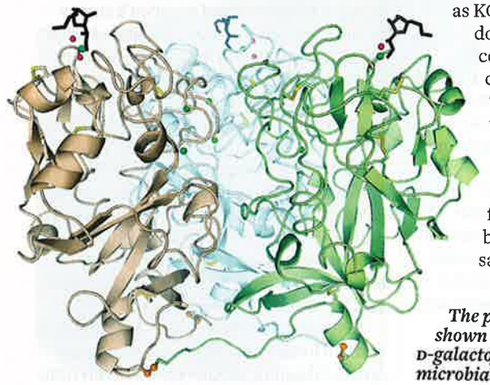
SPERM RNA MARKS MALE FERTILITY

Male fertility tests typically begin with measuring semen volume and the motility and overall shape of the subject's sperm. Yet even good-looking sperm sometimes can't get the job done. New research suggests infertility clinics may also want to assess the molecular contents of sperm to determine their fecundity, in particular the presence of 648 nucleotide sequences in sperm RNA (*Sci. Transl. Med.* 2015, DOI: 10.1126/scitranslmed.aab1287). A team of researchers led by Stephen A. Krawetz of Detroit's Wayne State University found that if these RNA elements were present in sperm, then basic, relatively noninvasive fertility treatments had a good chance of achieving a live birth. Specifically, if the sperm contained all of these RNA elements, couples who had intercourse at times selected to maximize fertility or who used intrauterine insemination had a 73% chance of achieving pregnancy. The authors argue that if sperm doesn't have all of these RNA elements, then the sperm probably cannot successfully achieve ovum penetration and fertilization, which is required in less invasive fertility treatments. It might be wiser for those couples to resort to more sophisticated and invasive techniques such as in vitro fertilization, the authors suggest.—SE

HUMAN LECTIN BINDS MICROBIAL GLYCANS

The cells of microbes and their mammalian hosts are decorated with glycans that can be read by carbohydrate-binding proteins known as lectins. By using microarrays with synthetic and microbial glycans, Laura L. Kiessling of the University of Wisconsin, Madison, and coworkers show that one such protein, human intelectin-1, exclusively binds microbial glycans instead of mammalian glycans (*Nat. Struct. Mol. Biol.* 2015, DOI: 10.1038/nsmb.3053). In particular, intelectin-1 binds the sugar β-linked D-galactofuranose (β-Gal*f*) and other microbial glycans. The researchers solved a crystal structure of intelectin-1 bound to β-Gal*f*. The structure reveals that the protein uses a bound calcium ion to form a bridge between the protein and a terminal 1,2-diol group on the glycan. The protein also interacts with other 1,2-diol-containing microbial carbohydrates, including phosphoglycerol and compounds known as KO and KDO. But the protein doesn't bind to sialic acid, a sugar commonly found in human glycans that also contains a 1,2-diol. Thus, human intelectin-1 is able to distinguish between microbial and human glycans despite structural similarities. Such ligand selectivity points to a role for human intelectin-1 in microbial surveillance, the researchers say.—CHA

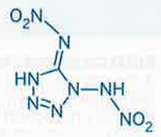


NAT. STRUCT. MOL. BIOL.

The protein human intelectin-1, shown here bound to allyl-β-linked D-galactofuranose (line structure), binds microbial, but not mammalian, glycans.

NEW EXPLOSIVE PACKS A WALLOP

In their quest for environmentally friendly but potent explosives, scientists have synthesized one of the most powerful nonnuclear explosives yet (*Angew. Chem. Int. Ed.* 2015, DOI: 10.1002/anie.201502919). Thomas M. Klapötke, Dennis Fischer, and Jörg Stierstorfer of Ludwig Maximilian University, in Munich, prepared the compound, 1,5-di(nitramino)tetrazole, a member of the 1-nitraminotetrazole family. Scientists had predicted that this molecule would have extraordinary explosive properties. Indeed, the authors found that it is so sensitive to friction and impact that it may be too difficult to use safely. However, they also synthesized a number of metal salts of 1,5-di(nitramino)tetrazole. All of the compounds are extremely impact sensitive, on par with lead azide. But the dipotassium salt is stable up to 240 °C. The authors say this potassium salt could be an environmentally benign and thermally stable initiating explosive. It could also be used instead of other explosives such as tetrazene, a common nitrogen-rich explosive that is toxic.—EKW



1,5-Di(nitramino)tetrazole

DECODING LITHIUM-ION CONDUCTIVITY IN SOLIDS

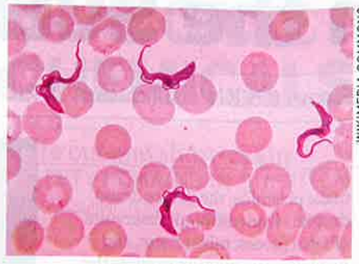
Rechargeable lithium-ion batteries power nearly all of today's electricity-hungry portable gadgets and tools. Although they boast extreme reliability, the cells' flammable liquid organic electrolyte solution poses a minute but potentially serious hazard. Nonflammable solid electrolytes would be ideal substitutes for the liquids. But suitable replacements have remained elusive because most solids are weak Li-ion conductors. Mixtures of Li_4SiO_4 and Li_3PO_4 are the exception. Compared with the pure components, some mixed compositions exhibit a jump of three orders of magnitude in ionic conductivity. But until now, the phases and their compositions have not been examined in detail, and the conductivity mechanism has not been understood. So a team led by materials chemist M. Saiful Islam of England's University of Bath applied NMR, electrochemistry, and computational techniques to address those issues, a key step toward making new types of batteries (*J. Am. Chem. Soc.* DOI: 10.1021/jacs.5b04444). The team found that mixed lithium phases with silicate-to-phosphate ratios of 0.25:0.75 and 0.5:0.5 are among the top solid Li-ion conductors. They also found that Li-ion diffusion proceeds via a concerted hopping motion of interstitial and lattice Li ions through three-dimensional networks, suggesting that increasing lithium disorder may further increase ion conductivity.—MJ

