

# RESEARCH

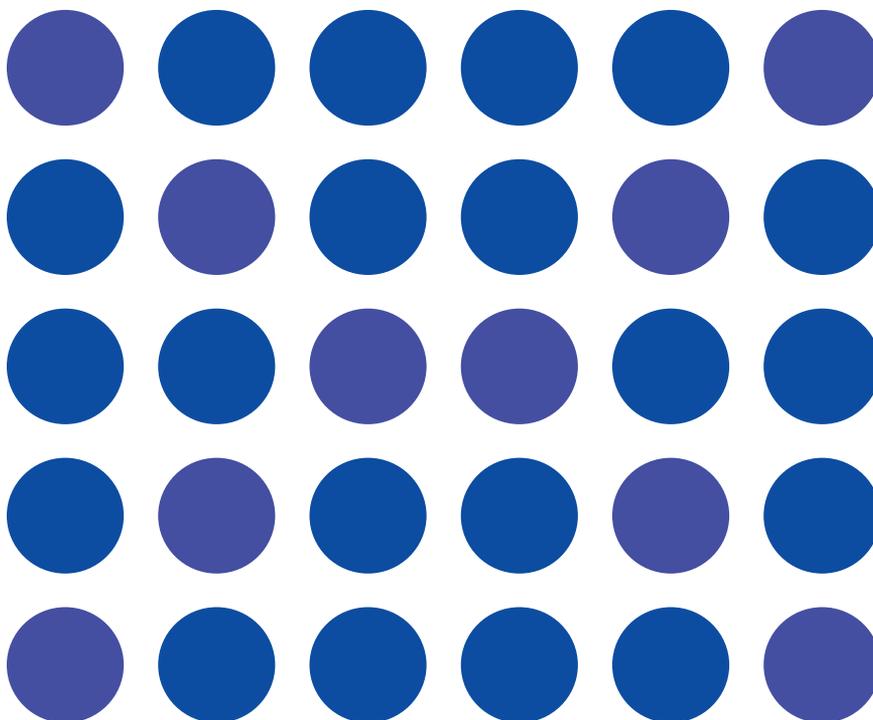
## Friction between polyelectrolyte brushes

Yu et al., p. 1434



## IN SCIENCE JOURNALS

Edited by **Caroline Ash**



### PSYCHOLOGY

## Perceptual and judgment creep

**D**o we think that a problem persists even when it has become less frequent? Levari *et al.* show experimentally that when the “signal” a person is searching for becomes rare, the person naturally responds by broadening his or her definition of the signal—and therefore continues to find it even when it is not there. From low-level perception of color to higher-level judgments of ethics, there is a robust tendency for perceptual and judgmental standards to “creep” when they ought not to. For example, when blue dots become rare, participants start calling purple dots blue, and when threatening faces become rare, participants start calling neutral faces threatening. This phenomenon has broad implications that may help explain why people whose job is to find and eliminate problems in the world often cannot tell when their work is done. —AMS

*Science*, this issue p. 1465

**Our perceptions of a signal, such as the number of blue dots, change when it becomes rare.**

### MOLECULAR BIOLOGY

## Structural basis for spliceosome assembly

The spliceosome removes noncoding sequences from precursor RNA and ligates coding sequences into useful mRNA. The pre-spliceosome (A complex) associates with a small nuclear ribonucleoprotein (snRNP) complex called U4/U6.U5 tri-snRNP to form the pre-B complex, which is converted into the precatalytic B complex. Bai *et al.* solved the cryo-electron microscopy structures of the pre-B and B complexes isolated from yeast. These structures show the U1 and U2 snRNPs and allow modeling of the A complex to reveal

the early steps of spliceosome assembly and activation. —SYM

*Science*, this issue p. 1423

### NEUROSCIENCE

## Imaging dopamine release in the brain

Neuromodulator release alters the function of target circuits in poorly known ways. An essential step to address this knowledge gap is to measure the dynamics of neuromodulatory signals while simultaneously manipulating the elements of the target circuit during behavior. Patriarchi *et al.* developed fluorescent protein-based dopamine indicators to visualize spatial and temporal release of dopamine directly with

high fidelity and resolution. In the cortex, two-photon imaging with these indicators was used to map dopamine activity at cellular resolution. —PRS

