


Nerves From Skin | Feynman's Vision Realized | Weed Killer Revisited

# ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ FEBRUARY 27, 2010



## It's in the air

**The H1N1 Virus: Biology vs. Hype**

**Dinos Show True  
Colors, Stripes**

**Science Budget Boost**

**Quantum Algae**

No  
Contract

Bigger, Brighter screen. Large, backlit numbers.

No  
prepaid  
hassles

# Easy to use. Easy to see. Easy on the wallet.

*Jitterbug... It's the cell phone that's changing all the rules.*

**For people like me, who want a cell phone that's easy to use.** Over the years, cell phones have become smaller and smaller with so many complicated features. They are harder to program and hard to use. But the Jitterbug has simplified everything, so it's not only easy to use, it's easy to try. No crowded malls, no waiting in line, no confusing sales people, or complicated plans. Affordable and convenient cell phone service is only a toll-free phone call away. Order your Jitterbug now and you'll receive a free car charger, a \$24.99 value!

## Questions about Jitterbug?

**Try our pre-recorded Toll-Free Hotline 1-888-890-3293.**

## The new Jitterbug cell phone makes calling simple!

- Bigger, Brighter LCD screen... easier to see even in daylight
- Comes pre-programmed and ready to use right out of the box
- No contract required
- Live, 24-hour Jitterbug Operators greet you by name, connect calls and update your Phone Book<sup>2</sup>
- Soft ear cushion and louder volume for better sound quality
- Comfortable keypad designed to make dialing easy
- Hearing aid compatible – top ratings in this category
- Familiar dial tone confirms service (no other cell phone has this)
- Service as low as \$14.99 a month<sup>3</sup>

## Why pay for minutes you'll never use!

Monthly Minutes	50	100
Monthly Rate	\$14.99	\$19.99
Operator Assistance	24/7	24/7
911 Access	FREE	FREE
Long Distance Calls	No add'l charge	No add'l charge
Voice Dial	FREE	FREE
Nationwide Coverage	Yes	Yes
Trial Period	30 days	30 days

Other plans available. Ask your Jitterbug expert for details.

**Service as low as \$14.99<sup>3</sup> a month and a friendly 30-day return policy.** If you've ever wanted the security and convenience of a cell phone, but never wanted the fancy features and minutes you don't need... Jitterbug is for you. Like me, you'll soon be telling your friends about Jitterbug. Call now.



Simple on/off button  
for speakerphone.

No confusing  
menus. Access  
all options with  
simple yes/no  
buttons.

Available in  
White and  
Graphite.



## FREE Gift

Order now  
and receive a  
free Car Charger.  
**A \$24 value!**

**jitterbug** 

**firstSTREET**  
for Boomers and Beyond<sup>3</sup>  
1998 Ruffin Mill Road  
Colonial Heights, VA 23834

Jitterbug Cell Phone

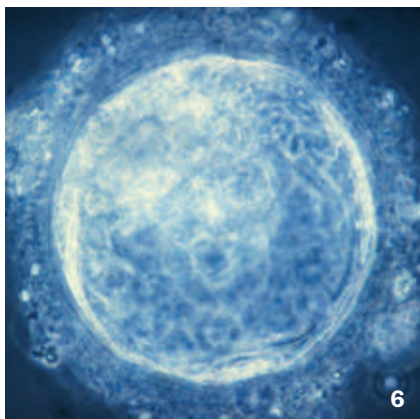
Call now for our lowest price.  
Please mention promotional code 40083.

**1-888-677-6855**

[www.jitterbugdirect.com](http://www.jitterbugdirect.com)

IMPORTANT CONSUMER INFORMATION: Subject to Customer Agreement, select calling plans and credit approval. Other changes and restrictions may apply. Coverage and service not available everywhere. Screen images simulated. <sup>1</sup>This GreatCall offer is available with activation by 3/31/10. <sup>2</sup>For each Operator service, you'll be charged a 5-minute "Operator assistance fee" in addition to the minutes used both for the length of the call with the Operator and any call connected by the Operator. <sup>3</sup>Not including government taxes, assessment surcharges and activation fee. Please visit [www.jitterbugdirect.com](http://www.jitterbugdirect.com) for further information about terms and conditions. Copyright ©2010 GreatCall, Inc. Jitterbug is a registered trademark of GreatCall, Inc. Samsung is a registered trademark of Samsung Electronics America, Inc. and its related entities. Copyright © 2010 by firstSTREET for Boomers and Beyond, Inc. All rights reserved.

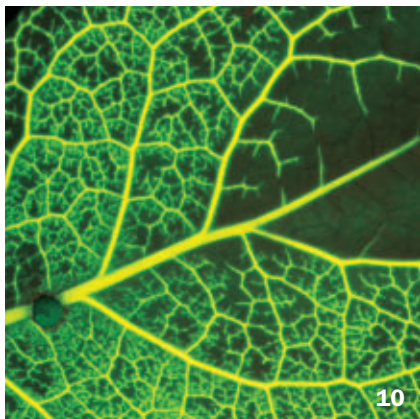
# ScienceNews



6



9



10



28

## In The News

### 5 STORY ONE

- Scientists to skin cells: Go directly to neurons, do not pass stem cell stage

### 7 ATOM & COSMOS

- Glimmers of cosmic dawn
- Wheels of Martian rover grind to final halt

### 8 LIFE

- With puny dads, pipefish moms boost eggs' protein
- Carnations speciate speedily
- Feathered dinos show true colors — spangles and all

### 10 MATTER & ENERGY

- Algae master quantum magic for photosynthesis

### 11 EARTH

- Drier atmosphere keeps global temps down

### 12 BODY & BRAIN

- Shocking treatment for irregular heartbeat
- Pore power for sperm
- Shape-changing protein plays helpful role in forming sea slug memories
- Breast milk flow delayed for moms on SSRIs

### 14 HUMANS

- Eurasian man in a Mongolian court
- Bare feet blunt running's force

### 16 SCIENCE & SOCIETY

- Science fares well in presidential budget

## Features

### 18 WEED KILLER IN THE CROSSHAIRS

New data on water monitoring and continuing health concerns put atrazine — a controversial herbicide — back in the spotlight.  
*By Janet Raloff*

### 22 OF SWINE AND MEN

COVER STORY: Scientists study the biology of H1N1 to see how it stacks up against seasonal flu.  
*By Laura Sanders*

## Essay

### 28 QUANTUM ON QUANTUM

Physicist Richard Feynman's vision of a computer that can precisely simulate nature is becoming real.  
*By Charles Petit*

## Departments

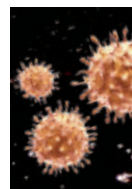
### 2 FROM THE EDITOR

### 4 NOTEBOOK

### 30 BOOKSHELF

### 32 COMMENT

Louis Lanzerotti discusses the latest report on the state of U.S. science and engineering.



**COVER** H1N1 influenza has earned pandemic status, but the biology of the virus suggests similarities to seasonal flu strains.  
*Eraxion/iStockphoto*



**publisher** Elizabeth Marincola **editor in chief** Tom Siegfried

**EDITORIAL STAFF** **managing editor** Eva Emerson

**senior editor/policy** Janet Raloff

**news editor** Elizabeth Quill **associate editor** Erika Engelhaupt

**astronomy** Ron Cowen

**behavioral sciences** Bruce Bower

**biomedicine** Nathan Seppa

**earth sciences** Sid Perkins

**environment/chemistry** Rachel Ehrenberg

**life sciences** Susan Milius

**molecular biology** Tina Hesman Saey

**staff writer** Laura Sanders

**editorial assistant**

Rachel Zerkowitz

**web specialist/editorial secretary**

Gwendolyn K. Gillespie

**science writer intern**

Lisa Grossman

**DESIGN** **design director** Beth Rakouskas

**assistant art directors** Theresa Dubé, Avik Nandy

## ADVERTISING | CIRCULATION

**advertising manager** Judy Lewis *West, Midwest & DC Metro*

**circulation manager** Tosh Arimura

**account executives** Gregg Oehler, Rich Cordero, Oehler Media, East;

Rick Johnson, National Brands; Jan Mason, Online Advertising

**advertising/circulation assistant** Kerwin Wilson **permissions** Evora Swoopes

## EDITORIAL, ADVERTISING AND BUSINESS OFFICES

1719 N Street NW, Washington, DC 20036 • Phone (202) 785-2255



**Subscriptions** subs@sciencenews.org • **Editorial/Letters** editors@sciencenews.org

**Advertising/Business** snsales@sciencenews.org

✳️ **Texterity** Digital edition provided by Texterity, www.texterity.com

**Science News** (ISSN 0036-8423) is published biweekly, for \$54.50 for 1 year or

\$98 for 2 years (international rate \$80.50 for 1 year or \$161 for 2 years) by

Society for Science & the Public, 1719 N Street NW Washington, DC 20036.

Preferred periodicals postage paid at Washington, DC, and an additional mailing office.

**Subscription Department:** PO Box 1205, Williamsport, PA 17703-1205.

For new subscriptions and customer service, call 1-800-552-4412.

**Postmaster:** Send address changes to Science News, PO Box 1205, Williamsport, PA 17703-

1205. Two to four weeks' notice is required. Old and new addresses, including zip codes,

must be provided. Copyright © 2010 by Society for Science & the Public. Title registered

as trademark U.S. and Canadian Patent Offices. Printed in U.S.A. on recycled paper.



