ECOLOGY

Reading the Bones

Large-scale fishing impacts in the open ocean are recent, mostly occurring during the past half century as industrial fishing technologies were developed. We can quantify these impacts on marine food webs by using current and historical animal tissues to document the temporal signature of human-driven diet change in marine species. Wiley *et al*. looked at isotopes from bones and flight feathers, collected at modern and historical breeding sites, of Hawaiian petrels. Ranging from current to 4000 years old, specimens represented individuals alive well before the first humans arrived on Hawaii, as well as those from the current depleted system. The percentage of N^{15} was relatively stable over roughly 3000 years, but rapidly decreased, across all Hawaiian populations, within the past 50 to 100 years, coincident with the onset of industrial fishing. A fisheries-induced decrease in trophic level is the most likely cause of this shift, and the petrel's generalist foraging strategy further suggests the presence of a wider fisheries-driven change in the oceanic food webs of the northeast Pacific Ocean. — SNV

Proc. Natl. Acad. Sci. U.S.A. **110**, 10.1073/pnas.1300213110 (2013).

ECONOMICS

Patent Commons

The ability of "green tech" to tackle environmental challenges depends on both scientific advances and deployed technologies. Despite widespread use of intellectual property (IP) incentives to promote technology transfer, IP restrictions may stifle diffusion of knowledge and development of "green" innovations. One proposed solution is the Eco-Patent Commons (EPC), formed in 2008 by IBM, Sony, Nokia, and Pitney Bowes. Participating firms offer, for free use by anyone, some of their patented environmentally relevant technologies. Hall and Helmers found that although EPC technologies were typically environmentally friendly, many were tangential to the creation of new environmentally sound technology. EPC patents were less than 0.1% of EPC firms' overall patent portfolios but were of similar value to the firms' other, non-EPC patents. Compared to other patents (including many from non-EPC firms), the EPC patents were of lower value. While acknowledging that EPC is relatively new and that knowledge diffusion may take years, they found that free access has not yet increased EPC patent citations. — BW

J. Environ. Econ. Manag. 10.1016/jjeem.2012.12.008 (2013).

CELL BIOLOGY

Ultralong Antibodies

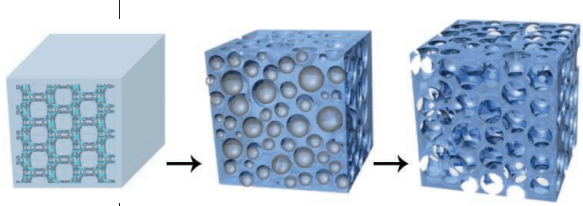
An antibody's specificity for antigens is largely determined by complementarity-determining regions (CDRs). These form protein loops of the heavy and light chains that bind to a target. The most diverse is region 3 of the immunoglobulin heavy chain (CDR H3), which forms a flat binding surface for antigens. However, 10% of all bovine antibodies bear a much longer loop that includes many cysteines. Wang *et al*. analyzed the crystal structures of two such cow antibodies and discovered that the stretch of residues forms a long stalk that protrudes from the antibody and terminates in a knob domain. The two antibodies have different disulfide bond patterns in the knob, which arise from different cysteine sequence positions. The stalks also differ in length, which alters the relative position of the knob domain. Sequencing of more than 10,000 ultralong CDR H3s indicates that the diversity (D) gene segment appears primed for mutation to cysteine, allowing new disulfide bonds to be made or broken. The authors propose that the cow's immune system uses cysteine diversification to increase the repertoire of unique "minifolds" in knob domains, thereby expanding the antibody arsenal for recognizing foreign targets. — LC

Cell **153**, 10.1016/j.cell.2013.04.049 (2013).

MATERIALS SCIENCE

From MOFs to Mesoporous Oxides

Mesoporous oxides can be made starting with organic frameworks, such as micelles, that form a template for metallorganic precursors. After the precursors react to form the oxide, the template can then be removed. Kim *et al*. have used crystalline metal organic frameworks (MOFs) as the precursors for magnesium and cerium oxides that develop mesoscale porosity. They made the MOF precursors with adipic acid, $HOOC(CH_2)_4COOH$, as the linker. The solvothermal reaction of a magnesium or cerium salt with this ligand and methanol and dimethylacetamide created MOFs in which each metal ion was coordinated to five or six oxygen atoms. Heating these materials under a flowing nitrogen atmosphere to 500°C and then holding these materials at that temperature for 12 hours created crystalline oxides.



