

SPECIAL SECTION

Carbon Capture and Sequestration

INTRODUCTION

1641 Clearing the Air

NEWS

1642 Round and Round:
A Guide to the Carbon Cycle

1644 Carbon Sequestration

1646 China Grapples With a Burning Question

REVIEW

1647 Carbon Capture and Storage:
How Green Can Black Be?

R. S. Haszeldine

>> *Science Podcast*

PERSPECTIVES

1652 Amine Scrubbing for CO₂ Capture
G. T. Rochelle

1654 Why Capture CO₂ from the Atmosphere?
D. W. Keith

1656 Onshore Geologic Storage of CO₂
F. M. Orr Jr.

1658 Storage of Carbon Dioxide in
Offshore Sediments
D. P. Schrag

>> *See also Editorial p. 1599*



page 1614

EDITORIAL

1599 Carbon Capture and Sequestration
Steven Chu

>> *Carbon Capture and Sequestration section p. 1641*

NEWS OF THE WEEK

1606 Obama Facing Tough Decision on
Whether to Keep Aiming for the Moon

1607 Grants 'Below Payline' Rise to Help
New Investigators

1609 A New Biology to Mend Society's Woes

1609 From *Science's* Online Daily News Site

1610 The Force Behind North Korea's
New Science University

1611 From the *Science* Policy Blog

1612 Germany: Election Heats Up Nuclear Debate

1613 Who Will Pay for China's
Planned X-ray Satellite?

NEWS FOCUS

1614 The Theory? Diet Causes Violence.
The Lab? Prison.

>> *Science Podcast*

1617 Exotic Telescopes Prepare to
Probe Era of First Stars and Galaxies

1620 Scoping Out Unseen Forces
Shaping North America

LETTERS

1622 Preserving Starry Nights

W. Freedman

Forecast for Reproducible Data:
Partly Cloudy

L. J. Osterweil et al.

Response

M. R. Nelson

Immune System: Not So Superior

S. M. Hedrick

1623 Life in Science: Having a Blast in Kenya

T. Parsons

1624 TECHNICAL COMMENTS ABSTRACTS

BOOKS ET AL.

1625 The Patent Crisis and
How the Courts Can Solve It

D. L. Burk and M. A. Lemley,
reviewed by R. S. Eisenberg

1626 Untangling the Double Helix

J. C. Wang, reviewed by A. Mondragón

EDUCATION FORUM

1627 Revising the AP Biology Curriculum

W. B. Wood

PERSPECTIVES

1629 Unraveling Traveling

C. P. Kyriacou

>> *Report p. 1700*

1630 A New Departure in Fluorination Chemistry

V. Gouverneur

>> *Research Article p. 1661*

CONTENTS continued >>



COVER

The Hellisheidi geothermal power project in southwestern Iceland, site of a pilot study on the feasibility of sequestration of carbon dioxide in basaltic rocks. Here, carbon dioxide released from the hot water that powers the facility is dissolved in cooling water and injected below ground to a depth of 300 to 800 meters, where it can react with basalt to form new, stable minerals. See the special section beginning on page 1641.

Photo: Haraldur Stefansson/Alamy

DEPARTMENTS

- 1596 This Week in *Science*
- 1601 Editors' Choice
- 1602 *Science* Staff
- 1605 Random Samples
- 1637 AAAS News & Notes
- 1709 New Products
- 1710 *Science* Careers

1631 Tin Takes Ethylene On—and Off

L. R. Sita

>> Report p. 1668

1632 Emergent or Just Complex?

A. C. Balazs and I. R. Epstein

1634 Simulating Multifunctional Structures

S. R. Phillpot and S. B. Sinnott

1635 Evolving Cell Signals

M. O. Collins

>> Reports pp. 1682 and 1686

BREVIA

1660 Oceanic Spawning Migration

of the European Eel (*Anguilla anguilla*)

K. Aarestrup et al.

Satellite tracking technology has allowed scientists to map part of the migration route of the European eel.

RESEARCH ARTICLE

1661 Formation of ArF from LPdAr(F): Catalytic Conversion of Aryl Triflates to Aryl Fluorides

D. A. Watson et al.

A catalyst enables versatile carbon-fluorine bond formation using simple fluoride salts.

>> Perspective p. 1630

REPORTS

1665 High-Detectivity Polymer Photodetectors with Spectral Response from 300 nm to 1450 nm

X. Gong et al.

Well-designed polymer photodetectors show performance comparable with the best inorganic devices.

1668 Reversible Reactions of Ethylene with Distannynes Under Ambient Conditions

Y. Peng et al.

Ethylene reacts reversibly with triply bonded tin, contrasting with its reactivity toward carbon triple bonds.

