EDITED BY GILBERT CHIN AND JAKE YESTON

ENGINEERING

A Biofuels Wiki

Turning corn sugar into ethanol involves well-established technology, but if the goal is to replace a substantial fraction of the world's petroleum with biofuel, alternative feedstocks that grow in poorer soil and don't compete with the food supply would be far preferable. At present, processing lignocellulosic feedstocks such as grasses and stover is relatively expensive and inefficient, but research to improve the methodology is progressing rapidly on many fronts. To help researchers leverage advances in the disparate fields contributing to biorefinery operation, Klein-Marcuschamer *et al.* have set up an online model that simulates the costs, yields, and energy balances under various process scenarios. Their initial condition considers the transport of corn stover to a refinery, acid pretreatment, enzymatic saccharification, yeast-mediated fermentation, and concomitant lignin combustion for energy generation. Users can then vary inputs to see the impact on overall cost, chemical efficiency, and outputs such as greenhouse gases. As examples, the authors consider how improving enzyme activity and reducing feedstock levels of acetate (toxic to the fermenting organisms) affect the minimum ethanol market price necessary for viable refinery operation. They further encourage scientists to model their own scenarios and contribute feedback at http://econ.jbei.org. — JSY

Biomass Bioenergy 10.1016/j.biombioe.2010.07.033 (2010).

BIOCHEMISTRY

A Microbial Spinning Jenny

Forests contain a lot of carbon, and much of that carbon is used to make the structural polymer cellulose. Like other biopolymers, cellulose is synthesized inside cells, yet it must be extruded across cell membranes as individual chains that are wound together, first into smaller fibrils and then into larger ones. The biological and physical properties of cellulose are remarkable, and *Acetobacter xylinium* is a prime bacterial source for medical and industrial applications (as well as the tasty dessert shown below). Hu *et al.* describe the crystal structure of subunit D of *A. xylinium* cellulose synthase, which is involved in the assembly and extrusion of the intact polymer. Subunit D is a toroidal tetramer of dimers, where the dimer-dimer interfaces spiral around the central axis. Soaking these crystals in cellopentaose solution revealed binding of four molecules to each subunit D octamer at the sites where the dimer interfaces open into the central pore, suggesting that the passage of four glucan chains across the membrane may be coupled to a twist that promotes fibril assembly. — GJC

Proc. Natl. Acad. Sci. U.S.A. **107**, 10.1073/pnas.1000601107 (2010).

EVOLUTION

Alone, But Not Lonely

Darwin's *On the Origin of Species* was shaped by his visits to the Galapagos Islands; in particular, he noted the prevalence of species, from land tortoises to finches, which were not found elsewhere. Since that time, it has been hypothesized that the remote location and singular environment of the Galapagos have shaped wayward migrants through *in situ* radiations into their myriad endemic and unusual forms. On the other hand, species that can travel long distances would be expected to be less likely to become lonely; instead, they would maintain gene flow with their mainland counterparts and thus limit the adaptive divergence observed in more sedentary species.

Darwin suggested that marine birds should display less endemism than other species, but recent work by Hailer *et al.* on the highly vagile magnificent frigate bird (*Fregata magnificens*) suggests that the power of the Galapagos to facilitate divergence is not due solely to its isolation. Specifically, by looking for divergence across a suite of genetic markers and proxies for body size in populations throughout the western hemisphere, they show not only that the Galapagos population is unique, but also that it is unique in its uniqueness. *F. magnificens* from other locations, extending from Mexico to the Virgin Islands, are genetically and phenotypically indistinguishable despite being separated by, in some cases, thousands of kilometers and the Panamanian Isthmus. So if geographic isolation is not driving divergence in Galapagos frigate birds, what is? The authors hypothesize that the drivers could be ecological or behavioral. — SNV

Proc. R. Soc. London Ser. B **277**, 10.1098/rspb.2010.1342 (2010).

