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## PSYCHOLOGY

## Training “fluid intelligence”

General intelligence, some psychologists maintain, is separable into “fluid” and “crystalline” components. An individual solving a variety of problems brings the same amount of fluid intelligence to bear on all problems, whereas crystalline intelligence is task-specific. Researchers have generally thought it impossible to increase fluid intelligence by training, except by practicing the tests themselves. Susanne Jaeggi *et al.* now report that a regimen of exercises designed to improve working memory also improves fluid intelligence. In four parallel experiments, subjects were first given a standard test of fluid intelligence in which they were asked to find and correctly match patterns in sets of images. They were then given a series of training exercises designed to improve working memory. The training was repeated for 8, 12, 17, or 19 days, after which the authors administered a second test of fluid intelligence. Although the performance of untrained controls improved slightly, the trained subjects showed significant improvement. Furthermore, the improvement appeared to increase linearly with training time. The authors say that the training exercises strengthened multiple “executive processes” that function in problem-solving. — K.M.

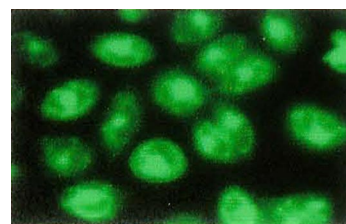
“Improving fluid intelligence with training on working memory” by Susanne M. Jaeggi, Martin Buschkuhl, John Jonides, and Walter J. Perrig (see pages 6829–6833)

## BIOCHEMISTRY

## The lung cancer enablers

Jong-Heum Park *et al.* illuminate one of the three pathways by which polycyclic aromatic hydrocarbons (PAHs) can be activated, showing for the first time the specific pathway for oxidative damage in human lung cells. Until now, research has focused on “bulky” DNA adducts derived from diol-epoxides. The authors demonstrated, using the lung adenocarcinoma cell line A549 (known to express aldo-keto reductase, or AKR, isoforms), that both cell extracts and intact cells were capable of activating the PAH *trans*-dihydrodiol. Using a fluorescent dye, they detected formation of reactive oxygen species in the nuclei

of A549 cells treated with both B[a]P-7,8-*trans*-dihydrodiol and B[a]P-7,8-dione. Their analysis showed that the cellular environment became significantly more oxidative in treated cells. Park *et al.* used a comet assay to detect 7,8-dihydro-8-oxo-2'-deoxyguanosine, a marker of oxidative damage to DNA, and showed that levels of this marker are increased in treated cells. Previous clinical and epidemiological studies have suggested that AKR expression is positively correlated with lung cancer progression. The authors say that AKRs increase the formation of mutagenic oxidative DNA lesions, enabling PAHs to act as carcinogens. — K.M.



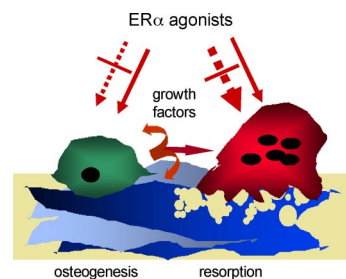
B[a]P-7,8-dione causes formation of reactive oxygen species.

“Evidence for the aldo-keto reductase pathway of polycyclic aromatic *trans*-dihydrodiol activation in human lung A549 cells” by Jong-Heum Park, Dipti Mangal, Kirk A. Tacka, Amy M. Quinn, Ronald G. Harvey, Ian A. Blair, and Trevor M. Penning (see pages 6846–6851)

## MEDICAL SCIENCES

## Estrogen-like molecule produced by osteoblasts

Sex steroid hormones play an important role in maintaining skeletal health and integrity. Physicians commonly prescribe estrogen for hormone-replacement therapy, to prevent osteoporosis and bone loss; however, many steroids can activate genes that may lead to certain types of cancer. Thomas McCarthy *et al.* found that osteoblasts—cells that build bone—produce a hormone-like molecule that has a restricted range and effect. The authors isolated osteoblasts from fetal rat bone and observed that the cells initially



ER $\alpha$ -dependent changes in osteoblast gene expression.

expressed little functional sex steroid receptor or hormones. However, after 3 weeks in culture, the osteoblasts secreted an endogenous estrogen receptor (ER) agonist that reprised many aspects of the hormone's activity. The as-yet-unnamed molecule drove gene expression through genetic estrogen-sensitive response elements and activated Runx2, a transcription factor necessary for osteoblast differentiation. The authors suggest that clinical use of this agonist, which is chemically and physically distinct from estrogen, may provide an alternative to standard therapies and aid in maintaining skeletal integrity, combating the effects of aging, and treating related metabolic disorders. — F.A.

