CHEMISTRY

Cage Match

What does water look like? Many think of waves and ripples, and various shades of color, reflected from whatever materials contain and constrain the liquid, disrupting an otherwise perfect clarity. Chemists want to know about the structure—how individual H_2O molecules orient relative to one another and thereby lend water its range of remarkable properties. In this context, the hexamer (six molecules) has special significance: It's the smallest, and therefore most easily analyzed, three-dimensional assembly. Yet even this simplified sub-structure has been the subject of decades-long debate regarding which of three possible arrangements is the most stable. Only very recently were all three successfully observed in the same experiment (see Pérez *et al*., Reports, 18 May 2012, p. 897). This gave the so-called cage a slight edge over the prism, though results depended on the inert carrier gas used for spectral characterization. Wang *et al*. have now performed high-level theoretical calculations that give the prism the very slightest edge but suggest that the cage has nearly the same energy at the lowest temperature and soon overtakes the prism upon warming, on account of its greater entropy. Eventually, a book shape with the greatest entropy is predicted to overtake them both, closing the book, perhaps, on the whole question. —JSY

J. Am. Chem. Soc. **134**, 11116 (2012).

ATMOSPHERIC SCIENCE

Constraints from Above

Atmospheric aerosols exert their largest influence on climate through the indirect effects that they have on clouds. These indirect effects, which influence cloud formation, lifetimes, and radiative properties, contribute the largest uncertainty in estimates of the radiative forcing of past and future climate change. Measuring the magnitude of the aerosol indirect effect is difficult, though, in large part due to the competing effects of meteorological variables such as temperature, pressure, relative humidity, and convection. Wang *et al.* use results from a collection of global climate models to suggest a way in which one component of the aerosol indirect effect, liquid water path, might be better determined by satellite observations of clouds. Their analysis indicates that the liquid water path response to aerosol perturbation is significantly smaller than calculated by most models and that aerosols seem to have a substantially smaller impact on shortwave cloud radiative forcing over the oceans than current global climate models suggest. Though much more work is needed to quantify satellite-derived estimates of cloud properties and the aerosol indirect effect, this research reveals another piece of a complex mosaic of cause and effect. — HJS

Geophys. Res. Lett. **39**, L15709 (2012).

ECONOMICS

The Long Shadow of Genetic Capital

Comparative analyses of human genomes have contributed to a spatiotemporal narrative that begins in East Africa and extends to the other continents. These historical traces reveal a decrease in genetic diversity as migratory distance from Addis Ababa increases. Ashraf and Galor present the hypothesis that genetic diversity has exerted a long-lasting effect on economic development—which is quantified as population density in the precolonial era and as per-capita income for contemporary nations—beyond the influences of geography, institutions, and culture. They posit that intermediate levels of heterozygosity allow for a productive balance between the social costs of high diversity and the creative benefits of higher variance in cognitive skills. They show that the optimal level of diversity was approximately 0.68 in 1500 CE, and that this increased to 0.72 (which is pretty much where the United States sits) in the year 2000, with the most homogeneous country, Bolivia, placed at 0.63 and the most diverse country, Ethiopia, at 0.77. Just how large an effect are we talking about? They estimate that genetic diversity accounts of 16% of the cross-country dispersion in per-capita income; put in another way, shifting the diversity of the United States higher or lower by one percentage point would decrease per-capita income by 1.9%. — GJC

Am. Econ. Rev., in press (2012); http://ideas.repec.org/p/bro/econwp/2010-7.html.

MOLECULAR BIOLOGY

Untangling Linked DNA

To access the information stored in the genome during replication, repair, and recombination, the two strands of DNA must be unwound and sometimes cut and rejoined. Such synthesis and repair work can result in DNA strands becoming catenated, or topologically linked to one another, and topoisomerase enzymes have evolved to deal with such problems. Cejka *et al.* show that a topoisomerase complex in yeast, consisting of topoisomerase III (Top3), the helicase Sgs1, and Rmi1, works hand in hand with the single-stranded (ss)DNA binding protein RPA