*Science*, this issue p. 1420

### BIOMEDICAL MATERIALS

## Eye can see neural activity

Organisms take up a tremendous amount of information through the visual system, which is then processed by the neural circuitry. Hong *et al.* developed a mesh electronics implant that is delivered by injection into mice retinas. With these devices, it is possible to obtain recordings from retinal ganglion cells

over long time periods in awake, active mice. Both orientation- and direction-selective retinal ganglion cells can be monitored, as can the circadian modulation of retinal ganglion cell activity. —MSL

*Science*, this issue p. 1447

### SOLAR CELLS

## Perovskite layers make the grade

Inverted planar perovskite solar cells offer opportunities for a simplified device structure compared with conventional mesoporous titanium oxide interlayers. However, their lower open-circuit voltages result in lower power conversion

efficiencies. Using mixed-cation lead mixed-halide perovskite and a solution-processed secondary growth method, Luo *et al.* created a surface region in the perovskite film that inhibited nonradiative charge-carrier recombination. This kind of solar cell had comparable performance to that of conventional cells. —PDS

*Science*, this issue p. 1442

## CONDENSED MATTER

### Golden ultrafast melting

Understanding fast melting of metals is important for applications such as welding and micromachining. However, fast melting leaves simulation as the only option for probing the process. Mo *et al.* performed ultrafast electron diffraction experiments on laser-pulsed gold films. This allowed detailed mapping of the melting process, which proceeds through two distinct regimes while the bonding behavior changes in unexpected ways. The results require adding new physical processes to high-energy melting models. —BG

*Science*, this issue p. 1451

## SEX DETERMINATION

### Sox9 regulation during sex determination

Sex determination is regulated by the *Sox9* gene. During testis differentiation, this gene is directly targeted by the product of the Y chromosome–encoded gene *Sry*. The regulatory region of *Sox9* is complex, which is typical of genes with multiple



If *Sox9* is not up-regulated, XY mice develop as females.

roles in development. Gonen *et al.* find that a single far-upstream 557–base pair element is critical for up-regulating *Sox9*. Without it, XY mice develop as females instead of males. The 557–base pair enhancer is conserved, likely to be relevant to human disorders of sex differentiation, and probably essential because it acts early in a time-critical process, and any failure allows ovary-specific factors to dominate. —BAP

*Science*, this issue p. 1469

## EVOLUTIONARY BIOLOGY

### Human influence on orangutans

The numbers of orangutans and their geographic distribution declined dramatically after the late Pleistocene. Experts have proposed climate change and human activities as possible causes. Synthesizing available archaeological, genetic, and behavioral data, Spehar *et al.* concluded that over the past 70,000 years, hunting especially played a role. Some adaptable orangutan populations continue to live in human-dominated environments, which challenges the long-held belief that orangutans require pristine habitats. —PJB

*Sci. Adv.* 10.1126/sciadv.1701422 (2018).

