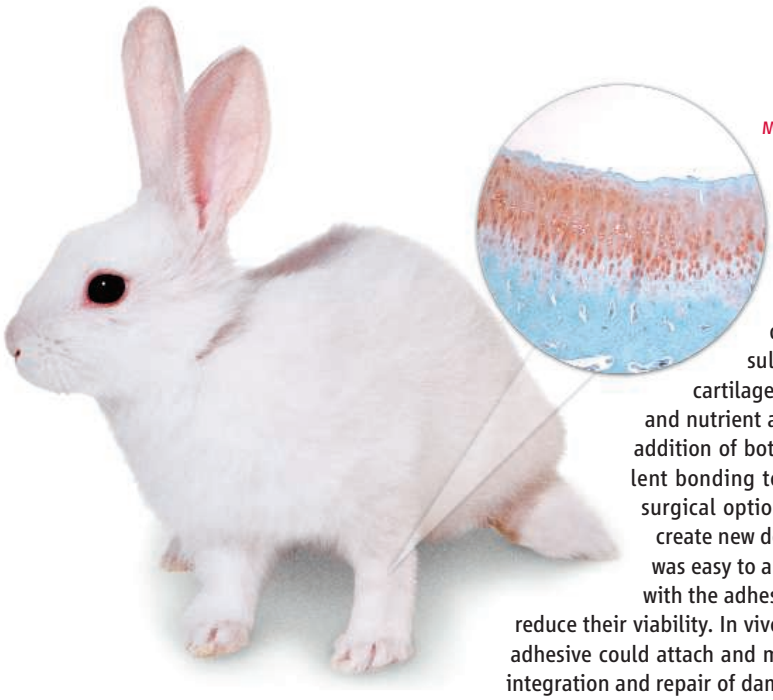


MATERIALS SCIENCE

Superglues for Tissues

A long-standing issue in the development of regenerative tissues is their attachment and integration into the body. Adhesives for this purpose have often shown poor biocompatibility or insufficient bonding strength. Wang *et al.* have devised an adhesive based on the biopolymer chondroitin sulfate (CS), a major component of the extracellular matrix of cartilage. CS has shown anti-inflammatory activity, and aids in water and nutrient absorption as well as wound healing. The CS was modified by addition of both a methacrylate and an aldehyde group, allowing for covalent bonding to both a biomaterial scaffold and a tissue surface. Current surgical options for grafting onto cartilage use sutures or tacks and thus create new defects in the tissue. In vitro tests showed that the CS adhesive was easy to apply and did not damage the cartilage tissue. Contact of cells with the adhesive in either the native tissue or a biomaterial matrix did not reduce their viability. In vivo experiments in mice, rabbits, and goats showed that the CS adhesive could attach and mechanically reinforce a cell-seeded hydrogel, and aid in the integration and repair of damaged tissue (shown above left for a rabbit). — MSL

Nat. Mater. **6**, 385 (2007).

BIOTECHNOLOGY

Straining Pathogen Sequences

Several methods have been explored as platforms for the rapid detection of infectious pathogens, including mass spectrometric analysis of amplified nucleic acid sequences and several microarray schemes. Most of these assays have been tested against a small subset of pathogens, and often do not resolve pathogen subtypes or have the ability to identify emerging strains.

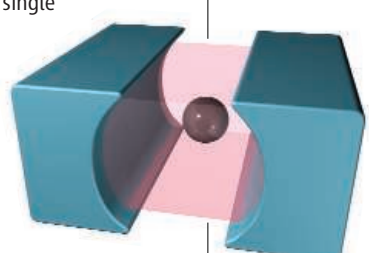
Lin *et al*. tested a microarray, the respiratory pathogen microarray version 1 (RPM v.1), against 424 nasal wash samples collected from military personnel in the Washington, DC, area from December 2004 to February 2005 (influenza season). Human DNA and RNA were removed from these samples before carrying out a single amplification step for viral and bacterial pathogen sequences and subsequent hybridization against 20 pathogens (some of which are represented by more than one strain). Software-based reassembly of incomplete or disconnected sequences improved the identification of pathogens, with an accuracy >98% compared to independent reference assays. In the 58 specimens that contained multiple pathogens, an increase was seen in bacterial colonizers when viral infection was present. In 250 of the samples positive for influenza A, nucleotide variations in the hemagglutinin gene were identified that allowed a phylogenetic tree of strain evolution to be assembled. In 14% of the samples, pathogens were not identified, even though the patients had flu-like symptoms; this finding likely reflects the underrepresentation of rhinovirus and enterovirus sequences in the microarray tiles. — PDS

PLoS ONE **2**, e419 (2007).

APPLIED PHYSICS

Reversible Atomic Memories

A key requirement for quantum information processing applications such as quantum communication or computation is the ability to reliably store, manipulate, and retrieve a piece of information, encoded, for example, in the polarization state of a single photon. Among the many routes presently being explored to achieve these goals is cavity quantum electrodynamics (c-QED), which entails trapping a single atom in a cavity and inducing it to interact with a single photon. In this vein, Boozer *et al.* show that they are able to imprint the state of a single photon onto a single trapped Cs atom, store it for an appreciable fraction of the lifetime of the atom in the trap, and then retrieve that information again sometime later in the form of another photon and send it on its way. They verify that the whole process is coherent, providing further support for c-QED–based systems as promising candidates for nodes in a quantum information processing network. — ISO



A cavity trap.

Phys. Rev. Lett. **98**, 193601 (2007).

