Inflammation improves insulin resistance

One of the hallmarks of diabetes is insulin resistance, a condition in which insulin accumulates because the body cannot effectively use it. Although insulin resistance occurs in both age- and obesity-associated diabetes, Bapat et al. now report that the underlying cellular mechanisms that drive these diseases differ. An overzealous inflammatory response contributes to obesity-associated insulin resistance. In contrast, an immunosuppressive subset of T cells, called regulatory T cells (Tregs), promoted insulin resistance in aging mice. Aged but not obese mice that lacked these cells experienced improvement in

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NEURODEVELOPMENT
Maturation of olfactory neurons
The sense of smell depends on neurons in the olfactory epithelium to perceive chemical scents. Each neuron specializes with one receptor. Hanchate et al. now show that the one-for-one relationship is not as simple as thought. As new neurons develop to replenish the olfactory epithelium, they initially express several different alleles of olfactory receptors. Then, as each neuron matures, they specialize to express a single receptor. — PJH

HUMAN GENETICS
Putting both heart and brain at risk
For reasons that are unclear, newborns with congenital heart disease (CHD) have a high risk of neurodevelopmental disabilities. Homsy et al. performed exome sequence analysis of 1200 CHD patients and their parents to identify spontaneously arising (de novo) mutations. Patients with both CHD and neurodevelopmental disorders had a much higher burden of damaging de novo mutations, particularly in genes with likely roles in both heart and brain development. Thus, clinical genotyping of patients with CHD may help to identify those at greatest risk of neurodevelopmental disabilities, allowing surveillance and early intervention. — PAK

EDUCATION
Toward a level playing field?
Do free learning resources benefit the disadvantaged and decrease gaps between rich and poor? Hansen and Reich studied the relationships between socioeconomic status (SES) and enrollment in and completion of free Massive Open Online Courses (MOOCs) offered by Harvard and MIT. Students from low-SES backgrounds were less likely to enroll in MOOCs and earn a certificate than their high-SES peers. Thus, although there are many free online learning opportunities, it is not safe to assume that they will “level the playing field.” — BJ

IN OTHER JOURNALS
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IN OTHER JOURNALS

WATER RESOURCES
Local decisions with global consequences
Some estimates suggest that humanity has already exceeded our sustainable global water footprint: the balance between fresh water use and supply. It seems that the situation may be more unsustainable than we realize. Jaramillo and Destouni analyzed hydroclimatic data for 100 large basins dating back to 1901. Better accounting of local water use revealed larger than anticipated effects on the global water cycle. For example, local regulation of surface water flow and expanded regional irrigation activities have increased global evapotranspiration rates. — NW

IMMUNOLOGY
When inhibitors don’t mimic knockouts
The T helper 2 (T_{h2}) subset of lymphocytes releases cytokines implicated in the pathogenesis of asthma, a process that requires the kinase ITK. ITK-knockout mice are resistant to airway inflammation, suggesting that ITK inhibitors might be used to treat human asthma. However, Sun et al. found that an ITK-specific inhibitor aggravated disease symptoms in a mouse model of asthma. The airways of these mice had more T cells and higher levels of cytokines that are typically released by T_{h2} lymphocytes. Thus, targeting ITK activity in asthma patients may exacerbate disease. — JFF

Published by AAAS
OIL SPILLS

Dispersants suppressed oil degradation

The 2010 Deepwater Horizon blowout released hundreds of millions of liters of oil into the Gulf of Mexico. One of the main mitigation strategies to prevent oil from reaching the shore—and potentially to stimulate natural bacterial communities capable of degrading oil and gas—was the application of 7 million liters of chemical dispersant. At the time, little was known about the effect these dispersants might have on hydrocarbon biodegradation rates. In a series of laboratory experiments, Kleindienst et al. observed that the same dispersant used in 2010 actually suppresses the major hydrocarbon-degrading groups in favor of dispersant-degrading bacteria. This confounding effect of dispersants therefore may explain why field data collected during the spill showed lower than expected biodegradation of oil and gas. — NW


PROTEIN ENGINEERING

Engineering enzymes to stand alone

Enzymes efficiently synthesize many useful compounds. However, in many cases, their need to associate with other proteins limits their biosynthetic utility outside of cells. Buller et al. used directed evolution (a method of protein engineering that mimics of the process of natural selection) to increase the catalytic activity of the β subunit of the tryptophan synthase complex (TrpB). TrpB makes l-tryptophan from l-serine and indole but is inefficient on its own. Mutations that restored activity to TrpB alone act through the same mechanism as partner protein binding. Both use a mechanism called allostery, in which changes distant from the active site affect enzymatic activity. The stand-alone TrpB provides a simplified platform to produce noncanonical amino acids. — VV


TRANSCRIPTION

Plants chemically modify their mRNAs

When Arabidopsis plants respond to stress, they often chemically modify their RNA transcripts; for instance, adding methyl groups to specific ribonucleotides. Such changes can alter RNA function and stability. In order to characterize such modifications on RNAs transcribed from genes, Vandivier et al. performed a high-throughput annotation of modified ribonucleotides within mRNA. They found that modifications were not random but rather distributed to specific types of RNAs, such as on degrading transcripts and long noncoding RNAs, or specific sites within transcripts, such as regions that regulate RNA splicing. Overall, their studies suggest that marks regulate the stability of mRNA transcripts.

— LMZ


CANCER

Tumors evolve free of Darwinian constraints

Mutations help shape how tumors evolve. What constrains the diversity of these mutations is less clear. Ling et al. determined the spectrum of single-nucleotide variations in 286 samples from a single hepatocellular carcinoma tumor. They then modeled how mutations accumulated in tumors using population genetic theory. Their analysis predicted that the tumor harbored more than 100 million mutations. Such high genetic diversity suggests that the tumors evolve in a non-Darwinian manner, because Darwinian evolution generally reduces genetic diversity within a population. These results imply that microscopic tumors are likely to be highly diverse, suggesting that even these tumors could quickly develop resistance in the face of therapy. — GR


X-RAY OPTICS

Guiding x-rays on a chip

For visible, infrared, and ultraviolet wavelengths of light, the ability to guide the light is very well served by a variety of mature platforms such as waveguides, optic fibers, and photonic crystals. Going to shorter wavelengths such as x-rays, however, provides a formidable challenge, because the light is penetrating and readily escapes attempts at confinement. By fabricating engineered channels in a layer of tantalum using electron beam lithography, Salditt et al. demonstrate the ability to guide hard x-rays in the curved waveguides and show that they can do so with channels of surprisingly small radii of curvature. The demonstration shows the possibility of extending the functionality of integrated optics to the x-ray regime. — ISO


MATERIALS SCIENCE

Switching locally or globally

Dynamic materials that can switch between two or more states have found a range of applications, from shape-memory materials to those with changeable surface adhesion properties. Lee et al. explore the properties of 1,3,5-tris(4-carboxyphenyl)benzene (BTB) absorbed from solution onto the surface of freshly cleaved, highly oriented pyrolytic graphite. BTB forms an open network structure and is able to accommodate polyaromatic guest molecules. However, though the application of a voltage bias, the network structure collapses, squeezing out the guest molecules in the local region. The same squeezing effect can also be achieved globally, by changing the temperature, thus giving two ways to tune the overall surface properties. — MSL

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Science 350 (6265), 1218-1219.
DOI: 10.1126/science.350.6265.1218-a