Growing from Below

Large ice sheets, like the one that covers Antarctica, grow when, over long periods of time, falling snow accumulates faster than it disappears. However, this type of accumulation is not the only way that ice sheets can thicken. Bell et al. (p. 1592, published online 3 March; see the Perspective by Tulaczyk and Hossainzadeh) found that as much as half of the thickness at some locations of an ice sheet can result from freezing at the bottom. This process alters the structure of the ice column and the topography of the ice sheet surface and has implications for how we understand ice sheet movement and the paleoclimatological information contained within.

An Eye on RNA Granules

During vertebrate organ development, gene expression is precisely regulated by controlling gene transcription, messenger RNA (mRNA) translation, or the stability of mRNAs. Lachke et al. (p. 1571; see the Perspective by Duncan) have determined that the Tudor Domain protein TDRD7, which forms RNA granules in developing lens tissue, is required for proper eye development and maintenance. TDRD7 deficiency in human patients and model organisms affects the expression of specific mRNAs and causes ocular defects including cataracts and glaucoma. Thus, regulation of posttranscriptional mRNA levels, like the regulation of gene transcription, is critical to mammalian organogenesis.

Pancreatic Cancer Immunotherapy

Pancreatic ductal adenocarcinoma (PDA) is a particularly deadly form of cancer for which few therapies have shown efficacy. The tumor microenvironment in PDA is largely immunosuppressive, blocking antitumor immunity. Beatty et al. (p. 1612) treated a small cohort of PDA patients with gemcitabine chemotherapy plus a monoclonal antibody that activates CD40, a protein known to promote T cell immunity. Because this combination showed efficacy in a small number of patients, the same treatment was analyzed in a mouse model of PDA. A subset of CD40 antibody-treated mice also showed tumor regressions. However, the antitumor effects depended not on T cells, but on macrophages. Macrophages that had infiltrated the tumors after antibody treatment were also tumoricidal in vitro. Thus, activation of macrophages by CD40 may promote antitumor immunity in PDA.

Cosmic Squeeze

Baryonic matter is made up of protons and neutrons, but represents just a small fraction of the matter in the universe—most of the rest being dark matter. Using high-quality data from the Suzaku x-ray telescope, Simionescu et al. (p. 1576) measured the fraction of baryonic mass to total mass in the Perseus Cluster of galaxies. Within the inner region of the cluster, the baryonic fraction is consistent with that measured globally for the universe. At large radii, however, the baryonic fraction exceeds the global value, suggesting that the cluster has undergone a major merging event that caused a compression of the gas, where most of the cluster’s baryons reside, relative to the dark matter in the cluster outskirts.

Mind the Pseudogap

Unlike conventional superconductors, the cuprate family of superconductors has an exotic phase above their transition temperature, $T_c$, where the material is neither superconducting nor in the normal state. This so-called pseudogap state commences at a higher-temperature $T^*$ and its nature is conjectured to hold the key to the resolution of the cuprate high-temperature superconductivity puzzle. Whether the “transition” at $T^*$ is a real phase transition characterized by broken symmetry or a crossover, is one of the crucial unanswered questions. He et al. (p. 1579) used three techniques on the same sample to reveal an abrupt transition at the same temperature, consistent with the existence of a true phase transition at $T^*$.

Strengthening Nanocrystalline Copper

A metal can be made stronger by reducing the size of its component crystalline grains. However, the material loses its ability to stretch and change shape, and will eventually fracture and fail completely. Because this sort of deformation precedes material failure, the loss of this plasticity has limited the application of nanocrystalline metals in the real world. Fang et al. (p. 1587; published online 17 February) confined nanocrystalline copper within a substrate of coarser-grained copper, using a transition region where the grain size slowly decreased, and they were able to create specimens that retained plasticity but also showed high yield strength.