**BOARD OF TRUSTEES** **chairman** Dudley Herschbach

**vice chair** Jennifer Yruegas **secretary** Gayle Wilson

**treasurer** Michela English **executive committee, at-large** Robert W. Fri

**members** Deborah Blum, S. James Gates Jr., H. Robert Horvitz, Tom

Leighton, Alan Leshner, Stephanie Pace Marshall, Anne C. Petersen,

Robert W. Shaw Jr., Frank Wilczek | Elizabeth Marincola, *ex officio*

**EXECUTIVE OFFICE** **president** Elizabeth Marincola

**executive assistant** Andres Bustamante

**FINANCE** **chief financial officer** Greg Mitchell

**accounting manager** Lisa M. Proctor **senior accountant** Sivakami Kumaran

**EXTERNAL AFFAIRS** **director** Rick Bates

**director of development** BJ Cortis **outreach director** Jennifer Carter

**membership and communications associate** Nancy Moulding

**EVENTS MANAGEMENT** **director of events** Cait Goldberg

**events associate** Marisa Gaggy

**SCIENCE EDUCATION PROGRAMS** **director** Michele Glidden

**program manager, Intel Science Talent Search** Caitlin Sullivan

**manager of international fairs** Sharon Snyder **office manager** June Kee

**program associates** Diane Rashid, Jinny Kim, Laurie Demsey

**INTERNAL OPERATIONS** **director** Harry Rothmann

**facilities manager** Paul Roger **logistics manager** Anthony Payne

**program operations manager** Christopher Brown

**computer programmer-webmaster** Thomas D. Smith

**systems and network administrator** James C. Moore

**information technology specialists** Gregory A. Sprouse, Amy An

**mail room clerks** Ben Bryan, Randy Williams

## FROM THE EDITOR

# Quantum computers have a curious complex history



Among the many imaginative products born in the creative minds of theoretical physicists, quantum computers stand out.

They are devices that were conceived in abstract terms long before they could be actually built. Even today they exist only in rudimentary forms. But one such quantum computer “toy” has now

succeeded in solving a complicated quantum problem — the energy levels of the hydrogen molecule — as freelance writer Charles Petit reports in this issue (Page 28).

As Petit correctly notes, the potential for quantum computers was predicted by Richard Feynman, one of the most celebrated physicists of the 20th century. Feynman’s talk at a 1981 conference outlined the basic idea of using a computing device based on quantum physics to simulate natural phenomena more precisely than possible with ordinary computers. But Feynman was not, as some accounts imply, the first to imagine a quantum-mechanical computer. A theorist at Argonne National Laboratory, Paul Benioff, discussed the idea in a paper prepared in 1979 and published in the *Journal of Statistical Physics* in 1980. He showed that it was possible, mathematically at least, for a quantum system to perform computations — a proposition that many physicists doubted at the time. “It is difficult to conceive how one would actually build such a machine,” Benioff wrote. But his mathematical model “at least suggests that the possibility of actually constructing such ... machines should be examined.”

Despite Benioff and even Feynman’s exhortations, nobody actually spent much effort trying to build a quantum computer until someone identified a killer app: breaking the codes that encrypt sensitive military and financial secrets. In 1994 mathematician Peter Shor devised an algorithm that showed how a quantum computer could be just such a code breaker.

Of course, just as Feynman had been anticipated by Benioff, Shor was beaten to the punch by Robert Redford. In the 1992 movie *Sneakers*, Redford and cohorts pursued a mysterious little box with the power to decode all those secrets. Nobody called it a quantum computer, but in retrospect, that’s clearly what it was. It would have been a great story if Shor had been inspired by the film to make his mathematical breakthrough, but alas, he says he developed his algorithm without having seen *Sneakers*. But his friends did make him watch it after his algorithm appeared.

—Tom Siegfried, Editor in Chief

Society for Science & the Public is a 501(c)(3) nonprofit corporation founded in 1921. The vision of Society for Science & the Public is to promote the understanding and appreciation of science and the vital role it plays in human advancement: to inform, educate, inspire. Visit Society for Science & the Public at [www.societyforscience.org](http://www.societyforscience.org). Republication of any portion of Science News without written permission of the publisher is prohibited. For permission to photocopy articles, contact Copyright Clearance Center at 978-750-8400 (phone) or 978-750-4470 (fax). Advertising appearing in this publication does not constitute endorsement of its content by Science News or Society for Science & the Public.



© Imaginore Co., Ltd. Corbis

## Become Fluent in the Language of Economics

We are all economists—when we work, buy, save, invest, pay taxes, and vote. It repays us many times over to be good economists. Economic issues are active in our lives every day. However, when the subject of economics comes up in conversation or on the news, we can find ourselves longing for a more sophisticated understanding of the fundamentals of economics.

Taught by Professor Timothy Taylor—the Managing Editor of the *Journal of Economic Perspectives*, a quarterly academic journal published by the American Economic Association—**Economics, 3<sup>rd</sup> Edition** enables you to master the basis of economics. Throughout this course, you'll learn about financial issues that affect you and the nation every day—interest rates, unemployment, personal investing, globalization, and many more—with a greater level of knowledge and sophistication. The bottom line: become fluent in the language of economics.

This course is one of The Great Courses®, a noncredit, recorded college lecture series from The Teaching Company®. Award-winning professors of a wide array of subjects in the sciences and the liberal arts have made more than 300 college-level courses that are available now on our website.

**Order Today!**

**Offer Expires Wednesday, April 28, 2010**

**Economics, 3<sup>rd</sup> Edition**  
Course No. 550  
36 lectures (30 minutes/lecture)

**DVDs** ~~\$374.95~~ **NOW \$99.95**  
+ \$15 Shipping, Processing, and Lifetime Satisfaction Guarantee

**Audio CDs** ~~\$269.95~~ **NOW \$69.95**  
+ \$10 Shipping, Processing, and Lifetime Satisfaction Guarantee

**Priority Code: 39663**

### Economics, 3<sup>rd</sup> Edition

Taught by Professor Timothy Taylor, Macalester College

#### Lecture Titles

- |  |   |
|--|---|
| 1. How Economists Think                        | 19. Macroeconomics and GDP                |
| 2. Division of Labor                           | 20. Economic Growth                       |
| 3. Supply and Demand                           | 21. Unemployment                          |
| 4. Price Floors and Ceilings                   | 22. Inflation                             |
| 5. Elasticity                                  | 23. The Balance of Trade                  |
| 6. The Labor Market and Wages                  | 24. Aggregate Supply and Aggregate Demand |
| 7. Financial Markets and Rates of Return       | 25. The Unemployment-Inflation Tradeoff   |
| 8. Personal Investing                          | 26. Fiscal Policy and Budget Deficits     |
| 9. From Perfect Competition to Monopoly        | 27. Countercyclical Fiscal Policy         |
| 10. Antitrust and Competition Policy           | 28. Budget Deficits and National Saving   |
| 11. Regulation and Deregulation                | 29. Money and Banking                     |
| 12. Negative Externalities and the Environment | 30. The Federal Reserve and Its Powers    |
| 13. Positive Externalities and Technology      | 31. The Conduct of Monetary Policy        |
| 14. Public Goods                               | 32. The Gains of International Trade      |
| 15. Poverty and Welfare Programs               | 33. The Debates over Protectionism        |
| 16. Inequality                                 | 34. Exchange Rates                        |
| 17. Imperfect Information and Insurance        | 35. International Financial Crashes       |
| 18. Corporate and Political Governance         | 36. A Global Economic Perspective         |

**ACT NOW!**

**1-800-TEACH-12**

**www.TEACH12.com/7sn**



**THE TEACHING COMPANY®**  
"The Joy of Lifelong Learning Every Day"  
GREAT PROFESSORS, GREAT COURSES, GREAT VALUE  
GUARANTEED.™



## Scientific Observations

“For me, the best health news of the previous decade is the fact that the long-overdue influenza pandemic has been so moderate in its impact.... Although the virus has not yet delivered any devastating surprises, we have seen some surprises on other fronts. We anticipated problems in producing enough vaccine fast enough, and this did indeed happen. But we did not anticipate that people would decide not to be vaccinated.... The days when health officials could issue advice based on the very best medical and scientific data and expect populations to comply may be fading. It may no longer be sufficient to say that a vaccine is safe, or testing complied with all regulatory standards, or a risk is real. In my view, this is a new communications challenge that we may need to address.” — **MARGARET CHAN, DIRECTOR-GENERAL OF THE WORLD HEALTH ORGANIZATION, IN AN ADDRESS TO ITS EXECUTIVE BOARD IN GENEVA ON JANUARY 18**



## SN Online

www.sciencenews.org

### DELETED SCENES BLOG

A medical council cited poor methods and conflict-of-interest concerns in slamming a paper connecting vaccines and autism, prompting the paper's retraction. See “Journal retracts flawed study linking MMR vaccine and autism.”

### LIFE

Picnic basket. Check. Pepper spray, rocks, rubber slugs. Check, check, check. Park rangers find these tools do keep bears away from human visitors, but not as effectively as making food inaccessible. See “Keeping black bears wild.”



### MATTER & ENERGY

Some chemical reactions can mix themselves, no stirring rod required. Read “Self-stirring liquids.”

## Science Past | FROM THE ISSUE OF FEBRUARY 27, 1960

**HUMAN SPIES FOR RUSSIA CHEAPER THAN SATELLITES** — It would be cheaper for Russia to spy on the U.S. through normal channels than by putting a reconnaissance satellite into orbit.... Russian agents in the U.S. can glean vast amounts of solid information merely by reading several major metropolitan daily newspapers.... The Department of Defense thus takes the attitude that the object recently found circling the earth in a polar orbit probably



was the last stage of Russia's Lunik III and not a reconnaissance satellite.... Spy satellites, when perfected, probably will be able to gather information by watching or by listening. They can watch by using either photographic or infrared equipment. They can listen with sensitive radios.

was the last stage of Russia's Lunik III and not a reconnaissance satellite.... Spy satellites, when perfected, probably will be able to gather information by watching or by listening. They can watch by using either photographic or infrared equipment. They can listen with sensitive radios.

