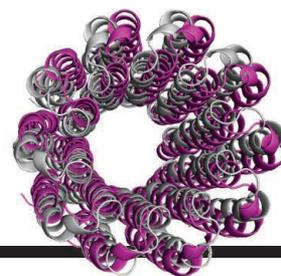


# RESEARCH

## Structure of yeast ATP synthase

Srivastava et al., p. 619



## IN SCIENCE JOURNALS

Edited by **Caroline Ash**

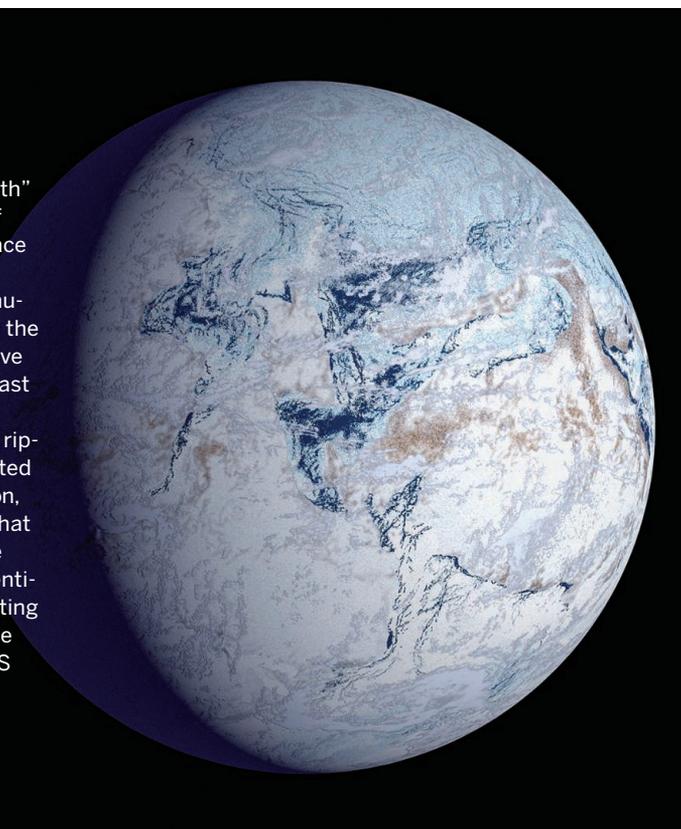
### SNOWBALL EARTH

#### A fast-melting snowball

**T**he Marinoan “snowball Earth” glaciation covered most of the planet in ice. The surface melted only when enough carbon dioxide had accumulated in the atmosphere to trap the Sun’s warmth. Melting must have occurred rapidly, but just how fast has been a topic of conjecture. Myrow *et al.* analyzed the wave ripples preserved in tidally deposited siltstones of the Elatina Formation, South Australia, to determine that sea level must have risen at the astounding rate of nearly 30 centimeters per year during the melting epoch, or roughly 100 times the rate that it is rising today. —HJS

*Science*, this issue p. 649

Artist’s rendering of the Neoproterozoic snowball Earth



### STRUCTURAL BIOLOGY

#### Toxic hijack of a cell signaling pathway

The pathogen *Clostridium difficile* colonizes the human colon when the normal microbiota is disrupted, often after antibiotic treatment. It is a leading cause of hospital-acquired diarrhea, especially among elderly patients. Chen *et al.* describe a 2.5-Å-resolution crystal structure that shows how a major virulence factor in *C. difficile*, toxin B (TcdB), binds to the G protein-coupled receptor Frizzled (FZD). This receptor activates the Wnt signaling pathway, which regulates

homeostasis of the colonic epithelium. Surprisingly, TcdB uses a lipid cofactor to recognize FZD. This cofactor replaces a lipid normally associated with the Wnt ligand that binds FZD to activate signaling. Inhibiting the Wnt pathway likely plays a role in *C. difficile* pathology. —VV

