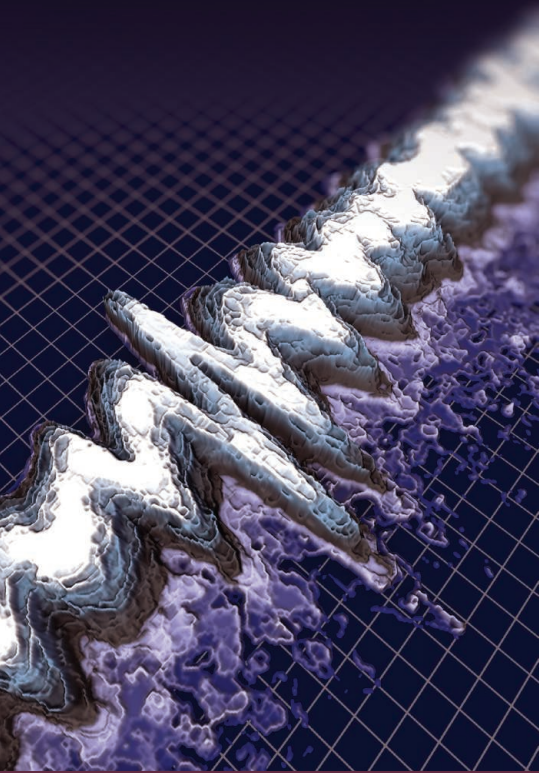


Pieces of Light

Waves consist of peaks and troughs, whether the oscillating medium is water in the ocean or electromagnetic energy in light. If waves with different wavelengths overlap precisely, the pattern gets more complex and less repetitive until eventually, with enough components, there is no cycle left—just an isolated blip pointing in some discrete direction. **Wirth *et al.*** (p. 195, published online 8 September) have achieved this subcycle state of light by packing a vast spectrum of light (from the near-infrared through the visible and into the ultraviolet) with a well-controlled phase into a single tight pulse. They further demonstrate the potential of the light pulses in probing atomic electron dynamics at the fastest time scales.

CREDITS (TOP TO BOTTOM): T.T. LUU, A. WIRTH, TH. NAESER; ZHONG *ET AL.*

Talking Teeth

Human evolution has often been closely tied to diet, and teeth are some of the most common fossils available. **Ungar and Sponheimer** (p. 190) review recent developments in understanding the diets of early humans, focusing on two emerging approaches that have provided new perspectives. The first is examination of microwear on teeth, which in part reflect the abrasiveness and hardness of foods. The second is stable isotope analysis; particularly, carbon isotopes that reflect the proportion of grasses versus fruits and nuts eaten directly, or consumed by an animal eaten by an early hominin. The diets of early humans appear to have been more diverse than previously assumed.

String Order

One of the first successes of cold atomic gases as quantum simulators was the achievement of a transition between the so-called Mott insulator to a superfluid phase: Optical lattices formed with lasers were populated with atoms that stayed stuck on the lattice sites in the insulating phase, and delocalized in the superfluid phase. Now, **Endres *et al.*** (p. 200) used the newly available ability to observe individual lattice sites to track the transition in more detail, and observed correlated pairs of doubly- and unpopulated sites, which represent the excitations of the insulating phase in which each site is populated by a single atom. A consequence of the correlated pairs, a hidden "string order," was found to mark the transition.

Rules for Positioning Nanoparticles

When atoms and molecules crystallize, the lattice that forms is usually fixed by temperature and pressure. For larger nanoparticles and colloids, more control can be exerted over the assembly into lattices because particle coatings and solvation can be varied, in addition to thermodynamic parameters. For example, DNA coatings with "sticky ends" have been used to assemble gold nanoparticles into body-centered cubic (bcc) and face-centered cubic (fcc) superlattices. **Macfarlane *et al.*** (p. 204; see the Perspective by **Travesset**) now show how control over hydrodynamic radii of particles and assembly kinetics can be used to create bcc and fcc lattices, and seven other lattices, with a wide variation in nanoparticle size and lattice parameters.

Ancient Ochre Workshop

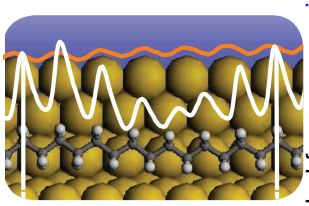
Ochre—essentially, colored earth—was commonly used by early humans for simple art work, body pigmentation, or protection. The use of ochre is well documented after about 60,000 years ago, although there is evidence of earlier use. **Henshilwood *et al.*** (p. 219) now describe an ochre processing workshop at Blombos Cave, South Africa, dated to about 100,000 years ago, considerably earlier than other such workshops. The workshop includes hammers and grindstones for making the ochre powder and two shells where the ochre was stored.

Flash Drive

The rate at which rocks slide past one another controls the stress accumulated along faults in Earth's crust, which eventually leads to earthquakes. Various mechanisms involving increased temperatures with friction have been invoked to explain the initial stages of earthquake nucleation and rupture, including lubrication of the contact area by the formation of a melt layer. However, many typically require slip to occur over relatively large distances in order for friction to become sufficiently reduced. **Goldsby and Tullis** (p. 216) demonstrated, through a series of friction experiments with a variety of silicate rock types, that the coefficient of friction can also drop dramatically across short distances—just a few centimeters—at high slip rates through a process known as "flash" heating. Flash heating may contribute to the weakening of faults during small earthquakes and at the beginning stages of large earthquakes.