*“Expression of an estrogen receptor agonist in differentiating osteoblast cultures”* by Thomas L. McCarthy, Mary E. Clough, Caren M. Gundberg, and Michael Centrella (see pages 7022–7027)

## MEDICAL SCIENCES

### Mending the dystrophin-deficient heart using sildenafil

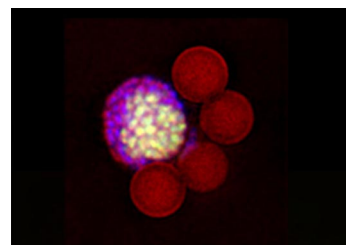
In Duchenne muscular dystrophy, dystrophin, which links the cytoskeleton of muscle cells to the sarcolemma, is mutated. This defect weakens the sarcolemmal membrane and causes progressive muscle degeneration. Meanwhile, neuronal NO synthase, normally found at the sarcolemma, is displaced to the cytoplasm, resulting in reduced levels of NO signaling that are thought to underlie associated cardiac failure. Downstream of normal NO signaling, cGMP relaxes the smooth muscle to widen blood vessels, but cGMP also acts by other avenues. M. Khairallah *et al.* show that enhancing cGMP signaling in a mouse model of Duchenne muscular dystrophy has major beneficial effects on heart contractility, metabolism, and cellular integrity. The authors examined cGMP signaling from two angles: genetic and pharmacological. They generated *mdx* mice with cardiomyocyte-specific overexpression of constitutively active guanylyl cyclase. Transgenic mice maintained normal cardiac function, sarcolemmal integrity, and mitochondrial function, even with aging and disease progression. Sildenafil (which inhibits cGMP breakdown), given at doses comparable to those used to treat erectile dysfunction in humans, also reduced signs of cardiomyopathic disease progression and cardiac cell damage. The authors suggest that cGMP may exert its beneficial effects by modulating mitochondrial function and may thus constitute a novel therapeutic to prevent or delay the onset of dystrophin-related cardiomyopathy. — K.M.

*“Sildenafil- and cardiomyocyte-specific cGMP signaling prevents cardiomyopathic changes associated with dystrophin deficiency”* by M. Khairallah, R. J. Khairallah, M. E. Young, B. G. Allen, M. A. Gillis, G. Danialou, C. F. Deschepper, B. J. Petrof, and C. Des Rosiers (see pages 7028–7033)

## MICROBIOLOGY

### Fishing for deep-sea methane eaters

Metagenomic sampling of the earth's harshest environments yields no shortage of information about the diversity and identity of the microbial life thriving there. One example is microbial partnerships, such as clusters of deep-sea organisms that form methane sinks, which reduce the amount of greenhouse gases in the atmosphere. Annelie Pernthaler *et al.* report a two-step technique that captures microorganisms directly from the environment, allowing researchers to better understand the pervasiveness of



Capture of sediment with paramagnetic beads (red).

such partnerships in nature. The authors used the method to purify syntrophic, anaerobic, methane-oxidizing ANME-2c archaea and associated methane-rich sediment from a deep-sea basin near the California coast and bathed the cells in a fluorescent DNA targeting ANME-2c. The fluorescently tagged cells were then selectively extracted from the sediment, and the purified archaea's genetic material was analyzed by using PCR and microscopy. The authors found four species of bacteria—three more than were previously thought to associate with ANME-2c. DNA sequencing revealed genetic hints of nitrogen fixation by ANME-2c, which was confirmed experimentally by isotope tagging. The interconnectedness of this community's metabolism also sheds light on the role aquatic microbes play in limiting oceanic emissions of methane, according to the authors. — C.E.

*“Diverse syntrophic partnerships from deep-sea methane vents revealed by direct cell capture and metagenomics”* by Annelie Pernthaler, Anne E. Dekas, C. Titus Brown, Shana K. Goffredi, Tsegereda Embaye, and Victoria J. Orphan (see pages 7052–7057)