



**Cover image:** Artist's conception of the impact of climate change on global agriculture and forestry. One of the challenges of the 21st century will be to increase food and timber supply to accommodate a human population of 10 billion while undergoing climate change. Success will require a steady stream of technical and institutional innovations. See the articles on pages 19680–19714, in which the lead authors of the chapter on food, fiber, and forestry in the recently released Fourth Assessment Report of the Intergovernmental Panel on Climate Change amplify their findings. Image courtesy of Glynn Gorick.

## From the Cover

- 19679 Food and forestry for a warming planet
- 19745 Prehistoric jade trade
- 19762 Altruistic marmosets
- 20061 Old sensation, new location

## Contents

### THIS WEEK IN PNAS

19657 **In This Issue**

### COMMENTARIES

19659 **Microscopic evidence for the domestication and spread of maize**

Vaughn M. Bryant, Jr.

→ See companion article on page 17608 in issue 45 of volume 104

19661 **New apes fill the gap**

Raymond L. Bernor

→ See companion article on page 19220 in issue 49 of volume 104

19663 **Neuro-anatomic evidence for the maturational delay hypothesis of ADHD**

Katya Rubia

→ See companion article on page 19649 in issue 49 of volume 104

### PROFILES

19665 **Profile of Steven Henikoff**

Beth Azar

→ See Inaugural Article on page 15974 in issue 41 of volume 104

19668 **Profile of Joachim Frank**

Kasper Mossman

→ See Inaugural Article on page 19671

### INAUGURAL ARTICLE

19671 **The process of mRNA–tRNA translocation**

Joachim Frank, Haixiao Gao, Jayati Sengupta, Ning Gao, and Derek J. Taylor

→ See Profile on page 19668

### CLIMATE CHANGE AND FOOD SECURITY SPECIAL FEATURE

#### PERSPECTIVE

19679 **Climate change and the adequacy of food and timber in the 21st century**

William E. Easterling

#### RESEARCH ARTICLES

19680 **The impact of climate change on smallholder and subsistence agriculture**

John F. Morton

19686 **Crop and pasture response to climate change**

Francesco N. Tubiello, Jean-François Soussana, and S. Mark Howden

19691 **Adapting agriculture to climate change**

S. Mark Howden, Jean-François Soussana, Francesco N. Tubiello, Netra Chhetri, Michael Dunlop, and Holger Meinke

19697 **Climate change impacts on forestry**

Andrei P. Kirilenko and Roger A. Sedjo



Freely available online through the PNAS open access option.

- 19703 **Global food security under climate change**  
Josef Schmidhuber and Francesco N. Tubiello
- 19709 **Global fish production and climate change**  
K. M. Brander

## PHYSICAL SCIENCES

### CHEMISTRY

- 19715 **Adiabatic operation of a molecular machine**  
R. Dean Astumian

### ENGINEERING

- 19885 **Circuit theory predicts gene flow in plant and animal populations**  
Brad H. McRae and Paul Beier

### ENVIRONMENTAL SCIENCES

- 19719 **Changes in severe thunderstorm environment frequency during the 21st century caused by anthropogenically enhanced global radiative forcing**  
Robert J. Trapp, Noah S. Diffenbaugh, Harold E. Brooks, Michael E. Baldwin, Eric D. Robinson, and Jeremy S. Pal

### GEOLOGY

- 19724 **Perennial stream discharge in the hyperarid Atacama Desert of northern Chile during the latest Pleistocene**  
Peter L. Nester, Eugenia Gayó, Claudio Latorre, Teresa E. Jordan, and Nicolás Blanco

### GEOPHYSICS

- 19730 **Observational evidence for volcanic impact on sea level and the global water cycle**  
A. Grinsted, J. C. Moore, and S. Jevrejeva

### MATHEMATICS

- 19735 **The heat kernel as the pagerank of a graph**  
Fan Chung

### STATISTICS

- 19741 **Scaling and efficiency determine the irreversible evolution of a market**  
F. Baldovin and A. L. Stella

## SOCIAL SCIENCES


### ANTHROPOLOGY

- 19745 **Ancient jades map 3,000 years of prehistoric exchange in Southeast Asia**  
Hsiao-Chun Hung, Yoshiyuki Iizuka, Peter Bellwood, Kim Dung Nguyen, Bérénice Bellina, Praon Silapanth, Eusebio Dizon, Rey Santiago, Ipoi Datan, and Jonathan H. Manton