Hydrocarbons Get Hitched

Saturated hydrocarbons are among the least reactive organic compounds. Once unsaturated (that is, deprived of hydrogen atoms at adjacent carbon centers) by heating on a catalyst, they are subject to polymerization, but the resulting product distribution tends to be complex. **Zhong *et al.*** (p. 213) now show that confining long-chain linear hydrocarbons in the one-dimensional channels of a gold surface leads to selective end-to-end catenation of the chains, following thermally induced loss of hydrogen.



A Time and a Place for *Hox* Genes

Patterning of the mammalian body relies on the stepwise transcriptional activation of *Hox* genes. **Noordermeer *et al.*** (p. 222) show that this process involves a dynamic transition in the global architecture of *Hox* gene clusters, with each gene transitioning, one after the other, from a negative three-dimensional (3D) compartment to an active compartment. This bimodal configuration parallels the distribution of distinct chromatin marks, suggesting the existence of a link between the presence of chromatin domains and the formation of 3D chromosomal structures. This model for *Hox* gene activation would ensure the proper sequence in the transcriptional activation of *Hox* genes within each gene cluster.

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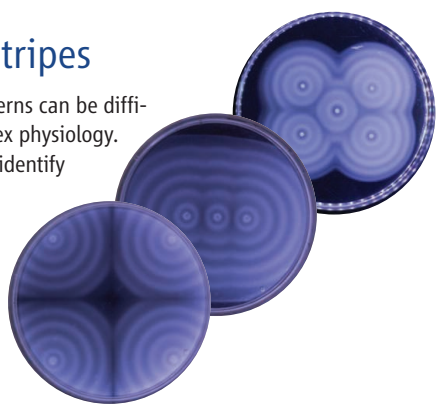
Forest Tipping Points

The existence of tipping points in natural systems is increasingly recognized (see the Perspective by **Mayer and Khalyani**). **Hirota *et al.*** (p. 232) analyzed a global data set on tree distribution showing that forest, savanna, and a treeless state represent alternative stable states on large scales. This result implies that, when drivers such as climate or logging reach a tipping point, there is a potential for irreversible shifts. **Staver *et al.*** (p. 230) explore the bimodalities in tree cover across sub-Saharan Africa, South America, and Australia and evaluate the potential role of fire in the distribution and dynamics of savanna and forest. Rainfall and seasonality are global predictors of tree cover but, at intermediate rainfall with mild seasonality, tree cover is bimodal. Within this climate envelope, fire differentiates between savanna and forest.

Skipping Replication

The DNA replication machinery replicates DNA in a 5′ to 3′ direction. Thus, the leading (5′ to 3′) strand of the DNA double helix is thought to be replicated continuously, and the lagging (3′ to 5′) strand discontinuously. DNA lesions on the lagging strand cause little impediment to replisome progress because of the discontinuous nature of replication. Lesions on the leading strand were thought to require DNA polymerase to dissociate from DNA and reinitiation downstream of the damage. **Yeeles and Marians** (p. 235) studied the in vitro replication of an *Escherichia coli* plasmid carrying a single cyclobutane pyrimidine dimer lesion, on the leading strand. On encountering the damaged template, a minimal *E. coli* replisome remained associated with the DNA, skipped across the lesion, and reinitiated leading-strand synthesis downstream of the damage, independent of any replication restart proteins.

How *Escherichia coli* Got Its Stripes



How living organisms develop regular anatomic patterns can be difficult to unravel when studied in the context of complex physiology. Synthetic biology provides a bottom-up approach to identify minimal circuits that can drive patterning. **Liu *et al.*** (p. 238) describe a synthetic genetic circuit that couples cell density and motility in order to program the formation of periodic stripes in a growing *E. coli* population. The system could be adjusted to modulate the patterning, and a mathematical model was able to predict the experimental results.

A Genetic Clue to Fibroids

Uterine fibroids (leiomyomas) are estimated to affect more than half of the female population over the age of 50. Although benign, these tumors nevertheless can cause serious health complications and are one of the most common reasons for hysterectomy. **Mäkinen *et al.*** (p. 252, published online 25 August) explored the pathogenetic basis of uterine fibroids by performing gene sequence analysis on 225 tumor samples derived from 80 patients. Remarkably, somatic mutations in a gene called *MED12* were found in over 70% of the tumors. The protein encoded by *MED12* is a subunit of the *mediator complex*, a 26-subunit transcription factor that is thought to regulate gene expression through its interactions with RNA polymerase II and DNA regulatory elements.

Keep Your Distance

Nearly one trillion bacteria reside in our gut, but amazingly, our immune system does not wage a war against them. How is such a peaceful coexistence achieved? There is likely a battery of mechanisms; however, one is necessary to keep the bacteria in the small intestine and colon physically separated from the immunologically active mucosal epithelium. **Vaishnava *et al.*** (p. 255; see the Perspective by **Johansson and Hansson**) used a combination of genetic approaches to demonstrate that signaling downstream of Toll-like receptors (TLR), which recognize conserved signatures of microorganisms to initiate immune responses, is required to maintain this separation.

CREDIT: YAJUAN WANG