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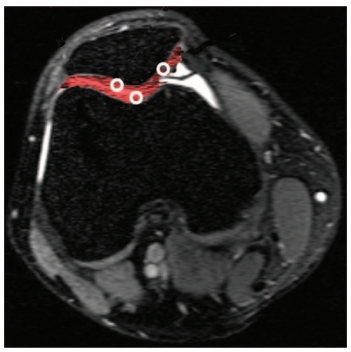
In This Issue

APPLIED PHYSICAL SCIENCES, MEDICAL SCIENCES

New spin on detecting osteoarthritis

As cartilage degrades with osteoarthritis, it loses molecules called glycosaminoglycans (GAGs). Measuring the concentration of GAGs in a host's tissue can indicate the progress of cartilage degeneration, but current methods only measure it indirectly and have other limitations. Wen Ling *et al.* developed a way to measure GAG concentration directly using magnetic resonance imaging (MRI), which could make it easier to diagnose and monitor degenerative joint conditions like osteoarthritis. Because GAG molecules have proton groups that are not tethered tightly, proton exchange in GAGs could allow concentrations of the molecule to be measured by MRI. Testing the idea in tissue samples, Ling *et al*. found that the available GAG protons provide an effective type of contrast enhancement, which they then implemented on a clinical MRI scanner. The authors suggest that modifying their method with a type of chemical exchange saturation transfer (gagCEST) could provide a noninvasive way to diagnose osteoarthritis at a very early stage, as well as identifying degenerative disc disease and defects in heart valves and the cornea. — T.H.D.



Glycosaminoglycan (GAG) concentration measured by MRI.

"Assessment of glycosaminoglycan concentration in vivo *by chemical exchange-dependent saturation transfer (gagCEST)" by Wen Ling, Ravinder R. Regatte, Gil Navon, and Alexej Jerschow* (see pages 2266–2270)

ENVIRONMENTAL SCIENCES

Broad decline in outdoor recreation

Regular contact with nature is known to perpetuate a love of the outdoors. However, researchers have found that people are participating less and less in all nature-based activities, which could lead to serious implications for biodiversity and conservation. To gauge participation in nature-based recreation, Oliver Pergams and Patricia Zaradic examined trends in visits to national parks in the United States, Japan, and Spain and U.S. state parks, as well as the number of hunting, camping, and hiking permits issued. The authors found that per capita visits are decreasing at a rate of just over 1% annually, continuing the downward slide that began in the 1980s and early 1990s. Since then, participation in these natural recreation activities has declined by 18–25%. Only day hikes, representing a small proportion of the U.S. visits, have increased. Pergams and Zaradic say that their result confirms that not only are a smaller proportion of people visiting national parks than in the past, but they are also participating less in other nature-based recreational activities. The authors suggest that with decreased contact with nature, current and future generations will likely have diminished interest in biodiversity and conservation issues, making such efforts more likely to fail. The authors have previously suggested videophilia, a preference for media activities over nature activities, as the cause. They say that, regardless of its cause, they have identified a clear trend away from nature-based recreation. — P.D.

Videophilia may be a cause of the decline in nature participation.

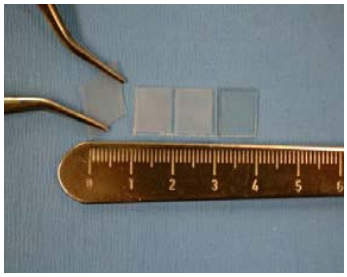
"Evidence for a fundamental and pervasive shift away from nature-based recreation" by Oliver R. W. Pergams and Patricia A. Zaradic (see pages 2295–2300)

APPLIED BIOLOGICAL SCIENCES

Gecko-inspired surgical adhesive

The legendary adhesive properties of the gecko's foot are known to come from nanoscale features of its tiny hairs. Researchers have long sought a synthetic mimic of gecko adhesion: tape that could be applied to hold cut tissue together until

it heals. The ideal adhesive would then biodegrade. However, previous studies have shown that gecko adhesion only works in dry conditions. Alborz Mahdavi *et al*. report a gecko-inspired, nanopatterned adhesive polymer that, though not hospital-ready, biodegrades and shows promise *in vitro* and in a rat model of hernia surgery. The polymer chosen by the authors, poly(glycercol sebacic acid acrylate), is also capable of being doped with drugs or growth factors to aid in healing. The authors cast the polymer, a sheet with conical pillars, on nanofabricated silicon molds and sought an optimum combination of feature dimensions and coating properties. Their results from pig intestine and living rat fascia show that aldehyde-functionalized dextran, which can form imine bonds with amine-bearing protein residues, doubles the shear force the polymer can withstand. In the range tested, the adhesive properties actually improve as the pillars become sparser. The authors suggest that the pillars dig into the tissue and induce it to conform, rather than increasing "contact line splitting," as do gecko hairs. — K.M.



