November 24, 2015 | vol. 112 | no. 47 | 14397–14740

PNAS

Proceedings of the National Academy of Sciences of the United States of America www.pnas.org

Cover image: Pictured are adult mesenchymal stem cells grown in a methylacrylate polymer spot, one of thousands on a microarray used in combinatorial development of biomaterials. The Engineering of Biology and Medicine PNAS 100th Anniversary Special Feature, appearing in this issue, reviews the progress made in the past century in biological and medical engineering, along with challenges in the effort to improve quality of life through nanotechnology, biomaterials, immunotherapy, and other fields. See the Introduction to the Special Feature by Mark E. Davis and Robert Langer on page 14423. Image courtesy of Benjamin Larson (Harvard–MIT Health Sciences and Technology, Cambridge, MA).

From the Cover

14423 Engineering of Biology and Medicine

14415 *Xist* gene imprinting

14518 Potentially biogenic ancient graphite

14717 Neural responses in macaques

Contents

THIS WEEK IN PNAS

14397 **In This Issue**

LETTERS (ONLINE ONLY)

E6411 **Genetics of alcohol use disorders: Actin gets into the act**
Golo Kronenberg, Matthias Endres, and Karen Gertz

E6412 **Distinguishing phases of biomedical research is critical to improving health outcomes**
Kevin Fiscella

E6413 **Reply to Fiscella: The phases of biomedical research should be studied to optimize health outcomes**
Anthony Bowen and Arturo Casadevall

E6414 **Vaginal microbiota during pregnancy: Pathways of risk of preterm delivery in the absence of intrauterine infection?**
Jeffrey A. Keelan and Matthew S. Payne

E6415 **Reply to Keelan and Payne: Microbiota-related pathways for preterm birth**
Daniel B. DiGiulio, David K. Stevenson, Gary Shaw, Deirdre J. Lyell, and David A. Relman

Free online through the PNAS open access option.

NEWS FEATURE—*An in-depth look at trending science issues*

14399 **News Feature: How online studies are transforming psychology research**
Amber Dance

COMMENTARIES

14402 **Managing variance: Key policy challenges for the Anthropocene**
John M. Anderies
→ *See companion article on page 14384 in issue 46 of volume 112*

14404 **Predictive model of 3D domain formation via CTCF-mediated extrusion**
Galip Gürkan Yardımcı and William Stafford Noble
→ *See companion article on page E6456*

14406 **Advanced neuroendocrine prostate tumors regress to stemness**
Leigh Ellis and Massimo Loda
→ *See companion article on page E6544*

14408 **Imprinted X chromosome inactivation offers up a double dose of epigenetics**
Nora Engel
→ *See companion article on page 14415*

14410 **Penciling in details of the Hadean**
Christopher H. House
→ *See companion article on page 14518*

PNAS PLUS

14412 **Significance Statements**
→ *Brief statements written by the authors about the significance of their papers.*

INAUGURAL ARTICLE

14415 ***Xist* imprinting is promoted by the hemizygous (unpaired) state in the male germ line**
Sha Sun, Bernhard Payer, Satoshi Namekawa, Jee Young An, William Press, Jovani Catalan-Dibene, Hongjae Sunwoo, and Jeannie T. Lee
→ *See Commentary on page 14408*

THE ENGINEERING OF BIOLOGY AND MEDICINE PNAS 100TH ANNIVERSARY SPECIAL FEATURE

INTRODUCTION

14423 **The Engineering of Biology and Medicine**
Mark E. Davis and Robert Langer

PERSPECTIVES

14424 **Advancing biomedical imaging**
Ralph Weissleder and Matthias Nahrendorf

14429 **Synthetic biology devices for in vitro and in vivo diagnostics**
Shimyn Slomovic, Keith Pardee, and James J. Collins

14436 **Nanotechnologies for biomedical science and translational medicine**
James R. Heath

14444 **Progress in material design for biomedical applications**
Mark W. Tibbitt, Christopher B. Rodell, Jason A. Burdick, and Kristi S. Anseth

14452 **Regenerative medicine: Current therapies and future directions**
Angelo S. Mao and David J. Mooney

14460 **Smart nanosystems: Bio-inspired technologies that interact with the host environment**
Ester J. Kwon, Justin H. Lo, and Sangeeta N. Bhatia

