

- 10415 Better math for better brain images
- 10505 An ensemble of protein structures
- 10522 Clues to the solar system
- 10552 Why concrete creeps
- 10620 Induced chromosomal translocations
- 10638 Controlling gene expression

- 10706 Fire mitigation treatments need better planning
- 10712 Exiting the poverty trap
- 10734 A step toward an alternative to immunosuppression

NEUROSCIENCE, MATHEMATICS

Better math for better brain images

The internal mechanics needed to produce fMRI images—the colorful snapshots of functional brain activity—are largely made up of mathematical algorithms that process a massive stream of data. Ingrid Daubechies et al. explored why some algorithms work better for analyzing fMRI than others. Currently, the most effective results for paradigm-independent separation come from independent component analysis (ICA) algorithms. The authors tested whether these algorithms' emphasis on the independence of the data's components enabled their effectiveness. Comparing 2 commonly used ICA algorithms, the researchers found that InfoMax offered systematically better results than FastICA, but was far less selective for independence. The authors determined that sparsity, or separation in space of the brain patterns, plays a significant role in the effectiveness of the algorithm. To confirm the relative importance of sparsity over independence, the authors tested a third algorithm that had performed well in handling independence, and it performed less well in fMRI experiments. Daubechies et al. show that although InfoMax and FastICA are effective in fMRI studies, more powerful algorithms may need to be designed that emphasize the components' sparsity over independence. — T.H.D.

“Independent component analysis for brain fMRI does not select for independence” by I. Daubechies, E. Roussos, S. Takerkart, M. Benharrosh, C. Golden, K. D'Ardenne, W. Richter, J. D. Cohen, and J. Haxby (see pages 10415–10422)

APPLIED PHYSICAL SCIENCES, BIOPHYSICS AND COMPUTATIONAL BIOLOGY

An ensemble of protein structures

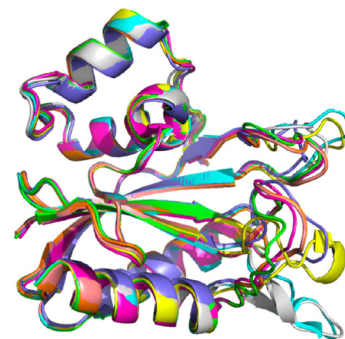
An increasing number of protein structural models in the publicly available Protein Data Bank (PDB) has led to a number of redundant submissions that present a snapshot of an enzyme or transcription factor at a particular conformational state. Prasad Burra et al. studied multiple models of identical proteins

in the PDB and derived the proteins' conformational states by clustering models with low root-mean-square deviations. The number of nonredundant pairs used in their analysis was

>220,000, and the proteins ranged in size from <100 amino acids to \approx 1,500 residues. The authors found that nearly all proteins have regions of high rigidity, where the structure varies little from model to model, and of high mobility, where fluidity and flexibility dominate. The extent of local flexibility typically correlated with the functional class of the protein.

Proteins that act like motors or transduce signals, for example, had a higher number of conformational states than enzymes or binding proteins. These results suggest that no single protein model can accurately represent the ensemble of conformations a protein can adopt, which belies the commonly held view that a protein's structure can be determined from its amino acid sequence, according to the authors. — F.A.

“Global distribution of conformational states derived from redundant models in the PDB points to non-uniqueness of the protein structure” by Prasad V. Burra, Ying Zhang, Adam Godzik, and Boguslaw Stec (see pages 10505–10510)



Variability in a protein's conformational state.

ASTRONOMY

Clues to the solar system

Isheyevo, an iron-rich chondrite that likely formed within the first million years of our solar system, contains a xenolith with pristine mineralogy similar to interplanetary dust particles. Giacomo Briani et al. found that the xenolith PX-18 contains a wide continuum of nitrogen isotopic variation, from very light to some of the heaviest ratios recorded from solar system material. The authors measured isotope ratios of hydrogen, car-

Fire mitigation treatments need better planning

Only 11% of National Fire Plan treatments are implemented near where people live and work, researchers have found. The result suggests that federal efforts are likely not effectively miti-



Smoke plume over Boulder, CO, from the 2003 Overland fire. Image courtesy of Kevin League.

gating the threat of wildfire to homes and people in the western United States. Tania Schoennagel et al. examined 44,000 fuels treatments (a type of controlled burning or forest thinning effort) applied between 2004 and 2008 and found that most of the treated areas were in forests and wildlands far from humans. The risk from forest fires is increasing due to expansion of humans into new, unprotected wildlands, warmer and drier summers, flammable invasive species, and the inability to prevent fires in at-risk lands not under federal control. Fire mitigation far from houses may have only small benefits, and is most effective near the wildland–urban interface. The authors suggest that better home construction, development planning, and cooperation and cost-sharing between government and private entities are the best ways to limit fire risks. — P.D.

