



**Cover image:** Pictured is grassland at the Jasper Ridge Biological Preserve in California. Over 17 years, Kai Zhu et al. subjected this grassland to changes in temperature, precipitation, carbon dioxide, and nitrogen, both individually and in combination, to determine how simultaneous changes in multiple global environmental factors would affect primary production. Primary production was a ridge-shaped function of temperature and precipitation, with peak production increasing with added nitrogen and shifting to lower temperatures with added carbon dioxide. See the article by Zhu et al. on pages 10589–10594. Image courtesy of Dan Quinn (Stanford University, Stanford, CA).

## From the Cover

- 10589 Grassland responses to climate change
- E5572 Bovid diversification and African savanna origins
- E5580 Ice age kiwi diversification
- E5636 Suppressing latent tuberculosis reactivation
- 10497 Atlantic Ocean dissolved carbon production

## Contents

### THIS WEEK IN PNAS

#### 10449 In This Issue

### LETTERS (ONLINE ONLY)

- E5540 Relationship between intelligence and spectral characteristics of brain biophoton emission: Correlation does not automatically imply causation  
*Vahid Salari, István Bókkon, Roohollah Ghobadi, Felix Scholkmann, and Jack A. Tuszynski*
- E5542 Reply to Salari et al.: Toward understanding the deep mechanisms regarding the biophotons related to human intelligence  
*Jiapei Dai, Zhuo Wang, Zehua Li, and Fangyan Xiao*

### INNER WORKINGS—An over-the-shoulder look at scientists at work

- 10451 Can single molecules bind together entire ecosystems?  
*Jyoti Madhusoodanan*

### COMMENTARIES

- 10453 How monocytes guard the glomerulus  
*William A. Muller*  
→ See companion article on page E5172 in issue 35 of volume 113
- 10456 Untangling complex organic mixture in prehistoric hearths  
*Alexandre Lucquin*  
→ See companion article on page 9757 in issue 35 of volume 113
- 10458 Angiogenic neovessels promote tissue hypoxia  
*Anusha Mishra*  
→ See companion article on page 9934 in issue 35 of volume 113

### PNAS PLUS


- 10461 Significance Statements  
Brief statements written by the authors about the significance of their papers.

### INAUGURAL ARTICLE

- 10464 eIF4B stimulates translation of long mRNAs with structured 5' UTRs and low closed-loop potential but weak dependence on eIF4G  
*Neelam Dabas Sen, Fujun Zhou, Michael S. Harris, Nicholas T. Ingolia, and Alan G. Hinnebusch*

## PHYSICAL SCIENCES


### APPLIED PHYSICAL SCIENCES

- 10473**  **Broadband high-efficiency dielectric metasurfaces for the visible spectrum**  
Robert C. Devlin, Mohammadreza Khorasaninejad, Wei Ting Chen, Jaewon Oh, and Federico Capasso
- 10479** **Biaxial ferromagnetic liquid crystal colloids**  
Qingkun Liu, Paul J. Ackerman, Tom C. Lubensky, and Ivan I. Smalyukh

### CHEMISTRY

- E5675** **Accelerated structure-based design of chemically diverse allosteric modulators of a muscarinic G protein-coupled receptor**  
Yinglong Miao, Dahlia Anne Goldfeld, Ee Von Moo, Patrick M. Sexton, Arthur Christopoulos, J. Andrew McCammon, and Celine Valant
- 10485** **Exploring the zone of anisotropy and broken symmetries in DNA-mediated nanoparticle crystallization**  
Matthew N. O'Brien, Martin Girard, Hai-Xin Lin, Jaime A. Millan, Monica Olvera de la Cruz, Byeongdu Lee, and Chad A. Mirkin
- 10491** **Covalent bonds against magnetism in transition metal compounds**  
Sergey V. Streltsov and Daniel I. Khomskii
- 10536** **Kinetic barriers to SNAREpin assembly in the regulation of membrane docking/priming and fusion**  
Feng Li (李峰), Neeraj Tiwari, James E. Rothman, and Frederic Pincet



### EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

- 10497** **New nutrients exert fundamental control on dissolved organic carbon accumulation in the surface Atlantic Ocean**  
Cristina Romera-Castillo, Robert T. Letscher, and Dennis A. Hansell
- 10503**  **Olivine anisotropy suggests Gutenberg discontinuity is not the base of the lithosphere**  
Lars N. Hansen, Chao Qi (蔡超), and Jessica M. Warren

### ENVIRONMENTAL SCIENCES

- 10589**  **Nonlinear, interacting responses to climate limit grassland production under global change**  
Kai Zhu, Nona R. Chiariello, Todd Tobeck, Tadashi Fukami, and Christopher B. Field

### PHYSICS

- 10507**  **Atom–atom interactions around the band edge of a photonic crystal waveguide**  
Jonathan D. Hood, Akihisa Goban, Ana Asenjo-Garcia, Mingwu Lu, Su-Peng Yu, Darrick E. Chang, and H. J. Kimble
- 10513**  **Ultrathin two-dimensional superconductivity with strong spin–orbit coupling**  
Hyoungdo Nam, Hua Chen, Tijing Liu, Jisun Kim, Chendong Zhang, Jie Yong, Thomas R. Lemberger, Philip A. Kratz, John R. Kirtley, Kathryn Moler, Philip W. Adams, Allan H. MacDonald, and Chih-Kang Shih

## SOCIAL SCIENCES

### ECONOMIC SCIENCES

- 10518** **Sufficient trial size to inform clinical practice**  
Charles F. Manski and Aleksey Tetenov

### PSYCHOLOGICAL AND COGNITIVE SCIENCES

- 10524** **In-group defense, out-group aggression, and coordination failures in intergroup conflict**  
Carsten K. W. De Dreu, Jörg Gross, Zsombor Méder, Michael Giffin, Eliska Prochazkova, Jonathan Kribe, and Simon Columbus



- 10696** **Episodic specificity induction impacts activity in a core brain network during construction of imagined future experiences**  
Kevin P. Madore, Karl K. Szpunar, Donna Rose Addis, and Daniel L. Schacter

### SOCIAL SCIENCES

- 10530** **Extracting multistage screening rules from online dating activity data**  
Elizabeth Bruch, Fred Feinberg, and Kee Yeun Lee

## BIOLOGICAL SCIENCES


### BIOCHEMISTRY

- E5544** **DNA and RNA topoisomerase activities of Top3 $\beta$  are promoted by mediator protein Tudor domain-containing protein 3**  
Grace Ee-Lu Siaw, I-Fen Liu, Po-Yen Lin, Michael D. Been, and Tao-shih Hsieh
- 10536** **Kinetic barriers to SNAREpin assembly in the regulation of membrane docking/priming and fusion**  
Feng Li (李峰), Neeraj Tiwari, James E. Rothman, and Frederic Pincet
- 10542** **Structure of Bor1 supports an elevator transport mechanism for SLC4 anion exchangers**  
Bryan H. Thurtle-Schmidt and Robert M. Stroud
- 10547** **WD40 domain of Apc1 is critical for the coactivator-induced allosteric transition that stimulates APC/C catalytic activity**  
Qihong Li, Leifu Chang, Shintaro Aibara, Jing Yang, Ziguozhang, and David Barford
- 10553**  **Structural mechanism for the recognition and ubiquitination of a single nucleosome residue by Rad6–Bre1**  
Laura D. Gallego, Medini Ghodgaonkar Steger, Anton A. Polyansky, Tobias Schubert, Bojan Zagrovic, Ning Zheng, Tim Clausen, Franz Herzog, and Alwin Köhler
- 10559**  **Energetics of side-chain snorkeling in transmembrane helices probed by nonproteinogenic amino acids**  
Karin Öjemalm, Takashi Higuchi, Patricia Lara, Erik Lindahl, Hiroaki Suga, and Gunnar von Heijne

### BIOPHYSICS AND COMPUTATIONAL BIOLOGY

- 10565** **Ultrafast anisotropic protein quake propagation after CO photodissociation in myoglobin**  
Levin U. L. Brinkmann and Jochen S. Hub