14467 **Engineering opportunities in cancer immunotherapy**
Laura Jeanbart and Melody A. Swartz

PHYSICAL SCIENCES

APPLIED MATHEMATICS

E6456 **Chromatin extrusion explains key features of loop and domain formation in wild-type and engineered genomes**
Adrian L. Sanborn, Suhas S. P. Rao, Su-Chen Huang, Neva C. Durand, Miriam H. Huntley, Andrew I. Jewett, Ivan D. Bochkov, Dharmaraj Chinnappan, Ashok Cutkosky, Jian Li, Kristopher P. Geeting, Andreas Gnirke, Alexandre Melnikov, Doug McKenna, Elena K. Stamenova, Eric S. Lander, and Erez Lieberman Aiden
→ *See Commentary on page 14404*

14473 **Accurate estimation of influenza epidemics using Google search data via ARGO**
Shihao Yang, Mauricio Santillana, and S. C. Kou

14569 **Choosing experiments to accelerate collective discovery**
Andrey Rzhetsky, Jacob G. Foster, Ian T. Foster, and James A. Evans

14694 **Intrinsic excitability measures track antiepileptic drug action and uncover increasing/decreasing excitability over the wake/sleep cycle**
Christian Meisel, Andreas Schulze-Bonhage, Dean Freestone, Mark James Cook, Peter Achermann, and Dietmar Plenz

APPLIED PHYSICAL SCIENCES

E6416 **Direct force measurements reveal that protein Tau confers short-range attractions and isoform-dependent steric stabilization to microtubules**
Peter J. Chung, Myung Chul Choi, Herbert P. Miller, H. Eric Feinstein, Uri Raviv, Youli Li, Leslie Wilson, Stuart C. Feinstein, and Cyrus R. Safinya

14479 **Mapping transient electric fields with picosecond electron bunches**
Long Chen, Runze Li, Jie Chen, Pengfei Zhu, Feng Liu, Jianming Cao, Zhengming Sheng, and Jie Zhang

14484 **Self-assembly of smallest magnetic particles**
Sara Mehdizadeh Taheri, Maria Michaelis, Thomas Friedrich, Beate Förster, Markus Drechsler, Florian M. Römer, Peter Bösecke, Theyencheri Narayanan, Birgit Weber, Ingo Rehberg, Sabine Rosenfeldt, and Stephan Förster

14490 **Wetting and phase separation in soft adhesion**
Katharine E. Jensen, Raphael Sarfati, Robert W. Style, Rostislav Boltyanskiy, Aditi Chakrabarti, Manoj K. Chaudhury, and Eric R. Dufresne

14495 **Topological mechanics of gyroscopic metamaterials**
Lisa M. Nash, Dustin Kleckner, Alismari Read, Vincenzo Vitelli, Ari M. Turner, and William T. M. Irvine

14501 **Heterogeneous lamella structure unites ultrafine-grain strength with coarse-grain ductility**
Xiaolei Wu, Muxin Yang, Fuping Yuan, Guilin Wu, Yujie Wei, Xiaoxu Huang, and Yuntian Zhu

CHEMISTRY

14506 **Electrochemical evidence that pyranopterin redox chemistry controls the catalysis of YedY, a mononuclear Mo enzyme**
Hope Adamson, Alexandr N. Simonov, Michelina Kierzek, Richard A. Rothery, Joel H. Weiner, Alan M. Bond, and Alison Parkin

EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

14512 **Shifts in coral reef biogeochemistry and resulting acidification linked to offshore productivity**
Kiley L. Yeakel, Andreas J. Andersson, Nicholas R. Bates, Timothy J. Noyes, Andrew Collins, and Rebecca Garley

14518 **Potentially biogenic carbon preserved in a 4.1 billion-year-old zircon**
Elizabeth A. Bell, Patrick Boehnke, T. Mark Harrison, and Wendy L. Mao
→ *See Commentary on page 14410*

14522 **Dynamic response of desert wetlands to abrupt climate change**
Kathleen B. Springer, Craig R. Manker, and Jeffrey S. Pigati

