

SPECIAL SECTION

## Data Replication & Reproducibility

### INTRODUCTION

1225 Again, and Again, and Again...

### PERSPECTIVES

1226 Reproducible Research in Computational Science  
*R. D. Peng*

1227 Methodological Challenges in the Study of Primate Cognition  
*M. Tomasello and J. Call*

1229 Replication in Field Biology: The Case of the Frog-Eating Bat  
*M. J. Ryan*

1230 Improving Validation Practices in "Omics" Research  
*J. P. A. Ioannidis and M. J. Houry*

1232 The Reproducibility of Observational Estimates of Surface and Atmospheric Temperature Change  
*B. D. Santer et al.*

>> *Editorial p. 1182; News stories pp. 1194 and 1200; Readers' Poll p. 1203; Science Careers p. 1179; and [www.sciencemag.org/special/data-rep/](http://www.sciencemag.org/special/data-rep/)*



page 1194

### EDITORIAL

1182 Addressing Scientific Fraud  
*Jennifer Crocker and M. Lynne Cooper*  
>> *Retraction p. 1202; Data Replication & Reproducibility section p. 1225*

### NEWS OF THE WEEK

1186 A roundup of the week's top stories

### NEWS & ANALYSIS

1189 Dispute Over Lab Notebooks Lands Researcher in Jail

1191 Berkeley Engineering Students Demand Greater Effort to Promote Diversity

1192 Controversial Studies Give a Deadly Flu Virus Wings

### NEWS FOCUS

1194 Aging Genes: The Sirtuin Story Unravels  
>> *Data Replication & Reproducibility section p. 1225; Science Podcast*

1199 'Third Pole' Glacier Research Gets a Boost From China

1200 Where Does the Time Go?  
>> *Data Replication & Reproducibility section p. 1225*

### LETTERS

1202 Retraction  
*D. A. Stapel and S. Lindenberg*  
>> *Editorial p. 1182*

Lobsters at Bat  
*M. Mendelson*

Top-Flight Safety Model for Nuclear Industry  
*J. R. Skoyles*

Response  
*M. Bunn and O. Heinonen*

Readers' Poll: The Well-Behaved Scientist  
>> *Data Replication & Reproducibility section p. 1225*

### 1203 CORRECTIONS AND CLARIFICATIONS

### 1203 TECHNICAL COMMENT ABSTRACTS

### BOOKS ET AL.

1204 Some Suggestions for 2011—The SB&F/Subaru Prizes Finalists

1207 From the UK—Finalists for the Royal Society's Young People's Book Prize

1208 Browsers

### POLICY FORUM

1210 Better Data for a Better Internet  
*J. Palfrey and J. Zittrain*  
>> *Science Podcast*

### PERSPECTIVES

1212 Yeast Informs Alzheimer's Disease  
*L. McGurk and N. M. Bonini*  
>> *Research Article p. 1241*

1213 Quantum Correlation Between Distant Diamonds  
*L.-M. Duan*  
>> *Report p. 1253*

1214 Mathematical Dances with Wolves  
*S. J. Schreiber*  
>> *Report p. 1275*

1216 The Pristine Universe  
*G. G. Kacprzak*  
>> *Research Article p. 1245*

1217 Personalized Cancer Diagnostics  
*C. L. Corless*

1219 Warburg Effect and Redox Balance  
*R. B. Hamanaka and N. S. Chandel*  
>> *Report p. 1278*

1220 Experimenting with Buddies  
*M. J. van der Leij*  
>> *Report p. 1269*

CONTENTS continued >>



### COVER

As streams of data continue to grow in size and complexity, the need to ensure that scientific results are reliable has become even greater. The special section beginning on page 1225 and associated Editorial, News, Careers, and Readers' Poll features explore the opportunities and the challenges of replicating or reproducing data in a variety of fields.

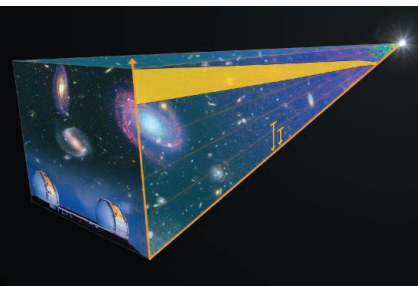
Image: [iStockphoto.com](http://iStockphoto.com)

