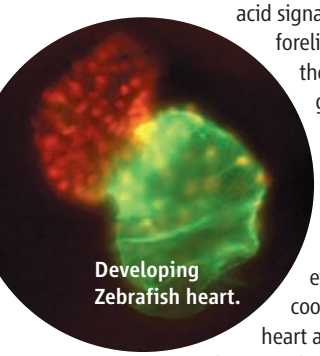
DEVELOPMENT

Hand Over Heart

Although each of us likes to feel unique, many of the physical characteristics that define us are not all that different from those of our neighbors. In particular, the size of one's body and the relative sizes of the component parts vary within a narrow range, but the guiding mechanisms are not well understood. For instance, after hepatectomy, the remaining liver cells divide only until the organ is fully regenerated and not beyond. How are the boundaries between individual organs and appendages controlled during development and regeneration? Evidence suggesting that cross talk between organs contributes to size determination comes from heritable congenital syndromes that affect multiple organs. Retinoic acid, a derivative of vitamin A, is part of a universal pathway involved in many aspects of vertebrate organogenesis. In zebrafish embryos, defective retinoic acid signaling causes an expansion of the heart and a reduction of the forelimb, but whether these two processes are coordinately regulated is unknown; although the heart and forelimbs are far apart in the adult, they are juxtaposed during early stages of development. Waxman *et al*. show that retinoic acid signaling in the developing forelimb restricts the size of the adjacent cardiac progenitor field; the downstream factor *hoxb5b*, which is expressed in response to retinoic acid in the forelimb, mediates this restrictive effect on the heart. The coordinated development of heart and limbs would explain their correlated defects in some syndromes and suggests a mechanism whereby communication between adjacent organs helps to regulate size. — HP*



Developing Zebrafish heart.

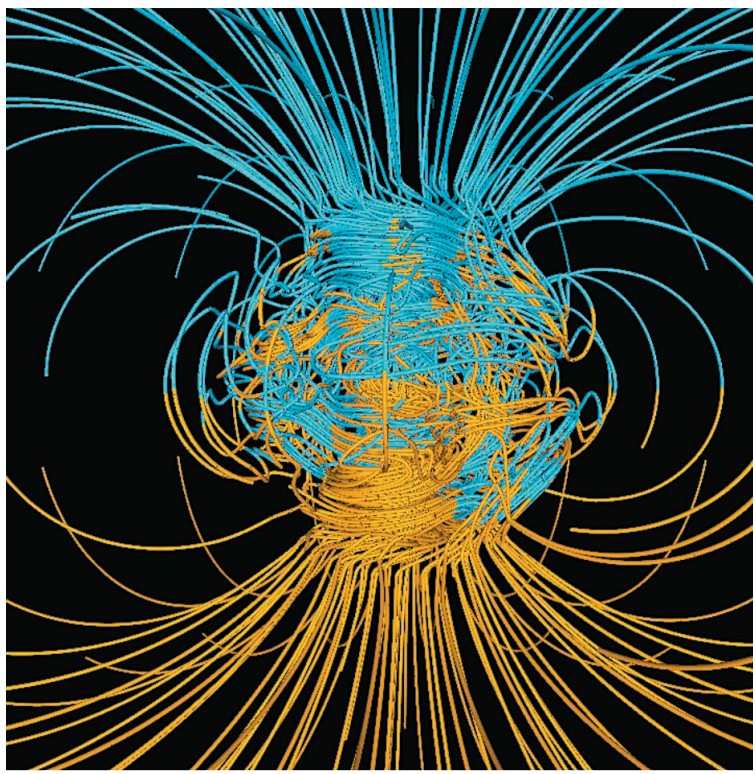
Dev. Cell **15**, 923 (2008).

BIOCHEMISTRY

No Hydrolysis Needed

DEAD-box proteins facilitate RNA rearrangements that locally disrupt secondary or tertiary structure or RNA/protein interactions. They are structurally similar to DNA helicases that use the energy from ATP hydrolysis to unwind double-stranded DNA, but they do not appear to move very far along the RNA, although they can pry apart short duplex regions. Two groups show that RNA strand separation depends directly on ATP binding rather than hydrolysis. Chen *et al.* report that the DEAD-box proteins CYT-19, Mss116p, and Ded1p achieve complete separation of short RNA duplexes with the hydrolysis of one or, under some conditions, even less than one ATP. Strand separation depends on ATP binding, which probably stabilizes a protein conformation that favors strand separation. Consistent findings are obtained by Liu *et al.*, who report that Ded1p, Mss116p, and eIF4A can separate short duplexes upon binding the ATP analog ADP-BeF_x, which is a mimic of the prehydrolysis state of ATP. They go on to show that ATP hydrolysis promotes dissociation of the protein from the RNA and thus is required for efficient enzyme recycling. Intriguingly, even though ATP hydrolysis does not fuel translocation in these DEAD-box proteins, the related DExD/H helicase RIG-1, which detects viral RNA and elicits an antiviral signaling cascade, undergoes ATP-dependent translocation on double-stranded RNA without unwinding it (see Myong *et al.*, Reports, *Science* Express, 1 January 2009). — VV

Proc. Natl. Acad. Sci. U.S.A. **105**, 20203; 20209 (2008).



