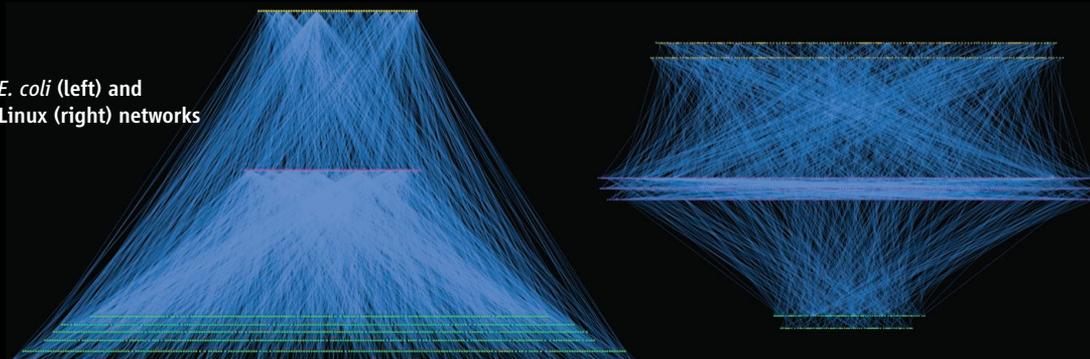


E. coli (left) and Linux (right) networks



SYSTEMS BIOLOGY

Industrial Organization

Yan *et al.* have compared the transcriptional control network in the bacterium *Escherichia coli* to the network depiction (known as the call graph) of the Linux kernel, which is the central component of a highly popular operating system. Both systems feature (i) master regulators (yellow in the graphic), which send directions to targets; (ii) middle managers (red), which both send and receive orders; and (iii) workhorses (green), which are controlled but do not control others. For the bacterium, there are lots of workhorses but relatively few regulators at the other levels. The Linux call graph is top-heavy or more populated at the master regulator and middle-manager levels. In other words, a workhorse in the transcriptional network usually has only a few super-

visors, but in Linux, a workhorse answers to a large number of regulators. The authors also contrasted evolution in the two systems by looking at the functions that persist in 24 versions of the Linux source code relative to genes that persist in 200 phylogenetically distinct bacteria. For *E. coli*, the workhorses showed the greatest persistence, whereas for Linux, there was persistence at all three levels, but mostly in the master regulators and middle managers. The authors interpret these differences in terms of two design principles. The need for cost-effectiveness (or reusability) is central in programming, and robustness—that is, resistance to breakdown due to failure of a part—is the driving factor in biological systems. Evolution, they speculate, goes from top to bottom in software, but from bottom to top in biological systems. — BJ

Proc. Natl. Acad. Sci. U.S.A. **107**, 9186 (2010).

ASTRONOMY

Close Encounters of the Second Kind

The Antennae galaxies are the nearest pair of interacting galaxies. As such, they have been extensively studied. Since the early 1970s, numerical simulations of the Antennae have successfully reproduced the system's large-scale morphology, with two long tidal tails and two distinct galactic disks, but they have failed to account for the observed high rate of star formation occurring in the overlap region between the two merging galaxies. Now, a model by Karl *et al.* can account for this off-nuclear burst of star formation if the

two galaxies are assumed to have had a second encounter 40 million years ago, after a first close passage 600 million years ago. In this timeline, the first passage comes much earlier than predicted by previous models—which implicated only a single close encounter—and puts the system in a later merger phase. The model predicts that the observed starburst has a very short lifetime as compared to the full merging process. This may explain why off-nuclear starbursts are rarely seen in interacting galaxies. — MJC

Astrophys. J. **715**, L88 (2010).

MICROBIOLOGY

Emergency Lighting

What happens when one's stores of energy run out? In vast and dilute oceans, high-energy nutrients can become quite scarce indeed, and many marine bacteria have the capacity to harvest energy directly from sunlight by means of light-activated proton pumps called proteorhodopsins. Nevertheless, the reasons for the widespread occurrence of proteorhodopsins and the fitness benefits of light-harvesting for bacteria have not been firmly established.

Gómez-Consarnau *et al.* cultured the *Vibrio* sp. AND4, knocked out its proteorhodopsin, starved it of organic detritus, and watched cell size shrink during the next 10 days. When the mutant was restocked with the missing gene and exposed to light again, it survived as well as the wild type, recovering to 3- to 6-fold higher cell densities than starved bacteria that had been left in the dark. It appears that proteorhodopsin fuels adaptive cell physiology and allows *Vibrio* to endure until more nourishment arrives. Although this study documents the evolutionary significance of bacterial proteorhodopsin, it does not yet explain the diversity of proteorhodopsins or their full ecological implications. More light is needed. — CA

PLoS Biol. **8**, e1000358 (2010).