## Science Future

### March 16

After a week of interviews, the winner of Intel Science Talent Search 2010 is announced at a gala in Washington, D.C. See [www.societyforscience.org](http://www.societyforscience.org)

### March 16–19

Researchers from various disciplines meet in Miami to discuss the state of the Arctic environment. See [soa.arcus.org](http://soa.arcus.org)

### March 21–25

The American Chemical Society hosts its spring meeting in San Francisco. See [www.acs.org](http://www.acs.org)

## Introducing...

A new species of lungless caecilian has turned up, only the second lungless one known. Caecilians look like worms but are amphibians. The new species, *Caecilita iwokrama*, lives in Guyana's Iwokrama Forest. In 1997, a survey team collected an 11.2-centimeter-long female caecilian with no

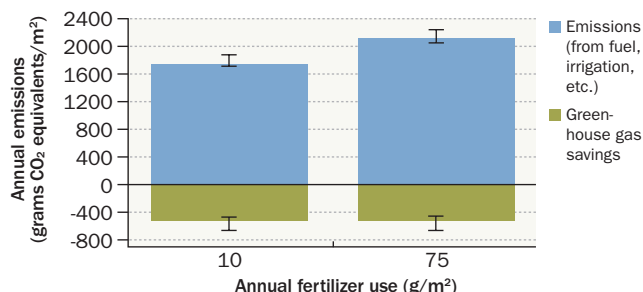


lungs or nostrils. In 2009, Marvalee Wake of the University of California, Berkeley and a colleague named the species, which they suspect may breathe through its skin. Plenty of salamanders do so, but biologists know of just one frog and now two caecilians that breathe without lungs.

## Science Stats | GREEN SPACE GREENHOUSE GAS EMISSIONS

Emissions from ornamental turf in urban areas outweigh these lands' potential to offset global warming, even when less fertilizer is used.

### Greenhouse gas emissions by fertilizer amount



SOURCE: A. TOWNSEND-SMALL, C. CZIMCZIK/GEOPHYSICAL RESEARCH LETTERS

CLOCKWISE FROM TOP LEFT: NATIONAL INSTITUTES OF HEALTH/DEPARTMENT OF HEALTH AND HUMAN SERVICES; KAREN LAUBENSTEIN/U.S. FISH AND WILDLIFE SERVICE; WAKE AND DONNELLY JOURNAL: PROCEEDINGS OF THE ROYAL SOCIETY B: BIOLOGICAL SCIENCES

“ One shouldn’t be scared of barefoot or minimal shoe running or think it odd. ” — DANIEL LIEBERMAN, PAGE 14

**Atom & Cosmos** Cosmic dawn’s light

**Life** Fish moms make up for loser dads

**Matter & Energy** Algae’s quantum tricks

**Earth** Less water vapor, less warming

**Body & Brain** Sizzling heart treatment

**Humans** Remains suggest misplaced man

**Science & Society** Budget breakdown

# In the News

## STORY ONE

### From skin cells to neurons, with no middle man

Team bypasses conversion to stem cell stage entirely

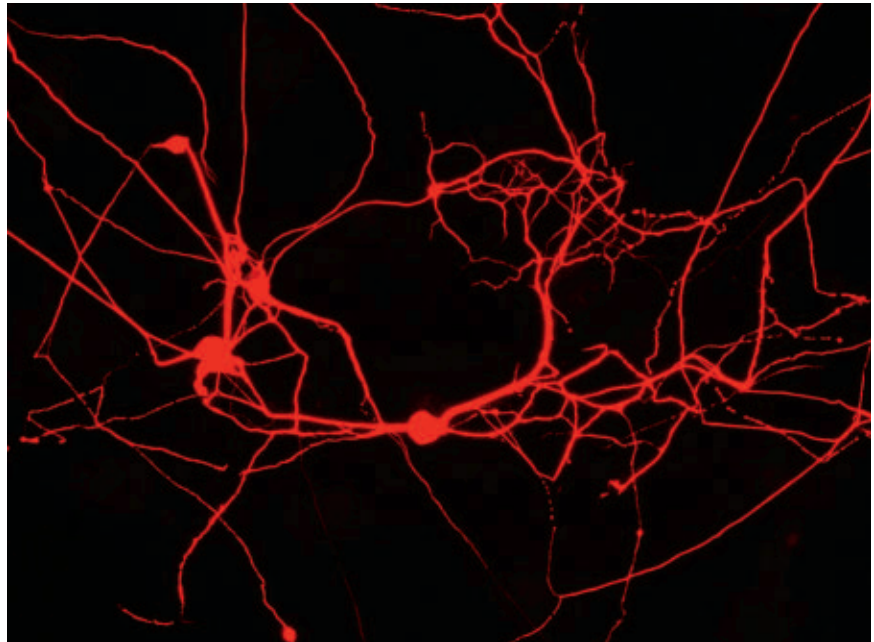
By Tina Hesman Saey

**O**ne small step for skin cells could mean one big leap for regenerative medicine. For the first time, scientists have converted adult cells directly into neurons.

If the technique, done on mouse cells, works for human cells, the achievement may bypass the need to revert a patient’s cells to an embryonic-like state before producing the type of cell needed to repair damage from disease or injury.

Researchers at Stanford University transformed skin fibroblast cells from mice into working neurons by using viruses to insert genes that encode transcription factors. Transcription factors are proteins that help regulate gene activity, usually by turning genes on. To convert skin cells into neurons, only three genes for these regulatory proteins needed to be added, the team reported online January 27 in *Nature*. The three transcription factors, called Ascl1, Brn2 and Myt1l, normally appear when new neurons are being born.

Scientists previously thought that such a transformation required taking cells several steps backward in development to become pluripotent stem cells, which are capable of adopting nearly any cellular identity. Both embryonic stem



**These neurons were made directly from mouse fibroblasts infected with a three-gene cocktail. Researchers hope that different cocktails could transform other cells.**

cells and other pluripotent stem cells created in the lab have these capabilities. The new technique skips the stem cell stage entirely, converting one mature cell type directly into another.

“It’s quite remarkable that you can jump over so many hills at once with just three transcription factors, and so quickly and so efficiently,” says Marius Wernig, a Stanford University stem cell biologist who led the new study. “This really blew me off the chair.”

Perhaps the conversion of skin cells into neurons shouldn’t have come as such a surprise, says Darwin Prockop of Texas A&M Health Science Center College of Medicine in Temple. “We’ve had fixed ideas about what cells are for a little too long,” he says. “We haven’t thought hard enough about cell plasticity.”

Most of the induced neurons, the team’s name for the transformed skin cells, belonged to a common group of brain cells with many functions. These neurons produce glutamate, an important chemical messenger in the brain that excites other nerve cells. Additional transcription factors may be needed to make other types of neurons, Wernig says. Different combinations might convert skin cells into heart, muscle, liver or other types of cells.

“I believe if you just find the right transcription factors, you can turn anything into anything,” Wernig says.

The idea of creating replacement versions of specific cell types from the cells in a person’s own body has been exciting because, in theory, it offers a way to substitute damaged cells with new cells. For



For today's top stories, visit  
SN Today at [www.sciencenews.org](http://www.sciencenews.org)

any number of diseases, this technique could one day provide new treatments, from swapping out neurons in Parkinson's disease patients to pumping up the number of insulin-producing pancreatic cells in diabetics.

But, Wernig says, some technical hurdles must be overcome before these cells could be used for such transplants. Until then, induced neurons made from patients with any of various genetic diseases could almost immediately help scientists learn how such diseases develop and can be used to test new drugs. Researchers are already working out ways to make a variety of cell types from induced pluripotent stem cells, but the new technique is faster and more efficient, Wernig says.

The majority of induced neurons created by the team behaved just like regular neurons, communicating with other neurons in the lab dish and making proteins. But the researchers don't yet know whether the cells' DNA carries normal chemical signatures, known as epigenetic marks, that usually help prevent cells from changing jobs. When altered, these marks can sometimes lead to cancer.

Scientists already know that some cells in the body change identities in a type of disease known as metaplasia. For example, cigarette smoking can change some cells that line the lungs into related skinlike cells, and reflux disease may alter cells in the esophagus to become another type of cell, Wernig says. The minor job switches help cells withstand the stress of smoke or stomach acid.

Researchers have thought that major changes, such as skin cells becoming neurons, were nearly impossible unless the epigenetic slate was wiped clean, as it is with induced pluripotent stem cells. Such big alterations might cause serious diseases if they happen willy-nilly. "It's actually a bit scary to think it's so easy to turn skin cells into neurons because that's not something you want to happen in your body," Wernig says.

But other scientists are excited about the prospect of such transformations occurring in the body. "If it's a naturally

occurring repair mechanism, that could be exciting," says Paul Sanberg, a neuroscientist at the University of South Florida College of Medicine in Tampa. If such conversions happen naturally, scientists may be able to figure out ways to get the

body to heal itself rather than having to transplant cells. After a stroke, for instance, brain cells known as glia rush to the injury site and multiply themselves. Glia might be coaxed to transform into neurons and repair the damage.

Because the scientists had to genetically engineer the mouse skin cells to make

the neuron-inducing transcription factors, the technology probably won't produce cells for transplant any time soon, Sanberg says. "Once you put in genes, it makes it a little more difficult to use clinically," he says. Inserting genes might cause cancer-promoting mutations, for example, so scientists may need to develop alternate approaches that would turn on the same transcription factors chemically instead of genetically. ■

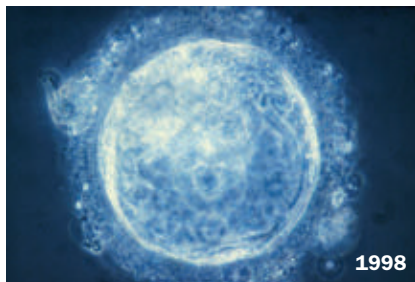
**"If it's a naturally occurring repair mechanism, that could be exciting."**

PAUL SANBERG

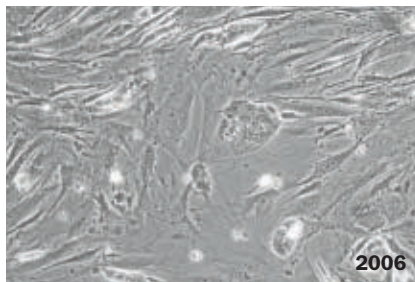
## Back Story | STEM CELL HISTORY HIGHLIGHTS



1996



1998



2006

**1962** DNA-carrying nucleus from an adult frog's intestinal cell is transplanted into an egg, producing a new frog

**1981** Embryonic stem cells are cultured from mouse embryos and grown into a mouse

**1996** Dolly the Sheep (left) is cloned, showing that mammalian adult cells can be reprogrammed

**1998** Embryonic stem cells are isolated from human blastocysts (one shown, top right)

**2006** Scientists use transcription factors to induce mouse cells to become pluripotent (induced pluripotent mouse cells shown)

**2007** Teams reprogram adult human skin cells to an embryonic-like state

**2008** Pancreatic cells in mice are turned directly into related insulin-producing cells

CLOCKWISE FROM LEFT: AP PHOTO/PA/FILES; ANDY WALKER, MIDLAND FERTILITY SERVICES/PHOTO RESEARCHERS, INC.; KATJA SCHENKELAYLAND/UCLA SCHOOL OF MEDICINE-CARDIOLOGY



## Atom &amp; Cosmos

**13.75**  
billion yearsRevised  
estimated age  
of universe**13.73**  
billion yearsPrevious  
estimated age  
of universe

# Relic radiation refines age of cosmos

## Satellite data support inflation, confirm primordial helium

**By Ron Cowen**

By analyzing snapshots of the earliest light in the universe, cosmologists have made the most accurate determination to date of the age of the cosmos, directly detected primordial helium gas for the first time and discovered a key signature of inflation, the leading model of how the cosmos came to be.

