

ECOLOGY/EVOLUTION

Asymmetric Nurture

An almost defining feature of the social hymenoptera (wasps, bees, and ants) is the absence of male workers; typically, females perform all of the tasks associated with care of the nest and larvae. Theoretical explanations centered on the genetic asymmetry of males and females (the males being haploid and the females diploid) have been discussed for decades, though experimental studies of this question have been few.

Sen and Gadagkar investigated whether males of the Indian wasp *Ropalidia marginata* would feed larvae, by manipulating the presence of females and the amount of food nearby. When food supplements were available and when females were missing, males were able to provision larvae at a frequency similar to that observed for females. It appears that under normal circumstances, males do not have enough access to food or are prevented from feeding larvae by females. Thus, the capacity to feed larvae is common to both sexes, and the mechanism preventing males from doing so may be behavioral rather than genetic or developmental. — AMS



A wasp's nest.

Anim. Behav. **71**, 345 (2006).

GEOPHYSICS

There and Back Again

As waves produced by earthquakes reverberate through the solid Earth, they can be reflected or scattered from discontinuities within and between the mantle and core. Changes in the composition and temperature of mantle minerals can cause the waves to speed up, slow down, or bend and even reverse their paths. By monitoring earthquakes occurring within 10° of a seismic receiver array in Alaska, Tkalčić *et al.* have spotted a new phase of seismic pressure wave. These waves appeared to travel directly through the center of the Earth and inner core, and bounced back after scattering off the underside of a discontinuity in the upper mantle, 150 to 220 km below Antarctica. Because these waves were back-scattered just below the surface, they arrived at the receiver about a minute ahead of similar waves reflected from the antipodal surface itself; hence the authors termed them P'P' near-podal precursors. The scatterers could be lenses of partially melted minerals or could comprise local concentrations of material different in composition than the rest of the upper mantle. — JB

Geophys. Res. Lett. **33**, 10.1029/2005GL024626 (2006).

BIOTECHNOLOGY

Crystals on a Chip

Protein crystallization is a complex and often unpredictable process, which depends critically on buffer conditions and dehydration rates.

Recently, microfluidic reactors have proven useful for screening a range of crystallization conditions with little material. However, these systems have rarely produced crystals large enough for analysis, nor has it been possible to preserve the crystals that do form for diffraction studies at cryogenic temperatures.

Hansen *et al.* have built a microfluidic device consisting of five parallel chambers, separated by a semipermeable membrane from a larger fluid reservoir. The osmotic strength of each chamber is equilibrated through internal diffusion among the chambers, as well as by a slow influx of vapor through the membrane. This motif can be repeated multiple times on a chip, with mixing times precisely controlled by

modification of the channel lengths and chamber volumes. For lysozyme, ferritin, insulin, and catalase, they found that modulation of the mixing kinetics offered control over crystal quality, size, and even morphology. Moreover, crystals grown in these chambers could be preserved and



Bladelike (top) and rhomboidal (bottom) crystal morphologies, selected by varying channel length.

studied in situ by x-ray diffraction to <2 Å resolution. — MSL

J. Am. Chem. Soc. **128**, 10.1021/ja0576637 (2006).

MICROBIOLOGY

Adapting All Too Well

Human-specific pathogens, such as *Helicobacter pylori* and *Mycobacterium leprae*, exhibit geographic variation that is linked to that of their host. Gagneux *et al.* show that this is also true of *M. tuberculosis* and, intriguingly, that this variation may be linked to infection dynamics. First, by screening tuberculosis samples from people encompassing a range of geographical origins, the international collaboration found six major lineages with distinct global footprints. Then, by analyzing over a thousand isolates from five human populations in San Francisco, they found that most belonged to three of these lineages: roughly a quarter to the Indo-Oceanic (the most ancestral), a quarter to the East-Asian, and about half to the Euro-American. By looking at chains of transmission, they saw that the lineages differed in secondary case frequency, with the Euro-American being the most successful and with each lineage transmitting most efficiently within its original population. They suggest that lineages might be adapted to distinct human populations, as seems to be reflected in the efficacy of bacillus Calmette-Guérin vaccination, which could have implications for new tuberculosis control strategies (see Gessler *et al.*, Policy Forums, this issue, p. 1245). — CA

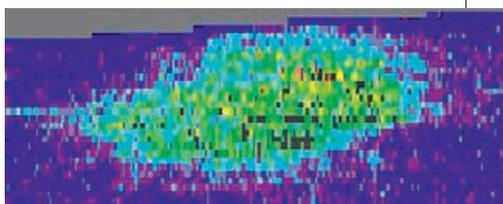
Proc. Natl. Acad. Sci. U.S.A. **103**, 2869 (2006).

