RESEARCH

IN *SCIENCE* JOURNALS

Edited by **Michael Funk**

CLIMATE FORCING

Not a big deal after all

Do volcanic eruptions affect El Niño–Southern Oscillation (ENSO) variability? Models indicate that sulfate aerosols resulting from large eruptions can initiate an El Niño–like response in the tropical Pacific, but observations have not shown evidence of such behavior. Dee *et al*. present an oxygen-isotope time series of fossil corals from the central tropical Pacific to investigate ENSO's response to large volcanic eruptions during the past millennium. They found a weak tendency for an El Niño–like response in the year after an eruption, but not one that was statistically significant. These results suggest that large volcanic events have not triggered a detectable response in ENSO over the past thousand years and that their impact is small relative to the degree of natural variability. —HJS *Science*, this issue p. 1477

Mount Rinjani on the island of Lombok in Indonesia lies in a crater left behind by the massive eruption of the Samalas volcano in 1257 CE.

PHOTO: PATRICK TR/SHUTTERSTOCK

PLANT SCIENCE

Fruit abscission in response to drought

Plants faced with drought, or simply not quite enough water, may be more likely to drop their fruit prematurely. Reichardt *et al*. found that a small signaling peptide hormone, phytosulfokine, which was previously known for its ability to regulate plant cell growth, also drives fruit abscission. Processed, and thus activated, by a subtilisin-like protease, phytosulfokine in turn drives expression of the hydrolases that degrade the cell walls in the abscission zone, leading to dropped fruit. —PJH

Science, this issue p. 1482

ASTROPARTICLE PHYSICS

X-ray data constrain dark matter decay

Dark matter may consist of previously unknown forms of subatomic particles. An unidentified astronomical x-ray emission line has been interpreted as being caused by the decay of a dark matter particle. If this is correct, then dark matter in the halo of the Milky Way Galaxy should produce a faint emission line across the whole sky. Dessert *et al*. tested this hypothesis using observations by the XMM-Newton (X-ray Multi-Mirror Mission) space telescope. Analyzing blank-sky regions with a total exposure time of about a year, they found no evidence for the predicted line and set upper limits on the decay rate that rule out the previously proposed dark matter interpretation. —KTS

Science, this issue p. 1465

CORONAVIRUS

How SARS-CoV-2 binds to human cells

Scientists are racing to learn the secrets of severe acute respiratory syndrome–coronavirus 2 (SARS-CoV-2), which is the cause of the pandemic disease COVID-19. The first step in viral entry is the binding of the viral trimeric spike protein to the human receptor angiotensin-converting enzyme 2 (ACE2). Yan *et al*. present the structure of human ACE2 in complex with a membrane protein that it chaperones,

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B^{0}AT1. In the context of this complex, ACE2 is a dimer. A further structure shows how the receptor binding domain of SARS-CoV-2 interacts with ACE2 and suggests that it is possible that two trimeric spike proteins bind to an ACE2 dimer. The structures provide a basis for the development of therapeutics targeting this crucial interaction. —VV

Science, this issue p. 1444

QUANTUM GASES

Capturing the transformation

Quantum statistics dictates the behavior of identical particles in the quantum world: Bosons like to congregate, whereas fermions avoid one another. However, strong interactions can cause a string of bosons to behave like fermions. This so-called fermionization phenomenon has been studied in equilibrium. Wilson *et al*. instead focused on dynamical fermionization in a nonequilibrium system consisting of tubes of strongly interacting bosonic rubidium atoms. After letting the tubes expand in the axial direction, the researchers monitored the momentum distribution of the atoms and found that it evolved from bosonic-like to fermionic-like. —JS

Science, this issue p. 1461

GLASSES

Glassy metal-organic frameworks

The node-and-linker structure of metal-organic frameworks could enable detailed structural studies of molecular glasses quenched from melts. Zinc-based zeolitic imidazole frameworks exhibit a high propensity for glass formation at conventional cooling rates. Madsen *et al*. used ultrahigh magnetic fields (19.5 and 35.2 tesla) to perform zinc-67 nuclear magnetic resonance of solid samples with magic-angle spinning on three samples with different ratios of imidazole and benzimidazole linkers. The structural disorder of the tetrahedral ligand environment around zinc nodes was higher in the glassy states than in the parent crystals. —PDS

Science, this issue p. 1473

CANCER

Metastasis: A matter of translation?

