

SPECIAL SECTION

# Breakthrough of the Year

**INTRODUCTION**

1431 2013 Breakthrough of the Year

**WINNER**

1432 Cancer Immunotherapy

**RUNNERS-UP**

- 1434 Genetic Microsurgery for the Masses
- 1434 CLARITY Makes It Perfectly Clear
- 1436 Human Cloning at Last
- 1436 Dishing Up Mini-Organs
- 1438 Cosmic Particle Accelerators Identified
- 1438 Newcomer Juices Up the Race to Harness Sunlight
- 1440 To Sleep, Perchance to Clean
- 1440 Your Microbes, Your Health
- 1442 In Vaccine Design, Looks Do Matter

>> Editorial p. 1417; Science Careers; Science Podcast; slideshow and videos at <http://scim.ag/Breakthrough13>

**OTHER FEATURES**

- 1435 Dmanisi Skull Gives New Face to Early Human Ancestors
- 1435 The Rat That Ages Beautifully
- 1435 Top-Gear Planthopper
- 1437 Voyager Is Really Out There, Somewhere
- 1437 Chairman Smith Versus the Scientists
- 1439 Siberian Meteor Blast Delivers a Warning Shot
- 1439 U.S. High Court Bars Human Gene Patents
- 1441 Breakdowns of the Year
- 1441 Genomes of the Year
- 1441 Ribosome Robot
- 1442 How We Did in 2013 and ...
- 1443 ... Areas to Watch in 2014

**EDITORIAL**

- 1417 Cancer Immunotherapy  
*Marcia McNutt*  
>> Breakthrough of the Year section p. 1431

**NEWS OF THE WEEK**

1422 A roundup of the week's top stories

**NEWS & ANALYSIS**

- 1424 Mega-Eruptions Drove the Mother of Mass Extinctions
- 1425 Money Woes Cloud Future of Workhorse U.S. Telescopes
- 1426 U.S. Budget Deal Offers Researchers Some Sequester Relief
- 1427 Amid Superconductor Debate, Clash of Physics Titans Resumes
- 1428 Scientists Campaign Against Killer Robots
- 1430 Swine Flu Connection Provides Clues About Narcolepsy  
>> Science Translational Medicine  
*Research Article by A. K. De la Herrán-Arita et al.*

**LETTERS**

- 1445 Sea-Level Rise by 2100  
*J. A. Church et al.*  
Credit for Impact Theory  
*H. J. Melosh et al.*  
Social Security and Medicare in the Black  
*T. M. Gruenfelder*  
Mercury Toxicity in Children  
*P. J. Landrigan et al.*

**1446 CORRECTIONS AND CLARIFICATIONS**

**BOOKS ET AL.**

- 1448 Knowledge in the Time of Cholera  
*O. Whooley, reviewed by J. H. Warner*
- 1449 Birds and People  
*M. Cocker, reviewed by H. T. Armistead*

**EDUCATION FORUM**

- 1450 Open Learning at a Distance: Lessons for Struggling MOOCs  
*P. McAndrew and E. Scanlon*



page 1424

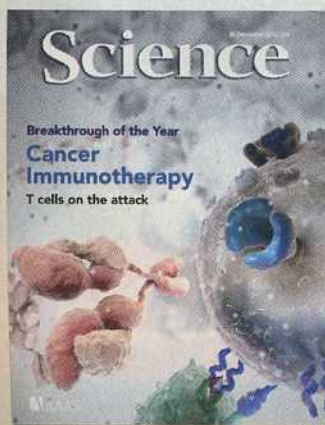
**PERSPECTIVES**

- 1452 How Cooperation Defeats Cheats  
*C. N. Spottiswoode*  
>> Report p. 1506
- 1453 A Common Pathway for a Rare Disease?  
*S. B. Vafai and V. K. Mootha*  
>> Report p. 1524
- 1454 No Barriers to Cellulose Breakdown  
*A. Berlin*  
>> Report p. 1513
- 1456 Genomic Clues to the Ancestral Flowering Plant  
*K. Adams*  
>> Research Articles pp. 1467 and 1468;  
Report p. 1516
- 1457 Enzyme Kinetics, Past and Present  
*X. S. Xie*
- 1459 Reformulating Table Salt Under Pressure  
*J. Ibáñez Insa*  
>> Report p. 1502
- 1460 Ronning After the Adiponectin Receptors  
*W. L. Holland and P. E. Scherer*

**CONTENTS** continued >>

**ON THE WEB THIS WEEK**

- >> **Science Podcast**  
Listen to a special show on this year's breakthrough, runners-up, and the top stories from our daily news site.
- >> **Breakthrough Online**  
Check out all the science highlights from 2013, including videos on the breakthrough, our genomes-of-the-year slideshow, and a special year-end podcast at [www.sciencemag.org](http://www.sciencemag.org).



