Climate Reversal

The climate and environment of the Arctic have changed drastically over the short course of modern observation. Kaufman et al. (p. 1236) synthesized 2000 years of proxy data from lakes above 60° N latitude with complementary ice core and tree ring records, to create a paleoclimate reconstruction for the Arctic with a 10-year resolution. A gradual cooling trend at the start of the record had reversed by the beginning of the 20th century, when temperatures began to increase rapidly. The long-term cooling of the Arctic is consistent with a reduction in summer solar insolation caused by changes in Earth’s orbit, while the rapid and large warming of the past century is consistent with the human-caused warming.

Stability Through Confinement

With the ability to vary experimental parameters—including particle density, geometry, interaction strength, and sign—cold atoms trapped in optical lattices are ideal test systems to probe many-body quantum physics. However, due to dissipation processes most of the scenarios studied to date have necessarily looked at ground state phases. Haller et al. (p. 1224) describe a technique in which confinement of the atoms to low dimensions, using a confinement-induced induced resonance, can stabilize excited states with tunable interactions. The ability to create these metastable states will allow a much wider range of quantum systems to be explored.

Massive White Dwarf

White dwarfs are the remnants of stars like the Sun, which blow their outer layers away and compress into dense cores as they end their nuclear-burning lives. Mereghetti et al. (p. 1222) observed an x-ray eclipse of a peculiar system comprising a white dwarf (which is also a fast pulsating x-ray source) and a subdwarf star (a star that lost its outer layers before nuclear fusion was extinguished in its core). Based on dynamical considerations and the presence of x-ray pulsations, the mass of both stars has been estimated. The white dwarf has a mass at least 1.2 that of the Sun, which is close to the limit of gravitational stability for this class of star. These results provide constraints on the poorly understood process that led to the formation of our solar system.

Inside Oort

Long-period comets are thought to come from the outermost region of the solar system, the Oort Cloud, where a large number of icy bodies orbit the Sun. Outer Oort Cloud bodies are more likely to penetrate the inner planetary region of the solar system as comets, because they experience stronger external gravitational perturbations. Inner Oort Cloud bodies, by contrast, are thought to be ejected before they reach observable orbits. Using numerical simulations that followed the orbital histories of bodies in the inner Oort Cloud, Kaib and Quinn (p. 1234, published online 30 July 2009; see the Perspective by Duncan) identified a dynamical pathway that allows comets in the inner Oort Cloud to move to the outer Oort Cloud, where they can be perturbed and enter the visible region in great numbers. According to this mechanism, the amount of mass in this region is consistent with the material needed to form the giant planets.

Epigenetic Signals

The lipid sphingosine-1-phosphate (S1P) is a signaling molecule that binds to receptors on the cell surface to initiate biochemical changes that control a range of biological processes from growth and survival to immune reactions. Halt et al. (p. 1254) report that S1P can also function by direct binding to the nuclear enzymes, histone deacetylases (HDACs) 1 and 2. The enzyme that generates S1P, sphingosine kinase 2 (ShpK2) is present in the nucleus in complexes with HDAC1 and HDAC2. Generation of S1P and its binding to HDACs inhibited deacetylation of histone. Such histone modification is an epigenetic mechanism that controls gene transcription. Thus, generation of S1P in the nucleus appears to be a signaling mechanism by which cells can control gene expression in response to various stimuli.

Adult Fears

Why are fear memories almost impossible to get rid of—even with extensive extinction training? Animal studies have shown that the efficacy of extinction learning depends on age. Fear memories in young animals can be permanently erased, but in adults they can be easily recovered after extinction training. Perineuronal nets, the highly organized form of extracellular matrix around inhibitory neurons, mediate the shift from juvenile to adult forms of learning in sensory systems. Gogolla et al. (p. 1258; see the Perspective by Pizzorusso) have discovered that the formation of perineuronal nets in the amygdala coincides with the developmental shift in the ability to erase fear memories by extinction. Removal of perineuronal nets in adult animals re-enabled the erasure of fear memories. Thus, in adults it appears that fear memories are actively protected from erasure by the perineuronal nets.
Adaptive Limits
Species adapt to a changing environment as a result of selection acting on current genetic variation. However, the degree of variation underlying traits that can respond to selection is unclear. Kellermann et al. (p. 1244; see the Perspective by Merilä) investigated the degree of genetic variation available to fruit flies for cold and desiccation tolerance. Species from the tropics tended to have low variability for these traits, while flies from more temperate climates showed higher levels of variation. However, overall genetic variability did not differ, suggesting that the tropical species lacked the alleles that confer tolerance to these environmental extremes and restrict their potential range.

Preparation for Cell Wars
When T cells encounter an infection, they proliferate to create a larger army to fight the invader. The overall magnitude of the T cell response depends on the severity of infection and is determined by the number of T cells of a particular antigen specificity that are initially recruited, as well as the magnitude of the proliferative response. The extent to which these two components contribute to the response is unknown. By using DNA barcoding to track the responses of individual T cells, van Heijst et al. (p. 1265) showed that the recruitment of T cells of a particular antigen specificity is similar and nearly complete, but that the extent of the proliferative response differed, and this determined the overall magnitude of the T cell response.

Fascin-Actin Rab Bristles
Rab proteins have diverse functions in directing intracellular traffic and may also affect development. Zhang et al. (p. 1250) show that during Drosophila development Rab35 influences the development of bristles, neurosensory structures built upon bundled actin. Rab35 also caused massive actin-rich filopodia protrusions from cultured cells. Activated Rab35 interacted directly with fascin, an actin filament bundling protein, to colocalize near the plasma membrane. When Rab35 was engineered to interact with the surface of mitochondria, it stimulated localized actin assembly in a fascin-dependent manner. Thus, fascin is a Rab35 effector protein that links membrane trafficking regulation to cytoskeleton assembly during development.

Boxing Clever?
Piaget showed that 10-month-old infants will persist in looking for a toy in box A, where it has been placed several times, even after having been shown that it has been moved to box B, whereas 12-month-old infants do not. This phenomenon marks a developmental milestone in human infant cognition that Topál et al. (p. 1269; see the Perspective by Tomasello and Kaminski and the news story by Pennisi) explored in a remarkable series of comparative tests. The results support the view that infants and adult dogs will both persevere in searching erroneously in box A because they regard the placement of the toy by a human experimenter as a social teaching event. By contrast, wolves rapidly learn correctly to search box B. They also observed that infants are able to generalize and thus still persevere when one experimenter places the toy in box A and a second then places the toy in box B. Dogs, however, display episodic learning, and a second experimenter reduces their searching choice to chance.

Carrots Are Better Than Sticks
The challenge of dealing with freeloaders—who benefit from a common good but refuse to pay their “fair share” of the costs—has often been met in theoretical and laboratory studies by sanctioning costly punishment, in which contributors pay a portion of their benefit so that freeloaders lose theirs. Rand et al. (p. 1272; see the news story by Pennisi and the cover) added a private interaction session after each round of the public goods game during which participants were allowed to reward or punish other members of their group. The outcome showed that reward was as effective as punishment in maintaining a cooperative mindset, and doing so via rewarding interactions allowed the entire group to prosper because less is lost to the costs of punishing.