IMMUNOLOGY

Too Little or Too Much?

Crohn's disease is a severe inflammation of the mucosa of the intestine and is prevalent in developed countries. Multiple predisposing and environmental factors—such as mutations in the protein NOD2, which recognizes bacterial cell wall components—appear to influence the onset and progression of the condition, and current thinking is that these factors conspire to stir up unwanted immune reactions to the microflora of the gut.

Marks *et al.* provide evidence that Crohn's may instead be more representative of immunodeficiency. Crohn's patients were found to have reduced neutrophil accumulation and interleukin-8 (IL-8) production at sites of tissue



Increased forearm blood flow after injection of bacteria.

trauma in the intestine and the skin. The defect in IL-8 production was independent of NOD2 mutation, and macrophages from patients were impaired in generating IL-8 in response to wound fluid from healthy individuals. Skin responses to subcutaneous injection of killed bacteria were also diminished, with local blood flow in the patients less enhanced relative to that in healthy controls. This is consistent with a lower potential for acute inflammatory responses in Crohn's patients; thus, although

Crohn's disease may culminate in a chronic inflammatory response, it may originate in deficient acute pro-inflammatory responses to bacteria. — SJS

Lancet **367**, 668 (2006).

CHEMISTRY

Building a Staircase

Despite carbon's propensity to adopt a tetrahedral bonding geometry, chemists have managed over the years to squeeze it into a wide range of strained shapes, such as cubes and dodecahedra. However, it was remarkable to find that anaerobic *Candidatus "Brocadia anammoxidans"* bacteria, which are presumably more concerned with function than geometry, produce a fatty acid derivative in which the acyl chain is tethered to five cyclobutane rings, fused through shared edges as in a staircase. Despite an estimated strain energy of 75 kcal/mol, this molecule is a primary component of the intracellular membrane in which ammonia is metabolized.

Mascitti and Corey previously synthesized this compound in racemic form and have now achieved an efficient asymmetric synthesis, in which the C₈ carboxylate chain is bound to one specific external corner of the staircase motif. The authors achieved enantioselection through the use of a bulky dimethylphenylsilyl group, which directed cyclopentenone orientation in the photoinduced [2+2] cycloaddition that formed the fourth cyclobutane ring. In general, the synthesis relied heavily on cyclizations and rearrangements induced by ultraviolet irradiation. How the bacteria make this molecule (presumably in the dark) remains a mystery. — JSY

J. Am. Chem. Soc. **128**, 10.1021/ja058370g (2006).



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<< Mice Are Not Men

Pro-opiomelanocortin (POMC) undergoes posttranslational processing to yield a bunch of physiologically active peptides. In the hypothalamus, POMC is a precursor to the melanocortins (α -MSH, β -MSH, and γ -MSH). Humans and mice lacking functional POMC or MC4R (melanocortin-4 receptor, which is activated by α - and β -MSH) become obese; because rodents cannot synthesize β -MSH, this effect has been attributed to α -MSH. Biebermann *et al.* find that a severely obese child has a mutant form of β -MSH in which a cysteine has been substituted for a tyrosine, a mutation also present in obese family members. Restriction enzyme analysis of 722 obese and 1270 non-obese children and adolescents uncovered the mutation in 2 obese individuals and none of the controls. Lee *et al.* discovered the same β -MSH variant in 5 of 538 unrelated severely obese children and 1 of 300 non-obese adults and found that the mutation segregated with obesity in family members. Both groups observe that the mutant form showed substantially reduced binding to human MC4R and conclude that, unlike in rodents, β -MSH is important in regulating energy balance and body weight in humans. — EMA

Cell Metab. **3**, 141; 135 (2006).

Science

Crystals on a Chip

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