Delayed Choice for Quantum Mechanics
Wave-particle duality is at the heart of quantum mechanics. Particles and photons can display both properties, and which property is measured depends on the type of measurement made. What if the experimental setup changes when the photon or particle is “in flight” and has already entered the experimental apparatus? Jacques et al. (p. 966) report an almost ideal realization of such a “delayed choice” experiment as formulated by Wheeler. A triggered single-photon source provides a mechanism for precise timing of the experiment within laboratory conditions. The behavior of the photon in the interferometer depends on the observable that is measured, even if that choice is made when the photon is already in the system.

Water Marks
Water may have once flowed on the surface of Mars when it was warm and wet. Today, however, all that remain are mineral deposits, including sulfates and clays. Okubo and McEwen (p. 983; see the cover) show in very detailed images from the Mars Reconnaissance Orbiter that water once flowed along fractures that crossed the layered deposits in western Candor Chasma. Geochemical bleaching and cementation are seen in the fracture zones that are similar to water-related processes on Earth.

Finding a Good Example
Complex data sets can be more readily analyzed if representative examples can be identified. Such “exemplars” might be points around which data will cluster, archetypal faces among a gallery of actual photos, or possible exons in a gene sequence. Unfortunately, extracting exemplars is computationally intensive, and conventional techniques only work well with numerical measures of data-point similarity and if the initial guess is close. Frey and Dueck (p. 972, published online 11 January; see the Perspective by Mézard) now report a method that enables much faster exemplar detection. The algorithm works by having the data points exchange “messages” that communicate whether a particular point could be an exemplar; iteration of the message-passing process allows dramatically faster processing as certain data points emerge as truly representative.

Unpeeling Granite’s History
Large granite bodies may have formed within Earth’s crust by intrusion of new magma or by remelting of igneous varieties of crustal rocks. The evolutionary history of granites can be revealed by examining the chemistry of successive layers of its large constituent crystals, notably zircon. Kemp et al. (p. 980; see the Perspective by Eiler) have measured hafnium and oxygen isotopes in zoned zircon crystals from the classic granites of eastern Australia. They found that these granites formed by the recycling of deep crustal rocks as mantle magma rose through them, rather than by remelting ancient, shallower crust, as was widely believed.

Hippocampal Dualism
The formation of discrete representations in memory has been hypothesized to reflect neuronal pattern separation at the early stages of the hippocampal formation, but both location and mechanisms of the process have remained elusive. Leutgeb et al. (p. 961; see the Perspective by Fenton) show that the hippocampus has at least two mechanisms for pattern separation associated with different parts of the hippocampal circuit. In the dentate gyrus, signals are separated by high-fidelity decorrelation of coactivity patterns within a subset of active cells. In CA3, further separation is achieved by activation of non-overlapping neuronal subpopulations. The two mechanisms of pattern separation, associated with different parts of the circuitry, support distinct forms of ensemble representation in the hippocampus.

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< Routes of Chili Pepper Domestication
A wide variety of chili peppers were cultivated and used in cooking throughout the New World. Perry et al. (p. 986; see the Perspective by Knapp) identified a starch from chili peppers on ancient pottery and stone tools that is diagnostic of groups of chili species. The starches were found at various archaeological sites, including from about 6500 years ago in Ecuador, and suggest multiple domesticated chili species by about 4000 years ago.

Guests Move in When It’s Hot
Microporous metal–organic extended arrays can absorb guest molecules at specific sites, and Bradshaw et al. (p. 977) show that water molecules in a Co extended array, \([\text{Co},(\text{bipy})_2\text{SO}_4\text{H}_2O]_2\), can undergo substitution reactions with sorbed methanol and bipyridine molecules upon heating in a dry inert atmosphere. Hydrogen-bonding interactions place two bipyridines or two methanols near alternating Co atoms along linear chains within the solid. When these molecules displace the water ligands, the chains adopt a zigzag geometry. Other Co sites are spectators that help maintain the framework while this reaction proceeds. The reaction can be reversed by rehydrating the crystal at room temperature.

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And Then There Were Three

During development, stem cells usually generate two daughter cells that go on to differentiate as well as another stem cell. Ohlstein and Spradling (p. 988) now describe one type of stem cell in the Drosophila intestine that produces three offspring fates—a stem cell, an enterocyte, and an enteroendocrine cell. The choice in fate seems to depend on the amount of the protein Delta (a membrane-bound signaling ligand that can activate the signaling receptor Notch) that is expressed in the stem cell at the time of cell division. Daughter cells with high amounts of Delta-Notch signaling become enterocytes, those with lower amounts become enteroendocrine cells, and those with the least amount retain the stem cell fate.

Sticky Fingers

As animal cells migrate across a surface, they send out processes known as filopodia that explore the substratum. Galbrraith et al. (p. 992) now find that the intracellular actin network directs very local protrusions that contain clusters of cell surface-adhesion molecules at their tips that are primed to interact with molecules of the extracellular matrix. These "sticky fingers" at the leading edge of motile cells appear to search for suitable sites of adhesion that can then be used to help move the rest of the cell.

Locust Navigation

The plane of polarization of sunlight depends on the Sun’s position, and a variety of insects use polarization patterns to guide spatial orientation. Heinze and Homberg (p. 995) show that the orientations of electric field vectors of linearly polarized light (E-vectors), presented from above the animal, are represented as a topographical map in the columns of the central complex in the locust brain. The central complex acts as an internal compass that uses the polarization pattern of the blue sky to code spatial directions relevant to animal orientation.

Lethal Injection

Pathogenic bacteria can inject into host cells virulence factors via the so-called type III machinery. Li et al. (p. 1000) describe a family of bacterial virulence factors that have a previously unknown phosphothreonine lyase activity that can remove the phosphate from signaling mitogen-activated protein kinase family members involved in innate immunity. This family of effectors is important in the virulence of a variety of animal and plant bacterial pathogens, including Shigella, Salmonella, and Pseudomonas syringae.

A RuBisCo with No Taste for CO₂

In photosynthetic organisms, RuBisCo (ribulose-1,5-bisphosphate carboxylase-oxygenase) fixes CO₂ through the “dark reaction” to make organic compounds such as sucrose, but one type of RuBisCo, found in nonphotosynthetic anaerobic archaeon, does not. Sato et al. (p. 1003) found that type III RuBisCo, acting solely as a carboxylase, in combination with newly revealed archaeal nucleoside phosphorylase and ribose-1,5-bisphosphate isomerase functions, converts CO₂, water, and adenosine 5’-monophosphate into 3-phosphoglycerate, which feeds ribose into carbon metabolism, salvages adenine, and generates ATP.

Joint Effort

Rheumatoid arthritis (RA) is an autoimmune condition that leads to joint inflammation. Lee et al. (p. 1006, published online 25 January; see the Perspective by Firestein) identify a new regulator of the cellular organization of the synovium that might also provide a potential therapeutic target for inflammatory arthritis. Mice lacking the cell adhesion molecule cadherin 11 showed significantly reduced growth of the synovium and were resistant to the development of an experimentally induced RA-like condition. Joint inflammation in mice could be inhibited with a monoclonal antibody to cadherin-11.