Purifying X-ray Pulses

Static structural information on solids is now routinely obtained in exquisite detail using coherent x-rays at synchrotron facilities. Probing of the dynamics of structural and electronic phase transitions can also be achieved using pulses of x-rays on the relevant time scales—picosecond and femtosecond—but the generation of such x-ray pulses is not trivial and the techniques are still under development. The usual route to obtain pulses of light is to use a cavity, with the output period of the pulses on the order of the return transit time of the cavity. However, it has been difficult to control the phase of the cycling x-rays within the cavity, leading to incoherent pulses. Based on the principle of reflection and trapping within the cavity, but using diffraction from crystallographic planes of silicon, Chen et al. have developed a Fabry-Perot type of cavity for x-rays. They demonstrate the ability to maintain coherence and form standing waves within the cavity, obtaining promising results toward the goal of obtaining a high-brightness source of quasi-coherent x-ray pulses for probing the dynamics of structural and electronic transitions. — ISO


Catch, Kill, and Release

During the implantation or insertion of medical devices such as catheters, pathogenic microbes may be introduced into the patient. Once implanted, microbes may attach to the surface of the device to form a biofilm, a common cause of device failure. To overcome these problems, several strategies have been used to create coatings that are either antimicrobial or nonfouling. Cheng et al. now report a coating that combines both properties, switching from antimicrobial to nonfouling upon hydrolysis. Specifically, they apply a poly(methacrylate) derivative with cationic side chains that become zwitterionic upon conversion of a terminal ester to a carboxylate. Within 1 hour of exposure to the initially prepared coating, 99.9% of attached Escherichia coli bacteria were dead. Over the course of the next 2 to 8 days, the coating slowly hydrolyzed, releasing 98% of the dead microbial cells. The nonfouling nature of the hydrolyzed coating prevents further attachment of microbial cells and formation of a biofilm. By tuning the hydrolysis rate of the coating, it should be possible to adapt it to a range of applications in implantable medical devices. — JFU


Early Life Experiences

The decline of Columbia River salmon may be one sign of the human impact on fisheries, and it has been argued that some of the Columbia River dams should be removed in order to reduce the hazards encountered by salmon smolts as they make their way from the spawning grounds to the sea. In order to assess migration losses in the Thompson-Fraser (which is not dammed) and the Snake-Columbia (which is) river systems in North America, Welch et al. measured the survival rate of Chinook and steelhead smolts with implanted acoustic tags. Surprisingly, their data suggest that the survival rates of juvenile fish making these journeys are comparable; in fact, they are somewhat higher in the hydroelectric power–generating portion of the Columbia. Two corollaries to be examined are (i) whether the Fraser River imposes an unidentified toll on juvenile survival, and (ii) whether the transit through the systems of dams exacts a later cost in terms of ocean mortality. — LMZ


A Diversity of Consumers

The vulnerability of coral reefs to human interference has become only too apparent. Caribbean reefs in particular have been battered by climate change, overfishing, and the excessive growth of seaweed (macroalgae). In order to isolate a key factor that improves reef health even under environmental challenge, Burkepile and Hay corralled herbivorous parrotfish and surgeonfish, alone and in combination, in cages on reefs off the Florida Keys. The outcomes: No fish, and seaweed takes over; add two fish species, and the algae are kept under control and coral cover increases. Alongside ocean surgeonfish, the red-band parrotfish were particularly effective consumers of early algal colonizers because the surgeonfish removed the less abundant species of algae that the parrotfish found distasteful. Not all parrotfish were the same: Princess parrotfish preferred the mat-forming seaweed, and redbands grazed the taller species.

*Helen Pickersgill and Chris Surridge are locum editors in Science’s editorial department.

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These experiments underline the importance of grazer diversity to coral reef health, especially in the Caribbean. — CA


**BIOPHYSICS**

**Swimming in Sand**

Several species of lizard are capable of traveling for long distances beneath the surface of desert sands. Most have very reduced, or even absent, limbs and adopt a serpentine motion akin to the swimming of water snakes. In contrast, the sandfish lizard (*Scincus scincus*) of North Africa and the Arabian peninsula has well-developed limbs that it was assumed were held tightly against its body when moving through sand.

Baumgartner *et al.* used nuclear magnetic resonance imaging to observe sandfish movement directly and found that they actually propel themselves with their limbs. Unlike a swimming snake, which drives its near-stationary head forward with sinusoidal movements of its body that increase in amplitude toward its tail, the whole body of the sandfish underwent sinusoidal oscillations with a frequency of 3 Hz and an amplitude of around half its body length. The oscillations of the lizard’s body act to fluidize the surrounding sand, an effect well known to engineers dealing with granular media. Using a vibrating metal rod of similar dimensions to a sandfish, the authors confirmed that the resistance to motion through dry sand dropped dramatically when horizontal oscillations were faster than 2.5 Hz. Within this localized volume of fluidized sand the sandfish swims by paddling its fore and hind limbs in synchrony with the flexing of its body. — CS*


**DEVELOPMENT**

**Giving a Twist to Twist**

Cells initiate and are subject to a great many morphogenetic movements—such as migration, stretching, and invagination—during early embryogenesis. The mechanics at play when cells shuffle around may serve not only to get them to the right place at the right time but also to regulate gene expression.

Desprat *et al.* tested this idea using physical means to mimic deformation forces during early gastrulation in *Drosophila*. In wild-type embryos, the expression of Twist increases when stomodeal cells are compressed during germ band extension. After experimentally eliminating the natural compressing forces by ablating the most dorsal cells, the authors mechanically perturbed the embryos either by using a needle to create a 20-µm indentation or by using magnetic tweezers to apply a force of 60 nN to a ferrofluid injected just before cellularization (and then captured by the newly formed anterodorsal cells). At the molecular level, reproducing stomodeum compression via these mechanical manipulations resulted in the nuclear localization of Armadillo, which led to elevated Twist expression that in turn was necessary for differentiation of the fly midgut. These results demonstrate the potential that the experimental manipulation of tissue deformation holds for the study of molecular and physiological responses. — BAP


**CELL BIOLOGY**

**Talking About Stress**

Cells encounter many different forms of stress and have evolved a variety of methods to deal with them. They tackle relatively minor stresses, such as excessive heat or insufficient oxygen (hypoxia), by forming cytoplasmic stress granules, which prevent the accumulation of defective proteins that can irreparably damage the cell. However, some stresses, including x-rays and DNA-damaging agents, are insurmountable, and the cell acknowledges defeat by killing itself in a process called apoptosis. This is triggered via the intracellular signaling cascades known as the stress-activated p38 and JNK MAPK (SAPK) pathways. Whether and how these two mechanisms of stress management are connected was unknown.

Arimoto *et al.* find that the formation of stress granules in response to minor stresses specifically inhibits the SAPK-mediated cell death response, indicating a connection between the two pathways. They found that the signaling scaffold protein RACK1 is required for the apoptotic response by binding directly to a protein in the SAPK pathway. However, during minor stresses RACK1 becomes sequestered within the cytoplasmic stress granules, thereby inhibiting apoptosis. The authors also showed that when cells are exposed to both types of stresses simultaneously, SAPK-mediated apoptosis is blocked. This mechanism of cross talk between two stress-management pathways could explain in part why cancer cells, which live under the constant minor stress of hypoxia, are resistant to apoptosis induced by radiotherapy and chemotherapy. — HP*

Early Life Experiences
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Science 322 (5902), 651.
DOI: 10.1126/science.322.5902.651c