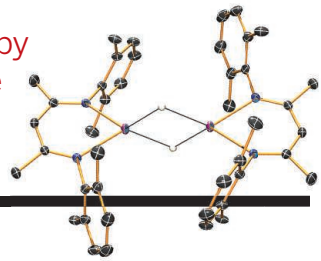
RESEARCH

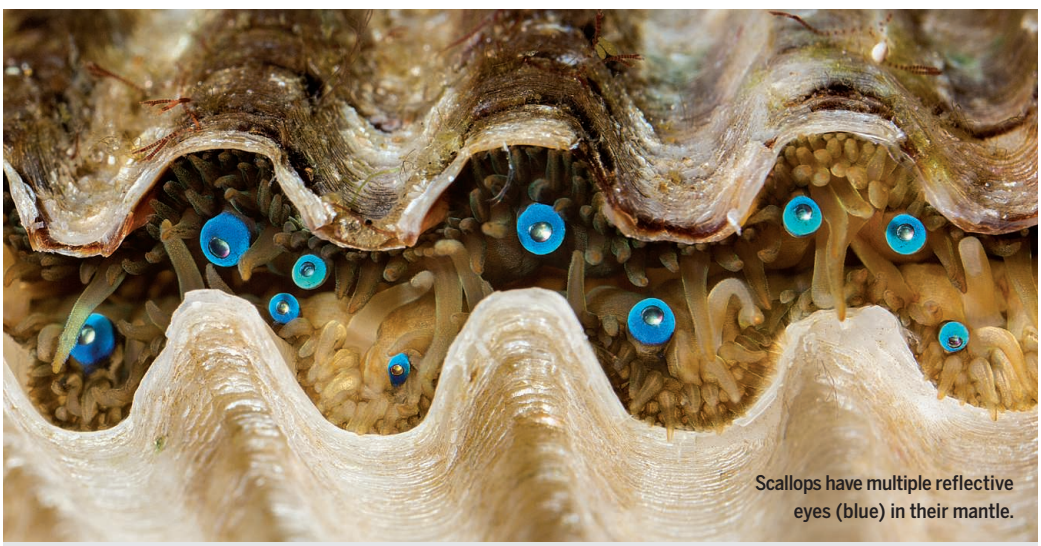
Alkylating benzene by displacing a hydride

Wilson et al., *p. 1168*



IN *SCIENCE* JOURNALS

Edited by **Stella Hurtley**



Scallops have multiple reflective eyes (blue) in their mantle.

BIOLOGICAL OPTICS

Fine-tuned for image formation

We typically think of eyes as having one or more lenses for focusing incoming light onto a surface such as our retina. However, light can also be focused using arrays of mirrors, as is commonly done in telescopes. A biological example of this is the scallop, which can have up to 200 reflecting eyes that focus light onto two retinas. Palmer *et al*. find that spatial vision in the scallop is achieved through precise control of the size, shape, and packing density of the tiles of guanine that together make up an image-forming mirror at the back of each of the eyes. —MSL

Science, this issue p. 1172

SOLAR CELLS

Minimizing losses at interfaces

Among the issues facing the practical use of hybrid organohalide lead perovskite solar cells is the loss of charge carriers at interfaces. Hou *et al*. show that tantalum-doped tungsten oxide forms almost ohmic contacts with inexpensive conjugated polymer multilayers to create a hole-transporting material with a small interface barrier. This approach eliminates the use of ionic dopants that compromise device stability. Solar cells made with these contacts achieved maximum efficiencies of 21.2% and operated stably for more than 1000 hours. —PDS

Science, this issue p. 1192

PHYSICS

Numerics converging on stripes

The Hubbard model (HM) describes the behavior of interacting particles on a lattice where the particles can hop from one lattice site to the next. Although it appears simple, solving the HM when the interactions are repulsive, the particles are fermions, and the temperature is low—all of which applies in the case of correlated electron systems—is computationally challenging. Two groups have tackled this important problem. Huang *et al*. studied a three-band version of the HM at finite temperature, whereas Zheng *et al*. used five complementary numerical methods that kept each other in check to discern the ground state of the HM. Both groups found evidence for stripes, or one-dimensional charge and/or spin density modulations. —JS