CHEMISTRY

Silver Surprise

Precious-metal nanoparticles are potent catalysts for oxidation and reduction reactions of commodity chemical compounds. Cong *et al.* have now discovered that silver nanoparticles also efficiently catalyze the Diels-Alder cycload-



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dition of dienes to hydroxychalcones, a broadly useful transformation for synthesizing more complex organic molecules of potential interest in medicinal research. Preliminary screening of a series of silver salts mixed with borohydride revealed the surprising catalytic capacity of the elemental particles formed in situ. The authors then optimized the preparation by supporting the catalytic particles on silica, and highlighted the utility of the system through its application in the synthesis of the natural product panduratin A. Electron paramagnetic resonance spectroscopy applied in tandem with a radical probe supported a mechanism relying on single-electron transfer from adsorbed chalcone to the silver particle. — JSY

J. Am. Chem. Soc. **132**, 10.1021/ja102482b (2010).

EVOLUTION

Not Continental Drift

A number of genes that have been identified among different species and habitats may be drivers of sympatric speciation—that is, speciation occurring within a population without physical isolation. These genes are generally believed to cause population-level divergence under strong selection, and hence it is expected that closely linked genes will experience genetic separation, resulting in “genomic islands” of divergence. However, in light of ongoing gene flow, the remaining genomic landscape is expected to remain relatively homogenous.

Michel *et al.* tested this hypothesis in a model organism for sympatric speciation, *Rhagoletis* flies, that utilize different

host species—apple versus hawthorn flies, diverging approximately 150 years ago. Surveying the genomes of apple and hawthorn flies across a latitudinal gradient and mimicking natural conditions

inducing diapause and eclosion, the authors found that large portions of the genome are divergent and are not merely islands linked to the putative drivers of divergence.

Based on these results, they conclude that loci located throughout the genome are under selection and that these differences are not due to genetic drift. This supports the view that genomic continents of divergence may occur even during early stages of speciation. — LMZ

Proc. Natl. Acad. Sci. U.S.A. **107**, 10.1073/pnas.1000939107 (2010).

CELL BIOLOGY

Stop and Go Controller

The enzyme glycogen synthase kinase 3 (GSK3) is a protein kinase that originally was named for its role in carbohydrate metabolism. More recently, it's become part of the signaling pathway activated by the secreted morphogen Wnt. In this guise, it phosphorylates the transcription factor β -catenin, which promotes its degradation and abrogates Wnt signaling. When Wnt binds to its receptor, one component of the receptor, LRP6, inhibits GSK3 activity, thus allowing β -catenin to accumulate. But GSK3 also has a positive role in this signaling nexus: phosphorylating LRP6 in a way that enhances signaling and ultimately leads to the inhibition of β -catenin-associated GSK3. In a *Xenopus* system, Jernigan *et al.* found that when signals activated G protein-coupled receptors, the G protein $\beta\gamma$ subunits bound to GSK3, promoted its translocation to the plasma membrane, and activated its phosphorylation of LRP6. Thus, GSK3 collaborates with other proteins to promote Wnt signaling in addition to holding β -catenin in check until the appropriate signals are given. — LBR

Sci. Signal. **3**, ra37 (2010).

PHYSICS

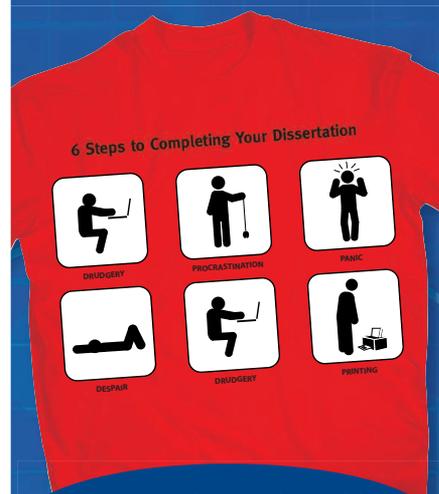
Hitting the Perfect Drive

Distance and accuracy are the twin goals of a good golf drive. On a shorter course, hitting noble gas atoms with intense infrared laser pulses can produce high harmonic light of extreme UV and soft x-ray wavelength. Control of this process—which involves transient liberation of an electron from the atom, followed by dramatic energy release upon their recollision—allows the generation of attosecond light pulses with tunable wavelength (energy). However, driving the atoms in just the just right way is key to achieving the desired output shot, in terms of wavelength and duration. Hit too hard and the atom rings out with a series of harmonics that run away (group delay dispersion), which makes it difficult to exert any control over construction of the pulses; drive too softly (with subthreshold pulses) and you get the control but don't reach the energy you want. Power *et al.* show that a temporal characterization technique can help to provide control over the process, so that subthreshold pulses can be used to generate harmonics up to higher energy. Driving the atoms in a soft but controlled manner should allow delivery of perfect, or least improved, attosecond pulses. — ISO

Nat. Photon. **4**, 10.1038/nphoton.2010.38 (2010).

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