

entire stretches of amino acids and the structures they form. McCarthy *et al.* identified an evolutionary signature defined by prevalent and recurrent deletions in the spike protein of SARS-CoV-2 at four antigenic sites. Deletion variants show human-to-human transmission of viruses with altered antigenicity. —CA

*Science*, this issue p. 1139

## IMMUNOTHERAPY

### Diabodies see the unseeable

RAS oncogene mutations are common in various cancers, controlling their growth and survival. Targeting mutant RAS proteins with antibodies has been unsuccessful because of low surface expression, even when targeting mutant RAS peptides presented by human leukocyte antigen (HLA) on the surface of cancer cells. Douglass *et al.* used phage display to generate single-chain variable fragments (scFvs) specific for mutant RAS peptide-HLA complexes. The authors tested various bispecific, T cell-engaging antibody formulations, finding that single-chain diabodies (scDb) combining the aforementioned scFv with an anti-CD3 scFv were able to induce T cell activation and subsequent killing of tumor cells expressing mutant RAS peptide-HLA complexes. This scDb approach opens the door for antibody-based therapies against mutant neoantigens expressed at very low levels on the surface of cancer cells. —DAE

*Sci. Immunol.* **6**, eabd5515 (2021).

## SYNTHETIC BIOLOGY

### Designing smarter anticancer T cells

Biological signaling systems can exhibit a large, nonlinear—or “ultrasensitive”—response, which would be useful to engineer into therapeutic T cells to allow for better discrimination between cancer cells and normal tissues. Hernandez-Lopez *et al.* modified human T cells using a two-step mechanism that allowed them to kill cells expressing large

amounts of cancer marker protein but not cells expressing a small amount of the same protein. A first synthetic receptor recognized the antigen with low affinity. That receptor signaled to increase expression of a chimeric antigen receptor (CAR) with high affinity for the same antigen. The circuit proved effective in cell culture and mouse cancer models, offering hope of extending the CAR T cell strategy against solid tumors. —LBR

*Science*, this issue p. 1166

## NANOMATERIALS

### Hydrogenating borophene

The two-dimensional material borophene, which is formed on silver surfaces, has a diverse polymorphism and is predicted to have unusual materials and electronic properties. However, it is highly unstable outside of ultrahigh vacuum conditions and oxidizes readily, which hampers exploration of its properties. Li *et al.* hydrogenated these materials with atomic hydrogen and showed that borophene has a lower local work function. This material is stable for days in air, and borophene can be recovered simply by thermally driving off the hydrogen. —PDS

*Science*, this issue p. 1143

## INORGANIC CHEMISTRY

### Calcium catches dinitrogen

Although lithium reduces dinitrogen, the other alkali and alkaline Earth metals have proven largely inert to the gas under ambient conditions. Rösch *et al.* report that with just the right  $\beta$ -diketiminate ligand and an assist from potassium as terminal reductant, calcium can mediate dinitrogen reduction. Crystallography and spectroscopic characterization revealed a product in which doubly reduced dinitrogen adopted a side-on bridging motif between two calcium centers. A subsequent reaction with coordinated tetrahydrofuran appeared to release diazene. —JSY

*Science*, this issue p. 1125

## IN OTHER JOURNALS

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

### SOCIAL COMMUNICATION

## Rays of communication

**S**ociality requires communication among individuals and is common across species. Identifying modes of communication in some systems and species, however, is much less straightforward than in others. Aquatic environments present challenges for communication, especially for species that are nonvocal, such as many fishes. Elasmobranchs are increasingly being shown to have a complex social structure, and manta rays (*Mobula* spp.) exhibit many different social behaviors. Perryman *et al.* characterized the associations between the cephalic lobes in reef mantas, organs known to assist feeding, and various social and behavioral conditions. The authors found clear relationships between specific lobe positions and interactions with other rays, cleaning fishes, and even human divers. These patterns suggest that they may be used in communication, although whether this communication is positional or chemical remains to be seen. —SNV

*Behav. Ecol. Sociobiol.* **75**, 51 (2021).

## TOPOLOGICAL MATERIALS

### Photonic crystals with a touch of topology

Manmade photonic crystals offer a flexible platform for controlling the propagation and flow of light. Such control can be extended across the electromagnetic spectrum by correctly engineering the bandgap. Limitations in the fabrication process, however, can result in structural imperfections that allow the light or energy to leak out. Wang *et al.* add magnetism to the mix to form heterostructures of magnetic photonic crystals. They demonstrate that, for microwaves, this magnetic addition provides a topological aspect to the band structure, resulting in the propagation of the microwaves in one direction that is robust to defects. The ability to controllably route and collimate electromagnetic waves also could be applied to

electronic and phononic waveguide systems. —ISO

*Phys. Rev. Lett.* **126**, 067401 (2021).