Science, this issue p. 1161, p. 1155

GEOPHYSICS

Gravity gets into the earthquake game

Earthquakes generate large movements of mass, which slightly change the gravitational field. Unlike the elastic waves that propagate from the earthquake, the gravity perturbations travel at the speed of light. Vallée *et al*. have finally observed these gravity perturbations in seismometer records from the great Tohoku earthquake in Japan in 2011. The signal would have allowed an accurate magnitude estimation in minutes, rather than hours, for this catastrophic earthquake. —BG

Science, this issue p. 1164

PALEONTOLOGY

Even more like birds

Ecological convergence between pterosaurs and birds is often invoked, but to what degree the two groups share behavior is debated. Wang *et al*. describe a site with more than 100 fossilized pterosaur eggs that reveals that hatchling pterosaurs were likely not as precocial as previously thought (see the Perspective by Deeming). Furthermore, the overlaying of multiple clutches suggests that the pterosaurs may have exhibited breeding site fidelity, similar to rookery-breeding seabirds.

Thus, the similarity between these two groups goes beyond wings. —SNV

Science, this issue p. 1197; see also p. 1124

IMMUNOLOGY

Blood DNases hack the NET

Neutrophil extracellular traps (NETs) are lattices of processed chromatin decorated with select secreted and cytoplasmic proteins that trap and neutralize microbes. However, their inappropriate release may do more harm than good by promoting inflammation and thrombosis. Jiménez-Alcázar *et al*. report that two deoxyribonucleases (DNases), DNASE1 and DNASE1L3, have partially redundant roles in degrading NETs in the circulation (see the Perspective by Gunzer). Knockout mice lacking these enzymes were unable to tolerate chronic neutrophilia, quickly dying after blood vessels were occluded by NET clots. Furthermore, the damage unleashed by clots during septicemia was enhanced when these DNases were absent. —STS

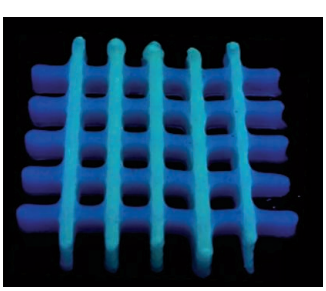
Science, this issue p. 1202; see also p. 1126

MATERIALS SCIENCE

3D printing with living inks

Intricate three-dimensional (3D)–printed structures teaming with bacterial life have been created using biocompatible hydrogel inks. Schaffner *et al.* blended the naturally occurring polymers κ-carrageenan, hyaluronic acid, and fumed silica in nearly equal parts in a salty, bacteria-rich broth. This yielded a nontoxic, functional living ink that could support free-standing objects written in submillimeter-scale printed filaments. Potential applications of such living materials range from degrading pollutants to producing synthetic skin scaffolds. —LAA

Sci. Adv. 10.1126/sciadv.aao6804 (2017).



Multimaterial 3D printing allows spatial segregation of two bacterial strains.

STRUCTURAL BIOLOGY

Holding a master regulator in check

A family of eukaryotic protein kinases, the phosphatidylinositol 3-kinase–related kinases (PIKKs), has key functions in DNA repair and nutrient sensing. In humans, ATR kinase locates DNA damage through its partner, ATRIP. Once activated, ATR initiates a cell-cycle cascade that culminates in cell-cycle arrest. Wang *et al*. determined the high-resolution structure of Mec1-Ddc2 (the yeast homolog of ATR-ATRIP) by electron microscopy. The structure shows the detailed architecture of the multidomain complex that overall forms a dimer of heterodimers. The detailed analysis of the structure reveals how an allosteric mechanism may activate the kinase. —VV

Science, this issue p. 1206

MUSCULAR DYSTROPHY

Making the cut

Mutations in the dystrophin gene cause Duchenne muscular dystrophy (DMD), a fatal childhood muscle disease. Amoasii *et al.* sought to optimize the correction of DMD mutations by CRISPR-Cas9 gene editing. They first generated mice in which exon 50, a common mutational hotspot region of the dystrophin gene in humans, was deleted. They then made a single cut in the dystrophin gene with CRISPR-Cas9, which resulted in up to 90% restoration of dystrophin expression in mouse skeletal and heart muscle. —OMS

Sci. Transl. Med. **9**, eaan8081 (2017).

IN OTHER JOURNALS

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

Invasive *Rudbeckia triloba* is less affected by climate warming than native European species.