### CELL BIOLOGY

- E5552** **Coordinated autoinhibition of F-BAR domain membrane binding and WASp activation by Nervous Wreck**  
Tatiana B. Stanishneva-Konova, Charlotte F. Kelley, Tania L. Eskin, Emily M. Messelaar, Steven A. Wasserman, Olga S. Sokolova, and Avital A. Rodal
- 10571** **In B cells, phosphatidylinositol 5-phosphate 4-kinase- $\alpha$  synthesizes PI(4,5)P<sub>2</sub> to impact mTORC2 and Akt signaling**  
Simon J. Bulley, Alaa Droubi, Jonathan H. Clarke, Karen E. Anderson, Len R. Stephens, Phillip T. Hawkins, and Robin F. Irvine
- 10577**  **P31<sup>comet</sup>, a member of the synaptonemal complex, participates in meiotic DSB formation in rice**  
Jianhui Ji, Ding Tang, Yi Shen, Zhihui Xue, Hongjun Wang, Wenqing Shi, Chao Zhang, Guijie Du, Yafei Li, and Zhukuan Cheng

## DEVELOPMENTAL BIOLOGY

### E5562 Selenoprotein H is an essential regulator of redox homeostasis that cooperates with p53 in development and tumorigenesis

Andrew G. Cox, Allison Tsomides, Andrew J. Kim, Diane Saunders, Katie L. Hwang, Kimberley J. Evason, Jerry Heidele, Kristin K. Brown, Min Yuan, Evan C. Lien, Byung Cheon Lee, Sahar Nissim, Bryan Dickinson, Sagar Chhangawala, Christopher J. Chang, John M. Asara, Yariv Houvras, Vadim N. Gladyshev, and Wolfram Goessling

### 10583 Minibrain and Wings apart control organ growth and tissue patterning through down-regulation of Capicua


Liu Yang, Sayantanee Paul, Kenneth G. Trieu, Lucas G. Dent, Francesca Froidi, Marta Forés, Kaitlyn Webster, Kellee R. Siegfried, Shu Kondo, Kieran Harvey, Louise Cheng, Gerardo Jiménez, Stanislav Y. Shvartsman, and Alexey Veraksa

## ECOLOGY


### E5572 Spiny plants, mammal browsers, and the origin of African savannas

Tristan Charles-Dominique, T. Jonathan Davies, Gareth P. Hempson, Bezeng S. Bezeng, Barnabas H. Daru, Ronny M. Kabongo, Olivier Maurin, A. Muthama Muasya, Michelle van der Bank, and William J. Bond

### 10589 Nonlinear, interacting responses to climate limit grassland production under global change

 Kai Zhu, Nona R. Chiariello, Todd Tobeck, Tadashi Fukami, and Christopher B. Field

### 10595 Configuration of the thermal landscape determines thermoregulatory performance of ectotherms

 Michael W. Sears, Michael J. Angilletta Jr., Matthew S. Schuler, Jason Borcherdt, Katherine F. Dilliplane, Monica Stegman, Travis W. Rusch, and William A. Mitchell

## ENVIRONMENTAL SCIENCES

### 10601 Ammonium and nitrite oxidation at nanomolar oxygen concentrations in oxygen minimum zone waters


Laura A. Bristow, Tage Dalsgaard, Laura Tiano, Daniel B. Mills, Anthony D. Bertagnolli, Jody J. Wright, Steven J. Hallam, Osvaldo Ulloa, Donald E. Canfield, Niels Peter Revsbech, and Bo Thamdrup

## EVOLUTION

### E5580 Explosive ice age diversification of kiwi

Jason T. Weir, Oliver Haddrath, Hugh A. Robertson, Rogan M. Colbourne, and Allan J. Baker

### 10607 Variation in the molecular clock of primates


 Priya Moorjani, Carlos Eduardo G. Amorim, Peter F. Arndt, and Molly Przeworski

### 10613 Convergent evolution of caffeine in plants by co-option of exapted ancestral enzymes


Ruiqi Huang, Andrew J. O'Donnell, Jessica J. Barboline, and Todd J. Barkman

## GENETICS

### E5588 Emergent rules for codon choice elucidated by editing rare arginine codons in *Escherichia coli*

 Michael G. Napolitano, Matthieu Landon, Christopher J. Gregg, Marc J. Lajoie, Lakshmi Govindarajan, Joshua A. Mosberg, Gleb Kuznetsov, Daniel B. Goodman, Oscar Vargas-Rodriguez, Farren J. Isaacs, Dieter Söll, and George M. Church