ENGINEERING

14527 **Ultrasensitive gas detection of large-area boron-doped graphene**
Ruitao Lv, Gugang Chen, Qing Li, Amber McCreary, Andrés Botello-Méndez, S. V. Morozov, Liangbo Liang, Xavier Declerck, Nestor Perea-López, David A. Cullen, Simin Feng, Ana Laura Elías, Rodolfo Cruz-Silva, Kazunori Fujisawa, Morinobu Endo, Feiyu Kang, Jean-Christophe Charlier, Vincent Meunier, Minghu Pan, Avetik R. Harutyunyan, Konstantin S. Novoselov, and Mauricio Terrones

14533 **Ultraflexible, large-area, physiological temperature sensors for multipoint measurements**
Tomoyuki Yokota, Yusuke Inoue, Yuki Terakawa, Jonathan Reeder, Martin Kaltenbrunner, Taylor Ware, Kejia Yang, Kunihiko Mabuchi, Tomohiro Murakawa, Masaki Sekino, Walter Voit, Tsuyoshi Sekitani, and Takao Someya

14700 **Optimal directional volatile transport in retronasal olfaction**
Rui Ni (倪睿), Mark H. Michalski, Elliott Brown, Ngoc Doan, Joseph Zinter, Nicholas T. Ouellette, and Gordon M. Shepherd

PHYSICS

14539 **Universal spectrum of normal modes in low-temperature glasses**
Silvio Franz, Giorgio Parisi, Pierfrancesco Urbani, and Francesco Zamponi

14545 **Deformation and failure of curved colloidal crystal shells**
Carlotta Negri, Alessandro L. Sellerio, Stefano Zapperi, and M. Carmen Miguel

14551 **Filling constraints for spin-orbit coupled insulators in symmorphic and nonsymmorphic crystals**
Haruki Watanabe, Hoi Chun Po, Ashvin Vishwanath, and Michael Zaletel

SOCIAL SCIENCES

ECONOMIC SCIENCES

14557 **Retrading, production, and asset market performance**
Steven D. Gjerstad, David Porter, Vernon L. Smith, and Abel Winn

PSYCHOLOGICAL AND COGNITIVE SCIENCES

14563 **Human emotions track changes in the acoustic environment**
Weiyi Ma (马维毅) and William Forde Thompson

SOCIAL SCIENCES

14569 **Choosing experiments to accelerate collective discovery**
Andrey Rzhetsky, Jacob G. Foster, Ian T. Foster, and James A. Evans

BIOLOGICAL SCIENCES

APPLIED BIOLOGICAL SCIENCES

14575 **Mapping landscape friction to locate isolated tsetse populations that are candidates for elimination**
Jérémy Bouyer, Ahmadou H. Dicko, Giuliano Cecchi, Sophie Ravel, Laure Guerrini, Philippe Solano, Marc J. B. Vreysen, Thierry De Meeûs, and Renaud Lancelot

BIOCHEMISTRY

E6426 **Conserved interdomain linker promotes phase separation of the multivalent adaptor protein Nck**
Sudeep Banjade, Qiong Wu, Anuradha Mittal, William B. Peeples, Rohit V. Pappu, and Michael K. Rosen

E6436 **Allosteric N-WASP activation by an inter-SH3 domain linker in Nck**
Julia Okrut, Sumit Prakash, Qiong Wu, Mark J. S. Kelly, and Jack Taunton

E6446 **Global shape mimicry of tRNA within a viral internal ribosome entry site mediates translational reading frame selection**
Hilda H. Au, Gabriel Cornilescu, Kathryn D. Mouzakis, Qian Ren, Jordan E. Burke, Seonghoon Lee, Samuel E. Butcher, and Eric Jan

14506 **Electrochemical evidence that pyranopterin redox chemistry controls the catalysis of YedY, a mononuclear Mo enzyme**
Hope Adamson, Alexandr N. Simonov, Michelina Kierzek, Richard A. Rothery, Joel H. Weiner, Alan M. Bond, and Alison Parkin

14581 **Guanine-vacancy–bearing G-quadruplexes responsive to guanine derivatives**
Xin-min Li, Ke-wei Zheng, Jia-yu Zhang, Hong-he Liu, Yi-de He, Bi-feng Yuan, Yu-hua Hao, and Zheng Tan

14587 **FOXO regulates RNA interference in *Drosophila* and protects from RNA virus infection**
Michael J. Spellberg and Michael T. Marr II

