

SPECIAL SECTION

## Education & Technology

### INTRODUCTION

53 Adding a T to the Three R's

### NEWS

54 NSF Rethinks Its Digital Library  
New Landscape for the Earth Sciences  
A Nobelist's Passionate Pursuit of Excellence  
A Vision in Search of Funding

59 Computers as Writing Instructors

60 Glow Lights Up Scottish Classrooms

62 Korea Tries to Level the Field  
>> *Science Podcast*

64 A Personal Tutor for Algebra

### PERSPECTIVES

66 Immersive Interfaces for Engagement  
and Learning  
C. Dede  
>> *Science Podcast*

### EDITORIAL

15 Making a Science of Education  
Bruce Alberts  
>> *Education & Technology* section p. 53

### NEWS OF THE WEEK

22 Holdren Named Science Adviser, Varmus,  
Lander to Co-Chair PCAST

23 Tehran Incident Threatens U.S.-Iran Project

24 U.K. University Research Ranked;  
Funding Impacts to Follow

25 For Many Scientists, the Madoff Scandal  
Suddenly Hits Home

69 Technology and Informal Education:  
What Is Taught, What Is Learned  
P. M. Greenfield

72 Education and Training Technology in  
the Military  
J. D. Fletcher  
>> *Science Podcast*

75 Technology and Testing  
E. S. Quellmalz and J. W. Pellegrino

79 Video Games: A Route to Large-Scale  
STEM Education?  
M. J. Mayo

82 Laptop Programs for Students  
A. A. Zucker and D. Light

### REVIEWS

85 Online Education Today  
A. F. Mayadas et al.

89 Opening Education  
M. S. Smith

>> For a list of all related content, see p. 53 or go to  
[www.sciencemag.org/education\\_technology/](http://www.sciencemag.org/education_technology/)

26 Did the Mammoth Slayer Leave a Diamond  
Calling Card? >> *Brevia* p. 94

27 Calcification Rates Drop in Australian Reefs  
>> *Report* p. 116

### NEWS FOCUS

28 Bending the President's Ear

30 A Viral Link to Glioblastoma?

32 A Death in Antarctica

### LETTERS

36 Literature Citations in the Internet Era  
Y. Gingras et al.  
Narrower Focus May Be More Efficient  
K. B. Wray  
To Each Citation, a Purpose  
C. S. Von Bartheld et al.



page 28

A Cycle of Tradition and Innovation  
H. Andersen  
Response  
J. A. Evans

38 CORRECTIONS AND CLARIFICATIONS

38 TECHNICAL COMMENT ABSTRACTS

### BOOKS ET AL.

39 What Video Games Have to Teach Us About  
Learning and Literacy  
J. P. Gee, reviewed by J. Willinsky

40 Applying Cognitive Science to Education  
F. Reif, reviewed by E. Stern

40 Creating Effective Undergraduate Research  
Programs in Science  
R. Taraban and R. L. Blanton, Eds.,  
reviewed by R. A. Lue and R. Losick

42 Measuring Up  
D. Koretz, reviewed by E. Haertel  
>> *Education & Technology* section p. 53

CONTENTS continued >>



### COVER

As students become absorbed with technology-based games, educators grapple with how best to use technology. Immersive simulations represent one way in which new media can enhance traditional learning experiences. See the special section beginning on page 53.

Photo Illustration: Yael Kats; Images: Walter Bibikow/  
Getty Images (desks); Alamy (girl)

### DEPARTMENTS

12 This Week in *Science*  
16 Editors' Choice  
18 *Science* Staff  
19 Random Samples  
21 Newsmakers  
145 New Products  
146 AAAS Meeting Program  
156 *Science* Careers

## POLICY FORUM

- 43 "True" Conservation Progress  
*E. McDonald-Madden et al.*

## PERSPECTIVES

- 45 How Old Is That Star?  
*D. R. Soderblom*
- 46 Cloaking with Curved Spaces  
*A. Nicolet and F. Zolla >> Report p. 110*
- 47 Repair or Replacement—A Joint Perspective  
*J. Klein*
- 49 A Matter of Preservation  
*C. Hawkesworth et al.*
- 50 Farewell, Lecture?  
*E. Mazur*  
>> *Education & Technology section p. 53*
- 51 Mosquitoes Cut Short  
*A. F. Read and M. B. Thomas >> Report p. 141*

## BREVIA

- 94 Nanodiamonds in the Younger Dryas Boundary Sediment Layer  
*D. J. Kennett et al.*  
Nanodiamonds in sites across North America suggest that an asteroid impact coincided with cooling 12,900 years ago.  
>> *News story p. 26*

## RESEARCH ARTICLES

- 95 Glucosinolate Metabolites Required for an *Arabidopsis* Innate Immune Response  
*N. K. Clay et al.*
- 101 A Glucosinolate Metabolism Pathway in Living Plant Cells Mediates Broad-Spectrum Antifungal Defenses  
*P. Bednarek et al.*  
Plant cells defend against fungal attack through an innate immunity pathway in which infection triggers glucosinolate synthesis, stimulating formation of a protective callose.

