

EDITORIAL

- 489 Improving Education Standards
Janet Coffey and Bruce Alberts

NEWS OF THE WEEK

- 494 A roundup of the week's top stories

NEWS & ANALYSIS

- 497 Graphene and Brain Projects Win European Jackpot
- 498 If Budget Woes Continue, Panel Says DOE Should Shut Last U.S. Collider
- 499 Brain Studies Stymied by Statistics
- 500 The Psst That Pierced the Sky Is Now Churning the Sea
>> Reports pp. 563 and 568
- 501 Advisers Urge NIH to Scale Back Chimpanzee Research

NEWS FOCUS

- 502 A Worm Vaccine, Coming at a Snail's Pace
- 504 Tight Budgets Squeeze European Earth Observation
- 505 World's Biggest Health Care System Goes Under the Knife
A New Dawn for Mental Health

SPECIAL FEATURE

- 509 2012 International Science & Engineering Visualization Challenge
>> For related online content, go to www.sciencemag.org/special/vis2012; Science Podcast

LETTERS

- 520 Transmission Studies Resume for Avian Flu
R. A. M. Fouchier et al.
- Eco-Compensation for Giant Panda Habitat
B. Yang et al.
- Environmental Health Crucial to Food Safety
P. E. Hulme

BOOKS ET AL.

- 523 The Where, the Why, and the How
J. Volvovski et al., Eds., reviewed by C. Matuk
- 524 Notes on Three Image-Rich Books

POLICY FORUM

- 526 Hurdles and Opportunities for Landscape-Scale Restoration
M. H. M. Menz et al.

PERSPECTIVES

- 528 Cancer Cell Phenotypes, in Fifty Shades of Grey
A. Marusyk and K. Polyak
>> Research Article p. 543
- 529 Toward Molecular-Scale MRI
P. Hemmer
>> Reports pp. 557 and 561
- 530 Undernutrition—Looking Within for Answers
D. A. Relman
>> Research Article p. 548
- 532 Measuring Mass in Seconds
J. E. Debs et al.
>> Report p. 554
- 533 Carbon Cycle Makeover
D. E. Canfield and L. R. Kump
>> Research Article p. 540

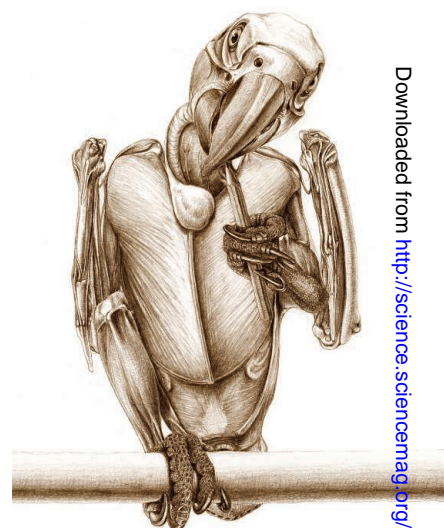
REVIEW

- 535 Carbon Nanotubes: Present and Future Commercial Applications
M. F. L. De Volder et al.

CONTENTS continued >>



page 502



page 524

Downloaded from <http://science.sciencemag.org/> on January 16, 2019

Explore our rich online offerings, including multimedia, news, *Science Careers*, and our two research journals—*Science Signaling* and *Science Translational Medicine*—at www.sciencemag.org



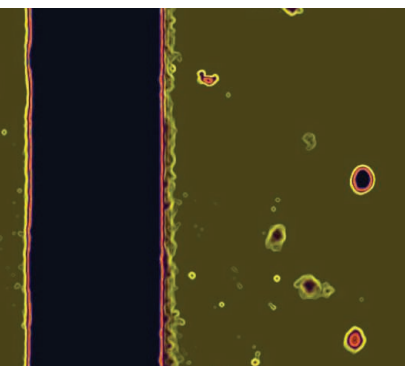
COVER

Detail of a “wiring diagram” showing long-distance neural connections between major regions of the macaque brain. This visualization provides guidance for connecting multiple computer chips into a brainlike network. This diagram was awarded first place in the illustration category in the 2012 *Science*/NSF International Science & Engineering Visualization Challenge. The winning entries are featured in a special section starting on page 509 and at www.sciencemag.org/special/vis2012.