CELL BIOLOGY

First In, Last Out

The mammalian cell nucleus is surrounded by a double membrane punctured by nuclear pores. The entire nuclear envelope is disassembled during mitosis and then reassembled in each daughter cell, and postmitotic assembly has been studied in some detail. Dultz and Ellenberg have asked what happens when additional pores are required. High-resolution light microscopy allowed the visualization of single nuclear pore

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complexes in living cells during interphase. As the nucleus grew, new pore complexes were assembled at a steady rate and involved the accumulation of one of the nuclear pore membrane proteins, Pom121, which then recruited other soluble pore components. This order of assembly is the opposite of that seen at the end of mitosis, which implies that the two processes are mechanistically distinct. — SMH

J. Cell Biol. **191**, 15 (2010).

BIOPHYSICS

Clouding the Issue

As anyone who has played table tennis knows, it's hard to throw a table tennis ball very far. Fungal spores, being even smaller and lighter, suffer much more from drag when they are ejected into air; individual *Sclerotinia sclerotiorum* spores are roughly 10 μm in size and would be predicted to travel only 3 mm after having been launched at a speed of almost 10 m s^{-1}. Streamlining the shape of the spore and sticking to one's brethren do confer some aerodynamic advantages and lead to wider dispersal. Roper *et al.* show that emerging in a cloud helps, too, and can boost the distance traveled to as much as 10 cm. This enhancement arises from the earliest spores having set the proximal layer of air into motion so that later spores can go with the flow. The authors numerically simulate the spatiotemporal behavior of the spore jet and find a good match with particle-imaging velocimetry measurements. They also find that spores that wait to emerge, so as to board the already moving air mass, can delay their departure only by around 50 ms lest the train leave the station without them. — GJC

Proc. Natl. Acad. Sci. U.S.A. **107**, 10.1073/pnas.1003577107 (2010).

PHYSICS

FFLO on the Horizon

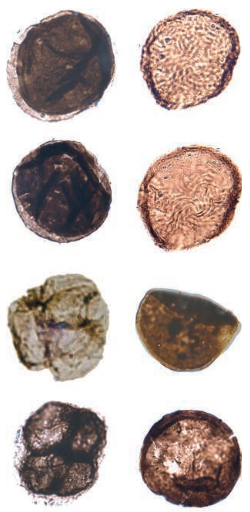
Such counterintuitive phenomena as the flow of electrical current through a solid without any dissipation, or the zero viscosity of ^{3}He at low temperatures, may be explained by the unlikely pairing of the electrons or He atoms (respectively) that constitute the flow. In the simplest case, pairing occurs between fermions of opposite spins and momenta, so that the total momentum of a pair is zero. Usually, the numbers of fermions of opposite spins is balanced, so that each up-spin has a down-spin partner; an exotic situation when this is not the case may lead to the formation of the so-called Fulde-Ferrell-Larkin-Ovchinnikov (FFLO), state, in which the pair momentum is finite and the pair density is oscillating in space. It is expected that this state will be the most stable in a one-dimensional (1D) wire-like system. Liao *et al.* recreate this situation in an ultracold gas of ^{6}Li confined to an array of 1D tubes. In line with theoretical predictions, the measured spin density profiles indicate that a core with unequal densities of up- and down-spins (a potential FFLO state) is flanked by either a fully paired or a fully spin-polarized state, depending on the overall degree of spin imbalance. Although not a direct demonstration of an FFLO state, the experiment may set the groundwork for such observations in the future. — JS

Nature **467**, 567 (2010).

EVOLUTION

Greening Argentina

Life on Earth began in the water. The subsequent rise of plants on land dramatically influenced most major processes on Earth's surface. Without plants, the climate would be markedly different, and terrestrial life as we know it would not exist. However, a spotty fossil record has made it difficult to pin down exactly when and where plants transitioned from sea to shore. Now, Rubinstein *et al.* describe new evidence—fossils of spore-forming embrophytes in Middle Ordovician sedimentary deposits—that pushes back the timing of the earliest land plants by ~10 million years (from ~462 to ~472 million years ago). The specimens represent five genera of plants, meaning that diversification had occurred even earlier. What's more, they were found in the current-day Central Andes of northwest Argentina, implying that land plants may have originated along the eastern margin of the former supercontinent of Gondwana. Because previous evidence discovered in present-day Saudi Arabia and the Czech Republic—both near what was previously the western edge of Gondwana—dates from a later point in time, land plants may have arrived at those sites via transport mechanisms across land. — NW



New Phytol. **188**, 365 (2010).

CREDIT: RUBINSTEIN *ET AL.*, *NEW PHYTOL* **188**, 365 (2010)