>> Perspective p. 1631

1670 Coordinatively Unsaturated Al³⁺ Centers as Binding Sites for Active Catalyst Phases of Platinum on γ -Al₂O₃

J. H. Kwak et al.

A combination of high-resolution spectroscopy and microscopy reveals the details of platinum binding to aluminum oxide.

1674 Distribution of Mid-Latitude Ground Ice on Mars from New Impact Craters

S. Byrne et al.

Observations of ground ice exposed by recent impact craters probe the composition of the upper layers of the surface of Mars.

1677 Holocene Glacier Fluctuations in the Peruvian Andes Indicate Northern Climate Linkages

J. M. Licciardi et al.

Glacial advances in the southern Peruvian Andes during the Holocene are correlated with the climate of the North Atlantic region.

1680 Chloroquine Transport via the Malaria Parasite's Chloroquine Resistance Transporter

R. E. Martin et al.

Chloroquine resistance in *Plasmodium falciparum* is due to the direct export of the drug via a mutant transporter protein.

1682 Global Analysis of Cdk1 Substrate Phosphorylation Sites Provides Insights into Evolution

L. J. Holt et al.

The range of sites phosphorylated by a protein kinase in yeast provides clues to the evolution of such regulatory mechanisms.

1686 Positive Selection of Tyrosine Loss in Metazoan Evolution

C. S. H. Tan et al.

Evolution of tyrosine phosphorylation as a signaling mechanism may have coincided with loss of tyrosine residues to avoid noise.

>> Perspective p. 1635

1688 Evolution of a Novel Phenolic Pathway for Pollen Development

M. Matsuno et al.

Gene copying and positive Darwinian selection promoted the emergence of a phenolic pathway in Brassicaceae.

1693 Creating Bacterial Strains from Genomes That Have Been Cloned and Engineered in Yeast

C. Lartigue et al.

A *Mycoplasma mycoides* genome was engineered in yeast and then transplanted into *M. capricolum* cells to produce a new strain.

1696 On Universality in Human Correspondence Activity

R. D. Malmgren et al.

Affinity toward a particular life-style affects the communication patterns between people.

>> Science Podcast

1700 Antennal Circadian Clocks Coordinate Sun Compass Orientation in Migratory Monarch Butterflies

C. Merlin et al.

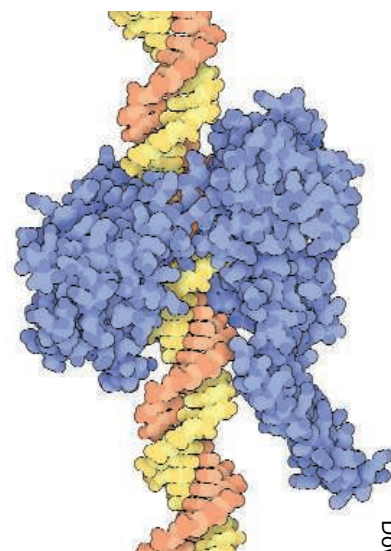
Monarch butterfly antennae contain the timing mechanism for time-compensated Sun compass orientation.

>> Perspective p. 1629

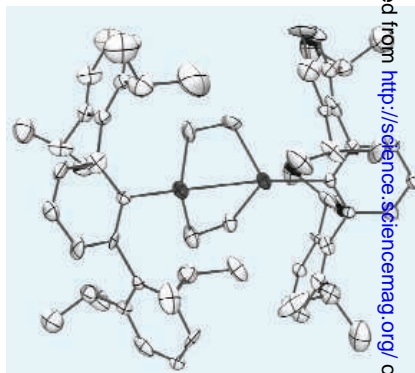
1705 Optimizing Influenza Vaccine Distribution

J. Medlock and A. P. Galvani

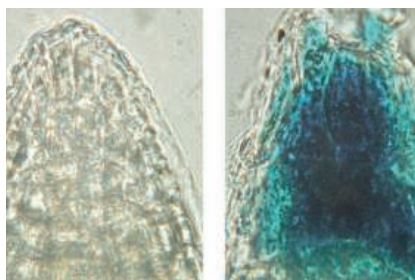
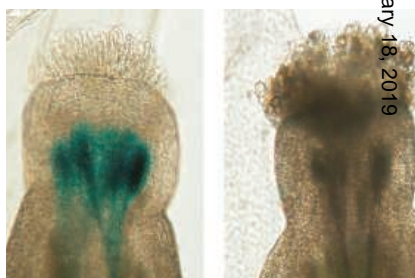
Age-related transmission patterns should be incorporated into vaccine distribution policy to minimize the impact of epidemics.



page 1626



pages 1631 & 1668



page 1688

CONTENTS continued >>

SCIENCEONLINE

SCIENCEEXPRESS

www.sciencexpress.org

Amyloid- β Dynamics Are Regulated by Orexin and the Sleep-Wake Cycle

J.-E. Kang et al.

