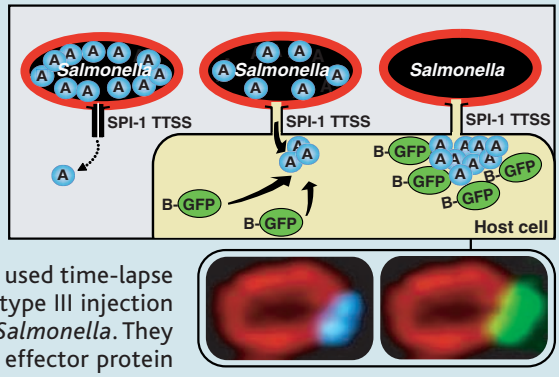
EDITORS' CHOICE

edited by Gilbert Chin

MICROBIOLOGY

In Living Color



Injection of SipA (blue) and detection by GFP-InvB (green).

Gram-negative bacteria, such as *Salmonella*, use a specialized secretion system (type III) to inject target eukaryotic cells with bacterial effector proteins that subvert the target cell's machinery and promote bacterial virulence. Schlumberger *et al.* have used time-lapse microscopy to follow in real time the type III injection of mammalian tissue culture cells by *Salmonella*. They observed the delivery of the bacterial effector protein SipA into the host cytosol using a green fluorescent protein (GFP) fusion to InvB (a binding partner of SipA) to measure the kinetics of arrival. Bacteria were mixed with mammalian cells, and individual bacterium-cell interactions were monitored to see how much SipA remained in the bacterium. After the initial attachment, effector protein was transported into the target cell over the subsequent 1 to 10 min, leaving the bacterium virtually devoid of SipA. The results vividly illustrate the efficiency of the type III secretion system, a key weapon in the establishment of a niche for bacterial multiplication. — SMH

Proc. Natl. Acad. Sci. U.S.A. **102**, 12548 (2005).

PSYCHOLOGY

An Unsteady State

Neuroticism has often been linked with instability, manifest as a tendency to worry excessively, to respond to similar situations in a variable fashion, or to cope poorly when emotionally stressed. What might be the neural mechanisms underlying the expression of this trait, and would they affect high- or low-level cognitive processes? Previous studies have begun to address the extent of trial-to-trial variation in neuronal firing rates and patterns, as well as the behavioral consequences of that variability.

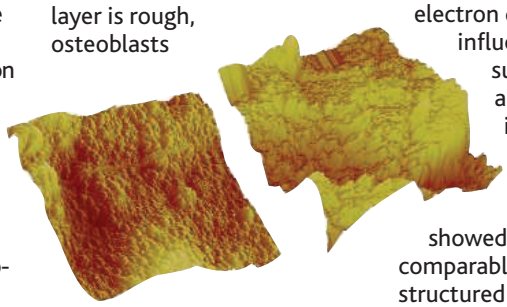
Robinson and Tamir have used a nested series of reaction time tasks—requiring (i) stimulus detection, (ii) stimulus detection and discrimination or (iii) stimulus detection and discrimination and response selection—and find that mean reaction time increases, as expected, over this series. In contrast, self-reported neuroticism did not correlate with mean reaction time but did correlate with the standard deviation of reaction time across all three tasks. They suggest that individuals scoring high on neuroticism, even though motivated or conscientious, may suffer from unreliable or inefficient low-level cognitive processing, which contributes to less stable and successful behavior. — GJC

J. Pers. Soc. Psych. **89**, 107 (2005).

MATERIALS SCIENCE

Capturing the Fine Details

Titanium has long been used as an orthopedic implant material because it is strong and relatively light. Many studies have shown in vitro that when the surface oxide layer is rough, osteoblasts (the bone-forming cells) deposit more calcium. However, these studies have not determined whether the enhanced activity is due to the surface roughness, crystallinity, crystal phase, or surface chemistry of the nanostructured material.



Atomic force microscopy of nanophase titania (left) and a PLGA replica (right).

Pallin *et al.* generated surface replicas using poly-lactic-*co*-glycolic acid (PLGA) to capture the roughness of conventional and nanostructured titania. In experiments with osteoblasts, both adhesion and proliferation were greater on the nanostructured titania and the PLGA replicas. The higher number of surface atoms, defects, and surface electron delocalizations may influence the initial cell-surface interactions and thus lead to the improved adhesion. An examination of samples from a bovine femur showed roughness values comparable to that of nanostructured titania, supporting the role of texture in affecting bone growth. — MSL

Nanotechnology **16**, 1828 (2005).

CHEMISTRY

Reviving Bohr Molecules

Before the Heisenberg-Schrödinger formulation of quantum mechanics, the semi-classical Bohr-Sommerfeld theory successfully accounted for quantized properties such as the energy levels in the hydrogen atom. However, the forcing of closed orbits for particle motion ran afoul of the uncertainty principle. Recently, the use of D scaling, in which the motion of each particle is described by a vector in D dimensions, was used to reintroduce the uncertainty principle to this earlier theory. When properly done, such equations reduce to the correct Schrödinger form for $D = 3$ but can still be solved in the more tractable $D \rightarrow \infty$ limit. This D scaling approach was applied successfully to atoms but did not yield bound states for molecules.