ENZYMES

An enzymatic route to alkenes

Conversion of fatty acids to fully deoxygenated hydrocarbons is a challenging reaction for which few biological routes are known. Christenson *et al.* have characterized a bacterial enzyme, OleB, that catalyzes decarboxylation of fatty acid–derived β-lactones to form cis-olefins. OleB is a member of an enzyme family that typically uses a nucleophilic carboxylate in hydrolysis reactions. Sequence analysis and biochemical assays suggest that the conserved catalytic residues have been adapted to facilitate excision of the β-lactone. This group of enzymes may prove to be useful for biofuel production if their substrate range and efficiency can be tuned through engineering. —MAF

Biochemistry **56**, 5278 (2017).

QUANTUM GASES

Putting an old law to the test

Most superfluids, liquids, and gases that flow without viscosity owe their exotic properties to Bose-Einstein condensation (BEC), the formation of a macroscopic wave function at low temperatures. However, not all particles in a superfluid condense; a fundamental limit is set by the interactions in the system. Lopes *et al.* studied the dependence of the superfluid fraction in a homogeneous BEC of potassium atoms on the (tunable) strength of interactions between them. The researchers used two laser beams to give a momentum "kick" only to the condensed atoms, causing them to physically separate from the uncondensed ones. The measured fraction closely followed the theoretical prediction made decades ago that had remained experimentally untested. —JS

Phys. Rev. Lett. **119**, 190404 (2017).

PROTEIN DESIGN

Designed to stand the heat

Enzymes are valued as catalysts in the synthesis of pharmaceuticals, fine chemicals, and biofuels. A limitation is that most enzymes are unstable under

PHOTOS: (LEFT TO RIGHT) SCHAFFNER *ET AL*., *SCI. ADV.* 10.1126/SCIADV.AAO6804 (2017); CLARE GAINEY/ALAMY STOCK PHOTO

ALSO IN *SCIENCE* JOURNALS

Edited by **Stella Hurtley**

DRUG DEVELOPMENT

An atlas for drug interactions

Kinase inhibitors are an important class of drugs that block certain enzymes involved in diseases such as cancer and inflammatory disorders. There are hundreds of kinases within the human body, so knowing the kinase "target" of each drug is essential for developing successful treatment strategies. Sometimes clinical trials can fail because drugs bind more than one target. Yet sometimes off-target effects can be beneficial, and drugs can be repurposed for treatment of additional diseases. Klaeger *et al*. performed a comprehensive analysis of 243 kinase inhibitors that are either approved for use or in clinical trials. They provide an open-access resource of target summaries that could help researchers develop better drugs, understand how existing drugs work, and design more effective clinical trials. —PNK

Science, this issue p. 1148

CANCER

A bona fide portrayal of tumor growth

Bone has a well-established role in advanced cancer. It provides a supportive microenvironment for the growth of metastatic cells that escape the primary tumor, which ultimately leads to loss of bone mass. Engblom *et al*. show that bone may also contribute to early-stage tumorigenesis through a mechanism that leads to an increase in bone mass (see the Perspective by Zhang and Lyden). In mouse models of lung adenocarcinoma, primary tumor cells remotely activated bone-resident cells called osteoblasts, which have a bone-building function. The activated osteoblasts in turn triggered production of a certain type of neutrophil that infiltrates the primary tumor and promotes its growth. Patients with early-stage lung cancer were also found to have an increase in bone density, consistent with the findings in mice. —PAK

Science, this issue p. 1147; see also p. 1127

PLANAR OPTICS

Looking sharp with metalenses

High-end imaging lenses have tended to be based on bulk optical components. Advances in fabrication techniques have enabled the development of ultrathin, lightweight, and planar lenses (metalenses) that have unprecedented functionalities. These metalenses have the potential to replace or complement their conventional bulk counterparts. Khorasaninejad and Capasso review the evolution of metalenses, summarizing achievements and applications and identifying future challenges and opportunities. Metalenses can have numerous applications, ranging from cellphone camera modules, to wearable displays for augmented and virtual reality and machine vision, to bio-imaging and endoscopy. —ISO