Solid tumors shed a small number of cancer cells into the bloodstream, some of which are believed to contribute to metastasis. The molecular features that confer these circulating tumor cells (CTCs) with metastatic potential are poorly understood. Ebright *et al*. studied CTCs from breast cancer patients and found that cells with increased expression levels of certain ribosomal proteins and regulators of translation had greater metastatic capacity in a mouse model (see the Perspective by Ma and Jeffrey). Consistent with this finding, patients with higher levels of this subset of CTCs tended to have a poorer prognosis. —PAK

Science, this issue p. 1468; see also p. 1424

IMMUNOTHERAPY

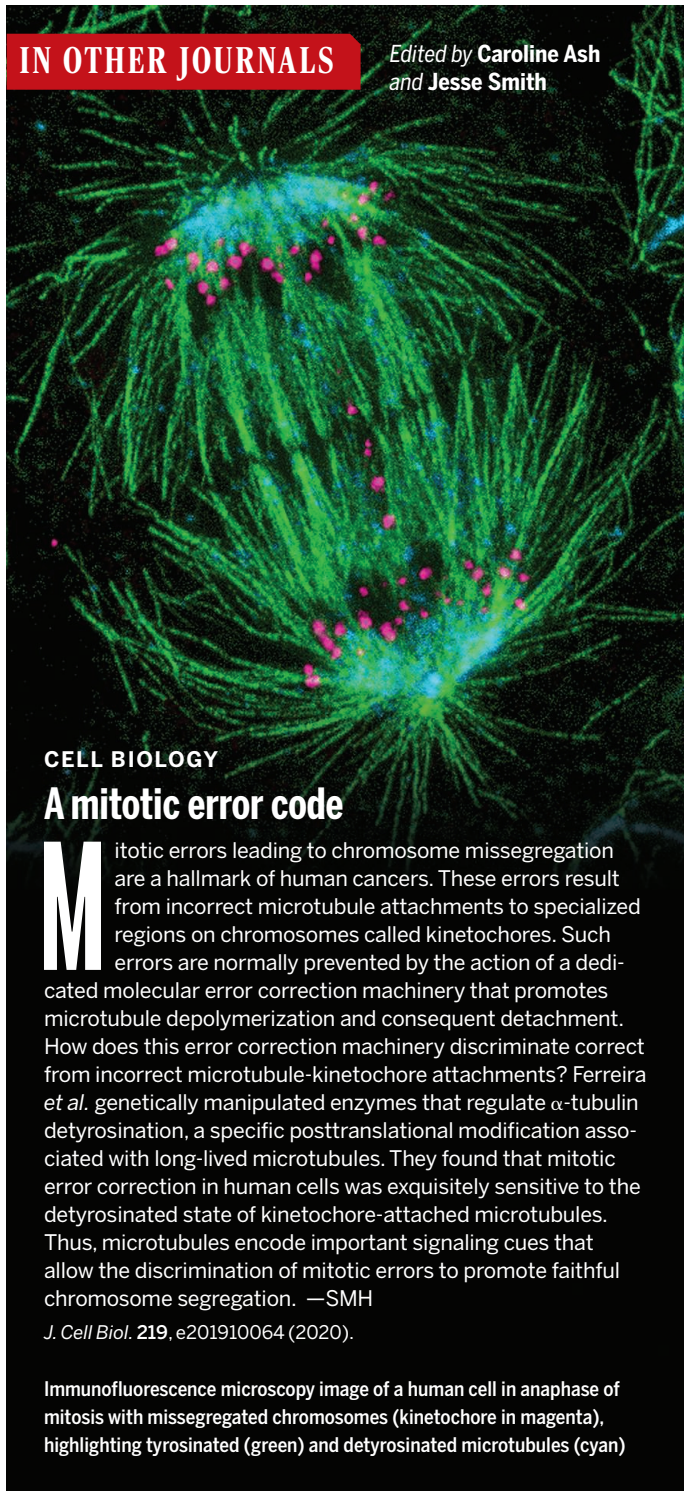
Priming NK cells for tumor destruction

Some tumors can evade CD8$^+$ T cells, which are used in several cancer immunotherapies, but natural killer (NK) cells provide another option to target such tumors for immune elimination. Nicolai *et al*. used several mouse models to investigate how a cyclic dinucleotide (CDN) agonist for an innate immune pathway called STING potentiates the antitumor activity of NK cells. CDN administration induced type I interferons that directly promoted NK cell activation and simultaneously enabled an indirect pathway of activation driven by induction of interleukin-15 signaling in dendritic cells. Amplification of NK-based tumor immunity may offer a valuable adjunct to CD8$^+$ T cell immunotherapy. —IW

Sci. Immunol. **5**, eaaz2738 (2020).