These oxides had a hierarchical structure of mesopores on the scale of tens of nanometers connected by larger pores on the scale of 50 to 100 nm. The magnesium oxide material also exhibited a high capacity for adsorption of carbon dioxide (~9% by weight) from combustion gas. The authors argue that the thermal decomposition process creates organic species that act as micellar templates ("porogens") that are removed during the thermal treatment. Thermal treatment of a MOF made with a more stable aromatic linker did not form the mesoporous oxide but instead led to nanoparticle formation. — PDS

J. Am. Chem. Soc. 10.1021/ja401869h (2013).

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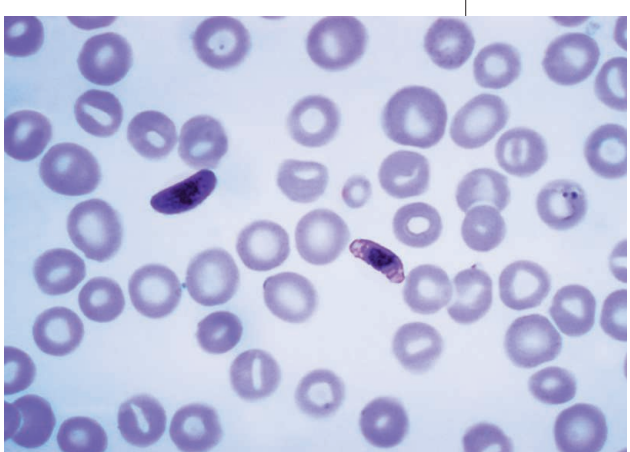
MICROBIOLOGY

Tuning Haploid Happenstance

How can the malarial parasite *Plasmodium falciparum* evolve drug resistance when it is haploid and does not have recourse to meiosis? Guler *et al.* challenged *P. falciparum* with a drug nicknamed DSM1, which inhibits the parasite's flavonoid enzyme, dihydroorotate dehydrogenase (DHODH), required for the biosynthesis of pyrimidine and nucleic acids. Resistant clones arose that had multiple copies of DHODH and no point mutations. Deep sequencing revealed that an initial duplication arose stochastically by mitotic rearrangements between scattered tracks of polyadenine or polythymine (A/T). The rigidity of A/T tracks is known to trigger recombination and so could promote mitotic DNA rearrangements. Hence, the first step is luck, and eventually a beneficial mutation is selected out of the millions of failures in the replicating parasite population. Subsequently, copies of DHODH are precisely ramped up and down depending on drug pressure. The amplicon responsible for resistance was the only new amplicon seen in DSM1-resistant parasites, so there is a further mechanism for restraining the collateral damage arising from



unlimited amplification of bits of haploid genome. In the A/T-rich genome of *P. falciparum*, this two-step mechanism may be the primary driver for evolution, not just drug resistance. — CA

PLoS Pathogens **9**, 10.1371/journal.ppat.1003375 (2013).

GEOPHYSICS

Spinning Iron in the Mantle

Transitions in the spin state, or electronic configuration, of iron can be induced by the high temperatures and pressures in Earth's interior. Spin transitions—whether they be abrupt or gradual with depth—could influence the physical properties of abundant iron-bearing minerals or affect the interpretation of seismic data; however, laboratory experiments at such extreme conditions have often been contradictory. Wu *et al.* developed a simple theoretical formulation to simulate the iron spin transition and used it to calculate elasticity in ferropericlase [(Mg, Fe)O], a major mineral in the lower mantle, across a wide range of pressures and iron compositions. The calculations predict that the spin transition should not have a strong effect on some important elastic properties, such as the shear modulus (the ratio of shear stress to shear strain). Moreover, the concentration of iron in ferropericlase will strongly influence seismic wave velocities, requiring readjustment of expected mantle compositions that are based on extrapolations of experimental results. — NW

Phys. Rev. Lett. **110**, 228501 (2013).

PHYSICS

Flat Condensate

Ultracold gases of atoms, which can be cooled to temperatures close to absolute zero, are a promising model system for the collective phenomena that emerge in the presence of many particles. To keep the atoms together, atomic physicists use "traps," with the center of the trap being the most densely populated with atoms and the density trailing off toward the edges; this spatial non-uniformity, however, complicates comparison with many-body theories. Gaunt *et al.* created a nearly uniform trapping potential by using three laser beams (one "tube" and two "sheet" beams) and loaded it with bosonic ^{87}Rb atoms, which they cooled down sufficiently to achieve their condensation into the lowest energy state. Both the condensed atoms and those that continued to populate higher energy levels behaved as one would expect from an ultracold gas in a uniform potential; for example, a signature bimodal distribution of momenta emerged with cooling below the transition temperature, whereas the spatial profile showed little change. It is expected that this technique will enable obtaining benchmark results for many-body theories and can be used to trap fermionic atoms as well. — JS

Phys. Rev. Lett. **110**, 200406 (2013).

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