*Science*, this issue p. 664

### CANCER

#### Anatomically correct tumor genomics

Glioblastoma is the most lethal form of human brain cancer. The genomic alterations and gene expression profiles characterizing

this tumor type have been widely studied. Puchalski *et al.* created the Ivy Glioblastoma Atlas, a freely available online resource for the research community. The atlas, a collaborative effort between bioinformaticians and pathologists, maps molecular features of glioblastomas, such as transcriptional signatures, to histologically defined anatomical regions of the tumors. The relationships identified in this atlas, in conjunction with associated databases of clinical and genomic information, could provide new insights into the pathogenesis, diagnosis, and treatment of glioblastoma. —PAK

*Science*, this issue p. 660

### CELL BIOLOGY

#### Tasting with ATP and mitochondria

The savory taste of umami, the sweetness of sugar, and the bitterness of quinine are transduced by type II taste cells. Unlike most other receptor cells, type II taste cells release their neurotransmitter, adenosine triphosphate (ATP), through voltage-gated CALHM1 channels, instead of in vesicles. Romanov *et al.* found that ATP came from unusually large mitochondria that were adjacent to clusters of CALHM1 channels within the plasma membrane. This anatomy enables neurotransmission that does not rely on vesicles. —WW

*Sci. Signal.* **11**, eaao1815 (2018).

### INTERSTELLAR MEDIUM

#### A vibrating molecular cloud in three dimensions

Molecular clouds are relatively dense assemblies of interstellar dust and gas (mostly molecular hydrogen) from which stars form. Determining the three-dimensional (3D) morphology of these clouds is difficult because we only see a 2D projection of them onto the sky. While examining far-infrared observations of the nearby Musca cloud, Tritsis and Tassis discovered that the cloud is vibrating with magnetohydrodynamic waves. The pattern of vibrations reveals the 3D structure and shows that Musca is a sheet seen edge-on, not a filament as previously assumed. —KTS

*Science*, this issue p. 635

## EVOLUTIONARY GENOMICS Selection, recombination, and hybrid evolution

Hybridization is an important force in evolution. The effects of hybridization across the whole genome are not understood. Using a fine-scale genetic map, Schumer *et al.* examined local ancestry in replicate natural hybrid populations of swordtail fish. Each parental species contributes different proportions of genetic material to the genomes of their descendants. Genes from the “minor” (less well-represented) parent occur in regions of the genome that are subject to higher recombination rates and where there are fewer potentially deleterious genes. Neanderthal ancestry in human genomes shows similar patterns. —LMZ

*Science*, this issue p. 656

## FISHERIES

### Big mammas matter for fish

The theoretical relationship between reproduction and body size has assumed that total mass relates directly to fecundity, regardless of the number of individuals involved. This assumption leads to fisheries management practices that suggest that one large female fish can be replaced by several smaller females. However, this assumption is incorrect. Barneche *et al.* show that larger females are far more productive than the same weight's worth of smaller females. Management practices that ignore the value of large females could contribute to unexplained declines seen in some fish stocks. —SNV

*Science*, this issue p. 642



The Atlantic cod,  
*Gadus morhua*

## NEUROENGINEERING Decoding brain-computer interfaces

Brain-computer interfaces (BCIs) can help humans with compromised motor function by using their brain activity to externally control movements. Existing methods, however, require extensive user training and effort. Ganesh *et al.* developed a BCI technique for decoding sensorimotor prediction errors that requires less user energy. It subliminally stimulates the user to think about an activity and then, instead of decoding what movement a user intends, decodes whether the movement that the user wants matches the sensory feedback that the stimulator induced. In 12 healthy individuals performing a wheelchair-turning task, this interface represented movements speedily (within 96 milliseconds) and without any training. —PJB

*Sci. Adv.* 10.1126/  
sciadv.aag0183 (2018).