## T CELL ACTIVATION

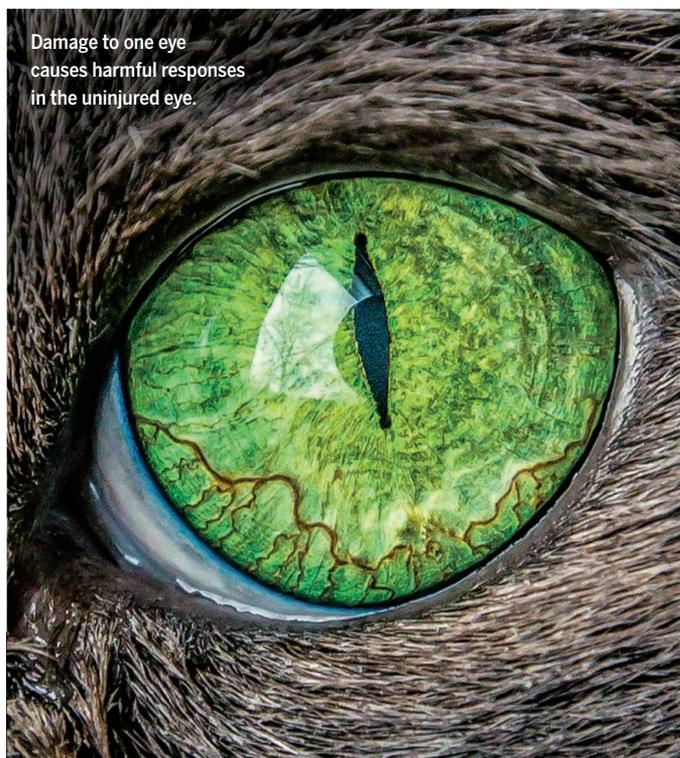
### Controlled activation

At the intestinal barrier, lymphocyte activation is a tightly regulated process that enables rapid responses to pathogens but avoids destructive inflammation. Konjar *et al.* examined how intraepithelial lymphocytes (IELs) maintain a controlled activation state, which is influenced by the composition of the mitochondrial membrane. Inflammation triggers changes in the mitochondrial membranes of IELs, particularly the cardiolipin composition, and these changes support rapid proliferation and effector functions. —CNF

*Sci. Immunol.* 3, eaan2543 (2018).

## IN OTHER JOURNALS

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



Damage to one eye causes harmful responses in the uninjured eye.

## IMMUNOLOGY

### A site for sore eyes

Mucosal tolerance arises when exposure to foreign antigens at mucosal sites results in suppressed immune responses mediated by regulatory T cells and tolerogenic antigen-presenting cells (APCs). In mammals, immune responses of the retina and cornea in both eyes are interdependent: Damage in one eye causes a response in the uninjured eye, too. Using a mouse model of ocular injury, Guzmán *et al.* show that damage to the conjunctival mucosa in one eye also leads to a loss of mucosal tolerance in the opposite, undamaged conjunctiva. TRPV1 channels in the injured eye signal via the central nervous system, which leads to the neuropeptide substance P being released in the uninjured eye. Consequently, epithelial nuclear factor  $\kappa$ B signaling and APC maturation direct antigen-specific T cells to an effector phenotype and potentially damaging inflammation in the intact eye. —STS

*Mucosal Immunol.* 10.1038/s41385-018-0040-5 (2018).

## CELL BIOLOGY

### Memories: Just a phase

Recently, several proteins have been shown to phase-separate into liquid droplets within the cell. Dine *et al.* found that such protein droplets exhibit a robust form of spatial memory. The

droplets maintained the spatial pattern of an inhibitor of droplet formation long after the inhibitor had been removed. Despite this persistence, individual droplets were highly dynamic, continuously exchanging their constituents with the cytosolic phase. The authors exploited

## ALSO IN SCIENCE JOURNALS

Edited by **Caroline Ash**

## ENERGY

**Path to zero carbon emissions**

Models show that to avert dangerous levels of climate change, global carbon dioxide emissions must fall to zero later this century. Most of these emissions arise from energy use. Davis *et al.* review what it would take to achieve decarbonization of the energy system. Some parts of the energy system are particularly difficult to decarbonize, including aviation, long-distance transport, steel and cement production, and provision of a reliable electricity supply. Current technologies and pathways show promise, but integration of now-discrete energy sectors and industrial processes is vital to achieve minimal emissions. —JFU