### E5598 Mutations in mitochondrial enzyme GPT2 cause metabolic dysfunction and neurological disease with developmental and progressive features

 Qing Ouyang, Tojo Nakayama, Ozan Baytas, Shawn M. Davidson, Chendong Yang, Michael Schmidt, Sofia B. Lizarraga, Sasmita Mishra, Malak El-Quessny, Saima Niaz, Mirrat Gul Butt, Syed Imran Murtaza, Afzal Javed, Haroon Rashid Chaudhry, Dylan J. Vaughan, R. Sean Hill, Jennifer N. Partlow, Seung-Yun Yoo, Anh-Thu N. Lam, Ramzi Nasir, Muna Al-Saffar, A. James Barkovich, Matthew Schwede, Shailender Nagpal, Anna Rajab, Ralph J. DeBerardinis, David E. Housman, Ganeshwaran H. Mochida, and Eric M. Morrow

### 10464 eIF4B stimulates translation of long mRNAs with structured 5' UTRs and low closed-loop potential but weak dependence on eIF4G


Neelam Dabas Sen, Fujun Zhou, Michael S. Harris, Nicholas T. Ingolia, and Alan G. Hinnebusch

### 10619 PAXX and XLF DNA repair factors are functionally redundant in joining DNA breaks in a G1-arrested progenitor B-cell line

Vipul Kumar, Frederick W. Alt, and Richard L. Frock

## IMMUNOLOGY AND INFLAMMATION

### E5608 Class II major histocompatibility complex mutant mice to study the germ-line bias of T-cell antigen receptors

 Daniel Silberman, Sai Harsha Krovi, Kathryn D. Tuttle, James Crooks, Richard Reisdorph, Janice White, James Gross, Jennifer L. Matsuda, Laurent Gapin, Philippa Marrack, and John W. Kappler

### 10625 Rabex-5 is a lenalidomide target molecule that negatively regulates TLR-induced type 1 IFN production

David Millrine, Mami Tei, Yohannes Gemechu, and Tadimitsu Kishimoto

### 10631 De novo DNA methylation by DNA methyltransferase 3a controls early effector CD8<sup>+</sup> T-cell fate decisions following activation

Brian H. Ladle, Kun-Po Li, Maggie J. Phillips, Alexandra B. Pucsek, Azeb Haile, Jonathan D. Powell, Elizabeth M. Jaffee, David A. Hildeman, and Christopher J. Gamper

### 10637 Leptin promotes systemic lupus erythematosus by increasing autoantibody production and inhibiting immune regulation

Elaine V. Lourenço, Aijing Liu, Giuseppe Matarese, and Antonio La Cava

### 10643 Gene-expression profiling of different arms of lymphatic vasculature identifies candidates for manipulation of cell traffic

Imtiaz Iftakhar-E-Khuda, Ruth Fair-Mäkelä, Anu Kukkonen-Macchi, Kati Elima, Marika Karikoski, Pia Rantakari, Masayuki Miyasaka, Marko Salmi, and Sirpa Jalkanen

### 10649 Mannose receptor induces T-cell tolerance via inhibition of CD45 and up-regulation of CTLA-4

Verena Schuette, Maria Embgenbroich, Thomas Ulas, Meike Welz, Jonas Schulte-Schrepping, Astrid M. Draffehn, Thomas Quast, Katharina Koch, Melanie Nehring, Jessica König, Annegret Zweynert, Frederike L. Harms, Nancy Steiner, Andreas Limmer, Irmgard Förster, Friederike Berberich-Siebelt, Percy A. Knolle, Dirk Wohlleber, Waldemar Kolanus, Marc Beyer, Joachim L. Schultze, and Sven Burgdorf

## MEDICAL SCIENCES

### E5618 Pericyte–fibroblast transition promotes tumor growth and metastasis

Kayoko Hosaka, Yunlong Yang, Takahiro Seki, Carina Fischer, Olivier Dubey, Erik Fredlund, Johan Hartman, Piotr Religa, Hiromasa Morikawa, Yoko Ishii, Masakiyo Sasahara, Ola Larsson, Giulio Cossu, Renhai Cao, Sharon Lim, and Yihai Cao


