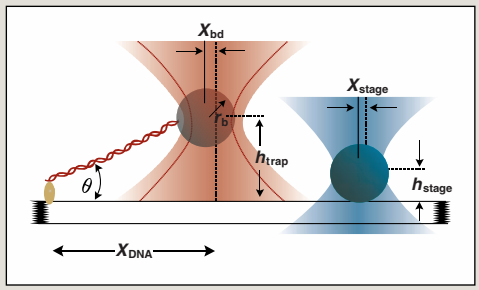
edited by Gilbert Chin

APPLIED PHYSICS

Tracking a Trap



Measuring stage motion in an optical trapping microscope removes mechanical drift.

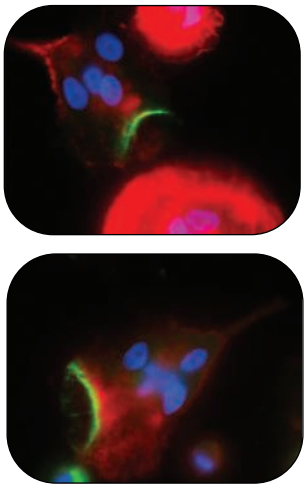
The movement of molecular motors along nucleic acids can be detected by imaging the fluorescence of single molecules or by following the movement of attached beads in optical traps. Both methods have resolution limits of 1 to 2 nm. For optical trapping, noise from Brownian motion can be decreased by time averaging, but the other source of noise, instrumental drift, cannot; and methods such as interferometry and back-focal plane detection have been used to combat this noise. Nugent-Glandorf and Perkins have developed a differential back-focal plane detection method that reduces instrument noise. They used two diode lasers, with wavelengths of 785 and 850 nm, to follow the motion of two 200-nm polystyrene beads stuck to the same glass coverslip; they also mechanically stabilized each beam to improve pointing stability. Both bead positions drifted several nanometers in 1 min, but the differential position drifted only 0.5 nm, and the resolution was better than 0.1 nm on the millisecond time scale. They could also follow apparent motion of 0.4-nm steps (equivalent to a one-base step along the DNA helix) by stepping one beam while leaving the other in place. — PDS

Opt. Lett. **29**, 2611 (2004).

CELL BIOLOGY

Metalloprotease, Migration, and Mitosis

The cell division cycle is controlled by the interplay of phosphorylation pathways and regulated proteolysis. McHugh *et al.* describe a new player involved in promoting mitotic progression—a metalloprotease they call invadolysin. Mutant *Drosophila* larvae lacking invadolysin display defects in nuclear and mitotic spindle morphology, and in addition exhibit abnormalities in the directed migration of germ cells. Invadolysin appears to act as a protease that degrades nuclear lamin proteins, whose disassembly is a key event at the beginning of mitosis. Generally, invadolysin is found localized in the cytoplasm in structures resembling invadopodia, which are found in invasive tumor cells munching their way through extracellular matrix. In migrating macrophages, invadolysin is concentrated at the leading edge, where it likely facilitates cell migration. — SMH



Invadolysin (green) accumulates at the leading edge of migrating macrophages (actin, red; DNA, blue).

J. Cell Biol. **167**, 673 (2004).

IMMUNOLOGY

How to Be a Good Host

In the middle of the past century, the Australian government took advantage of the species specificity of myxoma virus to control the spread of European wild rabbits, by then considered a pest. Although other poxviruses display specificity to varying degrees, it is not clear what influences host/virus compatibility.

Wang *et al.* observed that myxoma virus infection of primary mouse embryo fibroblasts, which are nonpermissive for replication of this virus, activated the kinase Erk1/2. In the presence of an Erk1/2 inhibitor or in cells with impaired Erk1/2 expression, viral replication increased, suggesting that this kinase normally represses this virus. Erk1/2 is linked with interferon regulatory factor 3, which in turn induces expression of type I interferons (IFNs). The possibility that these cytokines maintain the nonpermissive state induced by Erk1/2 activation is supported by the fact that cells unable to produce IFNs or the IFN-dependent transcription factor STAT-1 became susceptible to myxoma infection. Furthermore, STAT-1–deficient mice succumbed to inocula of the virus that had no effect on wild-type animals, raising the possibility that similar cellular mechanisms may govern species specificity of other poxviruses. — SJS

Nature Immunol. **5**, 1266 (2004).

MICROBIOLOGY

Same Genes, Distinct Lifestyles

The continuing efforts and accomplishments of genome sequencers have furnished the raw material for mapping networks of molecular interactions and pathway regulation. Winfield and Groisman use both this new kind of systems analysis and some tried-and-true molecular microbiology to show how homologous parts can evolve and be assembled in distinct ways.

