Hydrothermal processes on Enceladus

Saturn’s moon Enceladus has a subsurface ocean covered by a layer of ice. Some liquid escapes into space through cracks in the ice, which is the source of one of Saturn’s rings. In October 2015, the Cassini spacecraft flew directly through the plume of escaping material and sampled its chemical composition. Waite et al. found that the plume contains molecular hydrogen, H₂, a sign that the water in Enceladus’ ocean is reacting with rocks through hydrothermal processes (see the Perspective by Seewald). This drives the ocean out of chemical equilibrium, in a similar way to water around Earth’s hydrothermal vents, potentially providing a source of chemical energy. —KTS

Science, this issue p. 155; see also p. 132

Transporter layers for greater stability

Although perovskite solar cells (PSCs) can have power conversion efficiencies exceeding 20%, they can have limited stability under ultraviolet irradiation. This is in part because the mesoporous TiO₂ used as an electron-transporting layer can photocatalyze unwanted reactions in the perovskite layer. Shin et al. report a low-temperature colloidal method for depositing La-doped BaSnO₃ films as a replacement for TiO₂ to reduce such ultraviolet-induced damage. Solar cells retained over 90% of their initial performance after 1000 hours of full sun illumination. —PDS

Science, this issue p. 167

Stitching a belt out of carbon rings

If you had a molecular scalpel, you could slice a carbon nanotube twice against the long axis to excise a loop of fused phenyl rings. Of course, knives don’t come that small. Instead, Povie et al. succeeded in stitching together such a nanometer-scale belt in bottom-up fashion from molecular components, using consecutive Wittig reactions (see the Perspective by Siegel). The belt of 12 edge-sharing rings could ultimately be a first step toward more precisely controlled bottom-up syntheses of extended nanotubes. —JSY

Science, this issue p. 172; see also p. 135

IMMUNOTHERAPY

Targeting nonviral antigens in viral-driven cancer

Adoptive cell transfer harnesses a patient’s own T cells to destroy cancer. The strategy can successfully treat epithelial tumors driven by human papillomavirus (HPV), but it remains unclear why only some patients respond. Stevanović et al. examined the antitumor T cell response associated with HPV+ cervical cancers that underwent complete regression. Unexpectedly, reactive T cells were not directed against virally associated antigens, but rather against cancer germline antigens or neoantigens not previously recognized by the immune system. These findings counter the widely held belief that T cell responses against viral antigens are responsible for therapeutic effects in HPV-driven cancers. —PNK

Science, this issue p. 200

Colored electron microscopy image of a human cervical cancer cell

One antibody for all and all antibodies for one

Antibodies against related flaviviruses such as dengue (DENV) and West Nile (WNV) can cross-react with Zika virus (ZIKV) and could thereby increase disease severity. Bardina et al. tested whether DENV and WNV antibodies from humans, or even yellow fever vaccination, could enhance ZIKV infection. In a mouse model, low titers of DENV and WNV antibodies enhanced ZIKV viremia, especially in the spinal cord and testes, whereas high titers...
remained protective. Generally, WNV antibodies were less disease-enhancing than DENV antibodies, and, in macaques, yellow fever vaccination had very little effect. —CA
Science, this issue p. 175

STRUCTURAL BIOLOGY
Nucleosomes in contact
In eukaryotic cells, genomic DNA must be compacted to fit inside the nucleus. A key player in DNA packaging is the nucleosome, which comprises a segment of DNA wrapped around an octamer of histone proteins. During replication and transcription, nucleosomes must reposition themselves on the DNA. In this process, nucleosomes can collide to form a dinucleosome. Kato et al. report a high-resolution crystal structure of a dinucleosome. One of the octamers has lost a histone dimer so that the dinucleosome comprises an octamer and a hexamer. The structure may represent an intermediate during chromatin remodeling. —AV
Science, this issue p. 205

PHYSIOLOGY
A target for preventing kidney damage
Proteinuria, the appearance of protein in the urine, results when podocytes in the kidney are damaged. Rinschen et al. found that the activation of the transcriptional coactivator YAP and the expression of YAP target genes preceded proteinuria in rats with chemically induced nephrosis. YAP activity can be stimulated by mechanical stress, and activation of YAP in cultured podocytes depended on the stiffness of the substrate. A YAP inhibitor ameliorated proteinuria and damage-induced mechanosignaling in the nephrotic rat kidneys. —AV

DEFUNAUTION
Quantifying hunting-induced defaunation
As the human population grows and increasingly encroaches on remaining wildlife habitat, hunting threatens many species. Benítez-López et al. conducted a large-scale meta-analysis of hunting trends and impacts across the tropics (see the Perspective by Brashares and Gaynor). Bird and mammal populations were considerably lower in areas where hunting occurred. Although commercial hunting and proximity to roads and urban centers were the most damaging factors, all hunting had worrying impacts, even in protected areas. Protection and alternative approaches for sustainable subsistence hunting must be implemented soon if we are to prevent further, rapid defaunation. —SNV
Science, this issue p. 180; see also p. 136

GENETIC VARIATION
Near and far effects on gene expression
The genes in the human β-globin cluster are co-regulated by a single control region or master cis-regulatory site. Surprisingly, few other master regulators have been identified, although they are suspected to be important in disease. In the past, variants in master regulatory sites have been used to identify defects in the expression of single genes. Further analysis of the three-dimensional structure of the genome showed that chromatin looping brings the master regulators adjacent to the genes that they appear to affect. The looping pattern seems to be broadly conserved among mammals. Variation in such regulatory hubs has multiple downstream effects on both genes and noncoding regions that may have shaped genome evolution and complex disease associations. —LMZ
PLOS Genet. 10.1371/journal.pgen.1006673 (2017).