## CELL BIOLOGY

### A tight squeeze?

HIV-1 remains a clinically important challenge. The cell biology of HIV-1 is now quite well understood. The viral RNA is packaged within capsids consisting of 120-nanometer-by-60-nanometer cone-shaped particles, which make their way to the nucleus to allow viral replication. The nuclear envelope is studied with nuclear pores with an internal diameter of only about 40 nanometers. Zila *et al.* used correlative light and electron microscopy and subtomogram averaging to study viral capsids en route to the nucleus. Working with infected T cells, the authors unexpectedly found that the nuclear pore complex was able to dilate sufficiently to allow the



Reef manta rays appear to use the lobes on either side of their mouths to signal to other rays.

antiferroelectric phases, potentially allowing for a much higher information storage density. The structure occurs without symmetry changes and may not be restricted to oxides. —BG

*Matter* 10.1016/j.matt.2020.12.008 (2021).

## IMMUNE SIGNALING Shedding light on TCR activation

In mammals, T cells recognize fragments of pathogen and other alien peptide antigens using T cell receptors (TCRs). Loaded TCRs then interact with the polymorphic cell surface proteins of the major histocompatibility complexes of antigen-presenting cells, activating killing processes. O'Donoghue *et al.* engineered CD4<sup>+</sup> T cells with an optogenetic chimeric antigen receptor stimulated by blue light. This technique provides an experimental on–off switch with which to precisely control the TCR-signaling machinery. The authors could distinguish between the signals induced by self and foreign antigens, the latter inducing CD69, a marker of T cell activation. —STS

*Proc. Natl. Acad. Sci. U.S.A.* **118**, e2019285118 (2021).

## WEATHER FORECASTING Better predictions with water isotopes

Knowing the water isotopic makeup of the mid-troposphere can substantially improve weather forecasts. Toride *et al.* show that the incorporation of mid-tropospheric water isotope data collected by the Infrared Atmospheric Sounding Interferometer (IASI) into a weather model can improve its representation of parameters such as wind, humidity, and temperature. This allows the heating structure and large-scale circulation of the atmosphere to be better determined, leading to more accurate weather predictions. —HJS

*Geophys. Res. Lett.* **48**, e2020GL091698 (2021).

intact viral capsid to translocate into the nucleus. After translocation, rather than disassembling in an orderly fashion, the capsids ruptured, releasing the viral RNA into the nuclear interior. This detailed view of a key step in productive infection illustrates the power of recent advances in three-dimensional correlative fluorescence light and electron microscopy with cryo–electron tomography for increasing mechanistic understanding of intracellular events. —SMH

*Cell* **184**, 1032 (2021).

## CELL BIOLOGY Catching the action on the cell

For many proteins, specific proteolysis events are key to their function. This extends to the cell surface, where proteolysis of cell surface proteins can regulate communication

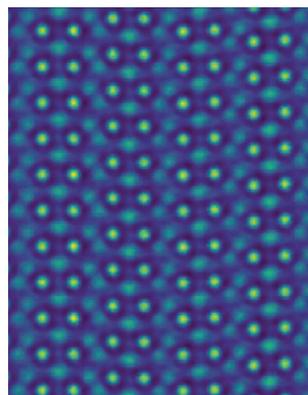
between cells. There are several methods to isolate N-terminal peptides derived from proteolytic cleavage, but existing methods do not efficiently detect cleavage of cell surface proteins. Weeks *et al.* started with an enzyme called subtiligase, a tool developed to modify N termini, and fused it to a transmembrane domain to target it to the cell surface (subtiligase-TM). The subtiligase biotinylates the N termini, which can then be isolated and sequenced by mass spectrometry. This method can be used for identifying therapeutic targets and biomarkers. —VV

*Proc. Natl. Acad. Sci. U.S.A.* **118**, e2018809118 (2021).

## FERROELECTRICS A way to shrink RAM

External electric fields can change the polarization of ferroelectric materials. One

application of this effect involves random access memory. Du *et al.* discovered multiple polarization orders in hafnium oxide colloidal nanocrystals. Crystallographic twinning creates an interesting polarization structure at the twin boundary with nanometer-sized ferroelectric and



False-color, vertically averaged atomic-resolution transmission electron microscopy image of HfO<sub>2</sub>

## Photonic crystals with a touch of topology

Ian S. Osborne

*Science* **371** (6534), 1118.

DOI: 10.1126/science.371.6534.1118-b

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