EDITORS' CHOICE

edited by Gilbert Chin

ECOLOGY/EVOLUTION

The Origins of Insects

In phylogenetic studies, the molecular clock hypothesis has become the basis for figuring the dates at which evolutionary lineages of organisms diverged. The number of nucleotide substitutions along the length of a branch of a phylogenetic tree is a surrogate parameter for the age of the branch. Because of variation in substitution rates, however, reliable molecular clocks are sometimes hard to identify.

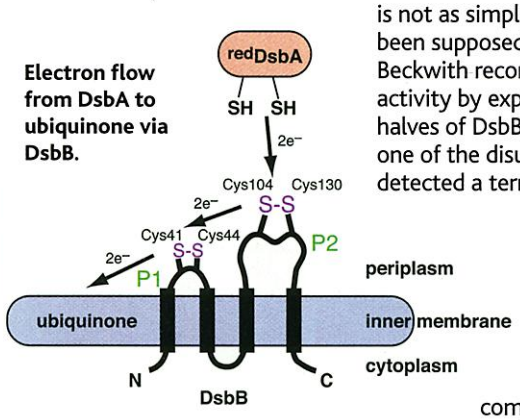
Using GenBank sequence data, Gaunt and Miles have now been able to define a robust molecular clock for the insects—the most diverse of animal groups—that identifies the deepest nodes in the phylogenetic tree and is in accord with the fossil record. According to this clock, the earliest insects cleaved from their nearest relatives, the fairy shrimps, about 430 million years ago, close to the emergence of the first land plants. — AMS

Mol. Biol. Evol. **19**, 748 (2002).

BIOCHEMISTRY

Disulfide Chains

In *Escherichia coli*, the periplasmic protein DsbA catalyzes disulfide bond formation in newly synthesized proteins that have been exported across the cytoplasmic membrane. (The periplasm and outer environs can be somewhat harsh, and the structural support of disulfide links is critical for protein stability and function.) The cytoplasmic protein DsbB maintains DsbA in the oxidized state by accepting electrons from reduced DsbA and transferring them to a membrane-embedded quinone. The activity of DsbB depends on two disulfide bonds, Cys^{41}-Cys^{44} and Cys^{104}-Cys^{130}, located in the first and second periplasmic loops, respectively.

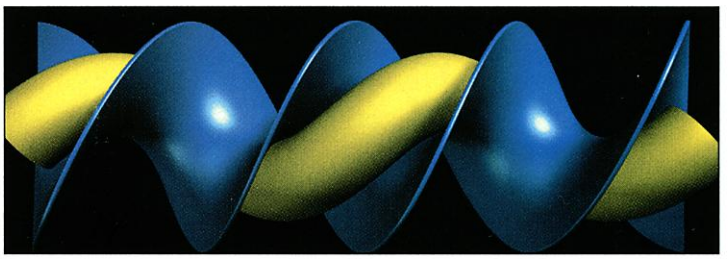


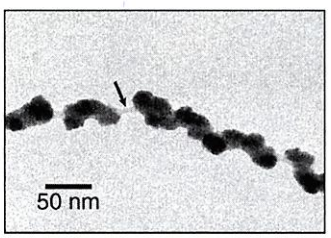
Electron flow from DsbA to ubiquinone via DsbB.

Two groups show that disulfide transfer from DsbB to DsbA is not as simple as might have been supposed. Kadokura and Beckwith reconstituted DsbB activity by expressing the two halves of DsbB, each containing one of the disulfide bonds. They detected a ternary complex (of the two halves plus DsbA) that appears to represent an intermediate in the electron transfer process. The complex contains an interprotein disulfide between Cys^{30} of DsbA and Cys^{104} of DsbB and an interdomain disulfide between Cys^{130} and Cys^{41} of DsbB. This coordinated transfer may be required to prevent the back reaction, which would regenerate reduced DsbA; that is, after formation of the interprotein disulfide, Cys^{130} may be positioned to react readily with the Cys^{41}-Cys^{44} bond. Inaba and Ito find that DsbB is intrinsically more reducing than DsbA with redox potentials of –0.21 V for Cys^{41}-Cys^{44} and –0.25 V for Cys^{104}-Cys^{130}, yet only –0.12 V for the DsbA pair Cys^{30}-Cys^{33}. They suggest that the oxidizing power of ubiquinone (+0.11 V) may drive the reaction, with DsbB serving as a regulatory bottleneck. — VV

EMBO J. **21**, 2354; 2646 (2002).

CREDITS: (TOP) SONE *ET AL., ANGEW. CHEM. INT. ED.* **41**, 1705 (2002); (BOTTOM) INABA AND ITO, *EMBO J.* **21**, 2646 (2002)





Micrograph (left) and model (above) of the organic ribbon (arrow, blue) and CdS helix (yellow).

CHEMISTRY

Helical Semiconductors

One of the aims of supramolecular chemistry is to build assemblies of molecules in a controllable fashion. These structures are held together by relatively weak noncovalent interactions and thus might be easily reconfigurable into a variety of morphologies for possible applications in nanotechnology.

Sone *et al.* show that supramolecular structures can also serve as templates for building inorganic nanoscale objects with complex shapes. Preparing triblock "dendron rodcoil" molecules, which previously had been shown to self-assemble into a nanoribbon, in ethyl methacrylate yielded a twisted ribbon; when cadmium nitrate and hydrogen sulfide gas were added, a helix of cadmium sulfide formed on the template. Growth of this inorganic strand (about 1 micrometer in length) appeared to be restricted to one face of the ribbon, so that the pitch of the CdS helix (about 50 nanometers) was twice that of the underlying organic template. — JU

Angew. Chem. Int. Ed. **41**, 1705 (2002).