IN OTHER JOURNALS

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



CELL BIOLOGY

A mitotic error code

Mitotic errors leading to chromosome missegregation are a hallmark of human cancers. These errors result from incorrect microtubule attachments to specialized regions on chromosomes called kinetochores. Such errors are normally prevented by the action of a dedicated molecular error correction machinery that promotes microtubule depolymerization and consequent detachment. How does this error correction machinery discriminate correct from incorrect microtubule-kinetochore attachments? Ferreira *et al.* genetically manipulated enzymes that regulate α-tubulin detyrosination, a specific posttranslational modification associated with long-lived microtubules. They found that mitotic error correction in human cells was exquisitely sensitive to the detyrosinated state of kinetochore-attached microtubules. Thus, microtubules encode important signaling cues that allow the discrimination of mitotic errors to promote faithful chromosome segregation. —SMH

J. Cell Biol. **219**, e201910064 (2020).

Immunofluorescence microscopy image of a human cell in anaphase of mitosis with missegregated chromosomes (kinetochore in magenta), highlighting tyrosinated (green) and detyrosinated microtubules (cyan)

PHOTO: LUÍSA FERREIRA AND HELDER MAIATO

REPRODUCTIVE BIOLOGY

In search of a male contraceptive

Although "the pill" has been widely used by women since the 1960s, contraceptive options for men are limited. Gruber *et al.* used an automated robotic screening method that tests candidate molecules for effects on sperm motility and changes in the cap or acrosome of the sperm's head. They identified several compounds from a collection of 12,000 molecules from the ReFRAME (Repurposing, Focused Rescue, and Accelerated

ALSO IN *SCIENCE* JOURNALS

Edited by **Michael Funk**

MEDICINE

Knocking down neurodegeneration

Antisense oligonucleotides (ASOs) target RNAs to prevent the production of an encoded protein. This therapy can therefore be used to suppress the expression of pathogenic proteins. In a Perspective, Leavitt and Tabrizi discuss the progress in developing and testing ASOs in patients with Huntington's disease. They also discuss the development of ASOs for potential application to other neurodegenerative diseases, including Alzheimer's disease and Parkinson's disease. These drugs are promising therapeutics for the treatment of neurological diseases as well as non-neurological conditions such as cancer. —GKA

Science, this issue p. 1428

ECONOMIC HISTORY

Deep origins of modern inequality

Methodological innovations are enabling scientists to study how events in the distant past affect contemporary life. Nunn reviews recent research at the intersection of history, development, and culture that aims to understand the cultural evolution of economic development. The persistence of global inequality is used as a case study to demonstrate the interplay of these dynamics. Future areas of research and implications for policy are discussed. —TSR

Science, this issue p. 1441

TOPOLOGICAL MATTER

A possible Majorana sighting

Majorana zero modes, exotic quasiparticles predicted to occur in topological superconductors, hold promise as a building block of topological quantum computing. Two of the frontrunners for the physical implementation of Majoranas include hybrid semiconductor-superconductor nanowires and topological insulators in contact with a superconductor. Vaitiekėnas *et al*. introduce a platform that combines elements of both: a semiconductor nanowire that is fully wrapped by a superconductor. Combining theoretical calculations with experiments, the researchers present evidence that is consistent with the emergence of Majorana zero modes in this system. —JS

Science, this issue p. 1442

ARCHAEOLOGY

Fruits of the sea

The origins of marine resource consumption by humans have been much debated. Zilhão *et al*. present evidence that, in Atlantic Iberia's coastal settings, Middle Paleolithic Neanderthals exploited marine resources at a scale on par with the modern human–associated Middle Stone Age of southern Africa (see the Perspective by Will). Excavations at the Figueira Brava site on Portugal's Atlantic coast reveal shell middens rich in the remains of mollusks, crabs, and fish, as well as terrestrial food items. Familiarity with the sea and its resources may thus have been widespread for residents there in the Middle Paleolithic. The Figueira Brava Neanderthals also exploited stone pine nuts in a way akin to that previously identified in the Holocene of Iberia. These findings add broader dimensions to our understanding of the role of aquatic resources in the subsistence of Paleolithic humans. —AMS

