

**Cover image:** The genetic code is the fundamental alphabet of life. This code, once thought to be universal and the same for all forms of life, shows a few enigmatic deviations between different species, e.g., bees and feather stars. One of those anomalies may be a primordial adaptation to aerobic respiration and oxidative stress, which results in a high concentration of methionine within the mitochondria. See the article by Aline Bender *et al.* on pages 16496–16501. Artwork courtesy of Michael Plenikowski (University of Mainz, Mainz, Germany).

## From the Cover

- 16496 Mitochondrial methionine and oxidative stress
- 16418 Electronic interactions on organic thin films
- 16466 Disassembly of declining networks
- 16614 Reading the roach embryo
- 16731 Probiotics and intestinal inflammation

## Contents

### THIS WEEK IN PNAS


16409 In This Issue

### LETTERS (ONLINE ONLY)

- E71 **The meaning of “macaque” facial expressions**  
Elisabeth H. M. Sterck and Brigitte M. A. Goossens
- E72 **Reply to Sterck and Goossens: Perception of facial expressions in rhesus macaques**  
Fadila Hadj-Bouziane, Andrew H. Bell, Leslie G. Ungerleider, and Roger B. H. Tootell

### COMMENTARIES

- 16411 **The molecular ancestry of segmentation mechanisms**  
E. M. De Robertis  
→ See companion article on page 16614
- 16413 **Therapeutic correction of bacterial dysbiosis discovered by molecular techniques**  
R. Balfour Sartor  
→ See companion article on page 16731

 Free online through the PNAS open access option.

### PROFILE

- 16415 **Profile of Ellen D. Williams**  
Farooq Ahmed  
→ See Inaugural Article on page 16418

### INAUGURAL ARTICLE


- 16418 **Dynamic interfaces in an organic thin film**  
Chenggang Tao, Qiang Liu, Blake S. Riddick, William G. Cullen, Janice Reutt-Robey, John D. Weeks, and Ellen D. Williams  
→ See Profile on page 16415

### PHYSICAL SCIENCES

#### APPLIED PHYSICAL SCIENCES

- 16418 **Dynamic interfaces in an organic thin film**  
Chenggang Tao, Qiang Liu, Blake S. Riddick, William G. Cullen, Janice Reutt-Robey, John D. Weeks, and Ellen D. Williams  
→ See Profile on page 16415

#### CHEMISTRY

- 16426 **Stability and structural recovery of the tetramerization domain of p53-R337H mutant induced by a designed templating ligand**  
Susana Gordo, Vera Martos, Eva Santos, Margarita Menéndez, Carles Bo, Ernest Giralt, and Javier de Mendoza
- 16537 **NMR studies of a channel protein without membranes: Structure and dynamics of water-solubilized KcsA**  
 Dejjan Ma, Tommy S. Tillman, Pei Tang, Eva Meirovitch, Roderic Eckenhoff, Anna Carnini, and Yan Xu

16543 **Atomic detail of chemical transformation at the transition state of an enzymatic reaction**  
Suwipa Saen-oon, Sara Quaytman-Machleder,  
Vern L. Schramm, and Steven D. Schwartz

16671 **How the thymus designs antigen-specific and self-tolerant T cell receptor sequences**  
Andrej Košmrlj, Abhishek K. Jha, Eric S. Huseby,  
Mehran Kardar, and Arup K. Chakraborty

#### ENGINEERING

16432 **Dynamics of shear-induced ATP release from red blood cells**  
Jiandi Wan, William D. Ristenpart, and Howard A. Stone

16438 **Electric field-induced direct delivery of proteins by a nanofountain probe**  
Owen Y. Loh, Andrea M. Ho, Jee E. Rim, Punit Kohli,  
Neelesh A. Patankar, and Horacio D. Espinosa

#### GEOLOGY

16444 **A humid corridor across the Sahara for the migration of early modern humans out of Africa 120,000 years ago**  
Anne H. Osborne, Derek Vance, Eelco J. Rohling,  
Nick Barton, Mike Rogerson, and Nuri Fello

#### PHYSICS

16448 **Managing light polarization via plasmon–molecule interactions within an asymmetric metal nanoparticle trimer**  
Timur Shegai, Zhipeng Li, Tali Dadosh, Zhenyu Zhang,  
Hongxing Xu, and Gilad Haran

16454 **Crystal structure of the pressure-induced metallic phase of SiH<sub>4</sub> from ab initio theory**  
D. Y. Kim, R. H. Scheicher, S. Lebègue, J. Prasadkit,  
B. Arnaud, M. Alouani, and R. Ahuja