**E5628 Pathological Ace2-to-Ace enzyme switch in the stressed heart is transcriptionally controlled by the endothelial Brg1–FoxM1 complex**  
*Jin Yang, Xuhui Feng, Qiong Zhou, Wei Cheng, Ching Shang, Pei Han, Chiou-Hong Lin, Huei-Sheng Vincent Chen, Thomas Quertermous, and Ching-Pin Chang*

**10518 Sufficient trial size to inform clinical practice**  
*Charles F. Manski and Aleksey Tetenov*

**10655 Circulating microRNA signature for the diagnosis of very high-risk prostate cancer**  
*Ali H. Alhasan, Alexander W. Scott, Jia J. Wu, Gang Feng, Joshua J. Meeks, C. Shad Thaxton, and Chad A. Mirkin*

**10661 Genome editing using CRISPR-Cas9 to create the HPFH genotype in HSPCs: An approach for treating sickle cell disease and  $\beta$ -thalassemia**  
*Lin Ye, Jiaming Wang, Yuting Tan, Ashley I. Beyer, Fei Xie, Marcus O. Muench, and Yuet Wai Kan*

**10666 Actinomycin D enhances killing of cancer cells by immunotoxin RG7787 through activation of the extrinsic pathway of apoptosis**  
*Xiu Fen Liu, Laiman Xiang, Qi Zhou, Jean-Philippe Carralot, Marco Prunotto, Gerhard Niederfellner, and Ira Pastan*


 **10672 Whole-exome sequencing identifies recurrent AKT1 mutations in sclerosing hemangioma of lung**  
*Seung-Hyun Jung, Min Sung Kim, Sung-Hak Lee, Hyun-Chun Park, Hyun Joo Choi, Leeso Maeng, Ki Ouk Min, Jeana Kim, Tae In Park, Ok Ran Shin, Tae-Jung Kim, Haidong Xu, Kyo Young Lee, Tae-Min Kim, Sang Yong Song, Charles Lee, Yeun-Jun Chung, and Sug Hyung Lee*

#### MICROBIOLOGY

**E5636 CD4<sup>+</sup> T-cell-independent mechanisms suppress reactivation of latent tuberculosis in a macaque model of HIV coinfection**  
*Taylor W. Foreman, Smriti Mehra, Denae N. LoBato, Adel Malek, Xavier Alvarez, Nadia A. Golden, Allison N. Buçsan, Peter J. Didier, Lara A. Doyle-Meyers, Kasi E. Russell-Lodrigue, Chad J. Roy, James Blanchard, Marcelo J. Kuroda, Andrew A. Lackner, John Chan, Shabaana A. Khader, William R. Jacobs Jr., and Deepak Kaushal*

**10678 Prolonged activation of innate antiviral gene signature after childbirth is determined by IFNL3 genotype**  
*Aryn A. Price, Dana Tedesco, Mona R. Prasad, Kimberly A. Workowski, Christopher M. Walker, Mehul S. Suthar, Jonathan R. Honegger, and Arash Grakoui*

**10684 Influence of IFNL3 and HLA-DPB1 genotype on postpartum control of hepatitis C virus replication and T-cell recovery**  
*Jonathan R. Honegger, Dana Tedesco, Jennifer A. Kohout, Mona R. Prasad, Aryn A. Price, Tera Lindquist, Samantha Ohmer, Melissa Moore-Clingenpeel, Arash Grakoui, and Christopher M. Walker*

 **10690 Point mutations in the major outer membrane protein drive hypervirulence of a rapidly expanding clone of *Campylobacter jejuni***  
*Zuowei Wu, Balamurugan Periaswamy, Orhan Sahin, Michael Yaeger, Paul Plummer, Weiwei Zhai, Zhangqi Shen, Lei Dai, Swaine L. Chen, and Qijing Zhang*

