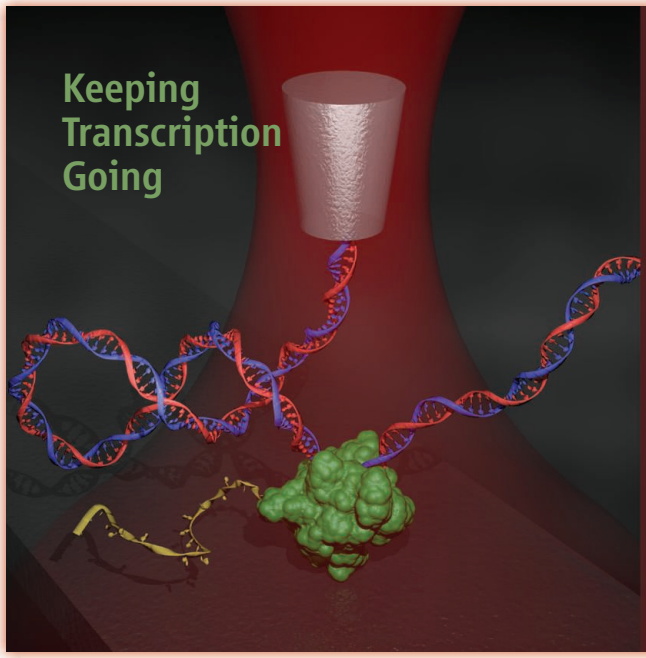
EDITED BY STELLA HURTLEY



In cells, the DNA double-stranded helix (dsDNA) is mostly supercoiled—either under- or overwound. RNA polymerase (RNAP) must transcribe though this supercoiled DNA. Furthermore, the act of transcription, which involves opening the double helix and threading the separated strands through the enzyme, generates supercoiling ahead and behind the polymerase. **Ma *et al.*** (p. 1580) used single-molecule methods to measure the upstream and downstream torque forces of *Escherichia coli* RNAP. The upstream torque was sufficient to disrupt dsDNA structure, and the stalled RNAP could also backtrack along the DNA. Release of the torsional stress allowed RNAP to resume transcription in vitro.

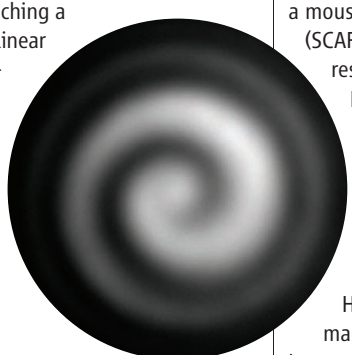
Revealed in Translation

The ribosome, with the help of transfer RNAs (tRNAs), converts the triple genetic code in messenger RNA (mRNA) into protein. Upon decoding of a codon, the mRNA and associated tRNAs must be moved through the ribosome, so that the next codon can be read, with a new charged tRNA taken in at the A (aminoacyl-tRNA) site, the newly extended peptidyl-tRNA moved into the P (peptidyl-tRNA) site, and the deacylated tRNA removed from the exit site in the ribosome (see the Perspective by **Rodnina**). Crystal structures from **Tourigny *et al.*** (p. 1542), **Pulk and Cate** (p. 1544), and **Zhou *et al.*** (p. 1543), variously capture the prokaryotic ribosome during this translocation phase, revealing the hybrid states of the tRNAs and the substantial motions of the 30*S* ribosomal subunit during the process, the role of elongation factor G, and suggest how the direction and reading frame of the mRNA is maintained.

Titanium Cleaver

A century after its discovery, the Haber Bosch process is still used to produce ammonia from nitrogen for fertilizer. Nonetheless, the process requires high temperature and pressure, and chemists continue to look for synthetic analogs to microbial nitrogenase enzymes, which have managed to slice through the N_2 triple bond under ambient conditions for millennia. Most efforts in this vein have relied on a boost from the reducing power of alkali metals. **Shima *et al.*** (p. 1549; see the Perspective by **Fryzuk**) instead explored the reactivity of a titanium hydride cluster, which cleanly slices through N_2 at room temperature and incorporates the separated N atoms into its framework. Though ammonia was not produced, the system offers hope in the search for mild nitrogen reduction catalysts.