In the *Salmonella enterica* PmrA/PmrB two-component system, PmrB senses high (0.1 mM) Fe and phosphorylates PmrA, which then activates transcription of genes that mediate resistance to the antibiotic polymixin; low (10 μM) Mg is sensed by the PhoP/PhoQ system, which generates PmrD, which then stimulates PmrA. In comparison, *Escherichia coli* carries homologs (amino acid identity 84 to 93%) of four of these proteins and of PmrD (55%) and can detect both low Mg and high Fe, but these pathways do not interact because PmrD does not talk to PmrA. Substituting the *S. enterica* version of *pmrD* restores communication and also the feedback inhibition of PmrA on *pmrD* transcription. Why does this matter? The *S. enterica* regulatory network involving PmrA supports virulence in mice, survival in soil, and colonization of chicken macrophages, and thus enables this bacterium to occupy a broader range of niches. — GJC

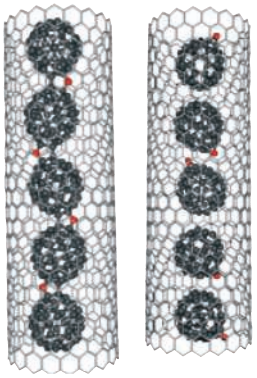
Proc. Natl. Acad. Sci. U.S.A. **101**, 17162 (2004).

PALEOCLIMATE

Drier Tropics, Wetter Poles

Earth's climate was noticeably warm during the Late Cretaceous, a time when dinosaurs and plants were found at polar latitudes. Climate models with enhanced greenhouse gases—notably CO_2 and water vapor—and increased poleward ocean circulation have not been able to simulate fully the high polar temperatures of that period. One possibility is that much more moisture generated by evaporation in the tropics may have been transported poleward than what occurs today. This process effectively transfers heat from the tropics to the poles, because evaporation consumes considerable heat whereas precipitation releases it. Ufnar *et al.* calculate the changes in precipitation and evaporation that could account for the anomalously warm climate and reproduce stable isotope data reflecting rainfall at that time. The data imply that, compared to today, the greenhouse climates of that time dried (decrease in precipitation minus evaporation) latitudes below 40° dramatically and increased precipitation at higher latitudes, resulting in a two- to threefold increase in latent heat tranport toward the poles. — BH

Geology **32**, 1049 (2004).



Forming a linear polymer (left) of $C_{60}O$ (oxygen, red).

CHEMISTRY

Polymerizing Peas in a Pod

When materials are introduced into the narrow interior of a carbon nanotube, the confinement can alter their properties; for example, by stabilizing crystal forms that are unstable in the bulk. Britz *et al.* show that confinement can also affect the reactivity of fullerene epoxide ($C_{60}O$) molecules that are lined up inside single-walled carbon nanotubes like peas in a pod, in a fashion similar to what has already been observed for fullerene (C_{60}). When the $C_{60}O$-containing nanotubes are heated for three days at 260°C, the $C_{60}O$ molecules form linear $(C_{60}O)_n$ chains connected via C–O–C bonds. In contrast, when heated under bulk conditions, $C_{60}O$ forms a tangled, branched, three-dimensional polymer. — JFU

Chem. Commun. 10.1039/b414247k (2005).

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Better Learning Without Channels

Nolan *et al.* conclude that a single type of ion channel can play different roles in learning and memory from their studies of mice lacking the HCN1 protein, a subunit of a channel that accounts for hyperpolarization-activated inward currents. HCN1-knockout mice exhibit motor learning deficits, but mice lacking HCN1 in forebrain neurons actually performed better than wild-type animals on a spatial memory task. Loss of the channel also enhanced long-term memory of how to perform the task. In the CA1 region of the hippocampus, enhanced low-frequency oscillations in neuronal activity were detected in the knockout animals. The pyramidal cells in this region integrate inputs that come from the entorhinal cortex (the perforant pathway) with those from the Schaffer collateral pathway. HCN1 channels are more abundant in the distal dendrites where perforant pathway inputs are localized, and loss of HCN1 preferentially enhanced postsynaptic responses to a single input from the perforant pathway. Similarly long-term potentiation was enhanced at these perforant path synapses. The authors propose that learning may be suppressed by HCN1 channels because they inhibit postsynaptic changes at distal dendrites that would otherwise result in synaptic plasticity. The loss of HCN1 changes the way in which pyramidal cells integrate incoming signals, enhancing responses to low-frequency waveforms and favoring responses to the distal rather than proximal dendrites. This may be particularly important for spatial learning and memory because CA1 pyramidal neurons are thought to compare sensory input from the perforant pathway with stored information from the CA3 region. — LBR

Cell **119**, 719 (2004).

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