### DEPARTMENTS

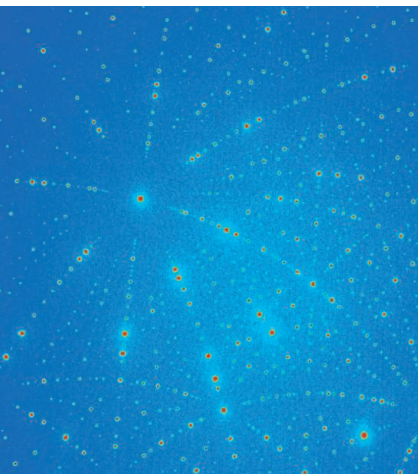
- 1180 This Week in *Science*
- 1183 Editors' Choice
- 1185 *Science* Staff
- 1298 New Products
- 1299 *Science* Careers



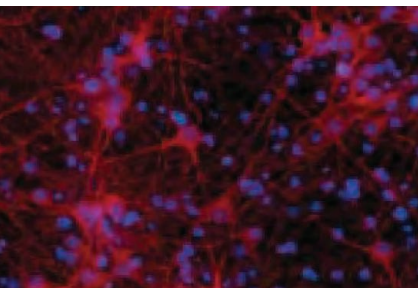
page 1204



pages 1216 &amp; 1245



page 1234



pages 1212 &amp; 1241

**GE PRIZE ESSAY**

- 1222 **Zoom!**  
*E. Lieberman Aiden*

**REVIEW**

- 1234 **The Race to X-ray Microbeam and Nanobeam Science**  
*G. E. Ice et al.*

**BREVIA**

- 1240 **The 2011 Tohoku-Oki Earthquake: Displacement Reaching the Trench Axis**  
*T. Fujiwara et al.*  
Vertical and horizontal displacement that occurred up to the Japan trench likely contributed to formation of the tsunami.

**RESEARCH ARTICLES**

- 1241 **Functional Links Between A $\beta$  Toxicity, Endocytic Trafficking, and Alzheimer's Disease Risk Factors in Yeast**  
*S. Treusch et al.*  
The use of yeast as a model organism reveals cellular factors involved in beta-amyloid toxicity.  
>> *Perspective p. 1212*
- 1245 **Detection of Pristine Gas Two Billion Years After the Big Bang**  
*M. Fumagalli et al.*  
Two cosmic clouds have been observed with a composition close to that of the universe before the first stars were formed.  
>> *Perspective p. 1216; Report p. 1250*

**REPORTS**

- 1250 **Protostellar Feedback Halts the Growth of the First Stars in the Universe**  
*T. Hosokawa et al.*  
Simulations suggest that most of the first stars in the universe might have been less massive than previously thought.  
>> *Research Article p. 1245*
- 1253 **Entangling Macroscopic Diamonds at Room Temperature**  
*K. C. Lee et al.*  
Optical pulses are used to quantum mechanically entangle two diamonds several centimeters apart.  
>> *Perspective p. 1213*
- 1256 **Enhancing Hydrogen Evolution Activity in Water Splitting by Tailoring Li<sup>+</sup>-Ni(OH)<sub>2</sub>-Pt Interfaces**  
*R. Subbaraman et al.*  
Combining two different types of catalysts accelerated the hydrogen-generation step in water electrolysis.
- 1261 **The Role of Carbon Dioxide During the Onset of Antarctic Glaciation**  
*M. Pagani et al.*  
Antarctica glaciation began soon after a large decrease in the concentration of atmospheric carbon dioxide around 35 million years ago.
- 1265 **Interhemispheric Ice-Sheet Synchronicity During the Last Glacial Maximum**  
*M. E. Weber et al.*  
Part of the East Antarctic Ice Sheet advanced and retreated in synchrony with Northern Hemispheric ice sheets.
- 1269 **An Experimental Study of Homophily in the Adoption of Health Behavior**  
*D. Centola*  
Greater similarity of paired obese participants in an online network increased access to and adoption of health behaviors.  
>> *Perspective p. 1220*
- 1272 **Specialized Face Learning Is Associated with Individual Recognition in Paper Wasps**  
*M. J. Sheehan and E. A. Tibbetts*  
Social wasps that can discriminate faces are specialized for facial learning, whereas other closely related species are not.  
>> *Science Podcast*
- 1275 **Modeling Effects of Environmental Change on Wolf Population Dynamics, Trait Evolution, and Life History**  
*T. Coulson et al.*  
Analysis of a 20-year data set on Yellowstone wolves reveals that environmental change generates eco-evolutionary responses.  
>> *Perspective p. 1214*
- 1278 **Inhibition of Pyruvate Kinase M2 by Reactive Oxygen Species Contributes to Cellular Antioxidant Responses**  
*D. Anastasiou et al.*  
The glycolytic metabolism of cancers differs from normal tissues, allowing tumor cells to survive under oxidative stress.  
>> *Perspective p. 1219*
- 1283 **Hemoglobins S and C Interfere with Actin Remodeling in *Plasmodium falciparum*-Infected Erythrocytes**  
*M. Cyrklaff et al.*  
The malaria parasite mines actin from the membrane skeleton of its erythrocyte host to generate a cytoskeletal structure.
- 1286 **Robust Crossover Assurance and Regulated Interhomolog Access Maintain Meiotic Crossover Number**  
*S. Rosu et al.*  
DNA breaks that drive crossing over between chromosomes in meiosis are tightly regulated in space and time.
- 1289 **Increasing the Potency and Breadth of an HIV Antibody by Using Structure-Based Rational Design**  
*R. Diskin et al.*  
Structural analysis of an HIV antibody reveals residues important for neutralization breadth and potency.
- 1293 **The Intraepithelial T Cell Response to NKG2D-Ligands Links Lymphoid Stress Surveillance to Atopy**  
*J. Strid et al.*  
Epidermal abrasion and T cells in the skin work together to drive the type of immune responses seen in allergy and asthma.

