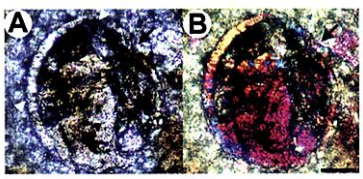
EDITORS' CHOICE

edited by Gilbert Chin

EVOLUTION AND ECOLOGY

Tracing the Explosion to Its Roots

The term Cambrian "explosion" describes the rapid diversification (on a geological timescale) of animals to form most of the major extant phyla. The fossil record of metazoa shows a sudden expansion at around 550–530 million years ago. Molecular data, however, suggest that the roots of this diversification stretch back much further in time, perhaps to the origin of the eukaryotes some 1000 million years ago.



Putative fossil embryo in bright-field (left) and polarized light (right) microscopy

Increasingly, palaeontologists, molecular phylogeneticists, and developmental biologists are attempting to integrate insights from their respective disciplines to address this conundrum. Conway Morris argues that the Cambrian explosion is a genuine phenomenon, driven largely by ecological processes—filter feeding, predation, and defense. Nevertheless, he points out that much of the metazoan genome was probably in place substantially earlier, the explosion representing a redeployment of existing genetic resources. In another commentary, Peterson and Davidson explore aspects of this redeployment with reference to the developmental biology of bilaterally symmetric animals. In their view, the advent of regional specification mechanisms (which govern the development of different body parts) and the full complement of *Hox* gene complexes that control development had come into existence by the beginning of the Cambrian.

Chen *et al.* provide possible fossil evidence for early developmental stages of metazoan organisms from the Precambrian. Their microfossils, from formations in Southwest China, resemble the larvae and free-floating embryos of cnidaria (sea anemones, jellyfish, corals), lending weight to the theory of earlier evolution of developmental genetic architecture. The confirmation that these fossils are indeed biogenic awaits further study, but if confirmed they will provide evidence for a long fuse to the explosion. — AMS

Proc. Natl. Acad. Sci. U.S.A. **97**, 4426; 4430; 4457 (2000).

CELL BIOLOGY

Regulating Interfacial Interactions

The ezrin-radixin-moesin (ERM) protein family regulates crosslinking of the membrane and cytoskeleton and is important in actin-rich cell surface structures such as microvilli. Function is regulated by an intramolecular association between the N-terminal FERM domain—a common membrane binding module—and the C-terminal F-actin binding domain.

Pearson *et al.* determined the structure of a complex of the FERM and tail domains of moesin. The tail binds in an extended conformation over a large area of the FERM surface. Phosphorylation destabilizes the interaction, and the free tail is likely to bind to actin in a distinct conformation.

Similar conformational plasticity was recently observed by Kim *et al.* for the Wiskott-Aldrich syndrome protein (WASP) which also is involved in regulation of the actin cytoskeleton. The GTPase-binding domain (GBD) of WASP is stabilized by interaction with the C-terminal region, and this prevents the C-terminal region from enhancing actin nucleation. Binding of the GTPase CDC42 to the GBD disrupts its hydrophobic core and abolishes the intramolecular interaction. This intramolecular interface also may be modulated by phosphorylation. — VV

Cell **101**, 259 (2000); *Nature* **404**, 151 (2000).

CHEMISTRY

Fine-Tuning Chemical Sensors

Non-destructive, real-time detection of small molecules can be achieved via recognition of the target by a larger receptor molecule, such as a fluorophore whose emission spectrum changes in the occupied state. In most cases, binding occurs at a single site.

Glass has explored the use of cooperative binding of ligands, which is more typical of biological receptors, with the goal of sacrificing some of the operating concentration range in return for greater affinity and selectivity. He designed a metal-ion sensor in which two halves of a recognition element join to form a metal binding site. Three such elements are attached in a pinwheel arrangement, and two such pinwheels are linked by a rigid carbon spacer, which serves as an axle. The unoccupied sensor adopts the lower energy or "staggered" configuration in which the recognition element halves are not properly juxtaposed. Binding of the first ion not only aligns these halves, but also brings the two empty sites into reg-

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GEOLOGY

Short-Term Storage

About 770,000 years ago, a massive volcanic eruption in Long Valley, California, formed a caldera 20 kilometers across and deposited volcanic ash that formed the Bishop Tuff. One particularly provocative result from the study of strontium and other isotopes in the ash was that the magma that became the Bishop Tuff apparently formed and remained relatively isolated in the crust for a long time—many hundreds of thousands of years—before erupting, which implies that the magma chamber had a continuous supply of heat.

