

RESEARCH

Solution processing with tandem organic solar cells

Meng et al., p. 1094



IN SCIENCE JOURNALS

Edited by Stella Hurtley



MIGRATION

Bird forecast

Billions of birds migrate across the globe each year, and, in our modern environment, many collide with human-made structures and vehicles. The ability to predict peak timing and locations of migratory events could greatly improve our ability to reduce such collisions. Van Doren and Horton used radar and atmospheric-condition data to predict the peaks and flows of migrating birds across North America. Their models predicted, with high accuracy, patterns of bird migration at altitudes between 0 and 3000 meters and as far as 7 days in advance, a time span that will allow for planning and preparation around these important events. —SNV *Science*, this issue p. 1115

A new prediction framework will protect migrating birds like this blue-winged warbler.

ENZYME DESIGN

Metals brought together do more

Enzymatic reduction of oxyanions such as sulfite (SO_3^{2-}) requires the delivery of multiple electrons and protons, a feat accomplished by cofactors tailored for catalysis and electron transport. Replicating this strategy in protein scaffolds may expand the range of enzymes that can be designed de novo. Mirts *et al.* selected a scaffold protein containing a natural heme cofactor and then engineered a cavity suitable for binding a second cofactor—an iron-sulfur cluster (see the Perspective by Lancaster). The resulting designed enzyme was optimized through rational mutation into a catalyst with spectral characteristics and activity similar to that of natural sulfite reductases. —MAF

Science, this issue p. 1098;
see also p. 1071

ROBOTICS

Flying fast and free

Insect flight can be fast and agile, making it hard to study its detailed aerodynamics. Karásek *et al.* designed an untethered, flapping-wing robot with impressive agility that can mimic fruitfly maneuvers (see the Perspective by Ruffier). They studied the robot's motion during rapid banked turns, which revealed that passive motion through the turn generated yaw torque coupling. This correcting yaw rotation propelled the robot toward the escape heading needed for effective turning. —MSL

Science, this issue p. 1089;
see also p. 1073

BIOCHEMISTRY

A protein designed to sense metabolites

Many diseases cause characteristic changes in blood metabolites. Yu *et al.* describe

a paper-based assay in which a chosen metabolite can be oxidized to generate reduced nicotinamide adenine dinucleotide phosphate (NADPH). Color changes in a designed NADPH sensor protein are then quantified by a digital camera. The sensor system successfully generated point-of-care measurements of phenylalanine, glucose, and glutamate. Concentrations of phenylalanine in the blood of phenylketonuria patients were analyzed within minutes with only half a microliter of blood. —VV

Science, this issue p. 1122

FOREST ECOLOGY

Mapping global deforestation patterns

Forest loss is being driven by various factors, including commodity production, forestry, agriculture, wildfire, and urbanization. Curtis *et al.* used high-resolution Google Earth imagery to map

and classify global forest loss since 2001. Just over a quarter of global forest loss is due to deforestation through permanent land use change for the production of commodities, including beef, soy, palm oil, and wood fiber. Despite regional differences and efforts by governments, conservationists, and corporations to stem the losses, the overall rate of commodity-driven deforestation has not declined since 2001. —AMS

Science, this issue p. 1108

MOLECULAR BIOLOGY

RNA takes over DNA repair

Damage to DNA genomes is normally thought to be repaired with DNA. Pryor *et al.* now describe a clear exception (see the Perspective by Modesti). They found that RNA is routinely incorporated during the repair of DNA double-strand breaks through the mammalian nonhomologous end-joining (NHEJ) pathway. In a variety of contexts,

including V(D)J recombination and Cas9-induced genome engineering, two “DNA” polymerases specific to NHEJ preferentially added RNA in cells. These RNA additions facilitated the critical step of ligation and were later replaced by DNA to complete the NHEJ repair process. —SYM

Science, this issue p. 1126;
see also p. 1069

METAMATERIALS

Going quantum with metamaterials

Metasurfaces should allow wafer-thin surfaces to replace bulk optical components. Two reports now demonstrate that metasurfaces can be extended into the quantum optical regime. Wang *et al.* determined the quantum state of multiple photons by simply passing them through a dielectric metasurface, scattering them into single-photon detectors. Stav *et al.* used a dielectric metasurface to generate entanglement between spin and orbital angular momentum of single photons. The results should aid the development of integrated quantum optic circuits operating on a nanophotonic platform. —ISO

Science, this issue p. 1104, p. 1101

ORGANISMAL BIOLOGY

Teasing apart ant venom

Ant venoms are primarily made up of poorly characterized polypeptides. Robinson *et al.*

combined transcriptomics and mass spectrometry-based proteomics to determine the mechanism of action of giant red bull ant venoms. Most of the venom peptides stemmed from a diverse hymenopteran toxin gene superfamily. Two peptides were responsible for causing pain in mammals, but by two different mechanisms. One peptide had both pain-causing activity and incapacitated crickets, a food for these ants, thereby functioning in both defense and predation. —PJB

Sci. Adv. 10.1126/sciadv.aau4640
(2018).