14593 **Direct measurements of the coordination of lever arm swing and the catalytic cycle in myosin V**
Darshan V. Trivedi, Joseph M. Muretta, Anja M. Swenson, Jonathon P. Davis, David D. Thomas, and Christopher M. Yengo

14599 **Directed evolution of the tryptophan synthase β-subunit for stand-alone function recapitulates allosteric activation**
Andrew R. Buller, Sabine Brinkmann-Chen, David K. Romney, Michael Herger, Javier Murciano-Calles, and Frances H. Arnold

BIOPHYSICS AND COMPUTATIONAL BIOLOGY

E6416 **Direct force measurements reveal that protein Tau confers short-range attractions and isoform-dependent steric stabilization to microtubules**
Peter J. Chung, Myung Chul Choi, Herbert P. Miller, H. Eric Feinstein, Uri Raviv, Youli Li, Leslie Wilson, Stuart C. Feinstein, and Cyrus R. Safinya

E6456 **Chromatin extrusion explains key features of loop and domain formation in wild-type and engineered genomes**
Adrian L. Sanborn, Suhas S. P. Rao, Su-Chen Huang, Neva C. Durand, Miriam H. Huntley, Andrew I. Jewett, Ivan D. Bochkov, Dharmaraj Chinnappan, Ashok Cutkosky, Jian Li, Kristopher P. Geeting, Andreas Gnirke, Alexandre Melnikov, Doug McKenna, Elena K. Stamenova, Eric S. Lander, and Erez Lieberman Aiden
→ *See Commentary on page 14404*

14605 **Designed protein reveals structural determinants of extreme kinetic stability**
Aron Broom, S. Martha Ma, Ke Xia, Hitesh Rafalia, Kyle Trainor, Wilfredo Colón, Shachi Gosavi, and Elizabeth M. Meiering

14611 **Atomic-resolution structure of the CAP-Gly domain of dynactin on polymeric microtubules determined by magic angle spinning NMR spectroscopy**
Si Yan, Changmiao Guo, Guangjin Hou, Huilan Zhang, Xingyu Lu, John Charles Williams, and Tatyana Polenova

14617 **Dynamic allostery governs cyclophilin A–HIV capsid interplay**
Manman Lu, Guangjin Hou, Huilan Zhang, Christopher L. Suiter, Jinwoo Ahn, In-Ja L. Byeon, Juan R. Perilla, Christopher J. Langmead, Ivan Hung, Peter L. Gor'kov, Zhehong Gan, William Brey, Christopher Aiken, Peijun Zhang, Klaus Schulten, Angela M. Gronenborn, and Tatyana Polenova

CELL BIOLOGY

E6466 **HAX-1 regulates cyclophilin-D levels and mitochondria permeability transition pore in the heart**
Chi Keung Lam, Wen Zhao, Guan-Sheng Liu, Wen-Feng Cai, George Gardner, George Adly, and Evangelia G. Kranias

E6476 **Screening for tumor suppressors: Loss of ephrin receptor A2 cooperates with oncogenic *KRas* in promoting lung adenocarcinoma**
Narayana Yeddula, Yifeng Xia, Eugene Ke, Joep Beumer, and Inder M. Verma

E6486 **TRPC6 channel translocation into phagosomal membrane augments phagosomal function**
Vladimir Riazanski, Aida G. Gabdoulkhakova, Lin S. Boynton, Raphael R. Eguchi, Ludmila V. Deriy, D. Kyle Hogarth, Nadège Loaëc, Nassima Oumata, Hervé Galons, Mary E. Brown, Pavel Shevchenko, Alexander J. Gallan, Sang Gune Yoo, Anjaparavanda P. Naren, Mitchel L. Villereal, Daniel W. Beacham, Vytautas P. Bindokas, Lutz Birnbaumer, Laurent Meijer, and Deborah J. Nelson

14623 **A systematic study of modulation of ADAM-mediated ectodomain shedding by site-specific O-glycosylation**
Christoffer K. Goth, Adnan Halim, Sumeet A. Khetarpal, Daniel J. Rader, Henrik Clausen, and Katrine T.-B. G. Schjoldager