## REPORTS

- 106 Mott Insulating State in Ultraclean Carbon Nanotubes  
*V. V. Deshpande et al.*  
Both metallic and semiconducting carbon nanotubes exhibit a radius-dependent energy gap arising from correlated electrons in the tubes.
- 110 Broadband Invisibility by Non-Euclidean Cloaking  
*U. Leonhardt and T. Tyc*  
In theory, materials with a negative refractive index deployed in a curved, non-Euclidean space can provide a route to cloaking and invisibility across a range of wavelengths.  
>> *Perspective p. 46*

- 112 Control of Self-Assembly of DNA Tubules Through Integration of Gold Nanoparticles  
*J. Sharma et al.*

Gold particles incorporated into DNA strands drive the formation of a variety of three-dimensional spiral architectures.

- 116 Declining Coral Calcification on the Great Barrier Reef  
*G. De'ath et al.*

Calcification by Great Barrier Reef corals decreased by about 14% since 1990, the largest decline in the past 400 years.  
>> *News story p. 27*

- 119 Stretching the Envelope of Past Surface Environments: Neoproterozoic Glacial Lakes from Svalbard  
*H. Bao et al.*

Unusual oxygen isotope compositions indicate that a Precambrian glacial period had an anomalous, perhaps extremely CO<sub>2</sub>-rich, atmosphere.

- 122 Why Peer Discussion Improves Student Performance on In-Class Concept Questions  
*M. K. Smith et al.*

In the classroom, discussion among students improves understanding and leads to more accurate answers to questions.  
>> *Education & Technology section p. 53*

- 124 Regulation of Neuronal Survival Factor MEF2D by Chaperone-Mediated Autophagy  
*Q. Yang et al.*

The degradation of a key neuronal survival factor by chaperone-mediated autophagy may contribute to Parkinson's disease.

- 127 Signal Sequences Activate the Catalytic Switch of SRP RNA  
*N. Bradshaw et al.*

Newly made proteins destined to be inserted into membranes trigger an RNA switch that promotes initiation of this process.

- 130 Floral Iridescence, Produced by Diffractive Optics, Acts as a Cue for Animal Pollinators  
*H. M. Whitney et al.*

The iridescence of tulip petals, as well as their pigmentation, affects foraging behavior by bumblebees.

- 133 Real-Time DNA Sequencing from Single Polymerase Molecules  
*J. Eid et al.*

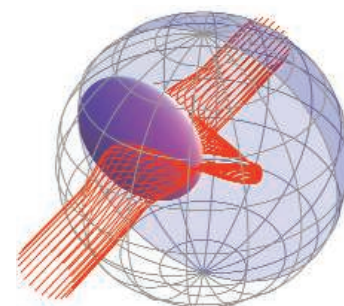
Arrays of narrow waveguides can record the action of a DNA polymerase stepping along a primer template, potentially providing a way to sequence DNA molecules.

- 139 Phage-Mediated Intergeneric Transfer of Toxin Genes  
*J. Chen and R. P. Novick*

Viruses may transfer toxin genes among pathogenic bacteria in raw milk, complicating veterinary use of phage therapy as a bacteriacide.



page 45



pages 46 &amp; 110

- 141 Stable Introduction of a Life-Shortening *Wolbachia* Infection into the Mosquito *Aedes aegypti*  
*C. J. McMeniman et al.*

Infection of mosquitoes with a bacterium shortens their lives and reduces disease transmission, without development of resistance.

>> *Perspective p. 51*

**CONTENTS** continued >>

## SCIENCEONLINE

## SCIENCEEXPRESS

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

**Cytosolic Viral Sensor RIG-I Is a 5'-Triphosphate-Dependent Translocase on Double-Stranded RNA**  
*S. Myong et al.*

A host protein that recognizes invading viruses activates innate immunity defenses only when it senses both double-stranded RNA and a 5' triphosphate.  
10.1126/science.1168352

**Neuronal Activity-Induced Gadd45b Promotes Epigenetic DNA Demethylation and Adult Neurogenesis**  
*D. K. Ma et al.*

Neural activity induces an immediate early gene that triggers epigenetic modifications needed for neurogenesis.  
10.1126/science.1166859

## TECHNICALCOMMENTS

**Comment on "Log or Linear? Distinct Intuitions of the Number Scale in Western and Amazonian Indigene Cultures"**

*J. F. Cantlon et al.*

full text at [www.sciencemag.org/cgi/content/full/323/5910/38b](http://www.sciencemag.org/cgi/content/full/323/5910/38b)

**Response to Comment on "Log or Linear? Distinct Intuitions of the Number Scale in Western and Amazonian Indigene Cultures"**

*S. Dehaene et al.*

full text at [www.sciencemag.org/cgi/content/full/323/5910/38c](http://www.sciencemag.org/cgi/content/full/323/5910/38c)

## SCIENCENOW

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

Highlights From Our Daily News Coverage

**The Top 10 ScienceNOWs of 2008**

A selection of our favorite and most read stories.