### ECONOMIC SCIENCES

- 19741 **Scaling and efficiency determine the irreversible evolution of a market**  
F. Baldovin and A. L. Stella

## PSYCHOLOGY

- 19751 **The hidden structure of overimitation**  
 Derek E. Lyons, Andrew G. Young, and Frank C. Keil
- 19757 **Subliminal exposure to national flags affects political thought and behavior**  
Ran R. Hassin, Melissa J. Ferguson, Daniella Shidlovski, and Tamar Gross

## SOCIAL SCIENCES

- 19680 **The impact of climate change on smallholder and subsistence agriculture**  
John F. Morton
- 19762 **Other-regarding preferences in a non-human primate: Common marmosets provision food altruistically**  
Judith M. Burkart, Ernst Fehr, Charles Efferson, and Carel P. van Schaik

## BIOLOGICAL SCIENCES

### AGRICULTURAL SCIENCES

- 19680 **The impact of climate change on smallholder and subsistence agriculture**  
John F. Morton
- 19686 **Crop and pasture response to climate change**  
Francesco N. Tubiello, Jean-François Soussana, and S. Mark Howden
- 19691 **Adapting agriculture to climate change**  
S. Mark Howden, Jean-François Soussana, Francesco N. Tubiello, Netra Chhetri, Michael Dunlop, and Holger Meinke


### ANTHROPOLOGY

- 19762 **Other-regarding preferences in a non-human primate: Common marmosets provision food altruistically**  
Judith M. Burkart, Ernst Fehr, Charles Efferson, and Carel P. van Schaik

### BIOCHEMISTRY

- 19767 **Structure, inhibitor, and regulatory mechanism of Lyp, a lymphoid-specific tyrosine phosphatase implicated in autoimmune diseases**  
Xiao Yu, Jin-Peng Sun, Yantao He, Xiaoling Guo, Sijiu Liu, Bo Zhou, Andy Hudmon, and Zhong-Yin Zhang
- 19773 **Hyperpolarized <sup>13</sup>C allows a direct measure of flux through a single enzyme-catalyzed step by NMR**  
Matthew E. Merritt, Crystal Harrison, Charles Storey, F. Mark Jeffrey, A. Dean Sherry, and Craig R. Malloy

- 19778 **Monomeric myosin V uses two binding regions for the assembly of stable translocation complexes**  
Alexander Heuck, Tung-Gia Du, Stephan Jellbauer, Klaus Richter, Claudia Kruse, Sigrun Jaklin, Marisa Müller, Johannes Buchner, Ralf-Peter Jansen, and Dierk Niessing

- 19784 **Structural insight into distinct mechanisms of protease inhibition by antibodies**  
 Yan Wu, Charles Eigenbrot, Wei-Ching Liang, Scott Stawicki, Steven Shia, Bin Fan, Rajkumar Ganesan, Michael T. Lipari, and Daniel Kirchhofer

19790 **Real-time observation of bacteriophage T4 gp41 helicase reveals an unwinding mechanism**  
 Timothée Lionnet, Michelle M. Spiering, Stephen J. Benkovic, David Bensimon, and Vincent Croquette

19796 **Insulin stimulates the cleavage and release of the extracellular domain of Klotho by ADAM10 and ADAM17**  
 Ci-Di Chen, Sonia Podvin, Earl Gillespie, Susan E. Leeman, and Carmela R. Abraham

19802 **Structural basis for reduced FGFR2 activity in LADD syndrome: Implications for FGFR autoinhibition and activation**  
 Erin D. Lew, Jae Hyun Bae, Edyta Rohmann, Bernd Wollnik, and Joseph Schlessinger

### BIOPHYSICS

19671 **The process of mRNA-tRNA translocation**  
 Joachim Frank, Haixiao Gao, Jayati Sengupta, Ning Gao, and Derek J. Taylor  
 → See Profile on page 19668

19808 **Metabotyping of *Caenorhabditis elegans* reveals latent phenotypes**  
 Benjamin J. Blaise, Jean Giacomotto, Bénédicte Elena, Marc-Emmanuel Dumas, Pierre Toulhoat, Laurent Ségalat, and Lyndon Emsley

19813 **Principles underlying energetic coupling along an allosteric communication trajectory of a voltage-activated K<sup>+</sup> channel**  
 Evgeniya Sadovsky and Ofer Yifrach

19819 **Localizing frustration in native proteins and protein assemblies**  
 Diego U. Ferreira, Joseph A. Hegler, Elizabeth A. Komives, and Peter G. Wolynes