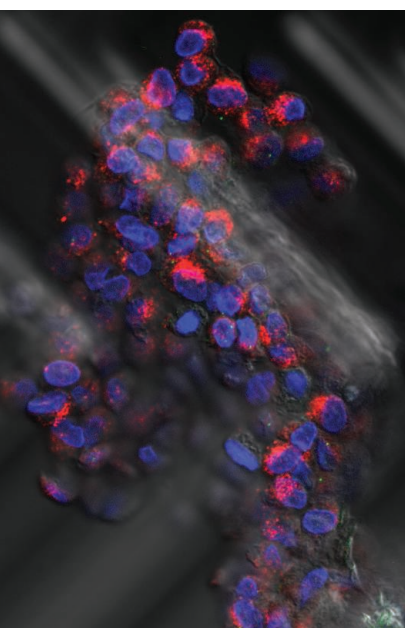
Illustration: Emmett McQuinn, Pallab Datta, Myron D. Flickner, William P. Risk, Dharmendra S. Modha/IBM Research - Almaden

DEPARTMENTS

- 487 This Week in *Science*
- 490 Editors' Choice
- 492 *Science* Staff
- 596 New Products
- 597 *Science Careers*



pages 529, 557, & 561



page 580

RESEARCH ARTICLES

- 540 **Authigenic Carbonate and the History of the Global Carbon Cycle**
D. P. Schrag et al.
Carbonate produced in sediment pore fluids played a major role in the carbon cycle in the geological past.
>> *Perspective p. 533; Science Podcast*
- 543 **Variable Clonal Repopulation Dynamics Influence Chemotherapy Response in Colorectal Cancer**
A. Kreso et al.
The functional diversity of heterogeneous tumor cells within tumors cannot be explained by genetic differences alone.
>> *Perspective p. 528*
- 548 **Gut Microbiomes of Malawian Twin Pairs Discordant for Kwashiorkor**
M. I. Smith et al.
Genomic analyses of gut microbiota explain responses to dietary therapy for severe malnutrition.
>> *Perspective p. 530*

REPORTS

- 554 **A Clock Directly Linking Time to a Particle's Mass**
S.-Y. Lan et al.
A clock is demonstrated wherein the ticks are related to the mass of a cesium atom.
>> *Perspective p. 532*
- 557 **Nanoscale Nuclear Magnetic Resonance with a Nitrogen-Vacancy Spin Sensor**
H. J. Mamin et al.
- 561 **Nuclear Magnetic Resonance Spectroscopy on a (5-Nanometer)³ Sample Volume**
T. Staudacher et al.
The optical response of the spin of a near-surface atomic defect in diamond can be used to sense proton magnetic fields.
>> *Perspective p. 529*
- 563 **Detecting Ozone- and Greenhouse Gas–Driven Wind Trends with Observational Data**
S. Lee and S. B. Feldstein
Observations reveal how stratospheric ozone depletion and greenhouse gas accumulation affect winds in the Southern Hemisphere.
- 568 **Recent Changes in the Ventilation of the Southern Oceans**
D. W. Waugh et al.
Changing westerly winds in the Southern Hemisphere have caused coherent changes in the southern ocean ventilation.
>> *News story p. 500*

- 571 **Uncovering the Protein Translocon at the Chloroplast Inner Envelope Membrane**
S. Kikuchi et al.
The protein transport channel in the chloroplast inner envelope requires both nuclear- and organelle-encoded subunits.
- 574 **Emergent Sensing of Complex Environments by Mobile Animal Groups**
A. Berdahl et al.
Living in a group amplifies the reach of an individual's capacity to sense environmental changes.
>> *Science Podcast*
- 576 **The Bacteriophage T7 Virion Undergoes Extensive Structural Remodeling During Infection**
B. Hu et al.
Cryo–electron tomography captures T7 bacteriophage virions at successive stages of bacterial infection.
- 580 **Circulating Breast Tumor Cells Exhibit Dynamic Changes in Epithelial and Mesenchymal Composition**
M. Yu et al.
Tumor cells circulating in the blood of cancer patients undergo a phenotypic change that may facilitate their spread.
- 584 **Systematic Identification of Signal-Activated Stochastic Gene Regulation**
G. Neuert et al.
A model quantitatively predicts stochastic activation dynamics during yeast cellular stress.
- 587 **Molecular Mechanism of Action of Microtubule-Stabilizing Anticancer Agents**
A. E. Prota et al.
Microtubule-targeted drugs use a common mechanism to stabilize the major loop in tubulin that controls microtubule dynamics.
- 590 **A Strategy for Modulation of Enzymes in the Ubiquitin System**
A. Ernst et al.
A technique for developing specific and potent enzyme inhibitors is validated on enzymes of the ubiquitin-proteasome system.

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.

Science

339 (6119)

Science **339** (6119), 487-596.

ARTICLE TOOLS

<http://science.sciencemag.org/content/339/6119>

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.