GEOLOGY

Magnetic Perseverance

Earth currently has a strong magnetic field generated from fluid motion in its outer core, thought to be driven by heat released from the solidification of its inner core. This field (depicted graphically above) helps shield Earth from harmful cosmic rays. The timing of the formation of the inner core and the nature of the field in the Archean (before 2.7 billion years ago) are debated but important for understanding the origin and early evolution of life. Selkin *et al.* were able to obtain more than 100 paleointensity measurements from the Stillwater layered intrusion, a large late Archean magma reservoir in Montana. The data imply that Earth's field then was as strong as it is today. Considering these data with the albeit sparse other Archean data, there is no clear indication that the field's strength has decreased or increased greatly over time. — BH

Geochem. Geophys. Geosyst. **9**, Q12023 (2008).

*Helen Pickersgill is a locum editor in *Science*'s editorial department.

Published by AAAS

BIOTECHNOLOGY

Lighting the Way Forward

The controlled expression of foreign genes has enabled all sorts of pyrotechnic displays, from the creation of carotene-rich golden rice to the riotous palette of neuronal arbors revealed via Brainbow by combinatorial derivatives of green fluorescent protein. In most instances, genes from the microbial world are identified, modified, and then packaged for delivery and expression in plant or animal tissues, sometimes for purposes completely unrelated to the specific aims for which the original research was funded. Berndt *et al.* describe one of the latest such endeavors, in which light-activated channelrhodopsin-2 (ChR2)—a cation-conducting protein from green algae—was engineered, on the basis of detailed structure-function analyses of the bacteriorhodopsin photocycle, and converted into a switch. Changing a single cysteine residue yielded a neuronally expressable ChR2 variant that turned on (and stayed on) when illuminated with 470-nm light for 10 ms, and could then be turned off with a 50-ms pulse of 530-nm light. These properties allow for noninvasive modulation of the membrane conductances of individual neurons with innocuous illumination. — GJC

Expressed ChR2-C128T.

Nat. Neurosci. 10.1038/nn.2247 (2008).

BIOMEDICINE

An Active Participant

In degenerative disorders of the central nervous system, inflammation at the site of neuronal injury is common, but it has not been clear whether this reaction is a primary factor in subsequent disease pathogenesis or a secondary response to the condition. Brochard *et al.* report that a particular subpopulation of T cells is critical for the development of Parkinson's disease (PD), a disorder characterized by the loss of brain neurons that use dopamine. The authors report the accumulation of $CD4^+$ and $CD8^+$ T cells in the postmortem brains of PD patients and also in the brains of a mouse model of PD during progression of the disease. However, in mice lacking $CD4^+$ T cells that express the cell surface protein FasL, dopaminergic neuronal injury was reduced, as was the activation of proinflammatory migroglial cells in the brain. FasL could either mediate the activation of microglial cells, thereby promoting inflammation and neurodegeneration, or it could mediate cell-cell contact that somehow allows T cells to destroy neurons directly. — LC

J. Clin. Invest. **119**, 182 (2009).

CHEMISTRY

Clean Coupling

Alcohol oxidation is a crucial step in the preparation of many drugs and fine chemicals, but it often requires large amounts of toxic reagents. Zweifel *et al.* present a rhodium catalyst that can dehydrogenatively couple a range of alcohols with water, methanol, or various amines (including ammonia, a generally recalcitrant substrate) to afford the corresponding acid, ester, or amide directly. The reactions proceed in a few hours at room temperature, driven by transfer of the liberated hydrogen to a cyclohexanone acceptor that can subsequently be recycled by reaction with hydrogen peroxide. Primary alcohols are oxidized selectively, and the catalyst tolerates olefin, thioether, and pyridine substituents. Simulations support a mechanism involving the transfer of a hydride to the Rh center, with accompanying protonation of a coordinated nitrogen ligand. — JSY

Angew. Chem. Int. Ed. **48**, 559 (2009).

PHYSICS

Weaving a Quantum Computer

Quantum matter can be described by a quantum-mechanical wave function. Correlated phases of such matter can give rise to excitations that have been proposed to be useful for quantum computation. Of particular interest are those excitations that exhibit Abelian or non-Abelian statistics. Anyons fall into this category and are particle-like excitations. Compared with bosons or fermions, where swapping two will respectively keep the wave function as it is or introduce a negative sign, swapping two anyons is quite different—the action imposes a nontrivial phase shift on the wave function so that when a number of anyon swaps have been performed, measurement of the phase can tell you exactly which particles have been swapped. Such a braiding technique is at the heart of some quantum computation schemes, but exactly how these states would be manipulated experimentally is still up for grabs. Aguado *et al.* propose that a lattice of atoms held in an optical trap could be one such realization, showing how the manipulation of atoms in their respective lattice sites can affect the wave function describing the whole ensemble, which can be read out quantitatively. — ISO

Phys. Rev. Lett. **101**, 260501 (2008).

CREDIT: BERNDT *ET AL.*, *NAT. NEUROSCI.* 10.1038/NN.2247 (2008)

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Lighting the Way Forward

Gilbert Chin

Science **323** (5912), 311.
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