19825 **Consequences of localized frustration for the folding mechanism of the IM7 protein**  
 Ludovico Sutto, Joachim Lätzer, Joseph A. Hegler, Diego U. Ferreira, and Peter G. Wolynes

19831 **How processing of aspartylphosphate is coupled to luminal gating of the ion pathway in the calcium pump**  
 Chikashi Toyoshima, Yoshiyuki Norimatsu, Shiho Iwasawa, Takeo Tsuda, and Haruo Ogawa

### CELL BIOLOGY

19837 **ERK MAP kinase is targeted to RSK2 by the phosphoprotein PEA-15**  
 Hema Vaidyanathan, John Opoku-Ansah, Sandra Pastorino, Hema Renganathan, Michelle L. Matter, and Joe W. Ramos

19843 **A role for the inositol kinase Ipk1 in ciliary beating and length maintenance**  
 Bhaskarjyoti Sarmah, Virginia P. Winfrey, Gary E. Olson, Bruce Appel, and Susan R. Wentz


19849 **The interplay between the master transcription factor PU.1 and miR-424 regulates human monocyte/macrophage differentiation**  
 A. Rosa, M. Ballarino, A. Sorrentino, O. Sthandier, F. G. De Angelis, M. Marchioni, B. Masella, A. Guarini, A. Fatica, C. Peschle, and I. Bozzoni

19855 **Profiling of UV-induced ATM/ATR signaling pathways**  
 Matthew P. Stokes, John Rush, Joan MacNeill, Jian Min Ren, Kam Sprott, Julie Nardone, Vicky Yang, Sean A. Beausoleil, Steven P. Gygi, Mark Livingstone, Hui Zhang, Roberto D. Polakiewicz, and Michael J. Comb

19861 **Runx2 deficiency and defective subnuclear targeting bypass senescence to promote immortalization and tumorigenic potential**  
 Sayyed K. Zaidi, Sandhya Pande, Jitesh Pratap, Tripti Gaur, Simina Grigoriu, Syed A. Ali, Janet L. Stein, Jane B. Lian, Andre J. van Wijnen, and Gary S. Stein

19867 **Control of mitotic exit by PP2A regulation of Cdc25C and Cdk1**  
 Craig M. Forester, Jessica Maddox, Justin V. Louis, Jozef Goris, and David M. Virshup

### DEVELOPMENTAL BIOLOGY

19873 **The origin of islet-like cells in *Drosophila* identifies parallels to the vertebrate endocrine axis**  
 Shu Wang, Natalia Tulina, Daniel L. Carlin, and Eric J. Rulifson

19879 **Sonic Hedgehog promotes the development of multipotent neural crest progenitors endowed with both mesenchymal and neural potentials**  
 Giordano W. Calloni, Corinne Glavieux-Pardanaud, Nicole M. Le Douarin, and Elisabeth Dupin

### ECOLOGY

19724 **Perennial stream discharge in the hyperarid Atacama Desert of northern Chile during the latest Pleistocene**  
 Peter L. Nester, Eugenia Gayó, Claudio Latorre, Teresa E. Jordan, and Nicolás Blanco

19885 **Circuit theory predicts gene flow in plant and animal populations**  
 Brad H. McRae and Paul Beier


19891 **The modularity of pollination networks**  
 Jens M. Olesen, Jordi Bascompte, Yoko L. Dupont, and Pedro Jordano

19897 **Exceptionally well preserved late Quaternary plant and vertebrate fossils from a blue hole on Abaco, The Bahamas**  
 David W. Steadman, Richard Franz, Gary S. Morgan, Nancy A. Albury, Brian Kakuk, Kenneth Broad, Shelley E. Franz, Keith Tinker, Michael P. Pateman, Terry A. Lott, David M. Jarzen, and David L. Dilcher

### EVOLUTION

19903 **Rapid diversification and dispersal during periods of global warming by plethodontid salamanders**  
 David R. Vieites, Mi-Sook Min, and David B. Wake

19908 **Nucleomorph genome of *Hemiselmis andersenii* reveals complete intron loss and compaction as a driver of protein structure and function**  
 Christopher E. Lane, Krystal van den Heuvel, Catherine Kozera, Bruce A. Curtis, Byron J. Parsons, Sharen Bowman, and John M. Archibald

19914 **Competitive release and facilitation of drug-resistant parasites after therapeutic chemotherapy in a rodent malaria model**  
 Andrew R. Wargo, Silvie Huijben, Jacobus C. de Roode, James Shephard, and Andrew F. Read