My, What New Teeth You Have

Mammals evolved within a group of tetrapods, the therapsids, which arose during the lower Permian period about 270 million years ago. After the end of the Permian, a group of therapsid anomodonts (mammal-like reptiles) differentiated into an extremely diverse group of herbivores—from small burrowing animals to large browsers. Cisneros et al. (p. 1603; see the Perspective by Fröbisch) describe a new basal anomodont, Tiarajudens, from Brazil that provides some clues about how this group managed to become such successful herbivores. Dental occlusion is a key component of successful herbivory that facilitates efficient processing of tough cellulosic plant materials through thorough grinding between hard teeth. Tiarajudens pushes the date of dental occlusion in this group back to 260 million years ago.

Stone Tool Manufacturers

Acheulean stone tools, including oval- and pear-shaped handaxes, were first manufactured in Africa about 1.6 million years ago. Comparable tools have been seen across Eurasia, but in
many cases their ages have been uncertain. Although the most confidently dated sites are thought to be less than 1 million years old, earlier migrations of Homo from Africa have been suggested. Pappu et al. (p. 1596; see the Perspective by Dennell) have now obtained consistent cosmogenic ages from Acheulian tools in Southeast India of at least 1.1 million and up to 1.5 million years ago. Thus, an early Eurasian migration of Homo did indeed possess Acheulian technology.

Forest Community Commitment

Tropical forests typically contain rich biodiversity with high conservation value, also providing important resources for human inhabitants and users. Persha et al. (p. 1606) used a social-ecological data set of 84 human-dominated landscapes in East Africa and South Asia to analyze the factors that shape the joint benefits of forest biodiversity conservation and forest-based subsistence livelihoods. Jointly positive outcomes across these two potentially competing forest benefits were far more likely when forest users participated in the rulemaking aspects of forest governance.

Along the Riverbank

Salmon are distributed around the Pacific Rim from California to Korea, and the carcasses of salmon returning to their native streams to spawn provide substantial nutrient input to the surrounding riverside vegetation. Hocking and Reynolds (p. 1609) show that these subsidies cause detectable shifts in plant communities along streams. In a large-scale study of 50 watersheds in British Columbian rainforests, the impact of subsidies led to a simplification of plant communities and a shift toward nutrient-demanding plant species. Thus, interactions across ecosystem boundaries can change ecological community structure and function, which will impact ecosystem-based management of salmon and their habitats.

Abscission in Glorious Technicolor

Abscission represents the very final stage of animal cell division, when daughter cells are physically separated from one another. Guizetti et al. (p. 1616, published online 10 February; see the Perspective by Raiborg and Stenmark) present three-dimensional electron tomographic reconstructions of intermediate stages of abscission in human cells, which reveal spirals of 17-nanometer-diameter filaments at a cortical constriction site within the intercellular bridge. Live-cell and structured illumination microscopy suggest that a protein complex involved in a variety of membrane-trafficking processes and in cytokinesis, ESCRT-III, builds the abscission structure and mediates cortical ingression of the intercellular bridge.

FGF19 and Liver Metabolism

Insulin has been the main hormone described to regulate metabolism in the liver. Kir et al. (p. 1621; see the Perspective by Kim-Muller and Accili) now show that fibroblast growth factor 19 (FGF19) appears to be another important regulator, promoting synthesis of glycogen and proteins. FGF19 is made in the small intestine in response to food intake, which stimulates receptors at the liver to regulate metabolism through a mechanism distinct from that of insulin. Unlike insulin, FGF19 did not promote lipogenesis in the liver. In a mouse model of diabetes, FGF19 promoted glycogen synthesis, and could thus provide a target for therapeutic control of insulin resistance.

RNA Quality Control

Eukaryotic genomes are extensively transcribed into RNA by RNA polymerase II. Quality-control and surveillance systems must ensure that all this RNA is processed correctly. A fission yeast histone methyltransferase involved in heterochromatin assembly, Clr4, helps mediate exosome-dependent degradation of potentially dangerous antisense transcripts. Zhang et al. (p. 1624) now show that Clr4 interacts with and methylates the RNA export protein Mlo3. Mlo3 promotes Clr4's ability to suppress aberrant antisense RNAs through its interaction with the RNA interference machinery and with a cofactor of the exosome nuclear surveillance system. Mlo3 and Clr4 may thus be part of a molecular sensor that differentiates aberrant RNAs from the real McCoy.