The analysis is based on the first seven years of data collected by NASA's Wilkinson Microwave Anisotropy Probe.

Researchers studying the light, known as the cosmic microwave background, unveiled the findings in six papers posted online at arXiv.org on January 26. The light was generated in the Big Bang but is seen as it appeared when it first streamed freely through space about 400,000 years later. The light is peppered with hot and cold spots, signs of tiny primordial lumps from which galaxies grew.

Using temperature data from the WMAP satellite and studies of distant supernovas and other phenomena, scientists including David Spergel of Princeton University and Charles Bennett of Johns Hopkins University in Baltimore find that

the universe is 13.75 billion years old, give or take 0.11 billion. (The team's previous calculation, using the same method but with only five years of observations, had pegged the universe at 13.73 billion years, plus or minus 0.12 billion.)

Data from WMAP support the idea that the early universe inflated rapidly, says Bennett. Inflation theory, which posits that the universe ballooned from subatomic scale to the size of a soccer ball during its first  $10^{-33}$  seconds or so, has had great success in explaining the structure of the universe. According to the theory, fluctuations in the intensity of microwave radiation over larger spatial scales should be slightly bigger than those on smaller scales. WMAP observations now confirm that behavior.

"This is a really strong endorsement for the theory," says Scott Dodelson of the Fermi National Accelerator Laboratory in Batavia, Ill.

The standard model of cosmology — replete with inflation, invisible material known as dark matter, and dark energy

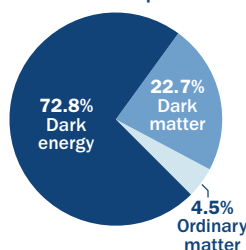
that is believed to accelerate cosmic expansion — "is a wild idea," admits Bennett. But with the newest WMAP analysis "we have confronted the model against the data in a substantially new way ... and this picture is holding up very well."

By using WMAP data to measure acoustic oscillations — the cosmic equivalent of sound waves — the team confirmed that the early universe forged helium as well as hydrogen, just as the Big Bang theory has long predicted. Previous studies provided only indirect evidence of helium. The new detection "is not a surprise, but it's nice to have confirmation," Spergel says.

Researchers also used the data to discern how many types of elementary particles called neutrinos exist. Three types (the tau, muon and electron neutrinos) are known. But current data are consistent with a total of either three or four types. Analyzing additional WMAP observations may settle the question, Bennett says.

WMAP, launched in 2001, will make its last observations this fall. The European Space Agency's Planck mission, launched last year, will monitor the microwave background in even finer detail. 

Universe composition



# Spirit stuck, but in good spot

After six years on Mars and nine months stuck in a sand pit, the driving days are officially over for the Spirit rover, NASA said January 26. The robotic geologist, roving the Red Planet since 2004, slid into the pit in April 2009. "We do not believe that [Spirit] is extractable," said Doug McCuiston, director of the Mars Exploration Program. With the Martian winter approaching, engineers will spend the next few weeks maneuvering Spirit into the best position to catch sunlight for power. The rover will enter hibernation mode in March or April and sleep until August or September, said project manager John Callas of NASA's Jet Propulsion Lab in Pasadena, Calif. Lead investigator Steve Squyres of Cornell University said that Spirit's position offers scientific opportunities. "We got stuck here for a reason, and that reason is this is bizarre soil," he said. "We have exciting science planned." Studies of Martian atmosphere-soil interactions and of Mars' core top the list. —Lisa Grossman 



FROM TOP: A. NANDY. SOURCE: E. KOMATSU ET AL./ARXIV.ORG 2010; JPL/NASA



## For pipefish, Mr. Mom gets help

Eggs carried by undersized dad get protein boost from female

By Susan Milius

If dad's a dud, mom may make it up to the kids with an extra shot of protein.

Female broad-nosed pipefish enhance their eggs with more protein—a boost of some 11 percent—when paired with an undersized mate rather than a large one, says ecologist Gry Sagebakken of the University of Gothenburg in Sweden.

It's the male pipefish that carries around embryos inside his body pouch after fertilization. He supplies some protein to the developing embryos, and previous research shows that larger males do tend to have larger offspring. So extra protein from mom may partly compensate for an undersized dad, the researchers suggest in the March 22 *Proceedings of the Royal Society B*.

In efforts to understand how sexual interactions drive evolution, this limited egg analysis illustrates how complicated sexual selection is, comments Elisabeth Bolund of the Max Planck Institute for

Ornithology in Seewiesen, Germany. Biologists have paid a lot of attention to how animals choose a partner, but “you need to look at all the stages in the process,” she says.

The pipefish have a girl-versus-girl dating scene. Females compete to insert eggs into a male's pouch, a tricky operation that can require multiple attempts. Then the successful female leaves the embryo-plumped male to brood the young as she swims off to look for the next partner.

Females of any species might adjust their eggs in response to a mate's charms, or lack thereof, in two ways. In one scenario, a female with a primo male would allocate extra resources to the young and make the most of an opportunity for robust and plentiful offspring. Examples of this great-mate effect exist, but theorists have also proposed an opposite scenario: Evolution may favor females that compensate when stuck with a loser.

To see what pipefish do, Sagebakken, Inês Braga Gonçalves, also of Gothen-



**In *Syngnathus typhle*, the broad-nosed pipefish, males brood young in pouches.**

burg, and colleagues provided each of 29 females with two chances to mate, once with a puny male and once with a hunk. After a female had transferred at least 20 eggs, researchers caught the male and coaxed the eggs out of his pouch for analysis. Eggs deposited in small males' pouches were not bigger or richer in fat but did have extra protein compared with eggs from the large males' pouches.

That makes sense for pipefish, researchers say, since a competitive female can easily get stuck with a less-than-hefty male. Once a female makes eggs, she can't reabsorb them. So at times she may mate with a male even if he's a shrimp of a fish. 🐟



## Carnation bloom boom

The carnation has a wild side. European carnations and pinks, members of the *Dianthus* group, form new species surprisingly fast. The quick pace suggests that Europe “has been underestimated as a cradle of recent and rapid speciation,” a team reports online January 27 in *Proceedings of the Royal Society B*. Of the 300 or so species, more than 100 are found in Europe (five shown). Luis Valente of the Royal Botanical Garden in Madrid and colleagues analyzed genes from plants collected all over the world. In Europe, the scientists found, new *Dianthus* species have appeared at an overall rate of 2.2 to 7.6 species per million years—comparable to the record rates for plants and land vertebrates. The rate jumped dramatically between 2 million and 1.3 million years ago. The increase coincided with climate changes: Wetter winters and drier summers could have boosted speciation rate. So too could have the flowers' tendency to bloom in summer, not spring; competition for scarce summer pollinators, combined with other factors, may have led the flowers to change more often. —Laura Sanders 🐾

# Feathered dinosaurs, bold and in living color

Stripes, spangles and spots abound

By Sid Perkins

Scientists can now reconstruct the colors that some ancient feathered dinosaurs and birds may have sported, thanks to two new analyses that have identified the remains of tiny pigment-bearing structures in the feathers and filaments that covered the creatures' bodies. Besides revealing snappy patterns and color schemes reminiscent of those seen in some modern birds, the new findings may shed light on why feathers first evolved — and it wasn't for flight, some scientists say.

A report appearing online February 4 in *Science* hints that *Anchiornis huxleyi*, the oldest feathered creature yet found in the fossil record, sported the boldest dinosaur color scheme found so far. This dinosaur, which lived between 151 million and 161 million years ago, probably had reddish-brown speckles on its head and neck, a crest of reddish-brown and gray feathers, and white racing stripes on its legs and winglike forelimbs. The long forelimb feathers were tipped with black spangles. "There was hardly any part of the creature that wasn't feathered," says Jakob Vinther, a paleobiologist at Yale University and a member of the research team reporting the find.

The analyses reported by Vinther and his colleagues "reveal an enormous amount of information," says Michael Benton, a paleontologist at the University of Bristol in England. The black-and-white bars on *A. huxleyi*'s forelimbs, as well as its colorful crest, are remarkably similar to features seen on some modern birds, he notes.

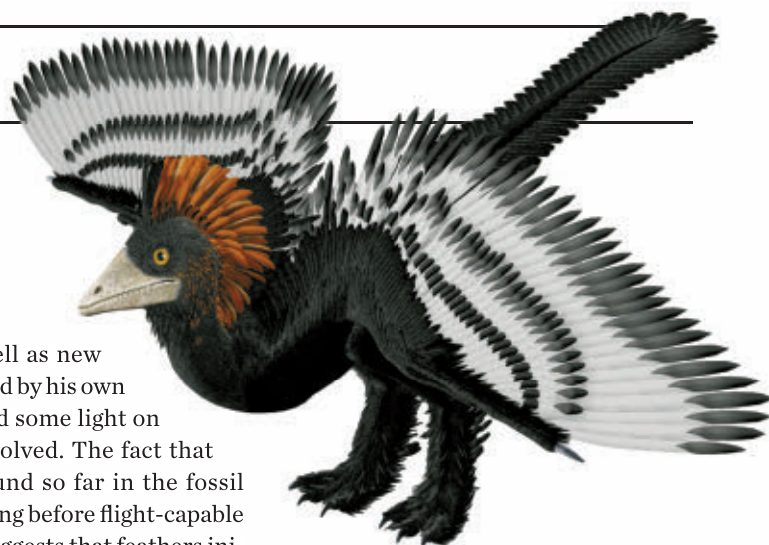
What's more, Benton says, these

findings — as well as new analyses reported by his own team — may shed some light on why feathers evolved. The fact that the feathers found so far in the fossil record appear long before flight-capable birds or dinos suggests that feathers initially served a behavioral function, possibly using color and pattern to send visual signals, and only later came to serve an aerodynamic function.