**A Whiff of Mad Cow**

Normal form of protein linked to neurodegenerative conditions may aid sense of smell.

**Is Morphine a Guy Drug?**

New research may explain why males benefit more from opioid painkillers.

## SCIENCESIGNALING

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

The Signal Transduction Knowledge Environment

**EDITORIAL GUIDE: Beyond Microarrays**

*M. B. Yaffe*

Studies of global changes in messenger RNA abundance may be less than insightful.

**RESEARCH ARTICLE: mAKAP Compartmentalizes Oxygen-Dependent Control of HIF-1 $\alpha$**

*W. Wong et al.*

The scaffold protein muscle A kinase-anchoring protein (mAKAP) regulates the stability and localization of the transcription factor HIF-1 $\alpha$ .

**RESEARCH ARTICLE: Type I IL-4Rs Selectively Activate IRS-2 to Induce Target Gene Expression in Macrophages**

*N. M. Heller et al.*

**PERSPECTIVE: Untangling the Complex Web of IL-4- and IL-13-Mediated Signaling Pathways**

*M. Wills-Karp and F. D. Finkelman*

Understanding how IL-4 and IL-13 signaling differ could result in the development of better anti-inflammatory therapies.

**PERSPECTIVE: Bursting into the Nucleus**

*G. R. Crabtree and I. A. Graef*

Calcium elicits bursts of nuclear localization of a yeast transcription factor, which may enable the coordinated activation of target genes.

**REVIEW: Structure and Function of the Phosphothreonine-Specific FHA Domain**

*A. Mahajan et al.*

The forkhead-associated (FHA) domain binds specifically to phosphothreonine residues and possesses unique structural and functional features.

**MEETING REPORT: Regulatory T Cells—The Cunning Fox and Its Clinical Application**

*D. S. Game et al.*

A conference in Beijing, China focused on the biology of regulatory T cells and their potential uses in treating various diseases.

## SCIENCECAREERS

[www.sciencereers.org/career\\_development](http://www.sciencereers.org/career_development)

Free Career Resources For Scientists

**Taken for Granted: Brother, Can You Spare a Temporary Worker Visa?**

*B. L. Benderly*

The controversial H-1B visa program needs major reform.

**In Person: Eggheads and Cheeseheads**

*D. Albert*

A researcher reflects on the institutional cultures between the Ivy League and Big Ten.

**Smarter Than the Average Desk**

*A. Saini*

Engineer Andrew Hatch hopes to create the paperless classroom of the future.

>> [Education & Technology section p. 53 and](http://www.sciencemag.org/education_technology/)

[www.sciencemag.org/education\\_technology/](http://www.sciencemag.org/education_technology/)

**January 2009 Funding News**

*J. Fernández*

Learn about the latest in research funding, scholarships, fellowships, and internships.

## SCIENCEPODCAST

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

Free Weekly Show

Download the 2 January special *Science* Podcast on education and technology to hear about immersive interfaces for learning, computer-assisted military training, and a new home-learning system in Korea.

>> [Education & Technology section p. 53 and](http://www.sciencemag.org/education_technology/)  
[www.sciencemag.org/education\\_technology/](http://www.sciencemag.org/education_technology/)



## SCIENCEONLINE FEATURE

**VIDEO: Education and Technology**

An introduction to this week's special section about how education is changing in the face of technology.

>> [Education & Technology section p. 53 and](http://www.sciencemag.org/education_technology/)  
[www.sciencemag.org/education\\_technology/](http://www.sciencemag.org/education_technology/)

## ScienceInsider

Breaking news and analysis from the world of science policy.

**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 © 2009 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): \$146 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$835; 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 \$20.00 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

**323 (5910)**

*Science* **323** (5910), 12-145.

**ARTICLE TOOLS**

<http://science.sciencemag.org/content/323/5910>

**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. The title *Science* is a registered trademark of AAAS.

Copyright © 2009 The Authors, some rights reserved; exclusive licensee American Association for the Advancement of Science. No claim to original U.S. Government Works.