A Twist on the Capacity Crunch



The rate at which data can be transmitted down optic fibers is approaching a limit because of nonlinear optical effects. Multiplexing allows data to be encoded in different modes of light such as polarization, wavelength, amplitude, and phase and to be sent down the fibers in parallel. Optical angular momentum (OAM) can provide another degree of freedom whereby the photons are given a well-defined twist or helicity. **Bozinovic *et al.*** (p. 1545) were able to transmit high-bandwidth data using OAM modes in long lengths of optical fibers, thus providing a possible route to get yet more capacity through optic fiber networks.

Lunar Mascons Explained

The origin of lunar mass concentrations (or mascons), which appear as prominent bull's-eye patterns on gravitational maps of both the near- and far side of the Moon, has been a mystery since they were originally detected in 1968. Using state-of-the-art simulation codes, **Melosh *et al.*** (p. 1552, published online 30 May; see the Perspective by **Montesi**) developed a model to explain the formation of mascons, linking the processes of impact cratering, tectonic deformation, and volcanic extrusion.

By the Sea Side

The Atlantic coastal plain of North America has been thought of as a passive margin, responding mostly to the weight of deposited sediments. As a result, the fine-scale stratigraphy of the sediments has been used to infer changes in global sea level through the Cenozoic. However, recent work has shown that the coastal plain has deformed in response to flow in Earth's mantle. **Rowley *et al.*** (p. 1560, published online 16 May) used a model of flow in the mantle to show that the topography of the mid-Atlantic and Southern United States coast varied by 60 meters or more during the past 5 million years.

Respiration Refined

Cells derive energy from redox reactions mediated by mitochondrial enzymes that form the electron transport chain. The enzymes can form large complexes, known as supercomplexes, whose function has been controversial. **Lapuente-Brun *et al.*** (p. 1567) discovered that a mouse protein, supercomplex assembly factor I (SCAFI), specifically modulates assembly of respiratory complexes into supercomplexes. Formation of the supercomplexes appears to cause electrons to be processed differently, depending on the substrate from which they are derived.

B Cell Tug of War

High-affinity, protective antibodies made by B cells are critical for providing long-term protection against reinfection. In order to produce antibodies, B cells must first bind to and extract antigens from the surface of antigen-presenting cells. Using an in vitro system that allows B cells to bind to antigen-laden, flexible membranes, **Natkanski *et al.*** (p. 1587, published online 16 May) show that antigen extraction relies on myosin IIA–mediated contractile forces that pull upon the antigen-presenting membrane. These forces break the antigen-receptor bonds if affinity is low, thus ensuring that B cells only extract, internalize, and presumably respond to, high-affinity antigens.

CREDITS (TOP TO BOTTOM): BOB FORTIES; NENAD BOZINOVIC

Published by AAAS

Additional summaries

Water at the Bottom of a Well

Earthquakes generate numerous fractures as they propagate through an underground fault zone. These fractures strongly influence the way in which fluids flow in the subsurface, and the permeability of fault zones is often used as a proxy for the extent of fracturing. Following the 2008 M_w 7.9 Wenchuan earthquake in central China, several wells were drilled in and around the fault zone to understand the mechanics of the earthquake. Because the bottoms of these deep boreholes were open, the water levels in the wells were sensitive to tidal forces acting on the surrounding rock. Through continuous measurements of water levels over 1.5 years, **Xue *et al.*** (p. 1555) found that the rate at which water was pumped in and out of the borehole was proportional to the permeability of the fault zone, providing a direct way to measure the evolution of the hydrologic properties of a fault zone following a major earthquake. Permeability decreased ~25% during that time, suggesting that fractures generated in fault zones heal relatively rapidly.

Borneo Paleohydrology

Climate records of the last glacial cycle provide a good picture of how climate changed at high and middle latitudes, but fewer records of the tropics are available. **Carolin *et al.*** (p. 1564, published online 6 June) present data from a suite of precisely dated stalagmites from Borneo that reveal how the western tropical Pacific region behaved between 100,000 and 15,000 years ago, a period during which many abrupt climate changes occurred in other parts of the world. While the hydroclimate of Borneo changed in response to precessional forcing, it responded only weakly to the forces that produced glacial-interglacial changes in global climate.

Desert Soil Shuffle

Soil microorganisms make up a substantial fraction of global biomass, turning over carbon and other key nutrients on a massive scale. Although the soil protects them somewhat from daily temperature fluxes, the distribution of these communities will likely respond to gradual climate change. **Garcia-Pichel *et al.*** (p. 1574, see the cover; see the Perspective by **Belnap**) surveyed bacterial diversity across a range of North American desert soils, or biocrusts—ecosystems in which photosynthetic bacteria determine soil fertility and control physical soil properties such as erodability and water retention. Most of the sites were dominated by one of two cyanobacterial species, but their relative proportions were controlled largely by factors related to temperature. Laboratory enrichment cultures of the two species at different temperatures also showed temperature as a primary determining factor of bacterial diversity. It is unknown if temperature will affect the distribution of other soil microorganisms, but the marked shifts of these two keystone bacterial species suggest further change is in store for these delicate ecosystems.