Philip J. Currie, a paleontologist at the University of Alberta in Edmonton, Canada, agrees: "Ancient creatures didn't just sprout feathers and start flying. The feathers were there for another reason first." Fossils reveal that dinosaurs often had very large eyes and sizable optic lobes in their brains. "Dinosaurs were very visual animals, just like birds are," he adds.

Both teams' findings stem from microscopic analyses of fossils so well preserved that the feathers and filaments contain remnants of melanosomes. In modern-day creatures, these tiny pigment-bearing structures come in two forms, Benton says. Cigar-shaped eumelanosomes hold a black pigment called melanin, he notes, and egg-shaped or near-spherical phaeomelanosomes contain pigments ranging from reddish brown through yellow.

In a study published online January 27 in *Nature*, Benton and his colleagues say they found signs of melanosomes in the fossils of several creatures. Some of those melanosomes, which include the first evidence of phaeomelanosomes in the fossil record, come from feathers on *Confuciusornis*, a bird that lived in what is now China about 125 million years ago, and from bristlelike filaments on the tail



**Analyses of fossilized feathers of *A. huxleyi* suggest that the dinosaur had striking multicolored plumage.**

of *Sinosauropteryx*, a dinosaur that lived in the same region a million or so years later. A number of detailed analyses suggest that the tiny structures aren't the remains of bacteria that colonized the creatures after the dinos and birds died, nor are they tiny bits of the mineral iron pyrite, which can form during the fossilization process, Benton says.

In previous studies, paleontologists discovered signs of black pigment in fossilized feathers (*SN*: 8/2/08, p. 10). The new findings provide tantalizing clues that dinosaurs and early birds weren't limited to a dark, drab color scheme. For instance, the pattern of melanosomes in fossils of *Confuciusornis* shows that the creature probably had patches of white, black and orange-brown feathers. And *Sinosauropteryx* may have sported alternating white and orange-brown rings on its tail, the researchers propose.

Such striking patterns of plumage, including those seen in *A. huxleyi*, could have served any of a number of functions, Vinther and his colleagues speculate. Besides communicating to members of a dinosaur's own species — a "come here, cutie" to members of the opposite sex, say, or a "back off" to rival suitors — a quick flash of boldly colored plumage could startle an attacking predator or flush prey out of hiding, the researchers say. ■





## Photosynthetic algae go quantum

Long-lasting coherence may explain electron transfer efficiency

By Laura Sanders

A dash of sunlight, a sprinkle of light-harvesting proteins and a healthy dollop of carbon dioxide is about all it takes to whip up a batch of tasty plant food—but you might want some quantum physics to stir the pot. A team has caught photosynthetic marine- and lake-dwelling algae performing quantum tricks at room temperature. The results, in the Feb. 4 *Nature*, suggest that quantum mechanics may be at the heart of sunlight-to-energy conversion in living organisms.

“This is quantum mechanics in a biological system,” says study coauthor Gregory Scholes, a physical chemist at the University of Toronto.

Photosynthesis relies on proteins that absorb incoming photons, or particles of light. In the algae, these photons excite electrons in the proteins, touching off a series of electron transfers that ultimately ferry the energy-laden electrons to centralized collection stations (called photosystems) where the conversion of energy to carbohydrates begins.

Under normal rules, electrons would travel to their destinations with quick random hops. But studies of photosynthetic bacteria and plants suggest that the electrons might act more like correlated waves instead of hopping particles, a behavior predicted by quantum mechanics (*SN*: 5/9/09, p. 26). These studies have mainly seen such quantum effects at very low temperatures. Scholes and colleagues devised an experiment to see whether these quantum-mechanical wavelike properties were also present at ambient temperatures.

At room temperature, the team used a laser to excite light-catching proteins purified from photosynthetic algae. A second laser pulse revealed where the resulting excited electrons went. Patterns of long-lasting electron waves—a property called quantum coherence—indicated quantum weirdness was at work.


“This study shows that quantum coherence is present at room tempera-

ture,” says Graham Fleming, a chemist at the University of California, Berkeley. “It is very likely a general feature of photosynthetic light-harvesting complexes,” says Fleming, a pioneer of studies on quantum effects in photosynthesis.

The researchers expected to see the coherence last for about 20 femtoseconds, Scholes says. Instead, it lasted for about 400 femtoseconds. These long-

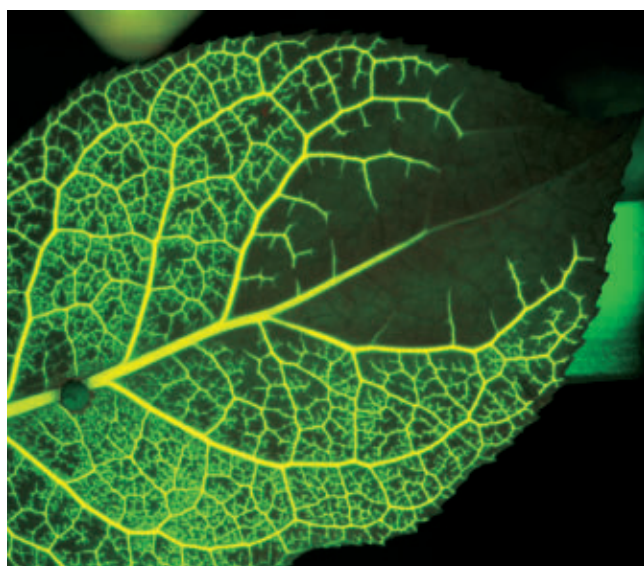
lasting quantum effects may help explain the mystery of why the initial electron-moving reactions in photosynthesis are so efficient. In an extreme version of the algae’s quantum-mechanical trick, electrons could simultaneously take all the possible paths to a photosystem and decide after arriving

which route was best. “That vibrating electron could put some feelers out and see which path to take,” Scholes says.


The researchers don’t yet know for sure whether quantum effects make the reaction chain more efficient. Scholes believes that they do, but more studies and modeling experiments will be required to say exactly how much of a boost quantum coherence provides. 

**“This study shows that quantum coherence is present at room temperature.”**

GRAHAM FLEMING



## Leaves’ loopy networks

Tree branches have inspired efficient transit networks, but a new study looks at the connected loops of leaf veins. In some plants the loops help circumvent damaged areas and channel nutrients efficiently, report researchers led by Eleni Katifori of Rockefeller University in New York City. The team programmed a computer to simulate how efficiently different network patterns could do the job of leaf veins, which move water and nutrients around. In the simulations, the looped network performed better than nonlooped ones in several important ways, the team reported January 29 in *Physical Review Letters*. Damage from insects, weather or parasites can interrupt leaves’ normal venation patterns. Connected circular veins allowed the flow of water and minerals to circumvent injured areas (dark green dot, shown on lemon leaf). The looped network also allowed easy adjustment of the flow rate of water through veins, which can help conserve moisture on a hot day, Katifori says. —Laura Sanders 

E. KATIFORI ET AL./PRL

## Earth

**10**  
percentDrop in water vapor  
levels in part of lower  
stratosphere, 2000–01**25**  
percentReduction in expected rise in  
global temperature linked to  
water vapor loss, 2000–09

# Water vapor drop dampens temps

## Global warming slowed by decline in upper atmosphere's H<sub>2</sub>O

**By Sid Perkins**

A sudden and unexplained drop in the amount of water vapor high in the atmosphere almost a decade ago has substantially slowed the warming at Earth's surface in recent years, scientists say.

In late 2000 and early 2001, concentrations of water vapor in a narrow slice of the lower stratosphere dropped by about 10 percent and have remained relatively stable since. Because the decline was noted by several types of instruments, including some on satellites and others lofted on balloons, the sharp decrease is presumed to be real, says Karen Rosenlof, a meteorologist at the National Oceanic and Atmospheric Administration's Earth System Research Laboratory in Boulder, Colo.

Because water vapor is a potent greenhouse gas, the decline has slowed the increase of global temperatures, Rosenlof, her NOAA Boulder colleague Susan Solomon and others report online January 28 in *Science*.

"This is such a sudden decrease, we can't explain what's behind it," says Rosenlof. One large source of water vapor in the stratosphere is the oxidation of methane, she notes. But the decline detected by the researchers seems to be limited to a layer 2 kilometers thick in the lower stratosphere, while methane is found throughout the stratosphere. And even though scientists have discerned a leveling off in atmospheric methane in recent years, that trend doesn't seem to be directly linked to the drop in levels of stratospheric water vapor, she says.

Regardless of the cause of the decline, the team's modeling suggests that the decrease in water vapor in the lower stratosphere has slowed down average global warming. The rate of increase in the average global surface temperature from 2000 to 2009 was about

25 percent lower than it otherwise would have been, the researchers report. The analyses suggest that average global surface temperatures rose only 0.1 degrees Celsius during that period, rather than the 0.14-degree rise expected because of increasing concentrations of other greenhouse gases.

The researchers speculate that the amount of water vapor gradually rising into the stratosphere at tropical latitudes has decreased, possibly because of a shift in global patterns of sea-surface temperatures that influence rates of evaporation and water vapor movement.