HOW TRANSCRIPTION FACTORS DEPART THEIR TARGETS IN CELLS

Binding of transcription factor proteins to genes is known to initiate gene transcription to mRNA and subsequent translation to protein. But the influences that cause transcription factors to detach from their gene targets in living cells are not as well understood. In vitro studies have shown that higher levels of free transcription factors in solution are associated with faster transcription factor release or faster exchanges of one for another. Peng Chen and coworkers at Cornell University have now used single-molecule assays to study this release and exchange process in living cells (*Nat. Commun.* 2015, DOI: 10.1038/ncomms8445). The study shows that higher concentrations of transcription factors in cells, like higher levels in vitro, are associated with faster unbinding of transcription factors from DNA. The free transcription factors either kick out or replace incumbent ones on DNA targets in cells, Chen explains. The study also shows that as chromosomes condense and become more compact, transcription factors detach faster. "Transcription factor-DNA complexes are essentially under mechanical tension," Chen says, "so changes in DNA tension from chromosome condensation help pop the regulators off DNA."—SB

NANOPARTICLES TARGET RESISTANT PARASITES

Drug therapies for the parasitic infection African trypanosomiasis, or sleeping sickness, have long had problems with high toxicity. These drugs must be administered in a hospital because of the likelihood of brain swelling and other reactions. In addition, many parasite strains have developed resistance by evolving altered transport proteins that keep the drugs out of their cells. But Spanish scientists may have discovered a way to address both problems with a novel formulation of the antiparasite drug pentamidine (*PLOS Pathog.* 2015, DOI: 10.1371/journal.ppat.1004942). By preparing a pentamidine-loaded chitosan nanoparticle that enters the parasite through endocytosis instead of through membrane transport, a team led by the University of Granada's José A. Garcia-Salcedo was able to lower the curative dose of pentamidine in mouse models to 1% of the normal dose. Even mice infected with resistant parasite strains lived significantly longer when treated with the nanoparticles than with free pentamidine. "This is a very intriguing paper in which the formulation of an existing drug is altered to improve treatment rather than screening for new drug entities," says tropical disease pathologist James McKerrow of the University of California, San Diego.—JL



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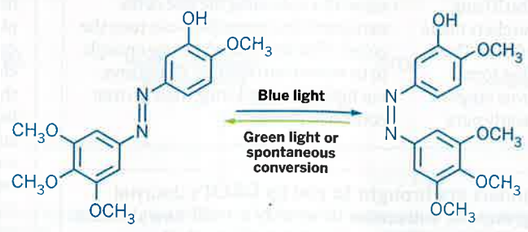
Trypanosoma brucei parasites, such as those shown in this SEM image (purple, about 20 μm long), caused more than 7,000 human cases of sleeping sickness in 2010.

LIGHT-TRIGGERED CHEMOTHERAPY

Although many small-molecule drugs target cancer cells' microtubules, these compounds often work at a patient's peril. That's because they don't distinguish between microtubules of cancer cells and healthy cells, resulting in serious side effects. Chemists have now come up with a strategy to target tumor cells selectively by using compounds that switch from an inactive form to an active conformation when exposed to light (*Cell* 2015, DOI: 10.1016/j.cell.2015.06.049). Dirk Trauner and Oliver Thorn-Seshold, of Ludwig Maximilian University, in Munich, spearheaded the development of the compounds, known as photostatins, or PSTs. PSTs' structures are based on that of the natural product combretastatin A-4. The researchers replaced the natural product's cis C=C with N=N so that it can be photoisomerized easily and reversibly with low-intensity visible light. In the presence of blue light, the PSTs adopt the active cis conformation. In the dark or in the presence of green light, the molecules switch to the trans form. Cell culture experiments show the cis form is 250 times as cytotoxic as the trans form. To treat patients, the researchers envision using light-equipped bandages for cancerous skin lesions and implantable light-emitting diodes for tumors within the body.—BH



***trans*-PST-1** ***cis*-PST-1**

PLUTONIUM'S SHIFTY GROUND STATES

Plutonium is arguably the most complex element in the periodic table. Early actinides behave like transition metals, and late actinides behave like lanthanides. But plutonium bridges the two, with physical properties reflective of both groups. A source of plutonium's curious and complex properties, at least for one of its six solid phases, is a superposition of electronic ground states, according to a neutron scattering study led by Marc Janoschek of Los Alamos National Laboratory (*Sci. Adv.* 2015, DOI: 10.1126/sciadv.1500188). To understand the basis of plutonium's properties, Janoschek and coworkers studied the δ phase of plutonium at ambient temperature and pressure. Confirming prior theoretical work, they found that δ-Pu fluctuates among $5f^6$, $5f^5$, and $5f^4$ states by delocalizing one or two valence electrons into the conduction band. The states have lifetimes of about 0.015 picoseconds. The results explain why plutonium's expected magnetism hasn't been observed experimentally: The $5f^4$ and $5f^5$ states are magnetic, but $5f^6$ is nonmagnetic. Also, the various states yield different ion sizes that contribute to plutonium's large volume changes—as much as 25%—in response to small temperature shifts.—JK