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## IMMUNOLOGY

### Sick Space Flies

A concern regarding manned long-term space missions is that changes in gravitational force compromise the human immune system, but the underlying cellular and molecular reasons have not been clear. Taylor *et al.* studied innate immunity in *Drosophila melanogaster* that traveled aboard Space Shuttle Discovery in 2006. Flies reared in space were compared to flies that underwent development on Earth. Upon the return of the space-reared flies to Earth, both groups of flies were subjected to bacterial (*Escherichia coli*) or fungal (*Beauveria bassiana*) infections, and their gene expression profiles were examined. Genes associated with Toll receptor-mediated immune responses to fungal infection were activated only in the Earth flies. The expression of specific antimicrobial peptides also failed in the space flies. Other mechanisms, such as the Imd signaling pathway response to bacterial infection, were not affected in space flies. The space flies exhibited increased expression of heat shock response genes, a subset of stress response genes that are activated to manage aberrant protein folding. The authors suggest that microgravity may alter the folding and stability of proteins, which triggers the deployment of heat shock proteins that in turn, may interfere with the Toll receptor signaling pathway. — LC

*PLOS One* 9, e86485 (2014).



## ENGINEERING

### Growing Graphene Receivers

One use of the extremely high conductivity of graphene is in radio-frequency (RF) applications. However, the devices they use require specialized fabrication methods to avoid damaging the active graphene channel layer. Conventional fabrication of practical RF devices starts by placing the channel material on a silicon substrate and then fabricating other passive device components on top of it, using deposition steps that can involve high temperatures that can degrade the device performance. Han *et al.* report on a fabrication scheme for a graphene RF receiver that first assembles the passive elements on a silicon substrate. After metal lines were fabricated, atomic layer deposition was used to deposit a thin alumina gate dielectric

layer, and the active graphene was grown through a chemical vapor deposition process. None of the processing steps required temperatures in excess of 400°C. The final device, which contains three GFETs transistors, four inductors, two capacitors, and two resistors in a 0.6-mm-square area, operates at 4.3 gigahertz and could receive and restore digital text transmitted with that carrier frequency. — PDS

*Nat. Commun.* 10.1038/ncomms4086 (2014).

## ATMOSPHERIC SCIENCE

### Early Intervention

Anthropogenic carbon dioxide emissions from the use of fossil fuels may be the most important cause of modern global warming, but it is important to remember that humans can affect climate in other ways, such as through anthropogenic land cover change (ALCC). Agriculture and industrial activities have modified more than half of Earth's natural biomes, and ALCC has influenced global climate both through biogeophysical feedbacks, such as modification of the exchange of momentum and moisture between the land and the atmosphere and the alteration of radiative and heat fluxes; and biogeochemical ones, including emissions of greenhouse gases and aerosols from biomass burning, deforestation, and rice cultivation. He *et al.* investigate how important ALCC has been in the past, by

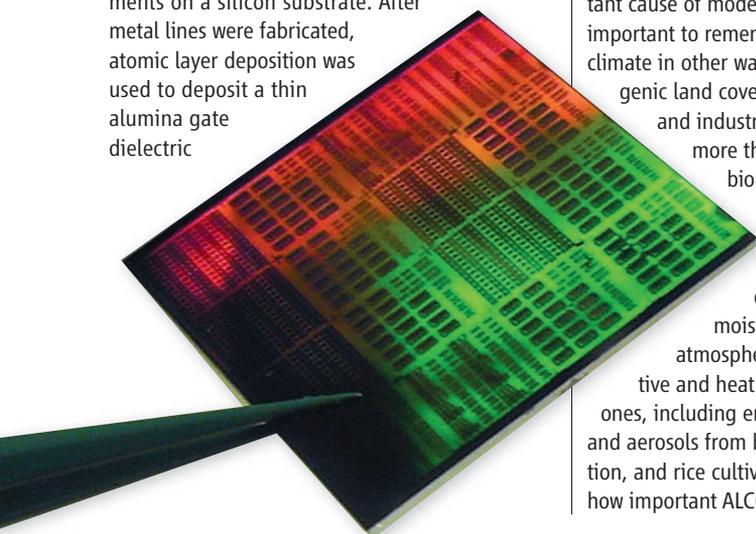
using a climate model forced by recently compiled observational data to assess how ALCC affected climate over the preindustrial Holocene. They found that ALCC increased global temperatures by around 0.73°C in that interval, an amount comparable to the ~0.8°C warming that has occurred during industrial times. So it seems that early anthropogenic activity had a significant impact on climate thousands of years before the Industrial Revolution began, mostly as a result of the greenhouse gas emissions caused by activities related to farming, such as deforestation and rice cultivation. — HJS

*Geophys. Res. Lett.* 41, 10.1002/2013GL058085 (2014).