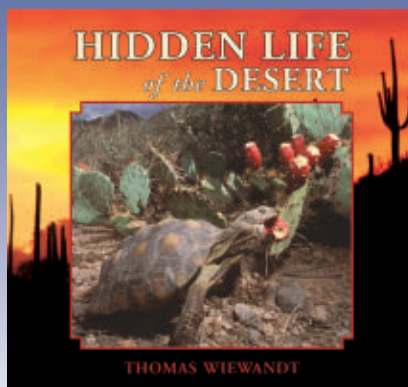
The new findings "are a nice demonstration of the sensitivity of the climate to water vapor concentrations in

the lower stratosphere," says Andrew Gettelman, an atmospheric scientist at the National Center for Atmospheric Research, also in Boulder.

Andrew Dessler, an atmospheric scientist at Texas A&M University in College Station, says that he thinks the team has identified a new source of short-term variability in climate, one different from long-term drivers of change such as other greenhouse gases. And even though the effect seems to be substantial, the decrease in water vapor may be temporary.

What's more, Dessler says, humans can't depend on a continued decline in water vapor in the lower stratosphere to slow surface warming further in the long term. "Water vapor is scarce in the lower stratosphere already, and you can't drop below zero," he notes. "This is not going to save our bacon." ☺

## Uncover the inhabitants of the harsh and beautiful Sonoran Desert



### Hidden Life of the Desert

Thomas Wiewandt

Discover the many interesting and unusual plants and animals that thrive in the Sonoran Desert—from howling mice to Gila monsters, from prickly pear to organ pipe cactus—through stunning color photographs and clear informative text.

96 pages, 9 x 8<sup>3</sup>/<sub>8</sub>, paper \$15.00  
For Ages 8 to Adult

Please  
include \$4.00  
for shipping and  
handling.

**MP Mountain Press**  
PUBLISHING COMPANY

P.O. Box 2399 • Missoula, MT 59806 • 406-728-1900  
toll free: 800-234-5308 • fax: 406-728-1635  
info@mtnpublishing.com • www.mountain-press.com

# Body & Brain



For longer versions of these and other Body & Brain stories, visit [www.sciencenews.org](http://www.sciencenews.org)

## Searing the heart for the better

Charged catheter destroys tissue to stifle atrial fibrillation

By Nathan Seppa

Talk about heartburn. Using a catheter with a charged tip, doctors can sizzle wayward heart cells and correct an irregular heartbeat better than standard drugs can, a head-to-head comparison shows. The report appears in the Jan. 27 *Journal of the American Medical Association*.

The procedure has been used for more than 20 years to correct atrial fibrillation — a weak, rapid heartbeat that carries health risks. But despite its long track record, the U.S. medical community hasn't fully accepted the technique.

"There are doctors who take a more conservative view and continue to try drugs" to treat atrial fibrillation, says


cardiologist David Wilber of Loyola University Health Center in Maywood, Ill., who coauthored the new study. As a result, the procedure, called catheter ablation, has remained a second-line treatment and continues to undergo testing, he says, even though about half of patients fail to control their atrial fibrillation with medication.

In the new study, Wilber and colleagues identified patients with atrial fibrillation who had failed to improve on at least one drug. The researchers randomly assigned 100 patients to get catheter ablation and 51 to receive a standard drug that they hadn't previously taken.

After nine months, 66 percent of those getting the procedure remained free of

atrial fibrillation episodes compared with 16 percent of those receiving medication. Patients getting the procedure also reported improvements in quality of life.

Earlier trials had found that up to 6 percent of patients getting catheter ablation experienced serious complications such as a heart puncture, blood clotting or damage to nearby nerves or to the esophagus. None of these side effects occurred in the new study. The authors note that many of the doctors performing the procedure "had considerable experience" in atrial fibrillation ablation, which may partly explain the low complication rate.

The doctors used a cooled catheter approved by the U.S. Food and Drug Administration last year. The new device also probably lessened the number of serious complications in this trial, says Giuseppe Stabile, a cardiologist at the Mediterranean Clinic in Naples, Italy. 

## Pore propulsion helps out sperm

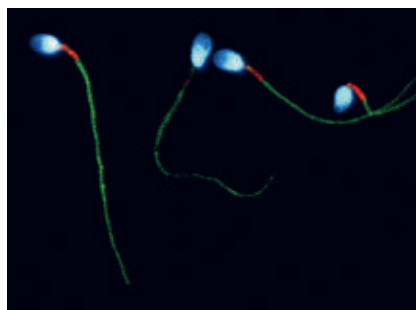
Study suggests possible link between marijuana, infertility

By Laura Sanders

Fancy goggles, a swim cap or the latest high-tech suit won't help human sperm power through their race to fertilize an egg. Instead, the tiny cells rely on a proton-shedding pore to speed toward their target, a study in the Feb. 5 *Cell* finds.

The study also reports that a compound similar to the active ingredient in marijuana might interfere with this channel, suggesting a molecular link between habitual marijuana use and male infertility. Finding other compounds that open or close the channel may offer new ways to control reproduction, the authors say.

Researchers knew that powerful sperm swimming depends on protons leaving the sperm cell, thereby lowering its acidity. The concentration of protons inside



**The proton channel Hv1 (green) is found on the tails of human sperm. DNA (blue) and mitochondria (red) are also shown.**


a sperm is roughly 1,000 times higher than outside, says Yuriy Kirichok of the University of California, San Francisco, a coauthor of the new study. As protons flood out of the cell, a host of changes kick the sperm into high gear. But just how the protons escaped was a mystery.

"This is an important paper because it reveals how human spermatozoa lower intracellular acidity," comments David Clapham, a Howard Hughes Medical Institute investigator at Harvard Medical School.

Kirichok and colleagues examined the electrical properties of mature human sperm by using an electrode to record proton movement across the cell membranes. The electrical properties of the sperm were similar to those of certain immune cells that are known to discharge protons through a channel called Hv1.

To verify that Hv1 was the right channel in sperm, the team stained the channel with green fluorescent antibodies. The tails of the sperm glowed green, indicating Hv1 was abundant there. The team also looked for substances that changed Hv1's behavior. A compound called anandamide, similar to the active ingredient in marijuana, opened the channel.

"It's been known for quite some time that marijuana reduces fertility, but nobody knows why this happens," says Kirichok. "We for the first time show the presence of a molecule on sperm that can be directly activated by anandamide."

He speculates that habitual marijuana use may activate sperm cells prematurely, leaving them burned out and unable to swim when it counts. 

Y. KIRICHOK



"It's been known for quite some time that marijuana reduces fertility, but nobody knows why this happens." — YURIY KIRICHOK

## Memory protein clumps like prion

### Slug study hints that molecular 'misbehavior' has a purpose

By Tina Hesman Saey

Sea slugs make memories with a twist. Screwing a normal nerve cell protein into a distorted shape helps slugs, and possibly people, lock in memories, new research shows.

Notably, the shape change also brings a shift in the protein's behavior, leading it to form clumps. That behavior is seen in prions, misshapen infectious proteins that cause mad cow disease and scrapie (*SN*: 7/31/04, p. 67). But the new study, published February 5 in *Cell*, shows a possible normal function for the shape shifting, suggesting that twists and clumps don't necessarily make prions monsters.

In one sense, prions are machines of "molecular memory," says biologist Yuri Chernoff of the Georgia Institute of Technology in Atlanta. The proteins remember their shape change and then transmit that change to other proteins. "But the notion of these machines being used for cellular, and therefore organismal, memory is truly amazing," he says.

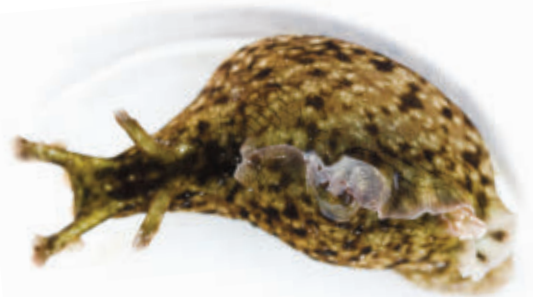
If the process works in humans, prion-

like proteins might someday be used in memory-enhancing treatments, he says.

Prions have a bad reputation because of the infamous twisting protein PrP (for prion protein). When PrP in nerve cells switches from its harmless form into a prion form, it corrupts other PrP molecules that then assemble into nearly indestructible plaques known as amyloids.

PrP's prion form is a neuron killer that can be transmitted from one animal to another if infected tissue is eaten. Other noninfectious amyloid-forming proteins, such as those involved in Alzheimer's and Parkinson's, also kill brain cells (*SN*: 8/16/08, p. 20). But the new study suggests that some proteins may change shape and form amyloids in helpful ways.


In large *Aplysia* sea slugs, scientists had discovered that a short-lived protein called CPEB (for cytoplasmic polyadenylation element binding protein) is needed to form strong neuron-to-neuron connections, such as those associated with long-term memories. Kausik Si of the Stowers Institute for Medical Research in Kansas City,



**A study in the sea slug *Aplysia* (shown) finds that shape changes and clumps don't always turn proteins bad.**

Mo., discovered that CPEB could behave like a prion in yeast, changing shape and triggering the formation of amyloids. In the new study, Si, Eric Kandel of Columbia University and colleagues show that CPEB twists and clumps in sea slug neurons, too. But instead of killing cells, CPEB amyloids strengthen nerve cell connections.

When CPEB's ability to form amyloid was blocked, connections between neurons were weak. When CPEB can change into amyloid form, neurons make long-lasting connections.

"It's super exciting that what they have here is good evidence for functional amyloid in the brain," says biochemist John C. Price of the University of California, San Francisco. 

## SSRIs may delay breast milk flow

### Antidepressants could affect serotonin's role in lactation

By Nathan Seppa

Breast milk takes longer to start flowing in new mothers using SSRI antidepressants than in moms not on the drugs, researchers report.

Although the new study, in the February *Journal of Clinical Endocrinology & Metabolism*, is too small to yield clear conclusions or change clinical practice, the authors say, the findings raise knotty


questions about taking selective serotonin reuptake inhibitors in late pregnancy.

"There's no question" that this finding should lead to further study of SSRIs and serotonin's role in inhibiting breast milk production, says Robert Collier of the University of Arizona in Tucson, a lactation biologist not involved in the study.