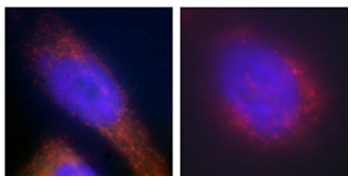
Gecko tissue tape from *in vivo* experiments.

"A biodegradable and biocompatible gecko-inspired tissue adhesive" by Alborz Mahdavi, Lino Ferreira, Cathryn Sundback, Jason W. Nichol, Edwin P. Chan, David J. D. Carter, Chris J. Bettinger, Siamrut Patanavanich, Loice Chignozha, Eli Ben-Joseph, Alex Galakatos, Howard Pryor, Irina Pomerantseva, Peter T. Masiakos, William Faquin, Andreas Zumbuehl, Seungpyo Hong, Jeffrey Borenstein, Joseph Vacanti, Robert Langer, and Jeffrey M. Karp (see pages 2307–2312)

MEDICAL SCIENCES, ENGINEERING

Targeted nanoparticle drug delivery

The merits of targeted delivery for toxic drugs like chemotherapeutics are undisputed. However, targeted nanoparticles (NPs) that carry the drugs to a specific destination must confer molecular specificity, evade the host's immune system, and release the drug in a timely manner. Each of these properties often comes at the expense of the others, making it difficult to craft the perfect particle. The current state-of-the-art in nanoparticle design is accomplished by encapsulating the drug in a particle and then coating it with targeting molecules and "stealth" polymers that help it avoid immune surveillance. These surface modifications are rarely reproducible, making them unsuitable for medical needs. To overcome these issues, Frank Gu *et al*. developed self-assembling NPs that share highly similar biophysicochemical properties. The authors tested the targeted NP on human prostate cancer cells and demonstrated efficient uptake *in vivo* and *in vitro*. — B.T.



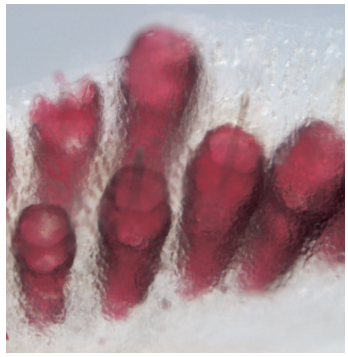
Early (*Left*) and late (*Right*) A10 aptamer uptake in nanoparticles. Cell nuclei in blue.

"Precise engineering of targeted nanoparticles by using self-assembled biointegrated block copolymers" by Frank Gu, Liangfang Zhang, Benjamin A. Teply, Nina Mann, Andrew Wang, Aleksandar F. Radovic-Moreno, Robert Langer, and Omid C. Farokhzad (see pages 2586–2591)

MEDICAL SCIENCES

TIF1α keeps artery calcium under control

Elderly human patients with Mönckeberg's disease exhibit calcification of medium- and small-diameter arteries. These symptoms are similar to those that Mihaela Ignat *et al.* now report in TIF1α knockout mice, thus making the strain a potential model of the human disease. The authors initially noted that TIF1α knockout induced liver tumors and only later found the arterial calcification in a wider tissue screen. Pathological calcification begins in TIF1$\alpha^{-/-}$ mice between 2 and 3 months of age. Hardening is particulary thorough in arteries supplying kidneys and skeletal muscles, although the authors also noted calcification in lung alveoli and in blood-containing capsules surrounding the whiskers. They report that blood calcium and phosphate levels were normal in mutant mice—calcium phosphate is the mineral responsible for hardening—further suggesting that the effect is mostly tissue-specific. When the authors conducted quantitative RT-PCR of kidney tissue, they found expression levels elevated for the calcium-sensing receptor gene *Casr* as well as for many other genes in the vitamin D signaling pathway. From previous work, the kidney is known to be a key target organ of vitamin D signaling, and abnormalities in the pathway can lead to pathological calcification. The authors suggest that TIF1α represses the vitamin D pathway. — K.M.



Pathological calcification of the blood-containing whisker capsules in TIF1$\alpha^{-/-}$ mice.

"Arterial calcifications and increased expression of vitamin D receptor targets in mice lacking TIF1α" by Mihaela Ignat, Marius Teletin, Johan Tisserand, Konstantin Khetchoumian, Christine Dennefeld, Pierre Chambon, Régine Losson, and Manuel Mark (see pages 2598–2603)