### SOCIAL SCIENCES

#### ANTHROPOLOGY

16460 **High-precision radiocarbon dating and historical biblical archaeology in southern Jordan**  
Thomas E. Levy, Thomas Higham, Christopher  
Bronk Ramsey, Neil G. Smith, Erez Ben-Yosef,  
Mark Robinson, Stefan Münzer, Kyle Knabb,  
Jürgen P. Schulze, Mohammad Najjar,  
and Lisa Tauxe

#### SOCIAL SCIENCES

16466 **Asymmetric disassembly and robustness in declining networks**  
Serguei Saavedra, Felix Reed-Tsochas,  
and Brian Uzzi

### BIOLOGICAL SCIENCES

#### APPLIED BIOLOGICAL SCIENCES

16472 **Kinase requirements in human cells: I. Comparing kinase requirements across various cell types**  
Dorre A. Grueneberg, Sebastien Degot, Joseph Pearlberg,  
Wenliang Li, Joan E. Davies, Amy Baldwin, Wilson Endege,  
John Doench, Jacqueline Sawyer, Yanhui Hu, Frederick  
Boyce, Jun Xian, Karl Munger, and Ed Harlow

16478 **Kinase requirements in human cells: II. Genetic interaction screens identify kinase requirements following HPV16 E7 expression in cancer cells**  
Amy Baldwin, Wenliang Li, Miranda Grace,  
Joseph Pearlberg, Ed Harlow, Karl Münzer,  
and Dorre A. Grueneberg

16484 **Kinase requirements in human cells: III. Altered kinase requirements in *VHL*–/– cancer cells detected in a pilot synthetic lethal screen**  
Archana Bommi-Reddy, Ingrid Almeciga, Jacqueline  
Sawyer, Christoph Geisen, Wenliang Li, Ed Harlow,  
William G. Kaelin, Jr., and Dorre A. Grueneberg

16490 **Kinase requirements in human cells: IV. Differential kinase requirements in cervical and renal human tumor cell lines**  
Dorre A. Grueneberg, Wenliang Li, Joan E. Davies,  
Jacqueline Sawyer, Joseph Pearlberg, and Ed Harlow

#### BIOCHEMISTRY

16496 **Adaptive antioxidant methionine accumulation in respiratory chain complexes explains the use of a deviant genetic code in mitochondria**  
Aline Bender, Parvana Hajjeva, and Bernd Moosmann

16502 **Quality control despite mistranslation caused by an ambiguous genetic code**  
Benfang Ruan, Sotiria Palioura, Jeffrey Sabina, Laure  
Marvin-Guy, Sunil Kochhar, Robert A. LaRossa,  
and Dieter Söll

16508 **Activities of human exonuclease 1 that promote cleavage of transcribed immunoglobulin switch regions**  
Aarthy C. Vallur and Nancy Maizels

16513 **Transport of LDL-derived cholesterol from the NPC1 compartment to the ER involves the trans-Golgi network and the SNARE protein complex**  
Yasuomi Urano, Hiroshi Watanabe, Stephanie R. Murphy,  
Yohei Shibuya, Yong Geng, Andrew A. Peden,  
Catherine C. Y. Chang, and Ta Yuan Chang

16519 **Insights into the structural dynamics of the Hsp110–Hsp70 interaction reveal the mechanism for nucleotide exchange activity**  
Claes Andréasson, Jocelyne Fiaux, Heike Rampelt,  
Silke Druffel-Augustin, and Bernd Bukau

16525 **Prolonged signaling at the parathyroid hormone receptor by peptide ligands targeted to a specific receptor conformation**  
 Makoto Okazaki, Sebastien Ferrandon, Jean-Pierre  
Villardaga, Mary L. Bouxsein, John T. Potts, Jr.,  
and Thomas J. Gardella

16531 **Dynamic stabilization of actin filaments**  
Hao Yuan Kueh, William M. Brieher,  
and Timothy J. Mitchison

#### BIOPHYSICS

16426 **Stability and structural recovery of the tetramerization domain of p53-R337H mutant induced by a designed templating ligand**  
Susana Gordo, Vera Martos, Eva Santos, Margarita  
Menéndez, Carles Bo, Ernest Giralt,  
and Javier de Mendoza

16432 **Dynamics of shear-induced ATP release from red blood cells**  
Jiandi Wan, William D. Ristenpart, and Howard A. Stone