DEVELOPMENTAL BIOLOGY

14629 **Fourteen babies born after round spermatid injection into human oocytes**
Atsushi Tanaka, Motoi Nagayoshi, Youichi Takemoto, Izumi Tanaka, Hiroshi Kusunoki, Seiji Watanabe, Keiji Kuroda, Satoru Takeda, Masahiko Ito, and Ryuzo Yanagimachi

14635 **Superresolution imaging reveals structurally distinct periodic patterns of chromatin along pachytene chromosomes**
Kirti Prakash, David Fournier, Stefan Redl, Gerrit Best, Máté Borsos, Vijay K. Tiwari, Kikuë Tachibana-Konwalski, René F. Ketting, Sapun H. Parekh, Christoph Cremer, and Udo J. Birk

14641 **Histone chaperone CAF-1 mediates repressive histone modifications to protect preimplantation mouse embryos from endogenous retrotransposons**
Yuki Hatanaka, Kimiko Inoue, Mami Oikawa, Satoshi Kamimura, Narumi Ogonuki, Eiichi N. Kodama, Yasuyuki Ohkawa, Yu-ichi Tsukada, and Atsuo Ogura

ENVIRONMENTAL SCIENCES

14512 **Shifts in coral reef biogeochemistry and resulting acidification linked to offshore productivity**
Kiley L. Yeakel, Andreas J. Andersson, Nicholas R. Bates, Timothy J. Noyes, Andrew Collins, and Rebecca Garley

14647 **Redistribution of soil water by a saprotrophic fungus enhances carbon mineralization**
Alexander Guhr, Werner Borken, Marie Spohn, and Egbert Matzner

14652 **Central role for ferritin in the day/night regulation of iron homeostasis in marine phytoplankton**
Hugo Botebol, Emmanuel Lesuisse, Robert Šuták, Christophe Six, Jean-Claude Lozano, Philippe Schatt, Valérie Vergé, Amos Kirilovsky, Joe Morrissey, Thibaut Léger, Jean-Michel Camadro, Audrey Gueneugues, Chris Bowler, Stéphane Blain, and François-Yves Bouget

EVOLUTION

E6496 **Extremely high genetic diversity in a single tumor points to prevalence of non-Darwinian cell evolution**
Shaoping Ling, Zheng Hu, Zuyu Yang, Fang Yang, Yawei Li, Pei Lin, Ke Chen, Lili Dong, Lihua Cao, Yong Tao, Lingtong Hao, Qingjian Chen, Qiang Gong, Dafei Wu, Wenjie Li, Wenming Zhao, Xiuyun Tian, Chunyi Hao, Eric A. Hungate, Daniel V. T. Catenacci, Richard R. Hudson, Wen-Hsiung Li, Xuemei Lu, and Chung-I Wu

GENETICS

14415 ***Xist* imprinting is promoted by the hemizygous (unpaired) state in the male germ line**
Sha Sun, Bernhard Payer, Satoshi Namekawa, Jee Young An, William Press, Jovani Catalan-Dibene, Hongjae Sunwoo, and Jeannie T. Lee
→ *See Commentary on page 14408*

14658 **Polymorphisms of large effect explain the majority of the host genetic contribution to variation of HIV-1 virus load**
Paul J. McLaren, Cedric Coulonges, István Bartha, Tobias L. Lenz, Aaron J. Deutsch, Arman Bashirova, Susan Buchbinder, Mary N. Carrington, Andrea Cossarizza, Judith Dalmau, Andrea De Luca, James J. Goedert, Deepti Gurdasani, David W. Haas, Joshua T. Herbeck, Eric O. Johnson, Gregory D. Kirk, Olivier Lambotte, Ma Luo, Simon Mallal, Daniëlle van Manen, Javier Martinez-Picado, Laurence Meyer, José M. Miro, James I. Mullins, Niels Obel, Guido Poli, Manjinder S. Sandhu, Hanneke Schuitemaker, Patrick R. Shea, Ioannis Theodorou, Bruce D. Walker, Amy C. Weintrob, Cheryl A. Winkler, Steven M. Wolinsky, Soumya Raychaudhuri, David B. Goldstein, Amalio Telenti, Paul I. W. de Bakker, Jean-François Zagury, and Jacques Fellay