Sleep patterns can influence amyloid plaque formation in a mouse model of Alzheimer's disease.

10.1126/science.1180962

Detection of Gamma Rays from a Starburst Galaxy

F. Acero et al.

Detection of our nearest starburst galaxy at very high energies confirms this galaxy-type as a new class of gamma-ray emitter.

10.1126/science.1178826

Character and Spatial Distribution of OH/H₂O on the Surface of the Moon Seen by M³ on Chandrayaan-1

C. M. Pieters et al.

10.1126/science.1178658

Detection of Adsorbed Water and Hydroxyl on the Moon

R. N. Clark

10.1126/science.1178105

Temporal and Spatial Variability of Lunar Hydration as Observed by the Deep Impact Spacecraft

J. M. Sunshine et al.

Space-based spectroscopic measurements provide evidence for water or hydroxyl (OH) on the surface of the Moon.

10.1126/science.1179788

A Lunar Waterworld

P. G. Lucey

10.1126/science.1181471

TECHNICALCOMMENTS

Comment on "Infants' Perseverative Search Errors Are Induced by Pragmatic Misinterpretation"

J. P. Spencer et al.

full text at www.sciencemag.org/cgi/content/full/325/5948/1624-a

Response to Comment on "Infants' Perseverative Search Errors Are Induced by Pragmatic Misinterpretation"

J. Topál et al.

full text at www.sciencemag.org/cgi/content/full/325/5948/1624-b

SCIENCENOW

www.sciencenow.org

Highlights From Our Daily News Coverage

Antplant Ants Are Never Satisfied

Tree-dwelling ants expand their territory beyond hospitable trees.

And the Solar System's Coldest Spot Is ...

Scientists reveal chilly findings—and uncertain prospects for future astronauts.

Gene Therapy Gives Monkeys Color Vision

Finding may point to future treatments for human colorblindness.

SCIENCE SIGNALING

www.sciencesignaling.org

The Signal Transduction Knowledge Environment

RESEARCH ARTICLE: The Single Transmembrane Domains of Human Receptor Tyrosine Kinases Encode Self-Interactions

C. Finger et al.

The transmembrane domain of any of the 58 human receptor tyrosine kinases is sufficient to mediate dimerization.

RESEARCH ARTICLE: MSK2 Inhibits p53 Activity in the Absence of Stress

S. Llanos et al.

The kinase MSK2 inhibits p53 transcriptional activity at a subset of promoters through a kinase-independent mechanism.

PERSPECTIVE: Integrin Proteomes Reveal a New Guide for Cell Motility

E. H. J. Danen

A proteomics analysis of integrin-associated complexes establishes an unexpected connection to cell migration.

PERSPECTIVE: Human-Specific Genes May Offer a Unique Window into Human Cell Signaling

P. D. Stahl and M. J. Wainszelbaum

Analysis of human-specific genes may reveal, at the molecular level, what makes humans human.

GLOSSARY

Find out what APR, NHEJ, and SLAM mean in the world of cell signaling.

SCIENCE CAREERS

www.sciencereers.org/career_magazine

Free Career Resources for Scientists

Special Feature: Careers in Humanitarian Science

E. Pain

Scientists are applying their skills to relieve hunger, disease, and human-rights violations.

Serving Human Rights and Humanitarian Needs

E. Pain

Three passionate scientists describe their careers dealing with human rights.

Helping Feed the World

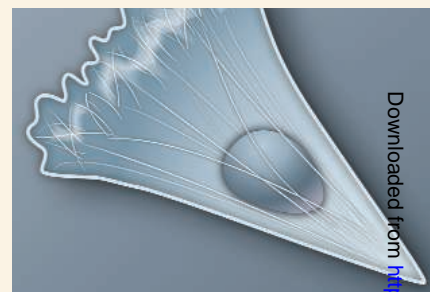
S. McLoone

Scientists are helping to increase and maintain food supplies where food is scarce.



SCIENCENOW

Now in technicolor.



SCIENCE SIGNALING

Migrating cell with lamellipodium.

SCIENCEPODCAST

www.sciencemag.org/multimedia/podcast
Free Weekly Show

Download the 25 September *Science* Podcast to hear about challenges to carbon capture and storage, human correspondence patterns, linking nutrition to violent behavior, and more.

ORIGINSBLOG

blogs.sciencemag.org/origins
A History of Beginnings

SCIENCEINSIDER

blogs.sciencemag.org/scienceinsider
Science Policy News and Analysis

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.

AAAS

ADVANCING SCIENCE. SERVING SOCIETY

Science

325 (5948)

Science **325** (5948), 1596-1709.

ARTICLE TOOLS

<http://science.sciencemag.org/content/325/5948>

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.