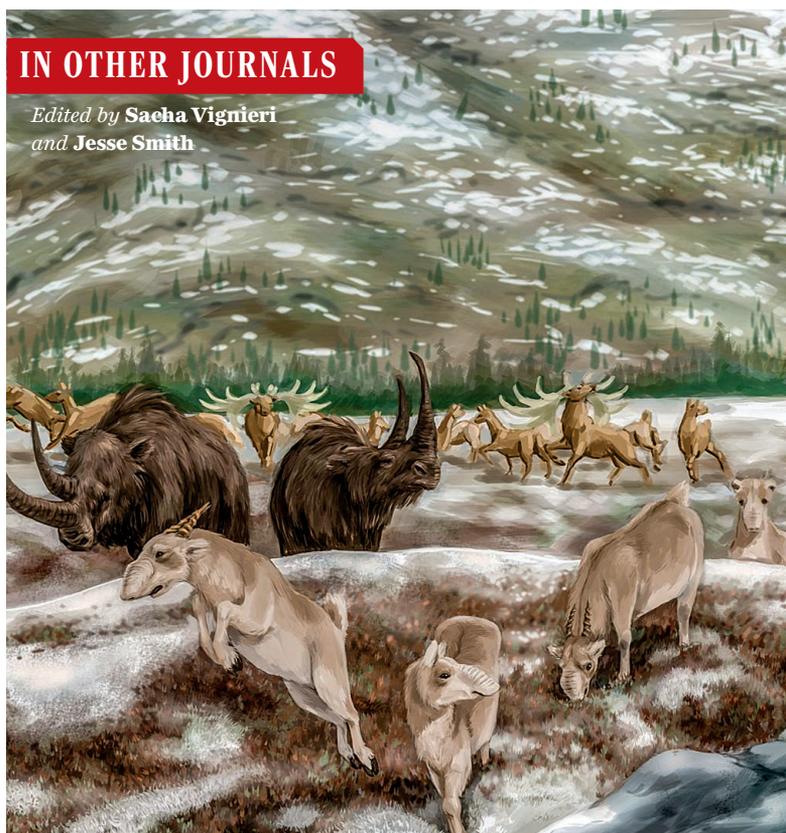
## ORGANIC CHEMISTRY H-bond to deliver fluoride

Simple fluoride salts are theoretically convenient reagents for carbon-fluorine bond formation. In practice, they are often insoluble in the solvents that dissolve their reaction partners. Pupo *et al.* developed urea-based catalysts that make fluoride soluble through hydrogen bonding. Moreover, their chiral substituents bias the reaction toward one of two mirror image products of C–F bond formation. This strategy should be applicable to the asymmetric addition of other salts, too. —JSY

*Science*, this issue p. 638

## IN OTHER JOURNALS

Edited by Sacha Vignieri  
and Jesse Smith



## MOLECULAR BIOLOGY

### Stress granule transcription

When translation initiation is stalled under stress, non-translating messenger ribonucleoproteins form insoluble assemblies called stress granules (SGs) in the cytosol. Namkoong *et al.* sequenced all transcripts from purified SGs. They found that although translation of most transcripts is inhibited, only a subset of transcripts form SGs. The length and abundance of the AU-rich elements are key features determining SG-targeting specificity, agreeing with a recent report by Van Treeck *et al.* showing that RNA self-assembly drives SG formation. SGs have been implicated in cancer and neurodegenerative diseases; understanding the specificity of their RNA components and the principles of their formation offers insights into their pathological contribution. —SYM

*Mol Cell.* 10.1016/j.molcel.2018.02.025;

*Proc. Natl. Acad. Sci. U.S.A.* 10.1073/  
pnas.1800038115 (2018).