HUNTINGTON'S DISEASE

Improving Huntington's disease detection

Early detection of Huntington's disease (HD) could help the development of therapeutic strategies to block or delay disease progression. Byrne *et al.* found that blood and cerebrospinal fluid concentrations of mutant huntingtin (mHTT) and neurofilament light (NfL) proteins correlated with disease severity in HD patients. Alterations in circulating mHTT and NfL concentrations were among the earliest detectable changes in HD. Thus, concentrations of these proteins in biofluids might be used in combination with other clinical measures for improving the accuracy and efficiency of early HD detection. —MM

Sci. Transl. Med. 10.eaat7108 (2018).

IN OTHER JOURNALS

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



CANCER

The benefits of marginal brain therapy

Diffuse gliomas are among the most common brain tumors in adults. Surgery is often successful, but, in many patients, the tumor eventually recurs at the surgical margins. A promising drug targets certain mutationally altered metabolic enzymes in gliomas but is toxic when delivered systemically. Shankar *et al.* hypothesized that both problems could be addressed by applying the drug directly to the surgical margins immediately after tumor resection. They developed a diagnostic tool that can be used in the operating room to determine tumor mutation status and, hence, drug sensitivity. By studying mouse models, they found that when they injected a sustained-release formulation of the drug directly into gliomas of the appropriate genotype, the mice survived

considerably longer than control mice. —PAK

Proc. Natl. Acad. Sci. U.S.A. 115, E8388
(2018).

DEVELOPMENTAL BIOLOGY

Unraveling the mystery of thalidomide

Off-label use of thalidomide became a worldwide trend in the 1950s and early 1960s to alleviate morning sickness. It resulted in a historical tragedy, as thousands of babies were born with severe birth defects. Donovan *et al.* may have found a missing link to explain how the drug affects fetal development. The researchers show that thalidomide and closely related drugs rapidly degrade the transcription factor Sal-like protein 4 (SALL4), which is necessary for fetal limb and organ formation. Adding further weight to their findings, certain individuals with mutations in the *SALL4*



The giant red bull ant has complex multifunctional venom.

ALSO IN SCIENCE JOURNALS

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IMMUNOLOGY

(IL-2) be or not to be?

Immunological T follicular helper (T_{FH}) cells are a subpopulation of $CD4^+$ T cells that support B cell antibody production and the establishment of B cell memory. By contrast, non- T_{FH} cells orchestrate enhanced innate immune cell functions at sites of pathogen encounter. The factors underlying differentiation into a T_{FH} or non- T_{FH} cell remain poorly understood, though there is evidence to suggest that the T cell growth factor interleukin-2 (IL-2) may play a role. Using IL-2 reporter mice, DiToro *et al.* show that naïve $CD4^+$ T cells that produce IL-2 are fated to become T_{FH} cells, whereas nonproducers, which receive IL-2, become non- T_{FH} cells. The $CD4^+$ T cell-fate decision was linked to T cell receptor strength—only those naïve $CD4^+$ T cells that received the highest T cell receptor signals were able to produce IL-2. —STS

Science, this issue p. 1086

ORGANIC CHEMISTRY

Steering together all four Ugi pieces

The nearly 60-year-old Ugi reaction is a remarkably efficient means of linking together four molecular building blocks: an aldehyde, an amine, a carboxylic acid, and an isocyanide. Because each component is independently tunable, the reaction is especially well suited to the assembly of diverse compound libraries. However, stereoselectivity has been a challenge. Zhang *et al.* now show that chiral phosphoric acids can catalyze the four-component coupling with high enantioselectivity (see the Perspective by Riva). Theory suggests that a hydrogen-bonded complex involving the phosphoric acid and carboxylic acid sets the stereochemistry for isocyanide attack on an imine intermediate. —JSY