CLIMATE SCIENCE

It's All in the Crust

The intensity of North Atlantic Deep Water (NADW) production is an important determinant of global ocean thermohaline circulation and climate. It is affected over long periods by large-scale processes such as glaciation and continental drift, but different proxies (a substitute parameter that is easily measured) can provide conflicting evidence about its strength.

To help resolve these inconsistencies and to construct a more detailed record of NADW since the mid-Miocene, Frank *et al.* analyzed the Nd- and Pb-isotopic compositions of ferromanganese nodule crusts from the Southern ocean. Furthermore, by combining them with analyses of other nodules from the North Atlantic basin, they reconstructed the rate of NADW production over the last 14 million years. This method has two major advantages: First, Nd and Pb are not subject to biological fractionation, as are other commonly used water-mass proxies like carbon isotopes or Cd/Ca; and second, ferromanganese nodules can be dated accurately with Be-isotopic determinations. They find that there was a continuous and strong export of NADW (or a precursor of it) into the South-

CONTINUED ON PAGE 1769

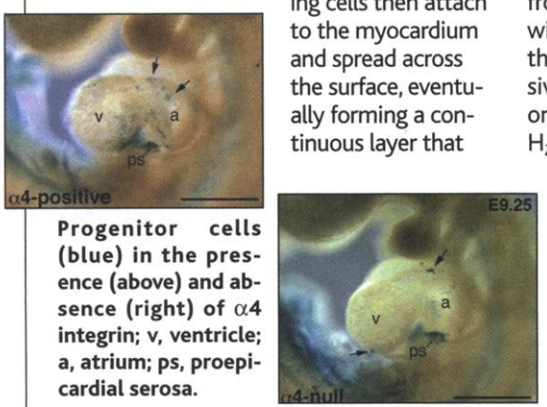
ern Ocean between 14 and 3 million years ago and that over the past 3 million years, since the start of Northern Hemisphere glaciation, a progressive reduction of about 25% has occurred. — HJS

Paleoceanography **17**, 10.1029/2000PA000606 (2002).

DEVELOPMENT

Close to the Heart

The outermost layer of cells in the heart is known as the epicardium. The epicardium develops from progenitor cells that originate in a structure called the proepicardial serosa. These progenitor cells migrate to the heart either through direct physical contact between the myocardium and the proepicardial serosa or as cellular aggregates or cysts that transit the pericardial cavity. The arriving cells then attach to the myocardium and spread across the surface, eventually forming a continuous layer that later gives rise to the coronary vessels. Sengbusch *et al.* show that the cell adhesion protein, integrin $\alpha4\beta1$, is a key player in the initial migration and long-term attachment of epicardial progenitor cells to the developing heart. Mice engineered to lack the $\alpha4$ subunit of this integrin produced considerably fewer proepicardial cysts, and those that did reach the myocardium did not spread out to form an epithelial sheet. — SMH



Progenitor cells (blue) in the presence (above) and absence (right) of $\alpha4$ integrin; v, ventricle; a, atrium; ps, proepicardial serosa.

J. Cell Biol. **157**, 873 (2002).

GEOPHYSICS

Subduction and Heat Flow

Quantitating the heat flux at the core-mantle boundary is important for understanding the cooling of the core, the convection of the mantle, and the movement of tectonic plates. This heat flux has been estimated indirectly as the heat flowing out at volcanic hotspots, about 2 terawatts. Labrosse has developed a refined numerical model that includes convection between isothermal layers and internal heating in the mantle. The simulations show that most of the hot plumes upwelling from the boundary do not make it all the way to the surface, so that looking only at hotspots (generated by the hot plumes) will underestimate the total heat flow from the core into the mantle. It appears that the downward flow of cold plumes from the surface toward the core, such as occurs at subduction zones, dominates the permeation of rising plumes and the heat flux across the core-mantle boundary, which is estimated from these simulations to total 6 terawatts. — LR

Earth Planet. Sci. Lett. **199**, 147 (2002).

CHEMISTRY

Cleaner Cleansers

Chemical processes that can use hydrogen peroxide (H_2O_2) to replace oxidants such as chlorine would be more environmentally friendly. However, the production of H_2O_2, from an indirect route through the stepwise reduction and oxidation of an alkylanthroquinone, often makes H_2O_2 too expensive to use. Previous studies have focused on catalytic production from mixtures of H_2 and O_2, including the use of palladium (Pd) supported on an oxide such as silica or alumina.

Dissanayake and Lunsford now find that H_2 and O_2 in a 2:1 ratio react with colloidal Pd in acidified water under ambient conditions to produce H_2O_2. Contact with the reactant gases appears to be critical; Pd that was deposited on the silica frit used for introducing the gases was far less active. The final concentration of H_2O_2 that was achieved in solution, 0.6%, appears to be limited under these conditions by the competing decomposition of H_2 and O_2. — PDS

J. Catal. **206**, 173 (2002).

VIROLOGY

Out of Africa

Usutu virus (USUV) is a mosquito-borne pathogen of African birds, occasionally infecting humans and other mammals, and is related to flaviviruses such as the West Nile and yellow fever viruses. During August and September 2001, migrant and residential birds in Austria died, and Weissenböck *et al.* were able to detect USUV in the corpses of blackbirds, swallows, and captive owls. Because of the scale of bird deaths observed, it appears that USUV in migrant birds has established in a European mosquito species and is managing to overwinter. This is the first observation of USUV outside Africa and may presage the advent of more broadly pathogenic tropical viruses into Europe. — CA

Emerg. Infect. Dis. (www.cdc.gov/ncidod/eid/vol8no7/02-0094.htm).

CREDITS: SENGBUSCH *ET AL.*, *J. CELL BIOL.* **157**, 873 (2002)