IMMUNOLOGY AND INFLAMMATION

E6506 **Engineering high-affinity PD-1 variants for optimized immunotherapy and immuno-PET imaging**
Roy L. Maute, Sydney R. Gordon, Aaron T. Mayer, Melissa N. McCracken, Arutselvan Natarajan, Nan Guo Ring, Richard Kimura, Jonathan M. Tsai, Aashish Manglik, Andrew C. Kruse, Sanjiv S. Gambhir, Irving L. Weissman, and Aaron M. Ring

E6515 **An extracatalytic function of CD45 in B cells is mediated by CD22**
Sarah Coughlin, Mark Noviski, James L. Mueller, Ammarina Chuwonpad, William C. Raschke, Arthur Weiss, and Julie Zikherman

14664 **Dendritic cells require NIK for CD40-dependent cross-priming of $CD8^+$ T cells**
Anand K. Katakam, Hans Brightbill, Christian Franci, Chung Kung, Victor Nunez, Charles Jones III, Ivan Peng, Surinder Jeet, Lawren C. Wu, Ira Mellman, Lélia Delamarre, and Cary D. Austin

MEDICAL SCIENCES

E6525 **Targeting CD146 with a ^{64}Cu-labeled antibody enables in vivo immunoPET imaging of high-grade gliomas**
Yunan Yang, Reinier Hernandez, Jun Rao, Li Yin, Yazhuo Qu, Jinrong Wu, Christopher G. England, Stephen A. Graves, Christina M. Lewis, Pu Wang, Mary E. Meyerand, Robert J. Nickles, Xiu-wu Bian, and Weibo Cai

E6535 **Leukocyte-specific protein 1 regulates T-cell migration in rheumatoid arthritis**
Seong-Hye Hwang, Seung-Hyun Jung, Saseong Lee, Susanna Choi, Seung-Ah Yoo, Ji-Hwan Park, Daehee Hwang, Seung Cheol Shim, Laurent Sabbagh, Ki-Jo Kim, Sung Hwan Park, Chul-Soo Cho, Bong-Sung Kim, Lin Leng, Ruth R. Montgomery, Richard Bucala, Yeun-Jun Chung, and Wan-Uk Kim

E6544 **A basal stem cell signature identifies aggressive prostate cancer phenotypes**
Bryan A. Smith, Artem Sokolov, Vladislav Uzunangelov, Robert Baertsch, Yulia Newton, Kiley Graim, Colleen Mathis, Donghui Cheng, Joshua M. Stuart, and Owen N. Witte
→ *See Commentary on page 14406*

14670 **Noninvasive detection of fetal subchromosomal abnormalities by semiconductor sequencing of maternal plasma DNA**
Ai-hua Yin, Chun-fang Peng, Xin Zhao, Bennett A. Caughey, Jie-xia Yang, Jian Liu, Wei-wei Huang, Chang Liu, Dong-hong Luo, Hai-liang Liu, Yang-yi Chen, Jing Wu, Rui Hou, Mindy Zhang, Michael Ai, Lianghong Zheng, Rachel Q. Xue, Ming-qin Mai, Fang-fang Guo, Yi-ming Qi, Dong-mei Wang, Michal Krawczyk, Daniel Zhang, Yu-nan Wang, Quan-fei Huang, Michael Karin, and Kang Zhang

14676 **Anti-VEGF treatment improves neurological function and augments radiation response in NF2 schwannoma model**
Xing Gao, Yingchao Zhao, Anat O. Stemmer-Rachamimov, Hao Liu, Peigen Huang, ShanMin Chin, Martin K. Selig, Scott R. Plotkin, Rakesh K. Jain, and Lei Xu

MICROBIOLOGY

14682 **Virion-associated phosphatidylethanolamine promotes TIM1-mediated infection by Ebola, dengue, and West Nile viruses**
Audrey Stéphanie Richard, Adam Zhang, Sun-Jin Park, Michael Farzan, Min Zong, and Hyeryun Choe

14688 **Asymptomatic humans transmit dengue virus to mosquitoes**
Veasna Duong, Louis Lambrechts, Richard E. Paul, Sowath Ly, Rath Srey Lay, Kanya C. Long, Rekol Huy, Arnaud Tarantola, Thomas W. Scott, Anavaj Sakuntabhai, and Philippe Buchy