- 19920 **A portrait of copy-number polymorphism in *Drosophila melanogaster***  
Erik B. Dopman and Daniel L. Hartl
- 19926 **Genetic drift at expanding frontiers promotes gene segregation**  
Oskar Hallatschek, Pascal Hersen, Sharad Ramanathan, and David R. Nelson

#### GENETICS

- 19931 **Input–output robustness in simple bacterial signaling systems**  
Guy Shinar, Ron Milo, María Rodríguez Martínez, and Uri Alon
- 19936 **Identification of genotype-correlated sensitivity to selective kinase inhibitors by using high-throughput tumor cell line profiling**  
Ultan McDermott, Sreenath V. Sharma, Lori Dowell, Patricia Greninger, Clara Montagut, Jennifer Lamb, Heidi Archibald, Raul Raudales, Angela Tam, Diana Lee, S. Michael Rothenberg, Jeffrey G. Supko, Raffaella Sordella, Lindsey E. Ulkus, A. John Iafrate, Shyamala Maheswaran, Ching Ni Njauw, Hensin Tsao, Lisa Drew, Jeff H. Hanke, Xiao-Jun Ma, Mark G. Erlander, Nathanael S. Gray, Daniel A. Haber, and Jeffrey Settleman
- 19942 **Runs of homozygosity reveal highly penetrant recessive loci in schizophrenia**  
Todd Lencz, Christophe Lambert, Pamela DeRosse, Katherine E. Burdick, T. Vance Morgan, John M. Kane, Raju Kucherlapati, and Anil K. Malhotra
- 19948 **Protein characterization of *Saccharomyces cerevisiae* RNA polymerase II after *in vivo* cross-linking**  
Daniel F. Tardiff, Katharine C. Abruzzi, and Michael Rosbash

#### IMMUNOLOGY

- 19954 **Allograft rejection mediated by memory T cells is resistant to regulation**  
Jaeseok Yang, Matthew O. Brook, Manuela Carvalho-Gaspar, Jidong Zhang, Hilda E. Ramon, Mohamed H. Sayegh, Kathryn J. Wood, Laurence A. Turka, and Nick D. Jones
- 19960 **Dramatic increase in naïve T cell turnover is linked to loss of naïve T cells from old primates**  
Luka Čičin-Šain, Ilhem Messaoudi, Byung Park, Noreen Currier, Shannon Planer, Miranda Fischer, Shane Tackitt, Dragana Nikolich-Zugich, Alfred Legasse, Michael K. Axthelm, Louis J. Picker, Motomi Mori, and Janko Nikolich-Zugich
- 19966 **Protective effect of noninherited maternal HLA-DR antigens on rheumatoid arthritis development**  
Anouk L. Feitsma, Jane Worthington, Annette H. M. van der Helm-van Mil, Darren Plant, Wendy Thomson, Jennie Ursum, Dirkjan van Schaardenburg, Irene E. van der Horst-Bruinsma, Jon J. van Rood, Tom W. J. Huizinga, René E. M. Toes, and René R. P. de Vries

#### MEDICAL SCIENCES

- 19971 **MicroRNA expression signatures accurately discriminate acute lymphoblastic leukemia from acute myeloid leukemia**  
Shuangli Mi, Jun Lu, Miao Sun, Zejuan Li, Hao Zhang, Mary Beth Neilly, Yungui Wang, Zhijian Qian, Jie Jin, Yanming Zhang, Stefan K. Bohlander, Michelle M. Le Beau, Richard A. Larson, Todd R. Golub, Janet D. Rowley, and Jianjun Chen