*Science*, this issue p. 1419

## PALEOGENOMICS

**Ancient steppes for human equestrians**

The Eurasian steppes reach from the Ukraine in Europe to Mongolia and China. Over the past 5000 years, these flat grasslands were thought to be the route for the ebb and flow of migrant humans, their horses, and their languages. de Barros Damgaard *et al.* probed whole-genome sequences from the remains of 74 individuals found across this region. Although there is evidence for migration into Europe from the steppes, the details of human movements are complex and involve independent acquisitions of horse cultures. Furthermore, it appears that the Indo-European Hittite language derived from Anatolia, not the steppes. The steppe people seem not to have penetrated South Asia. Genetic evidence indicates an independent history involving western Eurasian admixture into ancient South Asian peoples. —LMZ

*Science*, this issue p. 1422

## STEM CELLS

**Cross-talk in the mammary gland**

Macrophages engulf damaged and dead cells to clear infection, but they also participate in tissue regeneration. Chakrabarti *et al.* expand the macrophage repertoire for mammary gland development (see the Perspective by Kannan and Eaves). Mammary gland stem cells secrete the Notch ligand Dll1 and activate Notch signaling, which promotes survival of adjacent macrophages. This stimulates production of Wnt ligands, which signal back to the mammary gland stem cells. This cross-talk plays an important role in coordinating mammary gland development, tissue homeostasis, and, not least, breast cancer. —BAP

*Science*, this issue p. 1421;  
see also p. 1401

**QUANTUM SIMULATION  
Going beyond the first Chern number**

Topological properties of physical systems are reflected in so-called Chern numbers: A nonzero Chern number typically means that a system is topologically nontrivial. Sugawa *et al.* engineered a cold atom system with a nonzero second Chern number, in contrast to condensed matter physics, where only the first Chern number is usually invoked. The exotic topology relates to the emergence of a type of magnetic monopole called the Yang monopole (known from theoretical high-energy physics) in a five-dimensional space of internal degrees of freedom in a rubidium Bose-Einstein condensate. The results illustrate the potential of cold atoms physics to simulate high-energy phenomena. —JS

*Science*, this issue p. 1429

## BIOMIMETIC CHEMISTRY

**Inspiration from a vitamin**

Organic synthesis of molecules with defined stereochemistry requires a chiral center, which in turn may involve a chiral catalyst. Chen *et al.* developed an organic catalyst, modeled on vitamin B6, which contains an electron-withdrawing pyridine ring adjacent to an aldehyde group. This catalyst works like the vitamin by reacting with an amine, a derivative of the amino acid glycine, to create an activated species. An appendage on the catalyst coordinates the subsequent reactions, allowing for stereoselective formation of a product with two adjacent amines. —MAF

*Science*, this issue p. 1438

## THERMAL CONDUCTIVITY

**Glass-like and crystal-like**

Crystals with glass-like ultralow thermal conductivity are appealing as barrier coatings and thermoelectric materials. Mukhopadhyay *et al.* developed a class of thallium selenides with glass-like thermal conductivity. These materials may be promising for applications, but they also require the combination of glass-like and crystal-like thermal transport to explain their thermal properties. This two-channel model can be used to identify potential ultralow-thermal-conductivity compounds. —BG

*Science*, this issue p. 1455

## POLYMERS

**A brush with friction**

Polyelectrolyte brushes consist of charged polymer chains attached to a common backbone or surface. They provide excellent lubrication between two surfaces for both engineered and physiological materials. The packing of the brushes is sensitive to pH, temperature, or added salts. Yu *et al.* show that the presence of multivalent ions can cause brush collapse, similarly to monovalent

ions (see the Perspective by Ballauff). Critically—and not observed with the addition of monovalent ions—very low concentrations of multivalent ions cause bridging between the brushes and increase friction between the surfaces to the extent that their value for biomedical devices is limited. —MSL