NEUROSCIENCE

E6553 **A 3′ untranslated region variant in *FMR1* eliminates neuronal activity-dependent translation of FMRP by disrupting binding of the RNA-binding protein HuR**
Joshua A. Suhl, Ravi S. Muddashetty, Bart R. Anderson, Marius F. Ifrim, Jeannie Visootsak, Gary J. Bassell, and Stephen T. Warren

14694 **Intrinsic excitability measures track antiepileptic drug action and uncover increasing/decreasing excitability over the wake/sleep cycle**
Christian Meisel, Andreas Schulze-Bonhage, Dean Freestone, Mark James Cook, Peter Achermann, and Dietmar Plenz

14700 **Optimal directional volatile transport in retronasal olfaction**
Rui Ni (倪睿), Mark H. Michalski, Elliott Brown, Ngoc Doan, Joseph Zinter, Nicholas T. Ouellette, and Gordon M. Shepherd

14705 **Agonist binding to the NMDA receptor drives movement of its cytoplasmic domain without ion flow**
Kim Dore, Jonathan Aow, and Roberto Malinow

14711 **Conformational signaling required for synaptic plasticity by the NMDA receptor complex**
Jonathan Aow, Kim Dore, and Roberto Malinow

14717 **Whole-agent selectivity within the macaque face-processing system**
Clark Fisher and Winrich A. Freiwald

14723 **Unmyelinated type II afferent neurons report cochlear damage**
Chang Liu, Elisabeth Glowatzki, and Paul Albert Fuchs

PHARMACOLOGY

E6562 **Sigma-1 receptor mediates cocaine-induced transcriptional regulation by recruiting chromatin-remodeling factors at the nuclear envelope**
Shang-Yi A. Tsai, Jian-Ying Chuang, Meng-Shan Tsai, Xiao-fei Wang, Zheng-Xiong Xi, Jan-Jong Hung, Wen-Chang Chang, Antonello Bonci, and Tsung-Ping Su

PLANT BIOLOGY

E6571 **A vacuolar phosphate transporter essential for phosphate homeostasis in *Arabidopsis***
Jinlong Liu, Lei Yang, Mingda Luan, Yuan Wang, Chi Zhang, Bin Zhang, Jisen Shi, Fu-Geng Zhao, Wenzhi Lan, and Sheng Luan

14728 **RNA-directed DNA methylation enforces boundaries between heterochromatin and euchromatin in the maize genome**
Qing Li, Jonathan I. Gent, Greg Zynda, Jawon Song, Irina Makarevitch, Cory D. Hirsch, Candice N. Hirsch, R. Kelly Dawe, Thelma F. Madzima, Karen M. McGinnis, Damon Lisch, Robert J. Schmitz, Matthew W. Vaughn, and Nathan M. Springer

14734 ***QQS* orphan gene regulates carbon and nitrogen partitioning across species via NF-YC interactions**
Ling Li, Wenguang Zheng, Yanbing Zhu, Huaxun Ye, Buyun Tang, Zebulun W. Arendsee, Dallas Jones, Ruoran Li, Diego Ortiz, Xuefeng Zhao, Chuanlong Du, Dan Nettleton, M. Paul Scott, Maria G. Salas-Fernandez, Yanhai Yin, and Eve Syrkin Wurtele

PSYCHOLOGICAL AND COGNITIVE SCIENCES

14563 **Human emotions track changes in the acoustic environment**
Weiyi Ma (马维毅) and William Forde Thompson

SYSTEMS BIOLOGY

E6579 **Circadian and feeding rhythms differentially affect rhythmic mRNA transcription and translation in mouse liver**
Florian Atger, Cédric Gobet, Julien Marquis, Eva Martin, Jingkui Wang, Benjamin Weger, Grégory Lefebvre, Patrick Descombes, Felix Naef, and Frédéric Gachon

CORRECTIONS (ONLINE ONLY)

ECOLOGY

E6589 **Backbones of evolutionary history test biodiversity theory for microbes**
James P. O'Dwyer, Steven W. Kembel, and Thomas J. Sharpton

NEUROSCIENCE, PSYCHOLOGICAL AND COGNITIVE SCIENCES

E6590 **Purkinje cell activity during classical conditioning with different conditional stimulus explains central tenet of Rescorla–Wagner model**
Anders Rasmussen, Riccardo Zucca, Fredrik Johansson, Dan-Anders Jirenhed, and Germund Hesslow

ix Subscription Form