- 19977 **Mast cells are an essential hematopoietic component for polyp development**  
Elias Gounaris, Susan E. Erdman, Clifford Restaino, Michael F. Gurish, Daniel S. Friend, Fotini Gounari, David M. Lee, Guoying Zhang, Jonathan N. Glickman, Kichul Shin, Varada P. Rao, Theofilos Poutahidis, Ralph Weissleder, Kelly M. McNagny, and Khashayarsha Khazaie
- 19983 **An androgen-regulated miRNA suppresses Bak1 expression and induces androgen-independent growth of prostate cancer cells**  
Xu-Bao Shi, Lingru Xue, Joy Yang, Ai-Hong Ma, Jianjun Zhao, Ma Xu, Clifford G. Tepper, Christopher P. Evans, Hsing-Jien Kung, and Ralph W. deVere White
- 19989 **Signal sequence mutation in autosomal dominant form of hypoparathyroidism induces apoptosis that is corrected by a chemical chaperone**  
Rupak Datta, Abdul Waheed, Gul N. Shah, and William S. Sly
- 19995 **In vitamin B<sub>12</sub> deficiency, higher serum folate is associated with increased total homocysteine and methylmalonic acid concentrations**  
Jacob Selhub, Martha Savaria Morris, and Paul F. Jacques
- 20001 **Effects of rearrangement and allelic exclusion of *JJAZ1/SUZ12* on cell proliferation and survival**  
Hui Li, XianYong Ma, Jinglan Wang, Jason Koontz, Marisa Nucci, and Jeffrey Sklar
- 20007 **Assessing the significance of chromosomal aberrations in cancer: Methodology and application to glioma**  
Rameen Beroukhim, Gad Getz, Leia Nghiemphu, Jordi Barretina, Teli Hsueh, David Linhart, Igor Vivanco, Jeffrey C. Lee, Julie H. Huang, Sethu Alexander, Jinyan Du, Tweeny Kau, Roman K. Thomas, Kinjal Shah, Horacio Soto, Sven Perner, John Prensner, Ralph M. DeBiasi, Francesca Demichelis, Charlie Hatton, Mark A. Rubin, Levi A. Garraway, Stan F. Nelson, Linda Liao, Paul Mischel, Tim F. Cloughesy, Matthew Meyerson, Todd A. Golub, Eric S. Lander, Ingo K. Mellinghoff, and William R. Sellers
- 20013 **The preleukemic state of mice reconstituted with *Mixl1*-transduced marrow cells**  
Donald Metcalf, Stefan Glaser, Sandra Mifsud, Ladina Di Rago, and Lorraine Robb

#### MICROBIOLOGY


- 20019 **Recruitment of conjugative DNA transfer substrate to *Agrobacterium* type IV secretion apparatus**  
Minliang Guo, Shouguang Jin, Deying Sun, Choy L. Hew, and Shen Q. Pan
- 20025 **A herpesvirus ubiquitin-specific protease is critical for efficient T cell lymphoma formation**  
Keith Jarosinski, Lisa Kattenhorn, Benedikt Kaufer, Hidde Ploegh, and Nikolaus Osterrieder
- 20031 **Ubiquitin-dependent virus particle budding without viral protein ubiquitination**  
Maria Zhadina, Myra O. McClure, Marc C. Johnson, and Paul D. Bieniasz
- 20037 **Human cytomegalovirus uses two distinct pathways to enter retinal pigmented epithelial cells**  
Dai Wang, Qian-Chun Yu, Jörg Schröer, Eain Murphy, and Thomas Shenk

20043 **Mononeme: A new secretory organelle in *Plasmodium falciparum* merozoites identified by localization of rhomboid-1 protease**  
 Subhash Singh, Matthew Plassmeyer, Deepak Gaur, and Louis H. Miller


#### NEUROSCIENCE

20049 **RET signaling does not modulate MPTP toxicity but is required for regeneration of dopaminergic axon terminals**  
 Sebastian Kowsky, Charlotte Pöppelmeyer, Edgar R. Kramer, Björn H. Falkenburger, Anja Kruse, Rüdiger Klein, and Jörg B. Schulz

20055 **Trafficking-dependent phosphorylation of Kv1.2 regulates voltage-gated potassium channel cell surface expression**  
 Jae-Won Yang, Helene Vacher, Kang-Sik Park, Eliana Clark, and James S. Trimmer

20061 **Redirection of cutaneous sensation from the hand to the chest skin of human amputees with targeted reinnervation**  
 Todd A. Kuiken, Paul D. Marasco, Blair A. Lock, R. Norman Harden, and Julius P. A. Dewald

20067 **Deletion of the core-*H* region in mice abolishes the expression of three proximal odorant receptor genes in *cis***  
 Hirofumi Nishizumi, Kouhei Kumasaka, Nobuko Inoue, Ai Nakashima, and Hitoshi Sakano

20073 **Perceptual detection as a dynamical bistability phenomenon: A neurocomputational correlate of sensation**  
 Gustavo Deco, Mar Pérez-Sanagustín, Victor de Lafuente, and Ranulfo Romo

20078 **Two forces for arousal: Pitting hunger versus circadian influences and identifying neurons responsible for changes in behavioral arousal**  
 Ana C. Ribeiro, Evelyn Sawa, Isabelle Carren-LeSauter, Joseph LeSauter, Rae Silver, and Donald W. Pfaff