Science, this issue p. 1087;
see also p. 1072

NEUROSCIENCE

Representing the identity of a smell

We still don't know how odors retain their identities over a range of concentrations. Working in mice, Bolding and Franks simultaneously recorded spiking activity from neurons in the olfactory bulb and piriform cortex, two important brain regions for olfaction. Odor information was transformed from a representation that was highly concentration dependent in the olfactory bulb to a representation that was largely concentration invariant in the piriform cortex. The underlying mechanism involves a "winner-takes-all" lateral inhibition. In the collateral network of the piriform cortex, the principal cells responded promptly to output from the olfactory bulb, and recurrent inhibition curtailed the intensity dependence of the signal. —PRS

Science, this issue p. 1088

SOLAR CELLS

Tailoring tandem organics

Tandem solar cells can boost efficiency by using a wider range of the solar spectrum. The bandgap of organic semiconductors can be tuned over a wide range, but, for a two-terminal device that directly connects the cells, the currents produced must be nearly equal. Meng *et al.* used a semiempirical analysis to choose well-matched top- and bottom-cell active layers. They used solution processing to fabricate an inverted tandem device that has a power conversion efficiency as high as 17.4%. —PDS

Science, this issue p. 1094

PROTEIN TARGETING

ER-SURF protein import into mitochondria

Eukaryotic cells contain membrane-bound organelles, defined by distinct protein compositions. Almost all cellular proteins are

synthesized in the cytosol, and thus, organelle-resident proteins must be directed to their appropriate location after synthesis. Working in yeast, Hansen *et al.* identified a protein-targeting paradigm termed ER-SURF, in which the membrane expansion of the endoplasmic reticulum (ER) serves as a "capture net" for mitochondrial proteins. This process productively redirected mitochondrial precursor proteins for efficient mitochondrial import. Thus, two distinct organelles, once thought to be mutually exclusive protein destinations, can cooperate during protein targeting. —SMH

Science, this issue p. 1118

SUSTAINABILITY

Gaia enters a new state

According to the Gaia hypothesis, living organisms and their inorganic environments form a self-regulating system that helps to maintain the conditions for life on Earth. In a Perspective, Lenton and Latour argue that Gaia is entering a new state—Gaia 2.0—in which humans are becoming aware of their influence on Earth processes and will change their behavior to improve conditions for life on Earth. The authors explore some of the fundamental features of Gaia and how they can inform efforts to maintain a self-regulating, human life-supporting planet. —JFU

Science, this issue p. 1066

CANCER THERAPY

A target for medulloblastoma

Medulloblastoma is an aggressive brain tumor that most often arises in children and lacks targeted therapeutic options. The subtypes driven by the sonic hedgehog (SHH) pathway are particularly resistant to current drugs, such as SMO inhibitors that suppress this pathway. Purzner *et al.* found that the kinase CK2 drove SHH signaling in medulloblastoma. CK2

inhibitors blocked the growth of SMO inhibitor-resistant, SHH-type human and mouse medulloblastoma cells and markedly extended the survival of tumor-bearing mice. A clinical trial is under way to test a CK2 inhibitor in pediatric patients. —LKF

Sci. Signal. **11**, eaau5147 (2018).

ALLERGY

Age matters in allergy

Development of allergy is driven by the type 2 cytokines interleukin-4 (IL-4), IL-5, and IL-13. Type 2 innate lymphoid cells (ILC2s) and T cells can produce these cytokines. Saglani *et al.* studied mouse models of allergic airway inflammation and found that the contributions of T cells and ILC2s were dependent on age. T cells were the predominant source of IL-13 in neonatal mice, whereas ILC2s were mainly responsible for cytokine production in adult mice. Given that neonates have fewer T cells than adults, the results are contrary to expectations and bring to the fore an unappreciated role of neonatal T cells. —AB

Sci. Immunol. **3**, eaan4128 (2018).

PLANT SCIENCE

Rapid, long-distance signaling in plants

A plant injured on one leaf by a nibbling insect can alert its other leaves to begin anticipatory defense responses. Working in the model plant *Arabidopsis*, Toyota *et al.* show that this systemic signal begins with the release of glutamate, which is perceived by glutamate receptor-like ion channels (see the Perspective by Muday and Brown-Harding). The ion channels then set off a cascade of changes in calcium ion concentration that propagate through the phloem vasculature and through intercellular channels called plasmodesmata. This glutamate-based long-distance signaling is rapid: Within minutes, an undamaged leaf can respond to the fate of a distant leaf. —PJH

Science, this issue p. 1112;
see also p. 1068