

edited by Gilbert Chin

BIOCHEMISTRY

Isomeric Inducers

In a process called quorum sensing, bacteria momentarily set aside their solitary lifestyle and commence working with like-minded neighbors, such as during the production of bioluminescence by the marine bacterium *Vibrio harveyi*. Genetics infused with biochemistry resulted in the identification and characterization of the autoinducer signal AI-2 and its receptor LuxP. The biosynthesis of AI-2 is controlled by the enzyme LuxS, which catalyzes the last step of the synthesis of the starting material (4S)-4,5-dihydroxy-2,3-pentanedione (DPD) from the common metabolite S-adenosylmethionine. In *V. harveyi*, DPD cyclizes to give (2S,4S)-2-methyl-2,3,3,4-tetrahydroxytetrahydrofuran (S-THMF), which reacts with boron to form S-THMF-borate, the actual ligand of LuxP.

Miller *et al.* have solved the structure of the periplasmic protein LsrB, the *Salmonella typhimurium* counterpart to LuxP, and find that its ligand is a slightly different DPD derivative, (2R,4S)-2-methyl-2,3,3,4-tetrahydroxytetrahydrofuran (R-THMF) and that no boron is present. As in the case of LuxP, crystallization of the LsrB-ligand complex facilitated chemical characterization of the ligand, and the net negative charge within the LsrB binding cleft (unlike the positive charge in LuxP) suggests that it would not recognize S-THMF-borate. This diversity of autoinducer metabolites raises the possibility that bacteria might have enough bandwidth to receive multiplexed signals. — GJC

LsrB with R-THMF (left) and LuxP with S-THMF-borate (right).

Mol. Cell 15, 677 (2004).

(a defense used in another family of plants) and convert it, following existing enzymatic routes, to salicylaldehyde, thus turning themselves into an unpalatable mouthful. — GJC

Proc. Natl. Acad. Sci. U.S.A. 101, 13808 (2004).

CHEMISTRY

Making Zinc Glow

Zinc cations are abundant in biological systems and contribute to both the structure and function of proteins. Hanaoka *et al.* have developed a europium-based luminescent sensor that can be used to image Zn^{2+} ions in intact cells. The Eu^{3+} coordination compound bears a quinoline antenna that absorbs at 340 nm in the near-ultraviolet region, leading to visible emission at the Eu center on a ms scale.

A bis-(2-pyridylmethyl) aminomethyl group appended to the quinoline can bind Zn^{2+} ions and thereby induce an eight-fold enhancement in luminescence. The principal advantage of this sensor over previous systems is the use of a relatively long excitation wavelength, which reduces damage to biomolecules. The sensor is also water soluble, and it works equally well across a broad pH range (3.6 to 8.8) and in the presence of a greater than 1000-fold excess of sodium and potassium salts. — JSY

J. Am. Chem. Soc. 10.1021/ja0469333 (2004).

ASTROPHYSICS

A Cosmological Ruler

Measuring the distance to far-away astronomical objects is difficult. Astronomers use a standard candle, which is an object of a known luminosity, to estimate distance, where

MOLECULAR BIOLOGY

Ending with a Twist

The DNA double helix makes replication easy but creates topological problems. In both prokaryotes and eukaryotes, these problems are solved by enzymes called DNA topoisomerases, many of which relax supercoiling by nicking and re-sealing the DNA strands. While studying the replication of linear DNAs in the soil-dwelling bacteria *Streptomyces*, Bao and Cohen discovered a topoisomerase (TopA) with an intriguing new activity. TopA was identified as a component of a protein complex bound to the telomeric region (the ends) of DNA. Like the telomerase enzymes that synthesize the ends of DNA in eukaryotes, *Streptomyces* TopA exhibits reverse transcriptase (RT) activity; i.e., the ability to make DNA from an RNA template. The RT activity of TopA requires an Asp-Asp doublet that is also a requisite feature of eukaryotic reverse transcrip-

tases. The presence of this sequence motif in other bacterial topoisomerases suggests that this surprising RT activity—whatever its precise role—may not be restricted to the *Streptomyces* enzyme. — PAK

Proc. Natl. Acad. Sci. U.S.A. 10.1073/pnas.0404386101 (2004).

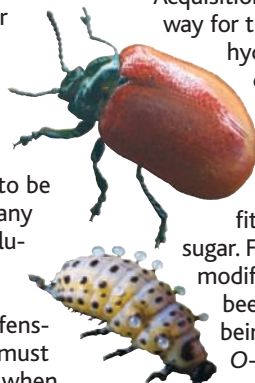
CHEMICAL ECOLOGY

Finicky Feeders

Dietary preferences within the animal world are varied, from our own omnivorousness to rather more specialized tastes, for example, that of the panda for bamboo. These are generally thought to be the outcome of many generations of evolution, particularly in cases where the eaten throw up defenses that the eaters must overcome, such as when insects feed on noxious plants. Kuhn *et al.* have exam-

ined how leaf-munching beetles (*Chrysomela populi* and *Phratora vitellinae*) might have not only refined their abilities to deal with the plant-derived chemical ordnance but also succeeded in adapting their internal biochemistry so as to expand their menu.

