

ASTROPHYSICS

Placing Uranus and Neptune

The solar system has two reservoirs of comets: the Kuiper Belt, where Pluto is also located, and the Oort cloud, much further beyond the orbits of the planets. The comets did not necessarily form in the regions they now occupy. In the case of the Oort cloud, computer simulations of its formation suggest that it originated from the region where Uranus and Neptune once were. Based on this constraint and the similarity between the deuterium enrichment in the ice of Oort cloud comets and in Saturn's moon Enceladus, Kavelaars *et al.* suggest that at the time the Oort cloud formed, Uranus and Neptune were much closer to Saturn than they now are. Deuterium enrichment varies with distance to the Sun and is linked to the time and location at which these ices condensed. The result is consistent with models of the dynamical evolution of the solar system wherein Uranus and Neptune migrate from their formation region to their current location via dynamical interactions. — MJC

Astrophys. J. 734, L30 (2011).

IMMUNOLOGY

Natural Helper Cells Hinder, Too

Viral infections in people with asthma can be particularly bad, because these patients are more prone to develop airway hyperreactivity (AHR) and inflammation, which can lead to substantial morbidity and even death. AHR is also seen in allergic asthma, but conventional therapies used for this disease are often not effective against virus-induced AHR, which suggests different underlying mechanisms of disease development and pathology. Chang *et al.* sought to determine the cellular and molecular mechanisms that drive AHR in response to viral infection by using mice infected with influenza virus. Infected mice rapidly developed AHR and inflammation that, instead of being dependent on the classical T helper type 2 cytokines typically associated with allergic asthma and AHR, were dependent on interleukin-33 (IL-33). Also unlike allergic asthma and AHR, influenza-induced AHR did not depend on the adaptive immune response. This led the authors to test the role of natural helper cells, an IL-33-secreting, newly described immune cell type that promotes immunity to intestinal helminth infections. Indeed, depletion of natural helper cells blocked the development of AHR in influenza-infected mice, and transfer of these cells to IL-33-deficient, influenza-infected mice

restored AHR. Although these results await confirmation in humans, they suggest that, like other immune cell subsets, natural helper cells can have both protective and pathological effects. — KLM
Nat. Immunol. 12, 10.1038/ni.2045 (2011).

CELL SIGNALING

Taking Sleep Up a Notch

Notch receptor signaling is best known for its regulation of pattern formation and cell fate during development, but recent evidence also indicates an important role for Notch in the adult brain. Two new studies now show that Notch signaling regulates sleep or sleep-like functions in the nematode *Caenorhabditis elegans* and the fruit fly *Drosophila melanogaster*. In *Drosophila*, Seugnet *et al.* found that a negative regulator of Notch signaling accumulated after sleep deprivation.

Restoration of Notch signaling decreased the amount of extra sleep required by sleep-deprived flies and prevented the deficit in learning caused by loss of sleep. In *C. elegans*, Singh *et al.* showed that Notch signaling promoted a sleep-like quiescent behavior normally associated with larval molting. Mutations in various Notch signaling components that led to a reduction of Notch signaling also lowered the arousal threshold from this sleep-like state, thus affecting the quality of sleep. Although the specifics of how Notch signaling affects sleep may vary between different organisms, these studies hint that reduced Notch signaling is associated with responses to environmental stress. — LBR

Curr. Biol. 21, 835 (2011);

Curr. Biol. 21, 825 (2011).

PSYCHOLOGY

Shame and Honor Work

Humans have evolved both rewards and punishments to dictate those behaviors that are acceptable and those that are not. The extent to which shame and honor affect individual decisions in group situations where cooperation leads to reduced individual benefit, however, is not well understood. Jacquet *et al.* used anonymous donations as a means to separate out behavior stimulated by honor and shame by



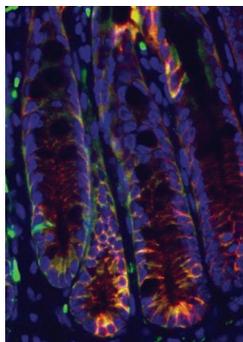
CREDIT (TOP TO BOTTOM): NASA; FOTORESEARCH.COM/ANNA KARWOWSKA

exposing those who had given the most versus the least in a public goods game setting. Both honoring those who donated the most as well as shaming those who donated the least led to an approximate 50% increase in cooperation, showing how the desire to avoid shame and gain honor shapes an individual's behavior. — LMZ
Biol. Lett. **7**, 10.1098/rsbl.2011.0367 (2011).