**COVER**

Antibodies (pink) zoom toward a T cell (gray, with CTLA-4 receptor proteins shown in light blue), giving the T cell a push to attack tumor cells. In 2013, new therapies targeting the immune system to treat cancer surged ahead, with promising but still preliminary results in people with many forms of the disease. See the Breakthrough of the Year special section beginning on page 1431 and at <http://scim.ag/Breakthrough13>.

Image: Valerie Altounian/Science

**DEPARTMENTS**

- 1415 This Week in Science
- 1418 Editors' Choice
- 1420 Science Staff
- 1464 AAAS News & Notes
- 1529 New Products
- 1530 Science Careers

## SCIENCE PRIZE ESSAY

- 1462 **DNA Barcoding from NYC to Belize**  
S. E. Harris and M. Bellino

## RESEARCH ARTICLES

- 1467 **The *Amborella* Genome and the Evolution of Flowering Plants**  
*Amborella Genome Project*  
The *Amborella* genome retains features of the ancestral angiosperm and illuminates flowering plant genomic evolution.  
*Research Article Summary; for full text: <http://dx.doi.org/10.1126/science.1241089>*
- 1468 **Horizontal Transfer of Entire Genomes via Mitochondrial Fusion in the Angiosperm *Amborella***  
D. W. Rice et al.  
Much of the mitochondrial DNA genome of the flowering plant *Amborella trichopoda* originated from other organisms.  
>> *Perspective p. 1456; Report p. 1516*
- 1473 **Constraining Exoplanet Mass from Transmission Spectroscopy**  
J. de Wit and S. Seager  
The mass of an exoplanet can be derived based on the properties of its atmosphere.
- 1477 **Crystal Structure of a Soluble Cleaved HIV-1 Envelope Trimer**  
J.-P. Julien et al.
- 1484 **Cryo-EM Structure of a Fully Glycosylated Soluble Cleaved HIV-1 Envelope Trimer**  
D. Lyumkis et al.  
Key structural features dictate how the HIV envelope protein functions and interacts with the human immune system.

## REPORTS

- 1490 **Detection of Berry's Phase in a Bulk Rashba Semiconductor**  
H. Murakawa et al.  
Transport measurements indicate a nontrivial spin texture stemming from strong spin-orbit coupling in the material BiTeI.
- 1494 **Photon-Mediated Interactions Between Distant Artificial Atoms**  
A. F. van Loo et al.  
Interaction between two separated superconducting qubits can be mediated and controlled by microwaves.
- 1496 **Relaxation Mechanism of the Hydrated Electron**  
M. H. Elkins et al.  
Spectroscopy of excited-state hydrated electrons in a liquid jet implicates nonadiabatic relaxation.
- 1499 **Dynamical Resonances Accessible Only by Reagent Vibrational Excitation in the F + HD → HF + D Reaction**  
T. Wang et al.  
A protocol for efficient vibrational excitation enabled discovery of an unusual reaction trajectory in a well-studied system.

- 1502 **Unexpected Stable Stoichiometries of Sodium Chlorides**  
W. Zhang et al.  
Several phases in the Na-Cl system are stable at high pressures and temperatures.  
>> *Perspective p. 1459*
- 1506 **Brood Parasitism and the Evolution of Cooperative Breeding in Birds**  
W. E. Feeney et al.  
The skewed global distribution of cooperatively breeding birds may result from their coevolution with brood parasites.  
>> *Perspective p. 1452*
- 1508 **C57BL/6N Mutation in Cytoplasmic FMRP interacting protein 2 Regulates Cocaine Response**  
V. Kumar et al.  
Acute locomotor responses to cocaine differ significantly in the most widely used inbred strains of laboratory mice.
- 1513 **Revealing Nature's Cellulase Diversity: The Digestion Mechanism of *Caldicellulosiruptor bescii* CelA**  
R. Brunecky et al.  
Electron microscopy reveals that a cellulose-degrading enzyme operates by drilling down, as well as by roaming the surface.  
>> *Perspective p. 1454*
- 1516 **Assembly and Validation of the Genome of the Nonmodel Basal Angiosperm *Amborella***  
S. Chamala et al.  
Fluorescence in situ hybridization allows for next-generation sequencing of a large, difficult genome.  
>> *Perspective p. 1456; Research Articles pp. 1467 and 1468*
- 1518 **CRL4 Complex Regulates Mammalian Oocyte Survival and Reprogramming by Activation of TET Proteins**  
C. Yu et al.  
Continuing female fertility in mammals requires the function of a ubiquitin ligase complex in oocytes.
- 1521 **Serial Femtosecond Crystallography of G Protein-Coupled Receptors**  
W. Liu et al.  
The structure of a human serotonin receptor was solved using a free-electron laser to analyze microcrystals.
- 1524 **mTOR Inhibition Alleviates Mitochondrial Disease in a Mouse Model of Leigh Syndrome**  
S. C. Johnson et al.  
A drug in clinical use for other disorders delays progression of an untreatable mitochondrial disease in knockout mice.  
>> *Perspective p. 1453*



page 1448



page 1490

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 © 2013 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 \$30.00 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.