

CHAMP satellite.

ASTROPHYSICS

Blast Wave Bounce

On 27 December 2004, a magnetic star, or magnetar, erupted. This event generated a huge burst of gamma rays that were spotted by gamma-ray and x-ray telescopes. In a fraction of a second, the magnetar SGR 1806-20 gave off as much energy as the Sun does in a quarter of a billion years. The energetic blast released by the star was sufficiently large for the generated gamma rays to affect Earth's environment when they arrived, causing ionosphere disturbances measured by radio receivers. Mandaev and Balasis have found that currents set up in the ionosphere by the crashing gamma rays briefly upset Earth's magnetic field. The records of the CHAMP and DEMETER satellites contain a faint ringing signal of the magnetar's explosion with a period of 7.5 s for the duration of the flare. — JB

Geophys. J. Int., 10.1111/j.1365-246X.2006.03125.x (2006).

IMMUNOLOGY

Two Ways to Bug Worms

Innate immunity in the nematode worm *Caenorhabditis elegans* involves two genes: *PMK-1* and *DAF-16*, which is up-regulated by the insulin/insulin-like growth factor tyrosine kinase *DAF-2*. Worms carrying loss-of-function mutations in *pmk-1* are more sensitive to pathogens, whereas *daf-2* null mutants are more resistant. Troemel *et al.* have shown that the pathogen resistance observed in *daf-2* mutants requires a functional *PMK-1* gene and that *PMK-1* works either downstream or in parallel with *DAF-2*. However, the downstream targets of the two genes do not overlap. Detailed analyses of pathogen resistance suggest that *PMK-1*, unlike *DAF-16*, is specific to the immune response required for pathogen response, whereas the *DAF-2* *DAF-16* pathway appears to play a less precise role in immunity. Thus, at least two separate pathways contribute to innate immunity in *C. elegans*. — LMZ

PLoS Genet. 2, 10.1371/journal.pgen.0020183.eor (2006).

BIOTECHNOLOGY

Multicultural Metabolic Map

The microbe-based treatment of wastewater has never been a glamorous topic of conversation, and efforts at improving the efficiency of solute removal have largely been empirical in approach. Furthermore, the population of microbes may, at times, fluctuate unpredictably, which can result in the collapse of the entire

community. García Martín *et al.* attempt to define the genomic composition of the candidate species, referred to as *Accumulibacter phosphatis*, that acquires inorganic phosphate, sequesters it as polyphosphate, and then conveniently sinks to the bottom of the treatment tank. From two lab-scale samples of sludge (derived from wastewater plants in Wisconsin,



A wastewater treatment plant.

USA, and Brisbane, Australia), they obtained enough sequence to estimate the genome size of *A. phosphatis* as 5.6 Mb, with a high degree of sequence identity between the two samples. The list of genes is consistent with an aerobic build-up of polyphosphate, which is then used as an energy source for the anaerobic caching of volatile organic acids as polyhydroxyalkanoates. An unexpected (inferred) capacity for nitrogen fixation and a parcel of cobalamin-dependent enzymes suggest that *A. phosphatis* might thrive in an environment supplemented with cobalt and low in fixed nitrogen. — GJC

Nat. Biotechnol. 24, 1263 (2006).

CLIMATE SCIENCE

Time to Talk

Earth's climate is warming, and carbon dioxide emitted from the burning of fossil fuel is very likely to be the major cause. Global temperatures are projected to rise above preindustrial values by 1.5° to 5.8°C by the end of the 21st century. The search is on for ways to slow warming, potentially by large-scale climate geoengineering.

One possible approach to this risky endeavor is to inject sulfate precursors into the stratosphere (see Wigley, Reports, 20 October 2006, p. 452), because sulfate aerosols reflect sunlight and would have a consequent cooling effect. In an attempt to lay the foundation for a more thorough discussion of climate geoengineering options Crutzen discusses the theoretical basis, possible methodologies, and advantages and disadvantages of such a scheme. Five other authors (Cicerone, Kiehl, Bengtsson, MacCracken, and Lawrence) weigh in on the history of such proposals, the practical as well as ethical considerations of various approaches, and how best to evaluate different geoengineering schemes. The authors make it clear that geoengineering climate is a less desirable potential solution to warming than controlling greenhouse emissions, and that only if warming causes sufficiently harmful impacts would geoengineering be a better choice. — HJS

Clim. Change 77, 211; 221; 227; 229; 235; 245 (2006).