The Long Valley Caldera

Reid and Coath have now dated cores and rims of zircons in the Bishop Tuff using the uranium-lead system. Zircons likely crystallized early in the magma chamber and retained radiogenic lead even at high temperatures. The zircon ages cluster about 820,000 to 840,000 years ago, and these ages and further considerations based on the thorium isotopic composition of the zircons imply a shorter history: a large amount of magma formed only about 100,000 years or less before the eruption. — BH

Geology **28**, 443 (2000).

SOURCE: (LEFT) CHEN *ET AL., PROC. NATL. ACAD. SCI. U.S.A.* **97**, 4457–4462 (2000); (RIGHT) S.R. BRANTLEY/U.S.G.S.

ister (the "eclipsed" configuration), increasing the binding affinity. For silver ions, the single-site sensor operates over a larger dynamic range (10 to 900 μM), but the cooperative pinwheel sensor is more responsive and more sensitive (0.6 to 6 μM, with a Hill coefficient of 2.9). — PDS

J. Am. Chem. Soc., in press.

APPLIED PHYSICS

Nanotube Conduction

The diverse electronic, mechanical, and combined electromechanical properties of carbon nanotubes together with the ability to gate or control the conductivity along the length of the tube make them attractive candidates for application in integrated molecular electronics. Tombler *et al.* show that the conductivity in an individual semiconducting nanotube can be controlled locally with the biased tip of a scanning probe microscope. As the probe is brought into close proximity to the tube, the bias locally modifies the band profile in the tube allowing it to be switched between a conducting and nonconducting state. Moreover, the technique can be used to determine the electronic properties of individual tubes that make junctions. — ISO.

Appl. Phys. Lett. **76**, 2412 (2000).

BIOCHEMISTRY

Eat Your Carrots!

Although β-carotene is known to be the 40-carbon precursor for the 20-carbon retinoids and thus for retinol (vitamin A), purification and identification of the vitamin A–generating enzyme has been elusive until now. By relying on sequence homology to a plant carotene-cleaving dioxygenase (which produces the growth regulator abscisic acid), von Lintig and Vogt identified a *Drosophila* gene encoding a 70-kilodalton protein that converted β-carotene to retinal. This gene maps to the same location as the *Drosophila* mutant *ninaB*, which displays a reduced content of rhodopsin, the protein that uses a covalently linked retinal chromophore to detect photons. The enzyme appears to utilize Fe in the oxidative cleavage of the double bond, and characterization of its mammalian counterpart is anticipated. — GJC

J. Biol. Chem. **275**, 11915 (2000).

PHYSIOLOGY

More Stress, Less Inflammation

Early life events commonly are thought to influence physiological and neuronal development directly, but they also may leave lasting impressions. By examining the after-effects of a neonatal challenge of bacterial endotoxin, Shanks *et al.* add to a growing body of results demarcating the persistent connection between the neuroendocrine and immune systems. They confirm earlier findings that endotoxin evokes increased circulating corticosteroid levels (a marker of stress) and also observe a heightened and more rapid corticosteroid responsiveness to later-in-life stress in comparison to non-endotoxin exposed rats. Furthermore, coupled to this augmented activity of the hypothalamic-pituitary-adrenal system is an apparent suppression of chronic inflammation, as assessed by relative sparing from adjuvant-induced arthritis. — GJC

Proc. Natl. Acad. Sci. U.S.A., in press.

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Neutrophil Immunodeficiency

Neutrophils migrate to and engulf foreign pathogens and then kill them by means of an onslaught of degradative enzymes and toxic oxygen metabolites, such as superoxide.

Ambruso *et al.* report the identification of a mutation in the small GTPase Rac2, the most abundant form of Rac in neutrophils, in an infant suffering from chronic severe bacterial infections. A mutation from Asp^{57} to Asn^{57} in one of the patient's Rac2 genes inhibits GTP binding and thus reduces formation of the activated, GTP-Rac2 complex. Neutrophils from the patient were defective for chemotactic response and for the production of myeloperoxidase and reactive oxygen species. Mice deficient in Rac2 have been reported to exhibit impaired neutrophil function but normal oxidase activity, suggesting that murine Rac1 protein may compensate for the absence of Rac2 and that the mutated Rac2 protein in the patient may exert a dominant negative effect in neutrophil signaling and activation, leading to immunodeficiency. — JN

Proc. Natl. Acad. Sci. U.S.A. **97**, 4654 (2000).