion molecules like sphingosine-1-phosphate. —PDS

*Science*, this issue p. 319

## TOPOLOGICAL MATTER

**An iron home for Majoranas**

The surface of the iron-based superconductor  $\text{FeTe}_{0.55}\text{Se}_{0.45}$  has been identified as a potential topological superconductor and is expected to host exotic quasiparticles called the Majorana bound states (MBSs). Wang *et al.* looked for signatures of MBSs in this material by using scanning tunneling spectroscopy on the vortex cores formed by the application of a magnetic field. In addition to conventional states, they observed the characteristic zero-bias peaks associated with MBSs and were able to distinguish between the two, owing to the favorable ratios of energy scales in the system. —JS

*Science*, this issue p. 333



## GERM CELL DEVELOPMENT

### Reconstituting a human ovary

Human pluripotent stem cells (hPSCs) have been induced into human primordial germ cell–like cells (hPGCLCs) in vitro, the first step toward human in vitro gametogenesis. Yamashiro *et al.* went a step closer to generating mature gametes by culturing hPSCs with mouse embryonic ovarian somatic cells in xenogeneic reconstituted ovaries (see the Perspective by Gill and Peters). Over a period of 4 months, hPGCLCs underwent hallmark epigenetic reprogramming and differentiated progressively into cells closely resembling human oogonia, an immediate embryonic precursor for human oocytes. This study creates opportunities for human germ cell research and provides a foundation for human in vitro gametogenesis. —BAP

*Science*, this issue p. 356;  
see also p. 291

## SUSTAINABILITY

### Policies to make you happy

Policy decision-making frequently involves economic models to assess their value. However, economic metrics do not tell the full story of how populations experience the policies implemented in their countries. In a Perspective, Graham *et al.* discuss the possible value of introducing well-being metrics—to assess factors influencing life satisfaction and happiness—to policy decision-making. They propose that including well-being considerations in policy-making could ensure future sustainability of the workforce. —GKA

*Science*, this issue p. 287

## ANTIGEN PRESENTATION

### Stitching peptides for presentation

Intracellular protein–derived peptides generated by proteasomal degradation are loaded onto major histocompatibility complex (MHC) class I molecules in the endoplasmic reticulum and presented to CD8<sup>+</sup> T cells. Although it has been assumed that these peptides are contiguous segments derived from intracellular proteins, recent studies have shown that noncontiguous peptides generated by cis-splicing of two distinct regions of an antigen can be presented by MHC class I molecules. Faridi *et al.* now demonstrate that MHC class I molecules can present peptides that are generated by the splicing together of segments from two distinct proteins—so-called trans-spliced peptides. Precisely how cis- and trans-spliced peptides are generated and how they contribute to T cell selection and expansion remain to be explored. —AB

*Sci. Immunol.* **3**, eaar3947 (2018).

## MAGNETIC RESONANCE

### Hyperfine spectra of surface atoms

The interaction of nuclei with nonzero spin with electron spins creates small electronic energy. With a scanning tunneling microscope tip, Willke *et al.* measured these hyperfine interactions for iron and titanium atoms that were manipulated on a magnesium oxide surface. The tip was also used to measure electron paramagnetic resonance spectra. The hyperfine structure of single atoms was sensitive to the binding site of the atom as well as its position relative to other magnetic atoms. —PDS

*Science*, this issue p. 336