Tissue Remodeling

When organs are damaged, dying cells must be replaced to maintain organ function. Using insect metamorphosis as a model for tissue replacement, Weaver and Krasnow (p. 1496, published online 31 July; see the Perspective by González-Reyes) examine the progenitor cells that rebuild the fly respiratory system. For most fly organs, new tissue arises from undifferentiated progenitor cells associated with the organ that remain quiescent until metamorphosis when they proliferate, migrate over, and replace dying cells. Individual cells were labeled and their fates followed to identify a second population of respiratory progenitors that arise from differentiated cells and replace local regions of the airways. These differentiated cells have substantial proliferative potential and developmental plasticity, including the ability to redifferentiate as a new cell type. Thus, even in a simple epithelial organ, tissue replacement requires different progenitors and cellular strategies.

Recovering Wasted Heat

The recovery of waste heat, especially on the industrial scale, normally relies on transferring heat with a working fluid, such as converting liquid water to steam. The efficiency of these approaches is highest on a large scale and when thermal gradients are very high. For recovery of heat on a smaller scale, such as from a car engine, thermoelectric systems, which use electrical current as the working fluid, are more attractive. Although most of the attention in thermoelectric materials have focused on their intrinsic efficiency (described by the parameter ZT), Bell (p. 1457) reviews the engineering challenges and opportunities in using such materials in cars, electronics, and other applications for heating, cooling, and power generation.

Extreme Behavior

Global warming is expected to have a large effect on the amount and distribution of precipitation, with wet areas projected to become wetter and dry areas drier, and an overall increase in total rainfall. Another important aspect of these predicted changes is the frequency of extreme rainfall events, because the impact of a few heavy rain events is very different from that of many more moderate ones. Allan and Soden (p. 1481, published online 7 August) use satellite observations and model simulations to evaluate how climate warming is affecting the frequency and strength of rain events. Heavy rains are occurring with increasing frequency when it is warm and less often when it is cold, and these extremes are happening more frequently than models have suggested they should. This implies that the impacts of precipitation changes due to global warming could be greater than have been assumed.

GOTCHA?

Thankfully, there are still tasks that humans can do that computers cannot. One of the 21st-century manifestations of this difference is the use of CAPTCHAs (distorted alphanumeric strings that must be read and typed) to safeguard entry into Web sites against nonhuman entities. Von Ahn et al. (p. 1465, published online 14 August; cover) describe a modification of this algorithm that serves to capture the effort expended by human users and to direct it toward digitizing scanned documents. Optical character recognition programs are unable to transcribe scans of printed matter for a variety of reasons, such as uneven shrinkage of the paper or fading of the ink; using these unrecognized words as queries for Web site visitors to decode exemplifies the approach known as crowd computing.

Bend Me, Stretch Me, Flex Me, Connect Me

One restriction in the development of rubbery electronics that can stretch as well as bend and flex is the need for a conductive, elastic material, especially for the interconnects between circuits. Sekitani et al. (p. 1468, published online 7 August) describe the development of a stretchable, multilayer single-walled carbon nanotube–polymer elastomer composite and incorporate it into an active matrix array of organic transistors. The elastomer shows excellent mechanical and electrical properties with both low resistivity and reversible stretchability to large levels of strain.

A Tale of Titan

Titan lacks its own internal magnetic field but is greatly affected by Saturn’s magnetic field. Recently, Titan passed outside of the influence of Saturn’s magnetic field, and was observed by the Cassini spacecraft, providing Bertucci et al. (p. 1475) a drastically different magnetic environment for comparison. Titan’s ionosphere retained a “memory” of Saturn’s field for some time, until it seems a magnetic reconnection in its tail replaced this field with the interplanetary one.

Dynamic Electron Microscopy

Transmission electron microscopy (TEM) is an excellent tool for studying structural changes in materials. While the resolution of the instrument has improved considerably, one challenge is being able to track fast-occurring phenomena with high resolution. Rapid snapshots can be acquired by using a laser to pump the electron gun. Kim et al. (p. 1472) apply this

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dynamic TEM method, where a second laser is used to initiate a reaction in a thin multilayer foil. Altering the time delay for the arrival of the electrons from the gun allowed for observation of localized cooling and phase separation at the propagating reaction front as the two materials mix and react with each other.

Rise of the Dinosaurs
Is the diversification of new groups of organism a matter of competitive superiority over other groups occupying similar niches, or does historical contingency play a part? Brusatte et al. (p. 1485) document the evolutionary patterns of the initial radiation of dinosaurs and other archosaur groups in the Triassic. For the first 30 million years of their history, dinosaurs lived alongside another major clade, the crurotosan archosaurs, which occupied similar niches, exhibited a greater range of morphology, and evolved at indistinguishable rates. These findings cast doubt on long-standing ideas of dinosaur “superiority” and notions that dinosaurs were preordained for success from the start.

Damage Control for the Heart
Many forms of heart disease begin with an ischemic event during which the heart muscle receives an inadequate blood supply, resulting in the accumulation of toxic metabolites that cause irreversible tissue damage. Studying rodent models, Chen et al. (p. 1493) found that a mitochondrial enzyme called aldehyde dehydrogenase 2 (ALDH2) was consistently activated in hearts that were the most resistant to ischemia-induced damage. In a rat heart-attack model, administration of a small-molecule activator of ALDH2 (Alfa-1) prior to the ischemic insult led to a reduction in the extent of heart damage, an effect most likely due to decreased formation of cytotoxic aldehydes. Thus, Alfa-1 or related compounds potentially might be used therapeutically to minimize heart damage in controlled settings such as coronary bypass surgery.

You Are What You Eat?
Ecological models suggest that biodiversity arises from the partitioning of resources among species, allowing new species with unique resource-use patterns to invade communities. However, these models have not been tested empirically because real-world species differences in resource use are often confounded with other species traits (size, rate of growth, metabolic rate, etc.). Finke and Snyder (p. 1488) overcome these obstacles by exploiting host-fidelity behavior among a group of parasitoid wasps that attack aphids. While each wasp species is a generalist consumer that attacks many aphid species, individual wasps prefer to attack the same host species from which they themselves emerged. By rearing wasps of different species on each of several aphid species, consumer wasp communities were constructed that could be independently manipulated for consumer species identity, species richness, and patterns of resource use. Exploitation of the aphid resource clearly improved with greater consumer biodiversity, but only when constituent consumers were specialists with distinct resource-niche partitioning. Thus differences in resource use among species, rather than biodiversity per se, intensify resource exploitation at higher levels of consumer biodiversity.

Now You See It, Now You Don’t
Each object can cast many different images on the eye. How can the brain combine different views of an object into a single object representation? Neurons at the inferior temporal cortex (brain area IT), the top processing level of the visual system, signal the presence of individual objects even if those objects appear in different positions. Li and DiCarlo (p. 1502) recorded neuronal responses in area IT of two monkeys to different objects presented at the central position and 3 degrees above or below. By systematically swapping object identity between two objects whenever the monkey made a fast eye movement (saccade) to one particular position in the visual field, the response of the IT neuron became less selective to the objects at the swap position or even inverted its selectivity. Thus, object representations in area IT can change in a short period of time.