#### NEUROSCIENCE

**E5645 GluA1 signal peptide determines the spatial assembly of heteromeric AMPA receptors**  
*Xue-Yan He, Yan-Jun Li, Chakrapani Kalyanaraman, Li-Li Qiu, Chen Chen, Qi Xiao, Wen-Xue Liu, Wei Zhang, Jian-Jun Yang, Guiquan Chen, Matthew P. Jacobson, and Yun Stone Shi*

 **E5655 TRiC subunits enhance BDNF axonal transport and rescue striatal atrophy in Huntington's disease**  
*Xiaobei Zhao, Xu-Qiao Chen, Eugene Han, Yue Hu, Paul Paik, Zhiyong Ding, Julia Overman, Alice L. Lau, Sarah H. Shahmoradian, Wah Chiu, Leslie M. Thompson, Chengbiao Wu, and William C. Mobley*

**E5665 Infiltrating monocytes promote brain inflammation and exacerbate neuronal damage after status epilepticus**  
*Nicholas H. Varvel, Jonas J. Neher, Andrea Bosch, Wenyi Wang, Richard M. Ransohoff, Richard J. Miller, and Raymond Dingledine*

**10696 Episodic specificity induction impacts activity in a core brain network during construction of imagined future experiences**  
*Kevin P. Madore, Karl K. Szpunar, Donna Rose Addis, and Daniel L. Schacter*

**10702 Unique pH dynamics in GABAergic synaptic vesicles illuminates the mechanism and kinetics of GABA loading**  
*Yoshihiro Egashira, Miki Takase, Shoji Watanabe, Junji Ishida, Akiyoshi Fukamizu, Ryosuke Kaneko, Yuchio Yanagawa, and Shigeo Takamori*

#### PHARMACOLOGY

**E5675 Accelerated structure-based design of chemically diverse allosteric modulators of a muscarinic G protein-coupled receptor**  
*Yinglong Miao, Dahlia Anne Goldfeld, Ee Von Moo, Patrick M. Sexton, Arthur Christopoulos, J. Andrew McCammon, and Celine Valant*

**E5685 SCAP/SREBP pathway is required for the full steroidogenic response to cyclic AMP**  
*Masami Shimizu-Albergine, Brian Van Yserloo, Martin G. Golkowski, Shao-En Ong, Joseph A. Beavo, and Karin E. Bornfeldt*

#### PLANT BIOLOGY

**10708 Chloroplast retrograde signal regulates flowering**  
*Peiqiang Feng, Hailong Guo, Wei Chi, Xin Chai, Xuwu Sun, Xiumei Xu, Jinfang Ma, Jean-David Rochaix, Dario Leister, Haiyang Wang, Congming Lu, and Lixin Zhang*

**10714 Synthesis and transfer of galactolipids in the chloroplast envelope membranes of *Arabidopsis thaliana***  
*Amélie A. Kelly, Barbara Kalisch, Georg Hölzl, Sandra Schulze, Juliane Thiele, Michael Melzer, Rebecca L. Roston, Christoph Benning, and Peter Dörmann*

**10720 RNA-binding protein DUS16 plays an essential role in primary miRNA processing in the unicellular alga *Chlamydomonas reinhardtii***  
*Tomohito Yamasaki, Masayuki Onishi, Eun-Jeong Kim, Heriberto Cerutti, and Takeshi Ohama*

#### CORRECTIONS (ONLINE ONLY)

##### SUSTAINABILITY SCIENCE

**E5694 Temperature-driven global sea-level variability in the Common Era**  
*Robert E. Kopp, Andrew C. Kemp, Klaus Bittermann, Benjamin P. Horton, Jeffrey P. Donnelly, W. Roland Gehrels, Carling C. Hay, Jerry X. Mitrovica, Eric D. Morrow, and Stefan Rahmstorf*

##### DEVELOPMENTAL BIOLOGY

**E5697 Erasure of DNA methylation, genomic imprints, and epimutations in a primordial germ-cell model derived from mouse pluripotent stem cells**  
*Norikatsu Miyoshi, Jente M. Stel, Keiko Shioda, Na Qu, Junko Odahima, Shino Mitsunaga, Xiangfan Zhang, Makoto Nagano, Konrad Hochedlinger, Kurt J. Isselbacher, and Toshi Shioda*

ix Subscription Form