## SCIENCEONLINE

## SCIENCEEXPRESS

[www.scienceexpress.org](http://www.scienceexpress.org)

### Voyager Measurements of Hydrogen Lyman- $\alpha$ Diffuse Emission from the Milky Way

R. Lallement et al.

This emission, observed in other galaxies mainly from regions around newborn stars, has now been detected in our galaxy.

10.1126/science.1197340

### Voyagers of Discovery

J. L. Linsky

10.1126/science.1200166

### Isotopic Evidence for Massive Oxidation of Organic Matter Following the Great Oxidation Event

L. R. Kump et al.

Analysis of two-billion-year-old rocks revealed an extreme carbon-cycle disruption after atmospheric oxygen increased.

10.1126/science.1213999

### Candle Soot as a Template for Transparent Robust Superamphiphobic Coating

X. Deng et al.

Coatings that are highly resistant to water and to hydrocarbons can be made starting from candle soot.

10.1126/science.1207115

### The Hedgehog Pathway Promotes Blood-Brain Barrier Integrity and CNS Immune Quiescence

J. I. Alvarez et al.

Hedgehog signaling is required for maintaining the integrity of the blood-brain barrier.

10.1126/science.1206936

### RNA Elimination Machinery Targeting Meiotic mRNAs Promotes Facultative Heterochromatin Formation

M. Zofall et al.

RNA processing factors regulate the assembly of heterochromatin at individual gene loci in fission yeast.

10.1126/science.1211651

## TECHNICALCOMMENTS

### Comment on "Preserved Feedforward But Impaired Top-Down Processes in the Vegetative State"

J.-R. King et al.

Full text at [www.sciencemag.org/cgi/content/full/334/6060/1203-d](http://www.sciencemag.org/cgi/content/full/334/6060/1203-d)

### Response to Comment on "Preserved Feedforward But Impaired Top-Down Processes in the Vegetative State"

M. Boly et al.

Full text at [www.sciencemag.org/cgi/content/full/334/6060/1203-e](http://www.sciencemag.org/cgi/content/full/334/6060/1203-e)

## SCIENCENOW

[www.sciencenow.org](http://www.sciencenow.org)

Highlights From Our Daily News Coverage

### Baffling Failure of Vaginal Gel Laced With Anti-HIV Drug

Negative results bring a large study in sub-Saharan Africa to an early end.

[http://scim.ag/Anti-HIV\\_Drug](http://scim.ag/Anti-HIV_Drug)

### Ladybugs Changed Color in Response to Climate Change

The bugs' switch from heat-absorbing black to cooler red coincides with warming temperatures.

<http://scim.ag/Ladybugs-Color>

### Transplanted Neurons Curb Obesity

Fetal cells rewire a brain circuit and ramp up metabolism in mice.

[http://scim.ag/Neurons\\_Obesity](http://scim.ag/Neurons_Obesity)

## SCIENCE SIGNALING

[www.sciencesignaling.org](http://www.sciencesignaling.org)

The Signal Transduction Knowledge Environment

29 November issue: <http://scim.ag/ss112911>

### RESEARCH ARTICLE: $G\alpha_{i2}$ Signaling Promotes Skeletal Muscle Hypertrophy, Myoblast Differentiation, and Muscle Regeneration

G. C. Minetti et al.

### PERSPECTIVE: Making Muscles Grow by G Protein-Coupled Receptor Signaling

D. C. Guttridge

Signaling through  $G\alpha_{i2}$  induces hypertrophy and can counterbalance pathways that promote muscle wasting.

