Sweet Smell of Communication

The aromas put out by plants serve to draw in insect pollinators, but they also enable communication with other plants. Runyon et al. (p. 1964; see the news story by Pennisi), studying a parasitic plant that is also a noxious weed, find that the dodder plant responds to volatile emissions from tomato plants such that the seedling parasite can rapidly locate and to latch onto a host plant. Wheat, which dodder generally disdains as a host, releases volatiles that include a seemingly repellent component. The function of volatile signals in this interaction between plants resembles the function of volatiles in signaling between insect herbivores and their plant fodder.

Field-Effect Modulation of Oxide Interfaces

Oxides tend to be insulators, but the interface region between two oxides can be grown to support a high-mobility, two-dimensional electron gas that can display a range of functional characteristics, such as superconductivity, magnetism, and ferroelectric behavior. Using oxide heterostructures, Thiel et al. (p. 1942, published online 24 August; see the Perspective by Hwang) now show the conductance of the interface region can be modulated over many orders of magnitude by applying an electric field. The versatility of these oxide materials and the ability to switch the behavior with an electric field bode well for potential applications.

A Lateral Look at Lipid Phases

Lateral heterogeneity in lipid bilayers can be difficult to assay at the length scale near 100 nanometers that has been associated with structures such as lipid rafts. Scanning probe methods provide sufficient spatial resolution but limited information on composition, and optical methods often have limited spatial resolution or introduce dye groups that may perturb the partitioning of lipid components. Kraft et al. (p. 1948; see the Perspective by Groves) have used a high-resolution, secondary-ion mass spectrometry probe and isotopic labeling to study supported bilayers of an equal mixture of DLPC (dilauroylphosphatidylcholine) and DSPC (distearoylphosphatidylcholine), which phase-separates at room temperature into a fluid phase and a gel phase. They identified variations in the gel-phase composition that may arise from small regions of trapped fluid phase.

Tracking Down Mn(III)

Manganese, an important trace element in ocean biochemistry, is directly incorporated into enzymes and widely affects the chemistry in different sediment and water layers. Soluble Mn(III), an important intermediate species, has been thought to be absent in the environment, yielding Mn(II) and Mn(IV) species instead. Trouwborst et al. (p. 1955; see the Perspective by Johnson) have now documented the presence of Mn(III) in regions of the Black Sea and the Chesapeake Bay that are low in O2. Ligands apparently stabilize Mn(III), which in turn stabilizes suboxic zones in all waters and water-rich sediments.

Clocking Spinning Carbons

Nuclear magnetic resonance (NMR) spectroscopy has long been used to measure hindered rotation rates about molecular single bonds, although its limitation to microsecond resolution has prompted chemists to categorize rotational barriers in terms of an "NMR time scale." Zheng et al. (p. 1951) show that an infrared vibrational analog to such NMR experiments can be used to clock the picosecond internal rotation dynamics of an ethane derivative at room temperature and shed light on the weak interactions that govern the low-energy isomerization barriers in such molecules.

Accelerated Melting

The Greenland Ice Sheet, the second largest ice sheet on Earth, is losing mass. Chen et al. (p. 1958, published online 10 August) report results from the Gravity Recovery and Climate Experiment (GRACE) satellite mission that indicate the Greenland Ice Sheet has been melting at an accelerated rate since 2004. It is now disappearing at the rate of about 240 cubic kilometers per year, which is three times as quickly as in the preceding 5 years. These results are consistent with other recent work that has used different techniques to estimate the mass balance of the ice sheet, and indicate that melting in Greenland is contributing enough water to raise global sea level by more than half a millimeter annually.

Mapping Biological Connectivity

Comprehensive catalogs of biological information (such as sequence or protein structure data) can have enormous utility in biomedical research. Lamb et al. (p. 1929) have extended this approach to create comprehensive catalogs of cellular states, as defined by RNA expression. The effects of 164 small molecules on the complete messenger RNA expression profiles were examined in established cell lines, with a primary focus on a breast cancer epithelial cell line. By comparing the genomic signature of drug candidates (the anticancer drug gedunin, estrogen, histone deacetylase, and phenothiazine antipsychotics) or a disease state (obesity, Alzheimer’s disease, and dexamethasone-resistant acute lymphoblastic leukemia) to this resource, it was possible to identify potential mechanisms of action, confirm previous applications of known drugs, and identify additional potential uses for known drugs.
Ribosome Structure at Higher Resolution

Significant insights into the mechanism of protein translation have come from recent high-resolution structures of the 50S and 30S ribosomal subunits. Progress has also been made on determining the structure of the whole ribosome, but a high-resolution view of the entire ribosome bound to its ligands has been lacking. Selmer et al. (p. 1935, published online 7 September) have determined the structure of the Thermus thermophilus ribosome complexed with messenger RNA (mRNA) and transfer RNA (tRNA) at 2.8 angstrom resolution. The structure reveals details of the interaction of the mRNA and tRNA ligands with the ribosome and the role of proteins and metal ions in the formation of inter-subunit bridges.

Immune Cells and Cancer Prognosis

In the mouse, the immune system can recognize a developing tumor and control its growth, but whether the same is true in humans has been controversial. To investigate the impact of the immune response on the prognosis of cancer patients, Galon et al. (p. 1960; see the news story by Couzin) analyzed tumor-infiltrating immune cells in human colorectal cancers by gene expression profiling and in situ immunohistochemistry. In three independent patient populations, the properties of the immune cells (type, density, and location) within the tumors were a better predictor of recurrence and overall patient survival than tumor histopathology. Thus, information about the immune response in individual cancer patients could help optimize treatment decisions.

Exon Junction Complex Revealed

Exon junction complex (EJC) assembles on newly spliced RNA and is a central effector of messenger RNA functions. Andersen et al. (p. 1968, published online 24 August) have determined a 2.3 angstrom resolution structure of a core EJC complex bound to an RNA oligonucleotide. The EJC core comprises the DEAD-box RNA helicase eIF4AIII bound to an adenosine triphosphate (ATP) analog, and three additional proteins—MLN51, MAGOH, and Y14. Tight binding of the complex to RNA requires that ATP hydrolysis by eIF4AIII is inhibited. The structure shows how eIF4AIII binds sequence-independently to the RNA backbone and how the protein partners participate in RNA recognition and regulate ATP hydrolysis of the DEAD-box helicase.

Stop to Start

The T cell surface receptor CTLA-4 helps dampening immune responses, and deficiency in the protein can lead to uncontrolled immune activation and autoimmunity. This effect has been attributed to the loss of negative signals that down-regulate T cell activation. Schneider et al. (p. 1972, published online 24 August; see the Perspective by Mustelin) tracked T cells as they interacted with activating dendritic cells in culture and in vivo. CTLA-4 appeared to stimulate roaming of T cells away from dendritic cells, which lessened the likelihood that the T cells would remain activated. This finding makes CTLA-4 a potentially important clinical target.

Muscle Building

When neurons innervate muscles, they secrete a protein, agrin, which causes neurotransmitter receptors to cluster on the muscle and form of a synapse at the point of nerve contact. A muscle-specific kinase is necessary for synapse development, as is the recently described protein Dok-7. Congenital myasthenic syndromes (CMS) are a group of inherited disorders of neuromuscular transmission, which lead to muscle weakness. Beeson et al. (p. 1975, published online 17 August) now find that a group of patients with CMS have mutations in Dok-7. These mutations result in the formation of small, abnormal synapses at the neuromuscular junction and help account for the symptoms of the disease.