Science, this issue p. 1146

MARINE MICROBIOME

Functional ocean biogeography

Marine ecosystems are well represented in metagenomic and transcriptomic data. These data are not routinely used to test ecosystem models that explore ocean biogeography or biogeochemistry. Coles *et al*. built a model in which genes for a range of functions were assigned to different suites of simulated microbes (see the Perspective by Rynearson). Communities emerged from the model with realistic biogeographical and biogeochemical profiles when compared to microbial data collected from the Amazon River plume. However, functional composition trumped the details of taxonomy, and different, coevolving community compositions emerged that provided similar biogeochemical outcomes. —CA

Science, this issue p. 1149; see also p. 1129

ORGANOMETALLICS

Calcium can breach benzene's defenses

Calcium plays a major, multifaceted role in biology and mineralogy. In organic chemistry, though, it is largely overlooked and overshadowed by the carbon compounds of its cousins lithium and magnesium. Wilson *et al*. now report that the element was just biding its time: Several organocalcium compounds that they prepared can alkylate benzene by displacing a hydride, with no need for a more conventionally reactive leaving group such as chloride (see the Perspective by Mulvey). This surprising, previously elusive reaction attests to the unusual nucleophilicity of the carbons bound to calcium. —JSY

Science, this issue p. 1168; see also p. 1132

ORGANIC CHEMISTRY

Lighting the way to drug labeling

It is important during drug development to study how candidate compounds get absorbed and broken down biologically. One common technique for tracking a drug's fate is to label its molecular framework with heavier isotopes of hydrogen (either deuterium or tritium). Loh *et al*. developed a light-promoted protocol to install these labels on alkyl carbons adjacent to nitrogen. The technique relies on incorporation of the heavy isotope into a thiol from a convenient heavy water source through acid-base chemistry. Next, a photoredox catalyst strips a hydrogen atom equivalent from the carbon, and the thiol engages in radical chemistry to transfer the deuterium or tritium in its place. —JSY

Science, this issue p. 1182

QUANTUM SIMULATION

Putting photons to work

Interacting quantum particles can behave in peculiar ways. To understand that behavior, physicists have turned to quantum simulation, in which a tunable and clean system can be monitored as it evolves under the influence of interactions. Roushan *et al*. used a chain of nine superconducting qubits to create effective interactions between normally noninteracting photons and directly measured the energy levels of their system. The interplay of interactions and disorder gave rise to a transition to a localized state. With an increase in the number of qubits, the technique should be able to tackle problems that are inaccessible to classical computers. —JS

Science, this issue p. 1175

NANOPHOTONICS

A plasmonic route for mixing waves

Nonlinear optics typically requires photons to interact over distances spanning hundreds or thousands of wavelengths. Nonlinear optical devices therefore tend to be bulk components. Nielsen *et al*. used a polymer material with a high nonlinear coefficient that they embedded within a plasmonic cavity to show that the interaction length scale could be reduced dramatically. The plasmonic cavity focused the light down to the nanoscale, providing an intense electromagnetic field that induced the nonlinear process of four-wave mixing in the polymer. The technique provides a versatile platform for compact nonlinear optical devices. —ISO

Science, this issue p. 1179

ELECTROCATALYSIS

Going with the grain boundaries

Bulk defects in a metal, such as grain boundaries, can create regions of increased strain at its surface that could affect its catalytic activity. Mariano *et al*. studied the electroreduction of CO_2 to CO on polycrystalline gold films, a reaction that competes with H_2 evolution. By annealing the films to create larger grains, they could change the types and distribution of grain boundaries at the surface. Scanning electrochemical cell microscopy revealed that the dislocation density correlated with CO_2 electroreduction activity, but such defects had no effect on H_2 evolution. —PDS

Science, this issue p. 1187

ION CHANNELS

Channeling Ca^{2+} for cancer

Ca^{2+} influx mediated by the channel Orai1 stimulates transcription factors such as NFAT. Frischauf *et al.* characterized various cancer-associated Orai1 mutants (see the Focus by Muallem). These constitutively active mutants activated NFAT and also stimulated mitophagy and autophagy, processes that can contribute to tumor progression. The authors determined in detail how Orai1 is gated and how constitutively activating mutations result in increased Ca^{2+} influx. These findings have implications for Orai1-mediated Ca^{2+} signaling in diverse cell types. —WW

Sci. Signal. **10**, eaao0358, eaaq0618 (2017).