20084 **Neural correlates of trust**  
 Frank Krueger, Kevin McCabe, Jorge Moll, Nikolaus Kriegeskorte, Roland Zahn, Maren Strenziok, Armin Heinecke, and Jordan Grafman

20090 ***Homer1a* is a core brain molecular correlate of sleep loss**  
 Stéphanie Maret, Stéphane Dorsaz, Laure Gurcel, Sylvain Pradervand, Brice Petit, Corinne Pfister, Otto Hagenbuehle, Bruce F. O'Hara, Paul Franken, and Mehdi Tafti

#### PHARMACOLOGY

20096 **dsAAV type 2-mediated gene transfer of MOR5196A-EGFP into spinal cord as a pain management paradigm**  
 S. L. Chen, H. I. Ma, J. M. Han, P. L. Tao, P. Y. Law, and H. H. Loh

#### PHYSIOLOGY

20102 **A developmental cycle masks output from the circadian oscillator under conditions of choline deficiency in *Neurospora***  
 Mi Shi, Luis F. Larrondo, Jennifer J. Loros, and Jay C. Dunlap

20108 **Loss of skeletal muscle strength by ablation of the sarcoplasmic reticulum protein JP45**  
 Osvaldo Delbono, Jinyu Xia, Susan Treves, Zhong-Min Wang, Ramon Jimenez-Moreno, Anthony M. Payne, María Laura Messi, Alexandre Briguet, Florian Schaerer, Miyuki Nishi, Hiroshi Takeshima, and Francesco Zorzato

20114 **Skeletal muscle resists stretch by rapid binding of the second motor domain of myosin to actin**  
 Elisabetta Brunello, Massimo Reconditi, Ravikrishnan Elangovan, Marco Linari, Yin-Biao Sun, Theyencheri Narayanan, Pierre Panine, Gabriella Piazzesi, Malcolm Irving, and Vincenzo Lombardi

20120 **Phorbol ester stimulation of RasGRP1 regulates the sodium-chloride cotransporter by a PKC-independent pathway**  
 Benjamin Ko, Leena M. Joshi, Leslie L. Cooke, Norma Vazquez, Mark W. Musch, Steven C. Hebert, Gerardo Gamba, and Robert S. Hoover

#### PLANT BIOLOGY

20126 **A high-affinity molybdate transporter in eukaryotes**  
 Manuel Tejada-Jiménez, Ángel Llamas, Emanuel Sanz-Luque, Aurora Galván, and Emilio Fernández

20131 ***Pseudomonas syringae* type III effector AvrRpt2 alters *Arabidopsis thaliana* auxin physiology**  
 Zhongying Chen, Jennifer L. Agnew, Jerry D. Cohen, Ping He, Libo Shan, Jen Sheen, and Barbara N. Kunkel

#### PSYCHOLOGY

20137 **Anterior temporal lobes mediate semantic representation: Mimicking semantic dementia by using rTMS in normal participants**  
 Gorana Pobric, Elizabeth Jefferies, and Matthew A. Lambon Ralph

#### SUSTAINABILITY SCIENCE

19680 **The impact of climate change on smallholder and subsistence agriculture**  
 John F. Morton

19686 **Crop and pasture response to climate change**  
 Francesco N. Tubiello, Jean-François Soussana, and S. Mark Howden

19691 **Adapting agriculture to climate change**  
 S. Mark Howden, Jean-François Soussana, Francesco N. Tubiello, Netra Chhetri, Michael Dunlop, and Holger Meinke

19697 **Climate change impacts on forestry**  
 Andrei P. Kirilenko and Roger A. Sedjo

19703 **Global food security under climate change**  
 Josef Schmidhuber and Francesco N. Tubiello

19709 **Global fish production and climate change**  
 K. M. Brander

#### CORRECTIONS

#### IN THIS ISSUE, MEDICAL SCIENCES

20142 **Carvedilol sidesteps G proteins**

**PERSPECTIVE**

- 20142 **Powering the planet: Chemical challenges in solar energy utilization**  
Nathan S. Lewis and Daniel G. Nocera

**BIOPHYSICS**

- 20142 **Drift and breakup of spiral waves in reaction–diffusion–mechanics systems**  
A. V. Panfilov, R. H. Keldermann, and M. P. Nash

**DEVELOPMENTAL BIOLOGY**

- 20143 **Unique germ-line organelle, nuage, functions to repress selfish genetic elements in *Drosophila melanogaster***  
Ai Khim Lim and Toshie Kai

xi–xii Author Index

xiii Subscription Form

xiv Classified Advertisements