BIOMEDICINE

Deconstructing a Probiotic

Despite aggressive marketing campaigns that highlight the beneficial effects of probiotics (therapeutics consisting of live microorganisms) on gastrointestinal health, in many cases the claimed benefits are made on the basis of



limited or controversial clinical data. Moreover, there are far more hypotheses than experimental data on the molecular mechanisms by which probiotics alter gut homeostasis. A better understanding of these mechanisms could shed light on the disparate clinical data and perhaps even lead to more effective drugs that can substitute for living microbes.

Studying *Lactobacillus rhamnosus* GG (LGG), which is used in yogurt as a nutritional supplement, Yan *et al.* found that this bacterium secretes a soluble protein, called p40, which prevents death of intestinal epithelial cells through activation of the epidermal growth factor receptor signaling pathway. In three mouse models of intestinal inflammation, administration of recombinant p40 (encased within special hydrogel beads to minimize its degradation) reduced disease symptoms in both a therapeutic and preventive setting. Whether p40 alone will show similar activity in humans without adverse side effects remains to be seen, but these results support the idea that the identification of the specific health-promoting factors made by probiotics is an avenue worth exploring. — PAK

J. Clin. Invest. **121**, 10.1172/JCI44031 (2011).

CHEMISTRY

A Fiery By-Product

Fire has alternately salvaged and savaged human beings since the dawn of civilization. It's rather remarkable, after so much time, that the combustion process still holds mysteries for chemists to probe. One such mystery is unraveling the

extraordinarily complex composition of the smoke-borne by-products that accompany release of the primary products, water and carbon dioxide. Among these by-products are a range of highly reactive small molecules that may cause physiological damage upon inhalation. Roberts *et al.* chart the abundance of one such molecule, isocyanic acid, by systematically probing the product stream of controlled laboratory biomass fires using a mass spectrometric technique especially sensitive to acids (negative-ion proton-transfer chemical ionization). In addition to documenting concentrations from these laboratory experiments of 600 parts per billion by volume, the authors detect hundreds of parts per trillion of the compound in urban Los Angeles air and in Boulder, Colorado, air after a wildfire. They furthermore estimate significant aqueous solubility of the compound at physiological pH, based on a Henry's Law partitioning measurement. Because previous studies have implicated isocyanic acid and its conjugate base in inflammation effects associated with protein carbamylation, the authors urge further study of the compound's exposure impact. — JSY

Proc. Natl. Acad. Sci. U.S.A. **108**, 8966 (2011).

PHYSICS

Quantum Conferencing

For certain critical transactions and communications, you want to be secure in the knowledge that your message cannot be stolen or compromised by a malicious hacker. Encrypting messages with keys distributed beforehand to all interested parties is the usual method to ensure security. For ultimate or unconditional security, however, one key per message or transaction is allowed, after which the key is discarded. This "one time pad" requirement can place a hefty overhead on distributing the keys and would not be particularly practical for everyday use. In quantum key distribution (QKD), the encryption keys are made up of a series of quantum bits, single photons of light, for instance, with the orthogonal polarization states encoding a logical 1 or 0. Because the bits are quantum mechanical in nature, any attempt by an eavesdropper to measure them would compromise that effort by a telltale sign. Sasaki *et al.* have now demonstrated the feasibility of quantum key distribution over an optical network in and around the metropolitan Tokyo area. Meshing together six separate QKD systems, they achieve secure video conferencing, encrypted with quantum keys, over a distance of 45 km. Stable operation and interfacing to the mobile telephone network widens the possible applications of quantum security. — ISO

Opt. Express **19**, 10387 (2011).

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