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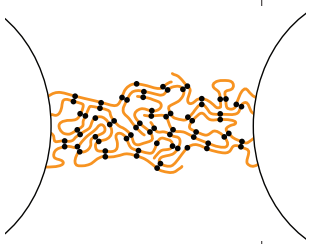
to unlink catenated and hemicatenated dsDNA rings, arising from late or partially replicated DNA intermediates, double holliday junctions, and so forth. They show that Sgs1 acts to unwind the dsDNA and that RPA captures the ssDNA to provide a substrate for Top3, which prefers single strands. Sgs1 delivers Top3 to the ssDNA, where it first cuts a DNA strand, forming a gap, and then passes intact ssDNA strands through the gap to unlink the DNA. Rmi1 stimulates strand passage by stabilizing the Top3 reaction intermediate, thereby lengthening the time for strand passage to occur. — GR

Mol. Cell **47**, 10.1016/j.molcel.2012.06.032 (2012).

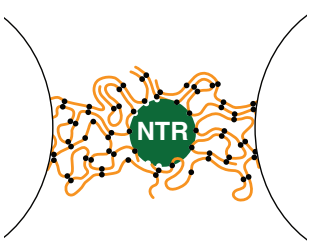
BIOCHEMISTRY

Screening Entry

Nuclear pore complexes are gateways between the cytoplasm and the nucleus, and they contain multiple copies of nucleoporins (Nups). Inert objects larger than 5 nm cannot pass, yet nuclear transport receptors (NTRs) facilitate the translocation of cargo up to 40 nm in diameter. Phenylalanine-glycine repeat–containing Nups (FG-Nups) bind NTRs during facilitated translocation, but how binding increases permeability and how FG-Nups keep out the nonbinders are unclear.



In a "reduction of dimensionality" model, the FG domains (black dots) form a surface that NTRs slide over to traverse the NPC. In two other models, the FG domains do bar passive transport: The virtual gate model relies on a brush-like behavior of noninteracting FG domains that repel inert material, whereas the selective phase model claims that the barrier is formed by a sieve-like hydrogel of interacting FG domains. Hülsmann *et al.* reconstituted nuclear pores and found that the FG-Nup Nup98 is essential both for active transport and maintenance of a passive barrier. The FG domain of Nup98 formed a hydrogel in vitro; this domain was required for the formation of a permeability barrier in reconstituted NPCs and could not be complemented by a noncohesive FG domain.



CREDIT: HÜLSMANN ET AL., *CELL* **150**, 738 (2012)

These data support the selective phase model in which the meshwork formed by interacting domains excludes inert molecules, but NTRs bind to the FG domains and disrupt the mesh in order to transport their cargoes. — VV

Cell **150**, 738 (2012).

APPLIED PHYSICS

Flexible and Fast

High-speed communications are essential in many prospective applications of flexible electronics. However, organic polymers, amorphous silicon, and oxide-based thin-film transistors have limited carrier mobilities for high-frequency operation. Lee *et al.* demonstrate a fully bendable, all-graphene modulator circuit that can encode a carrier signal with quaternary (four-wave) digital information. The ambipolarity and the nonlinearity in a graphene transistor were exploited in two types of modulation scheme, one that can convey digital data as shifts in amplitude (quaternary amplitude-shift keying) and the other as shifts in phase (quadrature phase-shift keying). These schemes were realized with just one or two all-graphene transistors, respectively, and could greatly reduce circuit complexity relative to conventional digital modulators. The devices are also highly transparent (~95% transmittance) because all components (the channel, interconnects, load resistor, and contact and gate electrodes) were fabricated from graphene films. — PDS

Nat. Commun. **3**, 10.1038/ncomms2021 (2012).

GENETICS

Geography and Genetic Destiny

Humans are the most cosmopolitan species across the globe, because they are found on every continent and have established populations in almost every climatic zone. In order to evaluate the impact of local geography on human genetic diversity, Wang *et al.* looked at genome-wide Single-nucleotide polymorphism data across 100 populations. The authors evaluated the data at the continent and sub-continental levels and found that worldwide populations cluster with their respective local geography. This correlation was stronger in East Asia, in spite of the barriers presented by the Himalayas, relative to other well-studied populations, such as Europe. Thus, human demography was shaped by how topology affected human dispersal and migrations, and a greater understanding of these relationships may provide the tools to allow us to trace back the original peopling of the globe. — LMZ

PLoS Genet. **8**, e1002886 (2012).