### RESEARCH ARTICLE: A Targeted siRNA Screen Identifies Regulators of Cdc42 Activity at the Natural Killer Cell Immunological Synapse

L. M. Carlin et al.

The oscillating activity of a cytoskeletal regulator enables natural killer cells to effectively kill their targets.

### RESEARCH RESOURCE: SH3 Domain-Based Phototrapping in Living Cells Reveals Rho Family GAP Signaling Complexes

H. Okada et al.

Domain-based proteomics analysis identifies binding partners and potential functions for cytoskeletal regulators.

### REVIEW: A Brand New START—Abscisic Acid Perception and Transduction in the Guard Cell

A. Joshi-Saha et al.

Understanding how plants respond to the hormone abscisic acid provides targets for designing crops resilient to drought.

## PODCAST

G. E. Breitwieser and A. M. VanHook

Activation of the calcium-sensing receptor promotes its trafficking to the cell surface and enhances signaling.

## SCIENCE TRANSLATIONAL MEDICINE

[www.sciencetranslationalmedicine.org](http://www.sciencetranslationalmedicine.org)

Integrating Medicine and Science

30 November issue: <http://scim.ag/stm113011>

### COMMENTARY: Testing the Right Target and Right Drug at the Right Stage

R. A. Sperling et al.

Drugs targeting early Alzheimer's disease should be tested in patients a decade before dementia onset.

### PERSPECTIVE: miRNA Processing and Human Cancer—DICER1 Cuts the Mustard

A. Bahubeshi et al.

Defects in the microRNA processing machinery have emerged as players in numerous tumor types and possible therapeutic targets.

### RESEARCH ARTICLE: The PDL1-PD1 Axis Converts Human $T_H1$ Cells into Regulatory T Cells

S. Amarnath et al.

The inhibitory ligand PDL1 transforms immune cells from attackers into regulators.

### RESEARCH ARTICLE: Personalized Oncology Through Integrative High-Throughput Sequencing—A Pilot Study

S. Roychowdhury et al.

Mutations in advanced cancers identified by integrative high-throughput sequencing will enable biomarker-driven clinical trials.

## SCIENCE CAREERS

[www.sciencereers.org/career\\_magazine](http://www.sciencereers.org/career_magazine)

Free Career Resources for Scientists

### To Replicate or Not to Replicate?

M. Price

Graduate students need to decide whether to spend time replicating other scientists' data.

[http://scim.ag/Data\\_Replication](http://scim.ag/Data_Replication)

>> *Data Replication & Reproducibility section p. 1225*

### Taken for Granted: A Blueprint for Safety Action Now

B. L. Benderly

The Chemical Safety Board's report on the Texas Tech explosion is essential reading for principal investigators.

[http://scim.ag/TFG\\_Safety](http://scim.ag/TFG_Safety)

### Science in the Military

R. Pidcock

From oceanography to artificial intelligence, there is a host of opportunities for early-career scientists within the United States armed forces.

[http://scim.ag/Military\\_Careers](http://scim.ag/Military_Careers)

## SCIENCEPODCAST

[www.sciencemag.org/multimedia/podcast](http://www.sciencemag.org/multimedia/podcast)

Free Weekly Show

On the 2 December *Science* Podcast: facial recognition in wasps, improving the quality of Internet data, sirtuins and the biology of aging, and more.

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals Mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2011 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership and subscription (51 issues): \$149 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$990; Foreign postage extra: Mexico, Caribbean (surface mail) \$55; other countries (air assist delivery) \$85. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request, GST #1254 88122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$10.00 current issue, \$15.00 back issue prepaid includes surface postage; bulk rates on request. Authorization to photocopy material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act is granted by AAAS to libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that \$25.00 per article is paid directly to CCC, 222 Rosewood Drive, Danvers, MA 01923. The identification code for *Science* is 0036-8075. *Science* is indexed in the *Reader's Guide to Periodical Literature* and in several specialized indexes.



ADVANCING SCIENCE. SERVING SOCIETY

# Science

**334 (6060)**

*Science* **334** (6060), 1180-1298.

**ARTICLE TOOLS**

<http://science.sciencemag.org/content/334/6060>

**PERMISSIONS**

<http://www.sciencemag.org/help/reprints-and-permissions>

Use of this article is subject to the [Terms of Service](#)

---

*Science* (print ISSN 0036-8075; online ISSN 1095-9203) is published by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005. 2017 © The Authors, some rights reserved; exclusive licensee American Association for the Advancement of Science. No claim to original U.S. Government Works. The title *Science* is a registered trademark of AAAS.