CELL BIOLOGY
TB exploits zombie cells
Mycobacterium tuberculosis, the bacterium that causes tuberculosis (TB), mainly grows within host cells. Lerner et al. studied the lifestyle of M. tuberculosis within human macrophages by inspecting them with a combination of live-cell imaging, correlative light and electron microscopy, and single-cell analysis. After infection, some of the macrophages became necrotic and had damaged plasma membranes, although they still supported mycobacterial proliferation. Indeed, inhibiting necrosis compromised the macrophages’ ability to support mycobacterium replication. Eventually, such cells ruptured to release progeny mycobacteria to infect new host cells. The ability of this microbe to exploit necrotic macrophages as a nutrient-rich
Stitching one alkyl group to another

Chemical reactions such as Heck and Suzuki coupling facilitate access to an enormous range of relatively flat molecules. This geometrical constraint is associated with the comparative ease of linking together aryl and alkyl carbons. Choi and Fu review recent developments in forming bonds between the more abundant alkyl carbon centers that underlie diverse molecules with complex three-dimensional structures. Nickel catalysis in particular has emerged as a powerful method to access individual mirror-image isomers selectively and thereby tune the biological properties of the targeted products. —JSY

Crustal rock strength from outer space

The response of crustal rock to stresses is challenging to estimate yet vital for determining risks from events such as earthquakes. Moore et al. show that in a new slip model that it was an incredibly complex event. Unlike most earthquakes, multiple faults ruptured to generate the ground shaking. A remarkable 12 faults ruptured overall, with the rupture jumping between faults located up to 15 km away from each other. The earthquake should motivate rethinking of certain seismic hazard models, which do not presently allow for this unusual complex rupture pattern. —BG

Machines learn what people know implicitly

AlphaGo has demonstrated that a machine can learn how to do things that people spend many years of concentrated study learning, and it can rapidly learn how to do them better than any human can. Caliskan et al. now show that machines can learn word associations from written texts and that these associations mirror those learned by humans, as measured by the Implicit Association Test (IAT) (see the Perspective by Greenwald). Why does this matter? Because the IAT has predictive value in uncovering the association between concepts, such as pleasantness and flowers or unpleasantness and insects. It can also tease out attitudes and beliefs—for example, associations between female names and family or male names and career. Such biases may not be expressed explicitly, yet they can prove influential in behavior. —GJC

Refined understanding of the preprophase band

Because plant cells do not move, plant tissues are constructed according to how they place the divisions of their constituent cells. Schaefer et al. found a mutation in the model plant Arabidopsis that abolishes a visible precursor of cell division, the preprophase band. Despite loss of the band—previously thought essential to define the division plane—the general orientations of cell division planes in the roots of these plants were normal. However, individual division orientations showed more variance than normal. Thus, the preprophase band serves to focus and refine the final orientation of the nascent cell division plane. —PJH

How the flagellum knows when to stop

The bacterial flagellum is important in bacterial pathogenesis and biofilm formation. It is a rotary nanomotor that allows bacteria to propel themselves through liquids and across
surfaces. Researchers interested in nanoscale robotics use the bacterial flagellum as a model for a machine that self-assembles on the nanoscale. Cohen et al. examined exactly how the flagellum precisely measures its shaft so that it spans, but does not extend beyond the edge of, the periplasm. The growing flagellum uses a mechanism by which it “senses” when it hits the outer membrane and stops growing. Changing the width of the periplasmic space by remodeling a particular lipid changed the length of the flagellar shaft. —SMH

Science, this issue p. 197

EMERGING INFECTIONS
The evolving Ebola virus host response
Although the Ebola virus sporadically causes outbreaks in humans, there is a relative paucity of information regarding the dynamics of the immune response in patients. During the recent outbreak, a health-care worker with severe Ebola virus disease was evacuated to the NIH Clinical Center, where he received supportive care and had longitudinal blood samples drawn up to almost a year after infection. Kash et al. performed transcriptomic analyses on these blood samples. This revealed how the patient’s body responded to the virus through the different phases of infection and recovery and could be compared with clinical symptoms and viral loads. These valuable data provide insights into Ebola pathogenesis and could help guide future treatments. —LP


ORGANIC ELECTRONICS
Adding a twist for enhanced performance
The efficiency of organic light-emitting diodes (OLEDs) is fundamentally governed by the ratio of emissive singlet to dark triplet excitons that are formed from spin-polarized electron and hole currents within the material. Typically, this has set an upper limit of 25% internal quantum efficiency for OLEDs. Di et al. manipulated the ratio of spin states through a modification of process chemistry. They introduced a rotation of the molecular structure, which inverted the spin-state energetics and enhanced OLED performance. —ISO

Science, this issue p. 159

IMMUNE REGULATION
Regulatory T cells sans FoxP3
Although expression of FoxP3 is largely synonymous with T regulatory (Treg) cell identity in mice, type 1 regulatory T cells (T1\textsuperscript{reg}) are an exception. T1\textsuperscript{reg} cells produce interleukin-10 but are FoxP3-negative. In comparison with FoxP3-positive Treg cells, the development and functions of T1\textsuperscript{reg} cells are poorly understood. Zhang et al. report that T1\textsuperscript{reg} cells play a critical regulatory role after allogeneic bone marrow transplantation (BMT) in mice and use this model to delineate the molecular circuits driving commitment to the T1\textsuperscript{reg} lineage. By documenting the presence of T1\textsuperscript{reg} cells after BMT in humans, they propose that modulation of T1\textsuperscript{reg} cells could be a therapeutic approach for increasing BMT success rates in the clinic. —AB