16537 **NMR studies of a channel protein without membranes: Structure and dynamics of water-solubilized KcsA**  
Dejian Ma, Tommy S. Tillman, Pei Tang, Eva Meirovitch, Roderic Eckenhoff, Anna Carnini, and Yan Xu

16543 **Atomic detail of chemical transformation at the transition state of an enzymatic reaction**  
Suwipa Saen-oon, Sara Quaytman-Machleder, Vern L. Schramm, and Steven D. Schwartz

16549 **Side-chain recognition and gating in the ribosome exit tunnel**  
Paula M. Petrone, Christopher D. Snow, Del Lucent, and Vijay S. Pande

16555 **Role of HAMP domains in chemotaxis signaling by bacterial chemoreceptors**  
Cezar M. Khursigara, Xiongwu Wu, Peijun Zhang, Jonathan Lefman, and Sriram Subramaniam

16561 **Crystallographic structure of xanthorhodopsin, the light-driven proton pump with a dual chromophore**  
Hartmut Luecke, Brigitte Schobert, Jason Stagno, Eleonora S. Imasheva, Jennifer M. Wang, Sergei P. Balashov, and Janos K. Lanyi

16566 **Using diastereopeptides to control metal ion coordination in proteins**  
Anna F. A. Peacock, Lars Hemmingsen, and Vincent L. Pecoraro

#### CELL BIOLOGY

16572 **Different polycomb group CBX family proteins associate with distinct regions of chromatin using nonhomologous protein sequences**  
Claudius Vincenz and Tom K. Kerppola

16578 **Human DNA polymerase  $\eta$  activity and translocation is regulated by phosphorylation**  
Yih-wen Chen, James E. Cleaver, Zafer Hatahet, Richard E. Honkanen, Jang-Yang Chang, Yun Yen, and Kai-ming Chou

16584 **Nuclear Akt interacts with B23/NPM and protects it from proteolytic cleavage, enhancing cell survival**  
Sang Bae Lee, Truong L. Xuan Nguyen, Joung Woo Choi, Kyung-Hoon Lee, Sung-Woo Cho, Zhixue Liu, Keqiang Ye, Sun Sik Bae, and Jee-Yin Ahn

16590 **Acid phosphatase 5 is responsible for removing the mannose 6-phosphate recognition marker from lysosomal proteins**  
Pengling Sun, David E. Sleat, Michèle Lecocq, Alison R. Hayman, Michel Jadot, and Peter Lobel

16596 **Specificity of the J-protein Sis1 in the propagation of 3 yeast prions**  
Takashi Higurashi, Justin K. Hines, Chandan Sahi, Rebecca Aron, and Elizabeth A. Craig

16602 **A bacterial control circuit integrates polar localization and proteolysis of key regulatory proteins with a phospho-signaling cascade**  
Antonio A. Iniesta and Lucy Shapiro

#### DEVELOPMENTAL BIOLOGY

16608 **Modulation of potassium channel function confers a hyperproliferative invasive phenotype on embryonic stem cells**  
Junji Morokuma, Douglas Blackiston, Dany S. Adams, Guiscard Seebohm, Barry Trimmer, and Michael Levin

16614 **Ancestral Notch-mediated segmentation revealed in the cockroach *Periplaneta americana***  
J. I. Pueyo, R. Lanfear, and J. P. Couso  
→ See Commentary on page 16411

16620 **Loss of ephrin-A5 function disrupts lens fiber cell packing and leads to cataract**  
Margaret A. Cooper, Alexander I. Son, Daniel Komlos, Yuhai Sun, Norman J. Kleiman, and Renping Zhou

16626 **Mesothelium contributes to vascular smooth muscle and mesenchyme during lung development**  
Jianwen Que, Bettina Wilm, Hiroshi Hasegawa, Fan Wang, David Bader, and Brigid L. M. Hogan

#### ECOLOGY

16466 **Asymmetric disassembly and robustness in declining networks**  
Serguei Saavedra, Felix Reed-Tsochas, and Brian Uzzi

16631 **Building trophic modules into a persistent food web**  
Michio Kondoh

#### EVOLUTION

16636 **Hindwings are unnecessary for flight but essential for execution of normal evasive flight in Lepidoptera**  
Benjamin Jantzen and Thomas Eisner

16641 **Molecular phylogeny of choanoflagellates, the sister group to Metazoa**  
M. Carr, B. S. C. Leadbeater, R. Hassan, M. Nelson, and S. L. Baldauf

16647 **Evolutionary redefinition of immunoglobulin light chain isotypes in tetrapods using molecular markers**  
Sabyasachi Das, Nikolas Nikolaidis, Jan Klein, and Masatoshi Nei