*Science*, this issue p. 1434;  
see also p. 1399

## HUMAN DEMOGRAPHY

**Mortality rates level off at extreme age**

The demography of human longevity is a contentious topic. On the basis of high-quality data from Italians aged 105 and older, Barbi *et al.* show that mortality is constant at extreme ages but at levels that decline somewhat across cohorts. Human death rates increase exponentially up to about age 80, then decelerate, and plateau after age 105. —AMS

*Science*, this issue p. 1459

## HEALTH CARE

**End-of-life health care spending**

In the United States, one-quarter of Medicare spending occurs in the last 12 months of life, which is commonly seen as evidence of waste. Einav *et al.* used predictive modeling to reassess this interpretation. From detailed Medicare claims data, the extent to which spending is concentrated not just on those who die, but on those who are expected to die, can be estimated. Most deaths are unpredictable; hence, focusing on end-of-life spending does not necessarily identify “wasteful” spending. —AMS

*Science*, this issue p. 1462

## CLIMATE CHANGE

**Warming after the big one**

The Chicxulub impact 65 million years ago, which caused the mass extinction at the

Cretaceous-Paleogene boundary, also initiated a long period of strong global warming. Using data from phosphatic microfossils, including fish teeth, scales, and bone, MacLeod *et al.* estimated global average temperature. Immediately after the asteroid strike, temperatures increased by ~5°C and remained high for about 100,000 years (see the Perspective by Lécuyer). These results are relevant to current climate projections, because the Chicxulub impact perturbed Earth systems on time scales even shorter than the current rate of change. —HJS

*Science*, this issue p. 1467;  
see also p. 1400

## NEUROSCIENCE

### Behavior with movement

The neuronal circuits required for movement reside in the spinal cord. But how does the nervous system coordinate multiple neuronal populations across different brain regions to fulfil an organism's behavioral needs? In a Perspective, Arber and Costa explore the organizational logic of specialized spinal microcircuits, sensory feedback loops, and brain motor commands. How action choice occurs, however, remains a mystery. —GKA

*Science*, this issue p. 1403

## MATERIALS

### A more sustainable materials system

Large-scale use and consumption of materials are central to modern lifestyles but increasingly cause environmental problems. In a Perspective, Olivetti and Cullen outline the impacts and indicate that a more sustainable materials system can be achieved by reducing consumption and changing technology. Economic incentives alone will not be sufficient to achieve the required changes. In addition, lifetime extension, higher manufacturing efficiency, and recovery are essential. Such reforms must be supported by

governance and education to drive research and practice in a more sustainable direction.

—JFU

*Science*, this issue p. 1396

## MALARIA

### Uncomplicating malaria

Severe malaria is caused by the parasite *Plasmodium falciparum*. Infections can result in organ failure and life-threatening hematological or metabolic abnormalities. Lee *et al.* sequenced patient and parasite transcriptomes from 46 *P. falciparum*-infected Gambian children to better understand host-pathogen interactions. The immune response in severe malaria, compared with that in uncomplicated malaria, was not necessarily dysregulated but instead reflected high parasite loads, although there was a distinct neutrophil response. —CAC

*Sci. Transl. Med.* **10**, eaar3619 (2018).

## SEPSIS

### Inflammatory decoy control

Bacterial infection can lead to sepsis, inflammation, and death. Li *et al.* found that the long noncoding RNA MEG3-4 and the mRNA encoding the proinflammatory cytokine interleukin-1 $\beta$  (IL-1 $\beta$ ) competitively bound to the microRNA miR-138 in the lungs of bacterially infected mice. Initially, MEG3-4 binding to miR-138 facilitated IL-1 $\beta$  production, but it ultimately shut down IL-1 $\beta$ -dependent inflammation. Lung-specific overexpression of MEG3-4 prolonged infection and exacerbated inflammation and lung injury in mice, whereas intravenously delivering miR-138 mimics to infected mice enhanced their survival. —LKF

*Sci. Signal.* **11**, eaao2387 (2018).