“Implementation of National Fire Plan treatments near the wildland–urban interface in the western United States” by Tania Schoennagel, Cara R. Nelson, David M. Theobald, Gunnar C. Carnwath, and Teresa B. Chapman (see pages 10706–10711)

ENVIRONMENTAL SCIENCES

Exiting the poverty trap

Researchers report on a Chinese government program that may help decrease poverty while increasing environmental sustainability. The technique shows that financial incentives could allow people to escape the cycle of environmental degradation and poverty known as the “poverty trap.” Shixiong Cao et al. spent ≈\$1.4 million (USD) in Chinese government funding to promote sustainable development in China’s Fujian province. The authors worked with farmers in Changting County, which has been severely deforested and had erosion and biodiversity problems. The farmers received subsidies that compensated them for preserving trees and promoting ecosystem restoration by using coal instead of wood as fuel, developing methane generation, using organic fertilizer, planting fruit trees, and raising pigs and fish. After 8 years, the environment and socioeconomic conditions have improved more than in comparable towns, resulting in more biodiversity, vegetation, employment, and income. The authors say that when these subsidies end, the

farmers should be able to continue using the infrastructure and industry they have developed and not revert to destructive practices. The study shows how effective conservation policies that protect the livelihood of affected populations can potentially reduce poverty and preserve ecosystems, according to the authors. — P.D.

“Development and testing of a sustainable environmental restoration policy on eradicating the poverty trap in China’s Changting County” by Shixiong Cao, Binglin Zhong, Hui Yue, Heshui Zeng, and Jinhua Zeng (see pages 10712–10716)

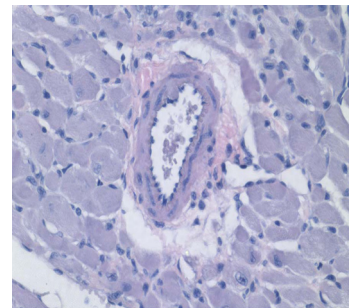


Government-paid farmers performing environmental restoration work.

IMMUNOLOGY

A step toward an alternative to immunosuppression

When organs are transplanted, immunosuppression is necessary to prevent the body from rejecting the foreign tissue, but lowering the body’s defenses weakens its ability to fight against pathogens. Costimulation blockade is an emerging alternative to immunosuppression: antibodies or fusion proteins are used to prevent costimulatory interactions between T cell and antigen-presenting cells. However, costimulation blockade has proven ineffective in preventing organ rejection in many transplantation models that are physiologically relevant to humans. Xueli Yuan et al. introduce another option that may restore the power of costimulation blockade. The authors worked with transcription factor T-bet knockout mice, which prevented differentiation into Th1 helper T cells. In cases where Th1 cells are weakened—as happens with immunosuppression—an amplified alloimmune response is driven by the cytokine IL-17. Blocking the interaction of Tim-1 with its ligand inhibited the secretion of IL-17 by T17 cells. T-bet knockout mice rejected transplanted organs faster than wild-type. The authors show that costimulation blockade is ineffective in T-bet knockouts unless blocking of Tim-1 is applied in parallel. A similar approach may help human patients, the authors say. — K.M.



Cardiac allograft in a knockout mouse treated with Tim-1.

“Targeting Tim-1 to overcome resistance to transplantation tolerance mediated by CD8 T17 cells” by Xueli Yuan, M. Javed Ansari, Francesca D’Addio, Jesus Paez-Cortez, Isabella Schmitt, Michela Donnarumma, Olaf Boenisch, Xiaozhi Zhao, Joyce Popoola, Michael R. Clarkson, Hideo Yagita, Hisaya Akiba, Gordon J. Freeman, John Iacomini, Laurence A. Turka, Laurie H. Glimcher, and Mohamed H. Sayegh (see pages 10734–10739)