#### GENETICS

16653 **Significant conservation of synthetic lethal genetic interaction networks between distantly related eukaryotes**  
Scott J. Dixon, Yaroslav Fedyshyn, Judice L. Y. Koh, T. S. Keshava Prasad, Charly Chahwan, Gordon Chua, Kiana Toufighi, Anastasija Baryshnikova, Jacqueline Hayles, Kwang-Lae Hoe, Dong-Uk Kim, Han-Oh Park, Chad L. Myers, Akhilesh Pandey, Daniel Durocher, Brenda J. Andrews, and Charles Boone

16659 **Small-scale copy number variation and large-scale changes in gene expression**  
Yuriy Mileyko, Richard I. Joh, and Joshua S. Weitz


16665 **Genes involved in pre-mRNA 3'-end formation and transcription termination revealed by a *lin-15* operon Muv suppressor screen**  
Mingxue Cui, Mary Ann Allen, Alison Larsen, Margaret MacMorris, Min Han, and Tom Blumenthal

#### IMMUNOLOGY


16671 **How the thymus designs antigen-specific and self-tolerant T cell receptor sequences**  
Andrej Košmrlj, Abhishek K. Jha, Eric S. Huseby, Mehran Kardar, and Arup K. Chakraborty

- 16677 **FADD and caspase-8 control the outcome of autophagic signaling in proliferating T cells**  
Bryan D. Bell, Sabrina Leverrier, Brian M. Weist, Ryan H. Newton, Adrian F. Arechiga, Keith A. Luhrs, Naomi S. Morrisette, and Craig M. Walsh
- 16683 **Adjuvants targeting innate and adaptive immunity synergize to enhance tumor immunotherapy**  
Grégory Verdeil, Kristi Marquardt, Charles D. Surh, and Linda A. Sherman
- 16689 **Exploring regulatory mechanisms of CD8<sup>+</sup> T cell contraction**  
 Martin Prlic and Michael J. Bevan
- 16695 **Functional recognition of a distinct receptor preferential for leukotriene E<sub>4</sub> in mice lacking the cysteinyl leukotriene 1 and 2 receptors**  
Akiko Maekawa, Yoshihide Kanaoka, Wei Xing, and K. Frank Austen
- MEDICAL SCIENCES**
- 16701 **Increased substrate oxidation and mitochondrial uncoupling in skeletal muscle of endurance-trained individuals**  
 Douglas E. Befroy, Kitt Falk Petersen, Sylvie Dufour, Graeme F. Mason, Douglas L. Rothman, and Gerald I. Shulman
- 16707 **Striatal progenitors derived from human ES cells mature into DARPP32 neurons *in vitro* and in quinolinic acid-lesioned rats**  
Laetitia Aubry, Aurore Bugi, Nathalie Lefort, France Rousseau, Marc Peschanski, and Anselme L. Perrier
- 16713 **The ubiquitin ligase Siah2 regulates tumorigenesis and metastasis by HIF-dependent and -independent pathways**  
Jianfei Qi, Koh Nakayama, Supriya Gaitonde, James S. Goydos, Stan Krajewski, Alexey Eroshkin, Dafna Bar-Sagi, David Bowtell, and Ze'ev Ronai
- 16719 **Hec1 overexpression hyperactivates the mitotic checkpoint and induces tumor formation *in vivo***  
 Elena Diaz-Rodríguez, Rocio Sotillo, Juan-Manuel Schwartzman, and Robert Benezra
- MICROBIOLOGY**
- 16725 **HIV rebounds from latently infected cells, rather than from continuing low-level replication**  
Beda Joos, Marek Fischer, Herbert Kuster, Satish K. Pillai, Joseph K. Wong, Jürg Böni, Bernard Hirschel, Rainer Weber, Alexandra Trkola, Huldrych F. Günthard, and The Swiss HIV Cohort Study
- 16731 ***Faecalibacterium prausnitzii* is an anti-inflammatory commensal bacterium identified by gut microbiota analysis of Crohn disease patients**  
Harry Sokol, Bénédicte Pigneur, Laurie Watterlot, Omar Lakhdari, Luis G. Bermúdez-Humarán, Jean-Jacques Gratadoux, Sébastien Blugeon, Chantal Bridonneau, Jean-Pierre Furet, Gérard Corthier, Corinne Grangette, Nadia Vasquez, Philippe Pochart, Germain Trugnan, Ginette Thomas, Hervé M. Blottière, Joël Doré, Philippe Marteau, Philippe Seksik, and Philippe Langella  