Science, this issue p. 1443; see also p. 1422

CLONAL EXPANSION

Evolutionary dynamics in hematopoiesis

Cells accumulate mutations as we age, and these mutations can be a source of diseases such as cancer. How cells containing mutations evolve, are maintained, and proliferate within the body has not been well characterized. Using a quantitative framework, Watson *et al*. applied population genetic theory to estimate mutation accumulation in cells in blood from sequencing data derived from nearly 50,000 healthy individuals (see the Perspective by Curtis). By evaluating how mutations differ between blood cell populations, a phenomenon known as clonal hematopoiesis, the researchers could observe how recurrent mutations can drive certain clonal lineages to high frequencies within an individual. The risk of specific mutations, some of which are associated with leukemias, rising to high frequencies may therefore be a function of cellular selection and the age at which the mutation originated. —LMZ

Science, this issue p. 1449; see also p. 1426

SUPERCONDUCTIVITY

A resilient superconductor

Superconductivity typically does not fare well in the presence of magnetic fields, which tend to break the electron pairs that make a material superconducting. However, some materials, such as the recently discovered Ising superconductors, retain their properties in very high magnetic fields. Ising pairing was identified in transition metal dichalcogenides such as molybdenum disulfide and required the breaking of inversion symmetry. Falson *et al*. have now found a similar resilience to in-plane magnetic fields in another two-dimensional material, few-layer stanene. The band structure of stanene and the lack of inversion symmetry breaking in the system required a distinct theoretical model to explain this property, now dubbed type II Ising pairing. —JS

Science, this issue p. 1454

SPECTROSCOPY

Precision spectroscopy with single ions

Spectroscopy is a powerful tool that can identify chemical species used in a wide range of settings. Usually, the samples are formed of ensembles, and this can limit the resolution with which the different species can be detected or identified. Chou *et al*. demonstrate an optical frequency comb technique with a single pair of trapped ions, Ca^+ and CaH^+, to obtain the rotational spectrum of a single trapped ion, CaH^+. With the ions isolated and the ensemble interactions removed, the rotational structure of the trapped molecular ion can then be obtained with high precision. As the trapping and manipulation process is general, this technique could be applied to a number of chemical species for specific purposes. —ISO

Science, this issue p. 1458

OCEAN CIRCULATION

Disrupting deep circulation

Atlantic Meridional Overturning Circulation (AMOC) and the related process of North Atlantic Deep Water (NADW) have been thought to be stable during warm, interglacial periods. Galaasen *et al*. report that episodes of reduced NADW over the past 500,000 years actually have been relatively common and occasionally long-lasting features of interglacials and that they can occur independently of the catastrophic freshwater outburst floods normally thought to be their cause (see the Perspective by Stocker). This discovery implies that large NADW disruptions might be more likely than we have assumed in the warmer climate of the future. —HJS

Science, this issue p. 1485; see also p. 1425

NUTRITION

Salting neutrophils' game

Sodium chloride, commonly known as table salt, has been shown to invigorate immune responses in various contexts. However, Jobin *et al*. now show that salt can impair antibacterial responses in the neutrophils of mice. Animals on a high-salt diet experienced exacerbated *Escherichia coli* kidney or systemic *Listeria monocytogenes* infections due to a reduced capacity of neutrophils to kill ingested bacteria. The neutrophil deficiencies were not caused directly by salt or urea, but instead were dependent on salt-induced hyperglucocorticoidism. Neutrophils from healthy human volunteers who had consumed additional salt in their diet were also less capable of controlling bacteria ex vivo. High-salt diets need further investigation as a factor in some types of infections. —LP

Sci. Transl. Med. **12**, eaay3850 (2020).

IMMUNOLOGY

Inflamed by TLR4 internalization

The pattern recognition receptor Toll-like receptor 4 (TLR4) stimulates the production of proinflammatory cytokines when activated on the cell surface, but endocytosed TLR4 signals through different effectors to drive the production of an antiviral cytokine called interferon-β. Metwally *et al*. found that endocytosed TLR4 also contributed to the production of a pair of proinflammatory cytokines. Endocytosed TLR4 promoted the noncanonical phosphorylation of the transcription factor STAT1, which alters its target DNA motif and, in a series of steps, stimulates the production of the cytokines. These results add another dimension to signaling by TLR4 after endocytosis. —JFF

Sci. Signal. **13**, eaay0574 (2020).