CHEMISTRY

Boron Swap

In boron neutron capture therapy, the radioactive decay induced by neutron collisions with ^{10}B nuclei is channeled toward tumor destruction. Implementation of the technique remains challenging because of the need to devise boron compounds that selectively concentrate in tumors while remaining relatively nontoxic overall. Moreover, ^{10}B is one-fourth as abundant as the heavier ^{11}B isotope, which is inert to neutron bombardment. Thus, synthetic routes to various candidate molecules are hampered by the need for isotopic enrichment.

In a step toward improved efficiency, Yinghuai *et al.* have found that ruthenium nanoparticles can catalyze the isotopic exchange of boron atoms from excess $^{10}B_2H_6$ to the larger $B_{10}H_{14}$ cluster. They prepared the catalyst by reduction of a metallocene precursor in a biphasic mixture of ethylene glycol and a trialkylphosphonium ionic liquid (chosen because imidazolium systems can poison the catalysis). After six successive treatments of the decaborane with the catalyst and diborane, combined Raman and mass spectral analysis were consistent with ~90% ^{10}B enrichment of the larger cluster. The mechanism is as yet unresolved. — JSY

J. Am. Chem. Soc. **129**, 6507 (2007).

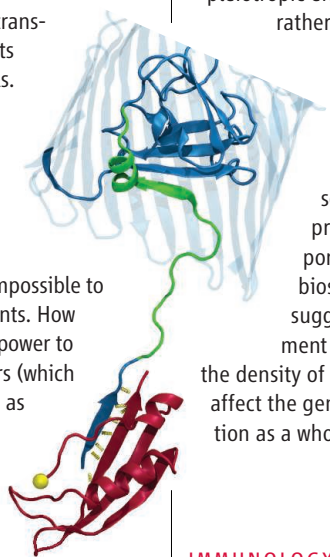
Continued on page 1101

Continued from page 1099

BIOCHEMISTRY

Pulling on a Trailor Hitch

Building transmembrane gradients of small molecules, such as protons and alkali metal ions, is the job of ion-transporting enzymes, which convert adenosine triphosphate into an electrochemical potential; this stored energy is then used by coupled transporters for the import of nutrients and the export of waste materials. Gram-negative bacteria feature inner and outer membranes. Members of the porin family of membrane proteins reside in the outer membrane and allow small molecules to pass across freely, but this makes it impossible to establish electrochemical gradients. How then do these bacteria transmit power to the outer-membrane transporters (which collect essential substances such as vitamin B_{12} and chelated iron)?



Pulling (at the yellow ball) on TonB (red) begins to unravel the BtuB plug (green/blue).

Using steered molecular dynamics (for more, see Sotomayor and Schulten, Reviews, this issue, p. 1144), Gumbart *et al.* have looked at the interaction between the barrel-like outer-membrane protein BtuB (the vitamin B_{12} transporter) and the inner-membrane protein TonB, which is known to provide the energy that drives the inward transport of many substrates across the outer membrane. They start from a configuration that is based on the crystal structure of a TonB fragment in complex with the TonB-binding region of BtuB, and find that pulling (computationally) on the TonB portion does not distort it. Furthermore, through a network of hydrogen bonds oriented perpendicularly to the direction of applied force, TonB holds tightly to one end of the BtuB lumenal domain, which plugs the barrel. Pulling harder begins to unfold the plug and loosens it enough to allow vitamin B_{12} to squeeze by, but the simulated forces are somewhat higher than experimental measurements of what it takes to unravel a protein. — GJC

Biophys. J. **92**, 10.1529/biophysj.107.104158 (2007).

GENETICS

Love Thy Neighbor

Genes not only direct the expression of traits (phenotype) in an individual, but can also influence the phenotypes of neighbors. Mutic and Wolf have examined quantitative trait loci (QTL) governing size, growth, and fitness in *Arabidopsis* and whether they affect an individual directly as well as its neighbors indirectly. Of 15 QTL in the former category, they found that 13 showed indirect effects on the expression of traits in nearby plants. Unexpectedly, most of the pleiotropic effects were positively correlated rather than opposite in sign, as might have been expected on the basis of competition for resources. Facilitative or mutualistic relationships could involve interplant signaling, and several of the loci did map in the proximity of genes encoding components in the ethylene and auxin biosynthetic pathways. These results suggest that for plants, the environment in which they grow, especially the density of conspecific individuals, may affect the genetic composition of the population as a whole. — LMZ

Mol. Ecol. **16**, 10.1111/j.1365-294X.2007.03259x (2007).

IMMUNOLOGY

Selecting the Thymic Rank and File

During their passage through the thymus, developing T cells are selected on the basis of their capacity to recognize foreign antigens while remaining tolerant of the body's own constituents. This is achieved in part through interacting (in the thymic medulla) with specialized epithelial cells that offer up small samples of self proteins whose expression is largely restricted to other tissues. This supplemental expression of the self proteins is regulated by the transcription factor Aire and contributes to preventing autoimmunity.

Rossi *et al.* used organ cultures derived from fetal mouse thymus to ascertain that hematopoietic cells already known to induce peripheral lymphoid tissue, and aptly named lymphoid tissue inducing (LTi) cells, also regulate the development of a subset of medullary epithelial cells and their expression of Aire. This depended on the receptor activator nuclear factor–κB ligand (RANKL), and autoimmunity-like symptoms ensued after the transplantation of RANK-deficient thymus into athymic mice. Previous studies have reported that another tumor necrosis factor family member (lymphotoxin-α) is expressed in LTi cells and has similar effects, so resolving the contributions of each in regulating immunological tolerance will be of interest. — SJS

J. Exp. Med. **204**, 10.1084/jem.20062497 (2007).

CREDIT: GUMBART ET AL., *BIOPHYS. J.* **92**, 10.1529/BIOPHYS. J. 107.104158 (2007).

Reversible Atomic Memories

Science **316** (5828), 1099.
DOI: 10.1126/science.316.5828.1099c