Svidzinsky *et al.* have developed a D scaling description that fully quantizes one of the angles describing the interelectron coordinates and properly weights the contribution of electron-electron repulsion. After application of a leading correction term in $1/D$, the potential energy curves for the lowest singlet, triplet, and excited states of H_2 are in good agreement with accepted values after minimal numerical calculation. The procedure also yields reasonable agreement for the ground state of BeH. — PDS

Phys. Rev. Lett. **95**, 080401 (2005).

NEUROSCIENCE

One Singular Sensation

While not everyone enjoys the zing that garlic imparts to culinary fare, a variety of cultures—dating back to the ancient Egyptians—have firmly believed that the herb

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CREDITS: (TOP) SCHUMBERGER *ET AL.*, *PROC. NATL ACAD. SCI. U.S.A.* **102**, 12548 (2005); (BOTTOM) PALLIN *ET AL.*, *NANOTECHNOLOGY* **16**, 1828 (2005)

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has extraordinary medicinal powers. Although its health benefits remain somewhat contentious, garlic is currently marketed as an alternative therapy for high blood pressure, high cholesterol levels, excessive blood clotting, and many other disorders. Garlic's pungent taste and odor are due to sulfur-containing components such as allicin, whose physiological mechanism of action has been unclear.

Bautista *et al.* and Macpherson *et al.* show that allicin activates an excitatory ion channel called TRPA1, which is expressed on sensory neurons involved in innervation of the skin, tongue, and other tissues, including vascular smooth muscle. Based on experiments with isolated rat arteries, Bautista *et al.* propose that allicin-induced excitation of these neurons causes release of peptides that mediate vasodilation, which could potentially explain garlic's effect on blood pressure. Interestingly, the TRP family of ion channels had previously been identified as the molecular target of ingredients in other spicy foods such as chili peppers, wasabi, and yellow mustard, suggesting that these compounds all activate a common pathway. — PAK

Proc. Natl. Acad. Sci. U.S.A. **102**, 12248 (2005); *Curr. Biol.* **15**, 929 (2005).

CHEMISTRY

Magnetic Catalysts

In the chemical synthesis of drugs, the route via homogeneous catalysis by metal complexes is plagued by the challenge of separating residual toxic metal from the product. Binding the catalyst to a heterogeneous support can simplify this purification step, but at the expense of reducing the mixing efficiency between catalyst and reagent.

Hu *et al.* have found a compromise by fusing a ruthenium catalyst to magnetite (Fe_3O_4) nanoparticles. The tiny particles mix efficiently with molecular reagents and would ordinarily be hard to remove by filtration, but by holding a small magnet to the flask, the authors can retain the catalyst and decant the product. The Ru complex, a variant of Noyori's binaphthyl-based asymmetric hydrogenation catalyst, was attached to 8-nm-diameter particles through a phosphonate group. A range of aromatic ketones were reduced quantitatively to alcohols at room temperature and 0.1 mol % catalyst loading, with enantiomeric excesses ranging from 77 to 98%, and the catalyst could be recycled 10 times without loss of activity. — JSY

J. Am. Chem. Soc. 10.1021/ja053881o (2005).

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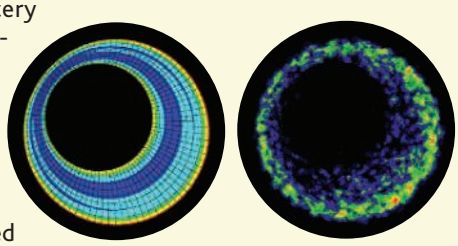
Geometry of Cell Proliferation

Localized differences in cell proliferation can help sculpt tissues during morphogenesis and produce the complex structures found in mature organisms. In some cases, however, changes in tissue structure occur before changes in cell proliferation. To show that geometry could itself feed back and regulate cell proliferation, Nelson *et al.* cultured bovine pulmonary artery endothelial cells on small fibronectin-coated islands surrounded by non-adhesive regions. Examination of cell growth on islands of different sizes and shapes—or on undulating surfaces—revealed distinctive and nonuniform patterns of proliferation. A finite element model predicted that cell proliferation would be greatest in regions of high mechanical stress; this was confirmed by culturing cells on a force sensor array that allowed traction forces to be measured directly. Pharmacological inhibition of Rho kinase, myosin light-chain kinase, or nonmuscle myosin II ATPase (to decrease tension generated through the cytoskeleton), or disruption of cadherin-mediated intercellular adhesions, attenuated gradients of cell proliferation, whereas expression of a constitutively active RhoA mutant enhanced them. — EMA



Cell proliferation (red, high; violet, low) in the model (left) and in the dish (right).

Proc. Natl. Acad. Sci. U.S.A. **102**, 11594 (2005).

CREDITS: NELSON *ET AL., PROC. NATL. ACAD. SCI. U.S.A.* **102**, 11594 (2005)

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