Animal tests reported in this study and earlier work hinted that serotonin plays a role in regulating lactation. SSRIs, which include the drugs Prozac, Zoloft and Paxil, keep excess serotonin in circulation in the brain and thus enhance the neurotransmitter's effects to alleviate depression.

Tests on female mice showed that serotonin also works as a brake on breast milk production, says study coauthor Nelson

Horseman, an endocrinologist at the University of Cincinnati College of Medicine. "Serotonin interprets signals that a breast is full and shuts off milk synthesis and secretion," he says, citing the work in mice. And the time between birth and mom's first copious milk secretion was longer on average for eight women taking SSRIs than for 423 who were not.

With the mice, the study authors use an "impeccable, elegant methodological design" to establish that SSRIs can affect milk production, says Salvatore Gentile, a physician at the Local Health Authority in Salerno, Italy. But the group of women using SSRIs was too small to determine whether these experimental results apply more generally in people, he says. 

# Humans



For longer versions of these and other Humans stories, visit [www.sciencenews.org](http://www.sciencenews.org)



This skull belonged to a man who held a prominent position in the Xiongnu Empire.

## Mongolian skeleton, western man

2,000-year-old DNA suggests early Indo-European migration

By Bruce Bower

Dead men can indeed tell tales, but they speak in a whispered double helix.

Consider an older gentleman whose skeleton lay in one of more than 200 tombs recently excavated at a 2,000-year-old cemetery for the elite in eastern Mongolia. DNA extracted from this man's bones pegs him as a descendant of Europeans or western Asians. Yet he still assumed a prominent position in ancient Mongolia's Xiongnu Empire, say Kyung-Yong Kim of Chung-Ang University in Seoul, South Korea, and his colleagues.

Previous excavations and descriptions in ancient Chinese texts led researchers to suspect that the Xiongnu Empire — which ruled a vast territory in and around Mongolia from 209 B.C. to A.D. 93 — included ethnically and linguistically diverse nomadic tribes. The Xiongnu Empire once ruled the major trading route known as the Asian Silk Road, opening the empire to both Western and Chinese influences.


Researchers have yet to pin down the language spoken by Xiongnu rulers and political elites, says archaeologist David Anthony of Hartwick College in Oneonta, N.Y. But the new genetic evidence shows that the 2,000-year-old skeleton belonged

to a man who “was multiethnic, like the Xiongnu polity itself,” Anthony says.

On his Y chromosome (inherited from paternal ancestors), this long-dead man possessed a set of genetic mutations that commonly appears today among male speakers of Indo-European languages in northeastern Europe, central Asia and northern India, Kim's team reports in an upcoming *American Journal of Physical Anthropology*. The man displayed a pattern of mitochondrial DNA mutations, inherited from maternal ancestors, characteristic of speakers of modern Indo-European languages in central Asia.

“We don't know if this 60- to 70-year-old man reached Mongolia on his own or if his family had already lived there for many generations,” says study coauthor Charles Brenner, a DNA analyst in Oakland, Calif.

The man's genetic signature supports the idea that Indo-European migrations to northeastern Asia

started before 2,000 years ago. This notion is plausible but not confirmed, says geneticist Peter Underhill of Stanford University. Further investigations of Y chromosome mutation frequencies in modern populations will allow for a more precise tracing of the man's geographic roots, Underhill predicts. 



Gold ornaments were found with the ancient skeleton.

## Running barefoot cushions impact of forces on foot

Too soon to say if shoeless approach reduces injuries

By Laura Sanders

The clothes don't make the man, but wearing no shoes might make the runner. A study of people who habitually run barefoot shows that these runners' feet strike the ground in a way that tempers impact forces and smooths the running movement, reports a study appearing online January 27 in *Nature*.

Though the results suggest that barefoot running might have benefits, it's too soon to say whether this style is less likely to cause injuries, the researchers say.

“One shouldn't be scared of barefoot or minimal shoe running or think it odd,” says study coauthor Daniel Lieberman of Harvard University. “From an evolutionary perspective, it's normal and, if done properly, it is very fun and comfortable. We evolved to run barefoot.”

The new study is elegant and offers a good example of the mechanics of different running gaits, comments Daniel Schmitt, an evolutionary anthropologist at Duke University in Durham, N.C.

Earlier studies suggested that people running barefoot land on the front or middle of the foot first, before lowering the heel and transitioning body weight to the back of the foot. The invention of the springy running shoe in the 1970s, the study's authors write, allowed runners to land comfortably on the heel before rolling weight forward on the foot. Shoe cushioning distributed the impact force, making the heel strike bearable. (Sprinters run primarily on their forefeet, but the mechanics of sprinting are different.)

Lieberman and colleagues traveled to the Rift Valley Province in Kenya and videotaped the movement styles of some

**0.58**  
body weights

Impact force for  
barefoot runners  
who forefoot strike

**1.74**  
body weights

Impact force for  
shod runners who  
strike heel first

famed endurance runners who grew up not wearing shoes. The researchers found that, as expected, these runners typically strike the ground with either the forefoot or the midfoot before lowering the heel. In contrast, shod runners in the United States typically landed on the heel first.

"This study is unique in that they actually went and found people who have been running barefoot and are world renowned as barefoot runners," says biomechanist Reed Ferber of the University of Calgary in Canada. Previous studies focused on people asked to run barefoot in laboratory experiments, he says.

In further experiments at Harvard, Lieberman's team used a scale called a force plate to precisely measure force from running. The average initial impact force in habitually barefoot U.S. runners who land on the forefoot first is about one-

third the force in shod U.S. runners who land on the heel, the researchers found. "A rear-foot strike is like someone hitting you on the foot with a hammer with about one and a half to three times your body weight. It would hurt without a shoe," Lieberman says. "A forefoot strike is like having no one hit you at all."

So far, there is no good evidence yet of whether barefoot running causes fewer injuries than does running with shoes, Ferber says. The idea that barefoot running is superior "is a massive assumption," he says. "Fundamentally, there are no studies out there that show barefoot running is less injurious."

Ferber notes that barefoot running also has drawbacks. Landing on the forefoot

can cause runners to flex the foot in a way that creates more mincing steps, shortening the stride. A 6-foot, 2-inch-tall man would have to take 7,500 more steps to finish a marathon if running barefoot

than if with shoes, because the length of the stride is shorter, Ferber says. "You could argue that if he's going to take 7,500 more steps he's more likely to get an injury. But you could also argue that all those steps don't have that impact peak, so that might be injury protective."

Lieberman agrees that it's too early for people to throw out their fancy shoes. "It's too complex a question, as it depends on one's feet, condition, ability to forefoot or midfoot strike, which takes more calf muscle, and so on."

**"One shouldn't be scared of barefoot or minimal shoe running or think it odd."**

DANIEL LIEBERMAN

The advertisement features a grid of eight car parts: a spark plug, a taillight, a cooling fan, a toy fire truck, a timing belt, a red battery, an air filter, and a water pump. Each part is labeled with a green checkmark and 'Yes' or a red 'x' and 'No'. The RockAuto.com logo is prominently displayed in the center, with the tagline 'ALL THE PARTS YOUR CAR WILL EVER NEED'. Below the logo, the text 'GO TO WWW.ROCKAUTO.COM' and 'ROCKAUTO, LLC (EST. 1999)' is visible. The background is dark blue with white text on the left and right sides: '✓ Huge Selection', '✓ Everyday Low Prices', '✓ Fast Shipping', and '✓ Easy to use Website'. A small 'ACCREDITED BUSINESS' logo is in the bottom right corner.

✓Yes ✓Yes ✓Yes xNo ✓Yes ✓Yes ✓Yes ✓Yes

✓ Huge Selection  
✓ Everyday Low Prices

✓ Fast Shipping  
✓ Easy to use Website

**ROCKAUTO.COM**  
ALL THE PARTS YOUR CAR WILL EVER NEED  
GO TO WWW.ROCKAUTO.COM ROCKAUTO, LLC (EST. 1999)





# President proposes higher levels of science spending in fiscal 2011

## 5.9% increase over 2010 requested for nondefense R&D

By Rachel Ehrenberg

Given the economy, research societies seemed pleased that the Obama administration plans on giving to science. The president's budget for fiscal 2011, released February 1, proposes \$147.7 billion for federal spending on research and development. Of that, nondefense-related funding would be \$66 billion, a 5.9 percent increase over what was allocated in 2010. Some programs, such as the Yucca Mountain nuclear waste facility and NASA's Constellation program, met an early death in the budget. Most agencies would see modest increases.

"Given that there's an overall freeze, you had to hope that the president was going to be true to his promise to use a scalpel rather than a hatchet," says Albert Teich, director of science and policy programs at the American Association for the Advancement of Science in Washington, D.C. "That seems to be the case. Within the budget, science seems to be treated pretty well."

Proposed Department of Energy

initiatives include more than \$108 million for research on renewable energy sources. About \$174 million would fund research intended to improve the reliability, efficiency and security — including cybersecurity — of the nation's electrical transmission and distribution networks.

The request also includes \$197 million to develop nuclear waste disposal alternatives while shutting down the controversial effort to store nuclear waste at the Yucca Mountain facility in Nevada.

The National Institutes of Health, which receives the lion's share of research money budgeted for the Department of Health and Human Services, will see an increase from \$31 billion in FY 2010 to about \$32 billion — a 3.2 percent rise (2 percent when adjusted for inflation).

NIH will also still feel the glow of an extra \$10 billion it received over fiscal years 2009 and 2010 as part of the Recovery Act. Some of that money is spread out in multiyear projects. Funds from the Recovery Act will probably also trickle into other agencies, presidential science adviser John Holdren said at a

briefing. Recovery Act funding is not included in the proposed 2011 budget.

NASA's budget will go up by \$6 billion over the next five years under the plan. The plan earmarks an extra \$183 million to extend the life of the International Space Station past its planned retirement date of 2016 and allots \$5 billion for space and Earth science research, including grants, telescopes and missions to study the moon and Mars.

The biggest shake-up was the cancellation of the Constellation program, which was to return astronauts to the moon by 2020 and has already cost some \$9 billion over the past four years. An independent panel found that the program was behind schedule and underfunded.