## ACADEMIC POLICIES

### Stop the clock: Tenure, gender, and children

Allowing both male and female faculty to stop their tenure clock when having a child can increase tenure rates for the former and reduce them for the latter. Antecol *et al.* analyzed data on all assistant-professor hires at top-50 economics departments from 1980 to 2005; 44% of women and 47% of men had a child within 5 years of completing their Ph.D., before typical tenure deadlines. Differential effects of clock policies on tenure are driven by the fact that men publish more in top-tier journals after policies take effect, whereas women do not. Policies may not compensate for the specific productivity challenges that women face after childbirth. Despite this early setback, and the subsequent career churn, clock policies do not hurt women's chances of ultimately gaining tenure in the profession. —BW

*Amer. Econ. Rev.* 10.1257/  
aer.20160613 (2018).

## ALSO IN SCIENCE JOURNALS

Edited by **Caroline Ash**

## ADIPOGENIC REGULATION

**Integrating glucose and fat**

Consuming too much glucose makes you fat, but it is unclear how this conversion is mediated by the body. Glycolysis links to gene transcription via the essential coenzyme nicotinamide adenine dinucleotide in its oxidized state (NAD<sup>+</sup>). Ryu *et al.* found that compartmentalized NAD<sup>+</sup> synthesis and consumption integrate glucose metabolism and adipogenic (fat-promoting) transcription during adipocyte differentiation (see the Perspective by Trefely and Wellen). Competition between the NAD<sup>+</sup> precursors—nuclear NMNAT-1 and cytosolic NMNAT-2—for their common substrate, nicotinamide mononucleotide, regulates the balance between nuclear NAD<sup>+</sup> synthesis for adipogenic gene regulation and cytosolic NAD<sup>+</sup> synthesis used in metabolism. —BAP

*Science*, this issue p. 618;  
see also p. 603

## MOLECULAR MOTORS

**Protons find a path**

Adenosine triphosphate (ATP) synthases are dynamos that interconvert rotational and chemical energy. Capturing the complete structure of these multisubunit membrane-bound complexes has been hindered by their inherent ability to adopt multiple conformations. Srivastava *et al.* used protein engineering to freeze mitochondrial ATP synthase from yeast in a single conformation and obtained a structure with the inhibitor oligomycin, which binds to the rotating c-ring within the membrane. Hahn *et al.* show that chloroplast ATP synthase contains a built-in inhibitor triggered by oxidizing conditions in the dark chloroplast. The mechanisms by which these machines are powered are remarkably similar: Protons are shuttled through a channel

to the membrane-embedded c-ring, where they drive nearly a full rotation of the rotor before exiting through another channel on the opposite side of the membrane (see the Perspective by Kane). —VV and MAF

*Science*, this issue p. 619, p. 620;  
see also p. 600

## AMPHIBIAN DECLINE

**Panzootic chytrid fungus out of Asia**

Species in the fungal genus *Batrachochytrium* are responsible for severe declines in the populations of amphibians globally. The sources of these pathogens have been uncertain. O'Hanlon *et al.* used genomics on a panel of more than 200 isolates to trace the source of the frog pathogen *B. dendrobatidis* to a hyperdiverse hotspot in the Korean peninsula (see the Perspective by Lips). Over the past century, the trade in amphibian species has accelerated, and now all lineages of *B. dendrobatidis* occur in traded amphibians; the fungus has become ubiquitous and is diversifying rapidly. —CA

*Science*, this issue p. 621;  
see also p. 604

## NUCLEAR PHYSICS

**How long does a neutron live?**

Unlike the proton, whose lifetime is longer than the age of the universe, a free neutron decays with a lifetime of about 15 minutes. Measuring the exact lifetime of neutrons is surprisingly tricky; putting them in a container and monitoring their decay can lead to errors because some neutrons will be lost owing to interactions with the container walls. To overcome this problem, Pattie *et al.* measured the lifetime in a trap where ultracold polarized neutrons were levitated by magnetic fields, precluding interactions with the

trap walls (see the Perspective by Mumm). This more precise determination of the neutron lifetime will aid our understanding of how the first nuclei formed after the Big Bang. —JS