CREDIT: MAC LOW

Threading Through

Protein antibiotics (bacteriocins) are frequently deployed by Gram-negative bacteria to combat competitors, a trait common in pathogens such as *Escherichia coli*, *Yersinia pestis*, *Pseudomonas aeruginosa*, *Xanthomonas campestris*, and *Klebsiella pneumonia*. As a result, bacteriocins are being developed as species-specific antibacterials. Bacteriocins must establish a translocon at the bacterial outer membrane in order to translocate into cells. Working in *E. coli*, **Housden *et al.*** (p. 1570) describe how the deoxyribonuclease, colicin E9, crosses the bacterial cell membrane by threading through a porin.

Stopping Transcription

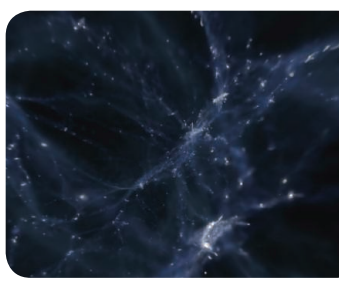
It is as important to terminate any biological process as it is to start it. Transcription, copying information encoded in genes into RNA, requires accurate and timely termination. **Nielsen *et al.*** (p. 1577) present a mechanism for transcription termination by RNA polymerase III, the enzyme that synthesizes the majority of RNA molecules in eukaryotes. In this scenario, the folding of the RNA as it is transcribed by polymerase into a highly structured transcript causes termination at the end of its synthesis. This mechanism may serve as a control of proper folding of structural or catalytic RNAs synthesized by RNA polymerase III. Comparison with other organisms suggests that this mechanism emerged before divergence of bacteria and eukaryotes.

Unreactive Death

A controversial proposal that all bactericidal antibiotics kill by reactive oxygen species (ROS) and not by their primary cell target has recently attracted high-profile refutations. The ROS-death pathway implicated overstimulation of the electron transport in respiratory chains; a malfunction that leads to ROS releasing Fe from Fe-S clusters and causing cell death via Fenton chemistry. **Ezraty *et al.*** (p. 1583) show that electron transport chains and Fe-S clusters are key to killing by aminoglycoside antibiotics but not for the reasons envisioned in the ROS theory. Fe-S clusters are essential for killing because they mature the respiratory chains that produce the necessary proton motive force for the energized uptake of aminoglycosides. Consequently, iron chelators protect against aminoglycosides, not because they scavenge the iron from Fenton chemistry, but because they block aminoglycoside uptake.

Understanding Star Formation

Understanding how galaxies and the chemical composition of the universe evolved through cosmic time relies on unraveling the history of star formation over the universe's almost 14-billion-year history. **Mac Low** (p. 1541) reviews the conditions of star formation in galaxies, focusing on the smaller-scale physics determining the conversion of gas into stars. Progress in understanding and modeling these processes and in observing galaxies at ever-earlier times are expected to lead to a convergence between model predictions and observations and to a full understanding of the cosmic history of star formation.



A Direct Line in the Brain

For decades, neuroscientists have assumed that there is a ''canonical microcircuit'' in the neocortex, in which information is transformed as excitation spreads serially along connections from thalamus, to cortical layer 4, then to layers 2/3, to layers 5/6, and finally to other brain regions. Each cortical layer is thought to transform sensory signals to extract behaviorally relevant information. Now, **Constantinople and Bruno** (p. 1591) challenge this dogma. In vivo whole-cell recordings revealed that sensory stimuli activate neurons in deep cortical layers simultaneously to those in layer 4 and that a large number of thalamic neurons converge onto deep pyramidal neurons, possibly allowing sensory information to completely bypass upper layers. Temporary blockade of layer 4 revealed that synaptic input to deep cortical layers derived entirely from the thalamus and not at all from upper cortical layers. This thalamically derived synaptic input reliably drove pyramidal neurons in layer 5 to discharge action potentials in the living animal. These deep layer neurons project to numerous higher-order brain regions and could directly mediate behavior.

Published by AAAS