The ancestral coping mechanism enables chrysomeline larvae to synthesize the iridoid terpene chrysomelidial and to release this when attacked. Acquisition of an uptake pathway for the O-glucoside of 8-hydroxygeraniol (an iridoid precursor in the plant) provided a quicker route as well as allowing the larvae to benefit from a pinch of sugar. Further transporter modifications have led to beetles in this lineage being able to absorb the O-glucoside of salicin



Adult (top) and larva (bottom) of *Chrysomela populi*.

the intensity of light from a source of constant luminosity decreases as a function of the square of the distance. Type Ia supernovae are used as standard candles because these thermonuclear explosions of carbon-oxygen white dwarfs are thought to represent a relatively uniform mass and composition. When they explode, they are extremely bright, with a maximum absolute magnitude that decays in a consistent fashion as a function of time, allowing the luminosity to be estimated accurately.

Two papers by Ghirlanda *et al.* suggest that gamma-ray bursts (GRBs) can be used as standard candles. They found a correlation between the peak energy and the collimation-corrected energy, which removes the scatter in luminosity estimates used to determine distance. Combining 15 GRBs with supernovae da-

ta yields a cosmological model consistent with recent cosmic microwave background estimates. GRBs can be measured to a redshift of about 10, whereas the supernovae reach redshifts up to 1 and the CMB is measured at a redshift of about 1000, so GRBs can provide an important link between the deep and shallow universe. — LR

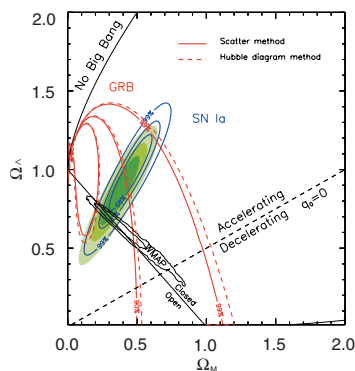
Astrophys. J. astro-ph/0405602; 613, L13 (2004).

CHEMISTRY

Exploring HOOOH

Antibodies catalyze the oxidation of water by singlet oxygen, generating hydrogen peroxide (H_2O_2) and probably ozone (O_3) as well. HOOOH has been identified as a likely intermediate in this reaction, and it can be made photochemically in a frozen matrix from H_2O_2 and O_3 . Nyffeler *et al.* have explored whether HOOOH can form in a completely thermal reaction of H_2O_2 and O_3 . The reaction of O_3 with H_2O_2 in deuterated organic solvents at -78°C led to an intermediate with a ^1H nuclear magnetic resonance peak characteristic of OOOH. The concentration of HOOOH generated in the organic solvent, about 3 mM, suggests that HOOOH may play a role even in the aqueous peroxone reaction of H_2O_2 and O_3 , whose products are used as antibacterial agents and to remediate persistent organic pollutants. In water, the decomposition of HOOOH could lead to the formation of singlet oxygen. — PDS

Angew. Chem. Int. Ed. 43, 4656 (2004).



Using GRBs and supernovae type Ia (SN Ia) to estimate the cosmological parameters Ω_M and Ω_A .

HIGHLIGHTED IN SCIENCE'S SIGNAL TRANSDUCTION KNOWLEDGE ENVIRONMENT



Regulator of Dendrite and Synapse Formation

Two papers by Shi *et al.* describe a receptor-like molecule that functions in the formation and maturation of dendrites, the specialized regions of neurons where they receive input from other neurons. Having noted genetic evidence from *Drosophila* that a protein from the immunoglobulin superfamily appeared to function in the formation of dendrites, the authors searched for and identified a mouse protein they named Dasm1, for dendrite arborization and synapse maturation. In cultured rat hippocampal neurons, loss of Dasm1 inhibited the outgrowth of dendrites but not of axons. To examine later stages of synapse formation, the authors prepared hippocampal slices from 8-day-old rats and found that inhibition of Dasm1 function reduced the acquisition of signaling through AMPA (α -amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid) receptors that is normally associated with synapse maturation. Two possible binding partners for Dasm1 are the proteins Shank (Src homology 3 domain- and ankyrin repeat-containing protein) and S-SCAM (synaptic scaffolding molecule), which have been implicated previously in the regulation of synaptic function. Thus, Dasm1 may transduce extracellular signals in postsynaptic neurons, regulating cytoskeletal organization and synaptic expression of neurotransmitter receptors. — LBR

Proc. Natl. Acad. Sci. U.S.A. 101, 13341; 13346 (2004).