## PLANT SCIENCE

### Predicting the Next Generation

Heterosis, in which the hybrid offspring perform better than the inbred parental lines, is a valuable but unpredictable aspect of maize cultivation. Traits that are useful in agricultural settings are often the outcome of complex genetic interactions, with many genes influencing each other and developmental outcomes in small ways. As a result, the genes controlling useful traits are often unknown. Nonetheless, crop breeders use what information they can find to generate more productive maize lines. Feher *et al.* have now used metabolites, the downstream output of complex gene suites, to predict heterosis. Looking at the early development of the



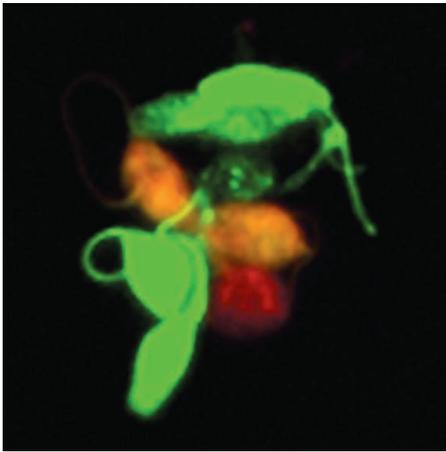
seedling's primary root (a well-functioning root gets the plant off to a good start) as their end point, the authors compared parental metabolite profiles to those of the hybrid offspring. A subset of the metabolites was identified as predictive of hybrid outcomes not only for that same metabolite but also for several other metabolites. The most effective predictions of hybrid root biomass were achieved by looking at only 5, but any 5, of the most predictive 10 to 20 metabolites. — PJH

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#### MICROBIOLOGY

### Ancestor Intercourse

Trypanosomes (notably including the sleeping sickness parasites) have long been thought to be



primitive protist oddities with strange biochemistries. Recent evidence from Peacock *et al.* shows that, just like the majority of eukaryotes, trypanosomes have sex. Starting from observations on the expression of meiosis-specific genes in trypanosomes within the salivary glands of the tsetse fly vector, distinctively shaped cells—putative gametes—were found. Subsequently, the cells were observed to intertwine flagella, squirm, and form intimate pairs. Labeling with different-colored fluorescent proteins revealed that membrane and cytoplasmic fusion occurred (although formal proof is still required for nuclear and kinetoplast DNA exchange), hence confirming that even the most ancestral eukaryotes indulge in sexual reproduction. — CA

*Curr. Biol.* 24, 181 (2014).

#### PHYSICS

### A Semisynthetic Lattice

Atomic vapors at very low temperatures are useful for the quantum simulation of solid-state systems, because their properties can be finely controlled

and tuned. These neutral atoms are not, however, completely analogous to the charged carriers in solids; for instance, an external magnetic field causes electrons to move in circular orbits but has no such effects on neutral atoms. Celi *et al.* propose a simple method for creating a uniform magnetic flux in a one-dimensional (1D) optical lattice that, if realized, might be used to observe exotic phenomena such as Hofstadter-butterfly-like fractal spectra or the dynamics of topological edge states. The method is based on synthetically extending the 1D lattice into the second dimension of internal atomic states (spin) by coupling those states using a pair of Raman laser beams that are directed at an angle with respect to the optical lattice; the required amount of the Raman laser light is substantially smaller than in existing schemes. The resulting band structure supports edge states in the spin variable whose dynamics should be observable through spin-sensitive density measurements. — JS

*Phys. Rev. Lett.* 112, 043001 (2014).

#### POLICY

### Cooperating on Climate

We've come to expect lack of progress at the annual United Nations climate talks. A key obstacle to agreement is the wealth inequality among the countries around the negotiating table. Such public-goods negotiations, and the exploitation of common resources, are tricky enough on their own, but addressing the gap between "haves" and "have nots" adds another level of difficulty. Building on laboratory experiments and earlier theoretical work, Vasconcelos *et al.* use Evolutionary Game Theory models to explore how wealth inequality and risk perception affect such negotiations, and address another key element, the homophily of parties; i.e., their tendency to align with others from the same wealth level. They found that if parties were willing to cooperate regardless of wealth levels, then some inequality among parties could actually lead to better cooperation, as the rich tend to contribute more and compensate for lower contributions from the poor. Contributions from the poor are still critical, though, and increased homophily, with limited cooperation across the wealth gap, can lead to collapse. Obstinate cooperative behavior, with a few poor countries cooperating with wealthier countries, can compensate for broader homophily. In addition to minimizing homophilic biases, the authors suggest that negotiations be portioned into smaller groups focused on local short-term targets for which uncertainty is relatively limited. — BW

*Proc. Natl. Acad. Sci. U.S.A.* 10.1073/pnas.1323479111 (2014).