→ See Commentary on page 16413
- 16737 **Chromosome replication dynamics in the archaeon *Sulfolobus acidocaldarius***  
Iain G. Duggin, Simon A. McCallum, and Stephen D. Bell
- 16743 **Roles of RIG-I N-terminal tandem CARD and splice variant in TRIM25-mediated antiviral signal transduction**  
Michaela U. Gack, Axel Kirchhofer, Young C. Shin, Kyung-Soo Inn, Chengyu Liang, Sheng Cui, Sua Myong, Taekjip Ha, Karl-Peter Hopfner, and Jae U. Jung
- 16749 **A host dicer is required for defective viral RNA production and recombinant virus vector RNA instability for a positive sense RNA virus**  
 Xuemin Zhang and Donald L. Nuss
- 16755 **Induction of group A *Streptococcus* virulence by a human antimicrobial peptide**  
Ioannis Gryllos, Hien J. Tran-Winkler, Ming-Fang Cheng, Hachung Chung, Robert Bolcome III, Wuyuan Lu, Robert I. Lehrer, and Michael R. Wessels
- 16761 **The potential of desferrioxamine-gallium as an anti-*Pseudomonas* therapeutic agent**  
Ehud Banin, Alina Lozinski, Keith M. Brady, Eduard Berenshtein, Phillip W. Butterfield, Maya Moshe, Mordechai Chevion, Everett Peter Greenberg, and Eyal Banin
- 16767 **Effects of the gut microbiota on host adiposity are modulated by the short-chain fatty-acid binding G protein-coupled receptor, Gpr41**  
 Buck S. Samuel, Abdullah Shaito, Toshiyuki Motoike, Federico E. Rey, Fredrik Backhed, Jill K. Manchester, Robert E. Hammer, S. Clay Williams, Jan Crowley, Masashi Yanagisawa, and Jeffrey I. Gordon
- NEUROSCIENCE**
- 16773 **Activation of P2X7 receptors in glial satellite cells reduces pain through downregulation of P2X3 receptors in nociceptive neurons**  
Yong Chen, Xiaofei Zhang, Congying Wang, GuangWen Li, Yanping Gu, and Li-Yen Mae Huang
- 16779 **Vulnerability of white matter towards antenatal hypoxia is linked to a species-dependent regulation of glutamate receptor subunits**  
Romain H. Fontaine, Paul Olivier, Véronique Massonneau, Philippe Leroux, Vincent Degos, Sophie Lebon, Vincent El Ghouzzi, Vincent Lelièvre, Pierre Gressens, and Olivier Baud
- 16785 **Procedure for recording the simultaneous activity of single neurons distributed across cortical areas during sensory discrimination**  
 Adrián Hernández, Verónica Nacher, Rogelio Luna, Manuel Alvarez, Antonio Zainos, Silvia Cordero, Liliana Camarillo, Yuriria Vázquez, Luis Lemus, and Ranulfo Romo
- 16791 **A specialized NMDA receptor function in layer 5 recurrent microcircuitry of the adult rat prefrontal cortex**  
Huaixing Wang, George G. Stradtman III, Xiao-Jing Wang, and Wen-Jun Gao

16797 **Delayed plasticity of inhibitory neurons in developing visual cortex**  
Sunil P. Gandhi, Yuchio Yanagawa, and Michael P. Stryker

16803 **Sequential development of synapses in dendritic domains during adult neurogenesis**  
 Wolfgang Kelsch, Chia-Wei Lin, and Carlos Lois

#### PHARMACOLOGY

16809 **Identification of a new JNK inhibitor targeting the JNK-JIP interaction site**  
 John L. Stebbins, Surya K. De, Thomas Machleidt, Barbara Becattini, Jesus Vazquez, Christian Kuntzen, Li-Hsing Chen, Jason F. Cellitti, Megan Riel-Mehan, Aras Emdadi, Giovanni Solinas, Michael Karin, and Maurizio Pellecchia

#### PLANT BIOLOGY

16814 **Submergence tolerance conferred by *Sub1A* is mediated by SLR1 and SLRL1 restriction of gibberellin responses in rice**  
Takeshi Fukao and Julia Bailey-Serres

#### CORRECTION

#### NEUROSCIENCE

16820 **Structural plasticity with preserved topology in the postsynaptic protein network**  
Thomas A. Blanpied, Justin M. Kerr, and Michael D. Ehlers

xiii–xiv Author Index

xv Subscription Form