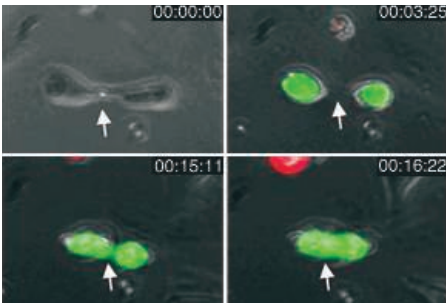
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MICROBIOLOGY

Opportunistic Invasion

Pseudomonas aeruginosa is a ubiquitous opportunistic pathogen that cannot infect healthy humans unless there is a preexisting injury to the epithelium. Shafikhani and Engel describe how *P. aeruginosa* capitalizes on epithelial wounds to establish itself within the host by using multiple strategies to prevent wound healing. The pathogen injects a protein termed exotoxin T (ExoT) into the cytosol of target cells using a specialized type III secretion apparatus. Once inside the target host cells, ExoT inhibits cytokinesis: the process by which daughter cells are physically separated dur-



Cells containing ExoT (green) complete mitosis but fail to complete cytokinesis.

ing cell division. Two domains of ExoT, an N-terminal GTPase-activating domain and a C-terminal ADP-ribosyl transferase domain, appear to act redundantly, one blocking an early step of cytokinesis, the other blocking a later step. This blocking of cytokinesis prevents further cell proliferation

and thus helps to prevent the efficient closure of wounds, allowing access to further bacteria, which can go on to establish an acute infection. — SMH
Proc. Natl. Acad. Sci. U.S.A. **103**, 15605 (2006).

COMPUTER SCIENCE

From Birds to Boards

One way to simulate a complex phenomenon such as the flocking of birds is to build a detailed computer model that incorporates the motion of all individuals as well as rules for their interaction. Many aspects of the underlying mechanisms must be incorporated into the program from the start, and such a system could be susceptible to wildly nonlinear outcomes. An alternative is to build a large number of autonomous entities having no central controller, and then allow the collective behavior to emerge over time through trial and error. As Liu and Tsui explain, such computing models have been labeled "nature-inspired" because they are truly analogous to the way birds flock or ants in a colony engage in purposeful collective behavior. The basic entities in such a model (which could be either software modules or actual hardware robots with internal software) are self-organized, most strongly influenced by local interactions, and capable of adapting their behavior in response to a changing environment. These emergent adaptive computing systems may find applications in studies of such complex collections of interacting entities as the human immune system, economic markets, or ecological communities. — DV

Commun. ACM **49**, 59 (2006).



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<< XIAP As a Positive Feedback Regulator of Caspase Activation

Inhibitor of apoptosis proteins (IAPs) are best known for their roles as inhibitors of caspases and thus of apoptotic cell death. Legewie *et al.* develop a mathematical model of the core intrinsic apoptotic process involving Apaf-1, caspase 9, caspase 3, and X-linked IAP (XIAP). In the wild-type model, as active Apaf-1 concentration increased, the time course with which active caspase 3 was produced decreased as expected. When the activation of caspase 3 was plotted against the concentration of active Apaf-1, a bistable and irreversible state was observed both in the wild-type model and in a caspase 9 mutant model. This suggested that the positive feedback between caspase 9 and caspase 3 was not the only contributor to bistability in the system. Further analysis suggested that XIAP contributed a positive feedback to caspase 3 activation. Caspase 3 was proposed to sequester XIAP away from caspase 9 under conditions of strong stimulation, thereby allowing caspase 9 to become further activated and ultimately allowing caspase 3 to be activated. The bistability and irreversibility of the models depended on the concentrations of both caspase 3 and caspase 9, with only the wild-type model showing irreversibility in the physiological concentrations of each caspase, indicating that both caspase 3-mediated feedback and XIAP-mediated feedback contribute to irreversible bistability under physiological conditions. The models echo observed differences in cellular responses to apoptotic stimuli by showing that the all-or-none threshold of the system is influenced by the abundance of caspase 3, caspase 9, and XIAP. — NRG
PLoS Comput. Biol. **2**, e120 (2006).