*Science*, this issue p. 627;  
see also p. 605

## METAMATERIALS

**Giving a hand to metamaterials**

Auxetic materials expand in an unusual way: perpendicular to the direction in which they are stretched. Lipton *et al.* engineered a type of auxetic material that also has handedness. When this material is sheared, it twists either to the right or the left. By tiling the underlying patterns onto spheres and cylinders, rigid or compliant structures can be made. Linear and 4-degree-of-freedom actuators can thus be made from hollow tubes, which could be valuable for a variety of engineering and medical applications. —BG

*Science*, this issue p. 632

## SEX DETERMINATION

**Making males and back again**

Temperature-dependent sex determination occurs in many reptilian species. An epigenetic mechanism is presumed to be at work, but thus far it has not been identified. Ge *et al.* show that in the red-eared slider turtle, an epigenetic modifier, the histone demethylase KDM6B, binds to the promoter of the dominant male gene to activate male development (see the Perspective by Georges and Holleley). Knock down the expression of KDM6B, and embryos destined to be male turn into females. —SNV

*Science*, this issue p. 645;  
see also p. 601

## COGNITIVE PSYCHOLOGY

**Balancing costs and performance**

Deciding whether a novel object is another instance of something already known or an example of something different is an easily solved problem. Empirical mapping of human performance across a wide range of domains has established an exponential relationship between the generalization gradient and interstimuli distance. Sims now shows that this relationship can be derived from a consideration of the costs of optimal information coding. —AMS and GJC

*Science*, this issue p. 652

## GEOPHYSICS

**Knowing how to prevent induced earthquakes**

Increasing evidence from around the world shows that human activities below Earth's surface, such as gas extraction and wastewater injection, can cause earthquakes. In a Perspective, Candela *et al.* explain some of the underlying mechanisms. Wastewater injection in Oklahoma, USA, and gas extraction in Groningen, the Netherlands, have notoriously caused earthquakes. Although the detailed mechanisms differ in the two situations, preexisting conditions within Earth's crust, such as faults and stresses, play a key role in whether an induced earthquake will occur. Knowledge of subsurface conditions is thus crucial to avoid sites that are vulnerable to induced earthquakes. —JFU

*Science*, this issue p. 598

## T CELLS

**Micromanaging NOD1 in T cells**

MicroRNAs constitute an additional layer of regulation between gene transcription and translation of mRNA. Schmolka

*et al.* show that the microRNA miR-146a is highly expressed in a subset of  $\gamma\delta$  T cells called CD27<sup>-</sup> $\gamma\delta$  T cells. These cells coexpress the cytokines interleukin-17 and interferon- $\gamma$  (IFN- $\gamma$ ). miR-146a represses IFN- $\gamma$  expression in CD27<sup>-</sup> $\gamma\delta$  T cells by targeting a pattern recognition receptor (PRR) called NOD1, which recognizes bacterial peptidoglycan. Deletion of NOD1 impaired production of IFN- $\gamma$  in the CD27<sup>-</sup> $\gamma\delta$  T cells by an as-yet unknown mechanism. The study adds to the increasing appreciation of the noncanonical functions of PRRs. —AB

*Sci. Immunol.* **3**, eaao1392 (2018).

### SPINAL CORD INJURY

## Spinal cord stem cell grafts in pigs

Neuronal precursor cells (NPCs) hold promise for treating spinal cord injury. Testing viability and engraftment properties of NPC transplants in large animal models is essential for understanding the clinical potential of this approach. Strnadel *et al.* transplanted syngeneic and allogeneic induced pluripotent stem cell-derived NPCs (iPSC-NPCs) into the spinal cords of naïve pigs and pigs with spinal cord injury. The transplanted cells showed a good safety profile, long-term survival, and differentiation into mature neurons and glial cells. Successful engraftment of allogeneic iPSC-NPCs required only temporary immunosuppression, an important consideration for the future clinical evaluation of iPSC-NPCs for treating spinal injuries. —MM

*Sci. Transl. Med.* **10**, eaam6651 (2018).