NASA will instead focus on developing new "game-changing" technologies to take humans beyond low-Earth orbit by increasing cooperation with and reliance on commercial space companies.

The proposed budget would expand the U.S. Environmental Protection Agency's spending on programs addressing climate change and promoting clean energy. EPA Administrator Lisa Jackson noted that the largest increase in her agency's research budget would bump up spending on Science to Achieve Results research grants to \$87 million, an increase of more than 40 percent. EPA is also slated to receive \$26 million to study hormone-mimicking pollutants and other chemicals, \$6 million more than this year.

The National Science Foundation budget would increase by some 8 percent, adjusted for inflation, in 2011. In addition to spending on basic research, NSF supports education and training programs.

The 2011 fiscal year starts on October 1. Congress will decide what the final budget will include.

"The administration's taken a pretty positive approach towards science and technology," says Teich. "We have to hope that Congress does the same thing."

*Nathan Seppa, Sid Perkins, Laura Sanders, Janet Raloff and Lisa Grossman contributed to this report.*

### Federal research and development funding

Proposed fiscal year 2011 budget by agency, in millions of dollars

U.S. agency or department	FY 2009 actual	FY 2010 estimate	FY 2011 proposed	Percent change†
Defense (military only)*	81,121	81,090	77,548	-5.4
NIH (and other HHS R&D)	41,658	31,177	32,156	2.0
Energy	13,268	10,693	11,219	3.8
NASA	11,677	9,286	10,986	17.0
NSF	7,576	5,092	5,571	8.2
Agriculture	2,613	2,591	2,448	-6.5
Commerce	1,969	1,516	1,727	12.7
Homeland Security	1,096	1,150	1,046	-10.0
Interior	775	755	772	1.1
EPA	559	622	651	3.5
Other Agencies and Departments	3,159	3,381	3,572	4.5
<b>TOTAL</b>	<b>165,471</b>	<b>147,353</b>	<b>147,696</b>	<b>-0.9</b>

Figures reflect rounding, FY 2009 column includes one-time Recovery Act funds

† Difference between 2010 and 2011, adjusted for 1.1 percent expected rate of inflation

\*Other agency budgets include some defense-related, nonmilitary projects

SOURCE: ADAPTED FROM OFFICE OF MANAGEMENT AND BUDGET

■ Increase ■ Decrease

# HARBOR FREIGHT TOOLS

Quality Tools at Ridiculously Low Prices

## FACTORY DIRECT TO YOU!

How does Harbor Freight Tools sell high quality tools at such ridiculously low prices? We buy direct from the factories who also supply the major brands and sell direct to you. It's just that simple! Come see for yourself at one of our 330 STORES NATIONWIDE and use this 20% OFF Coupon on any of our 7,000 products. We stock Automotive products, Shop Equipment, Hand Tools, Tarps, Compressors, Air & Power Tools, Material Handling, Woodworking Tools, Welders, Tool Boxes, Outdoor Equipment, Generators, and much more.

**NOBODY BEATS OUR QUALITY, SERVICE AND PRICE!**

- ✓ We Have 10 Million Satisfied Customers
- ✓ We Buy Factory Direct and Pass the SAVINGS on to YOU!
- ✓ Shop & Compare Our Quality Brands Against Other National Brands
- ✓ Thousands of People Switch to Harbor Freight Tools Every Day!
- ✓ NO HASSLE RETURN POLICY
- ✓ Family Owned & Operated

**LIFETIME WARRANTY**  
ON ALL HAND TOOLS!

**SUPER COUPON!**

# 20% OFF

ANY SINGLE ITEM!

Bring this coupon and Save 20% on one single item purchased at Harbor Freight Tools. Cannot be used with any other discount or coupon. One coupon per purchase. One coupon per customer. Coupon not valid on prior purchases or purchase of gift cards or purchase of extended service plans. Offer good on in-stock merchandise only. Savings discount percentage off Harbor Freight Tools current prices, including sale prices. This coupon cannot be duplicated in any manner including photocopies and computer printouts. Original coupon must be presented in order to receive the discount. All Campbell Hausfeld products are excluded from this offer. This offer is not valid on food or beverage items sold in our retail stores. Valid only in Retail Stores through 6/25/10.

31778024

See [HarborFreightusa.com/scinews](http://HarborFreightusa.com/scinews) for additional SUPER COUPONS

**SUPER COUPON!**

**3000 LB. CAPACITY LIGHTWEIGHT ALUMINUM RACING JACK**

**U.S. GENERAL®**

Item 91039 shown

LOT NO. 91039/67408

**\$59.99**

REG. PRICE \$99.99

**SAVE \$40**

**HARBOR FREIGHT TOOLS - LIMIT 1**  
These valuable coupons are only good when presented at your nearest Harbor Freight Tools store. Offer Ends 6/25/10. Coupons valid in Retail Store Only. Coupon not valid on prior purchases. Coupon cannot be bought, sold, or transferred. This coupon cannot be duplicated in any manner including photocopies and computer printouts. Original coupon must be presented in order to receive the discount.

**SUPER COUPON!**

**CENTRAL PNEUMATIC® 2 HP, 8 GALLON, 115 PSI PORTABLE AIR COMPRESSOR**

Item 95386 shown

LOT NO. 95386/40400/67501

**\$79.99**

REG. PRICE \$139.99

**SAVE \$60**

**HARBOR FREIGHT TOOLS - LIMIT 1**  
These valuable coupons are only good when presented at your nearest Harbor Freight Tools store. Offer Ends 6/25/10. Coupons valid in Retail Store Only. Coupon not valid on prior purchases. Coupon cannot be bought, sold, or transferred. This coupon cannot be duplicated in any manner including photocopies and computer printouts. Original coupon must be presented in order to receive the discount.

**SUPER COUPON!**

**MULTIFUNCTION POWER TOOL**

**CHICAGO® Electric Power Tools**

LOT NO. 67256

**\$34.99**

REG. PRICE \$59.99

**SAVE 41%**

**HARBOR FREIGHT TOOLS - LIMIT 1**  
These valuable coupons are only good when presented at your nearest Harbor Freight Tools store. Offer Ends 6/25/10. Coupons valid in Retail Store Only. Coupon not valid on prior purchases. Coupon cannot be bought, sold, or transferred. This coupon cannot be duplicated in any manner including photocopies and computer printouts. Original coupon must be presented in order to receive the discount.

**SUPER COUPON!**

**11 DRAWER ROLLER CABINET**

**STOREHOUSE®**

LOT NO. 67421

**\$149.99**

REG. PRICE \$289.99

**SAVE \$140**

**HARBOR FREIGHT TOOLS - LIMIT 1**  
These valuable coupons are only good when presented at your nearest Harbor Freight Tools store. Offer Ends 6/25/10. Coupons valid in Retail Store Only. Coupon not valid on prior purchases. Coupon cannot be bought, sold, or transferred. This coupon cannot be duplicated in any manner including photocopies and computer printouts. Original coupon must be presented in order to receive the discount.

**SUPER COUPON!**

**CHICAGO® 10" SLIDING COMPOUND MITER SAW**

Item 98199 shown

LOT NO. 98199/90891/96697

**\$79.99**

REG. PRICE \$139.99

**SAVE \$60**

**HARBOR FREIGHT TOOLS - LIMIT 1**  
These valuable coupons are only good when presented at your nearest Harbor Freight Tools store. Offer Ends 6/25/10. Coupons valid in Retail Store Only. Coupon not valid on prior purchases. Coupon cannot be bought, sold, or transferred. This coupon cannot be duplicated in any manner including photocopies and computer printouts. Original coupon must be presented in order to receive the discount.

**SUPER COUPON!**

**CENTRAL PNEUMATIC® HIGH SPEED METAL SAW**

LOT NO. 113/91753

**\$9.99**

REG. PRICE \$29.99

**SAVE 66%**

**HARBOR FREIGHT TOOLS - LIMIT 1**  
These valuable coupons are only good when presented at your nearest Harbor Freight Tools store. Offer Ends 6/25/10. Coupons valid in Retail Store Only. Coupon not valid on prior purchases. Coupon cannot be bought, sold, or transferred. This coupon cannot be duplicated in any manner including photocopies and computer printouts. Original coupon must be presented in order to receive the discount.

**SUPER COUPON!**

**9 PIECE HIGHLY POLISHED COMBINATION WRENCH SETS**

**SAE - LOT NO. 42304**  
**METRIC - LOT NO. 42305**

**\$6.99**

REG. PRICE \$9.99

**SAVE 30%**

**HARBOR FREIGHT TOOLS - LIMIT 1**  
These valuable coupons are only good when presented at your nearest Harbor Freight Tools store. Offer Ends 6/25/10. Coupons valid in Retail Store Only. Coupon not valid on prior purchases. Coupon cannot be bought, sold, or transferred. This coupon cannot be duplicated in any manner including photocopies and computer printouts. Original coupon must be presented in order to receive the discount.

**SUPER COUPON!**

**CAMOUFLAGE 12 VOLT 3000 LB. CAPACITY WIRELESS REMOTE CONTROLLED PORTABLE WINCH WITH ROLLER FAIRLEAD**

**CHICAGO® Electric Power Tools**

LOT NO. 95912

**\$49.99**

REG. PRICE \$99.99

**SAVE \$50**

**HARBOR FREIGHT TOOLS - LIMIT 1**  
These valuable coupons are only good when presented at your nearest Harbor Freight Tools store. Offer Ends 6/25/10. Coupons valid in Retail Store Only. Coupon not valid on prior purchases. Coupon cannot be bought, sold, or transferred. This coupon cannot be duplicated in any manner including photocopies and computer printouts. Original coupon must be presented in order to receive the discount.

**SUPER COUPON!**

**9 PIECE HIGHLY POLISHED COMBINATION WRENCH SETS**

**SAE - LOT NO. 42304**  
**METRIC - LOT NO. 42305**

**\$6.99**

REG. PRICE \$9.99

**SAVE 30%**

**HARBOR FREIGHT TOOLS - LIMIT 1**  
These valuable coupons are only good when presented at your nearest Harbor Freight Tools store. Offer Ends 6/25/10. Coupons valid in Retail Store Only. Coupon not valid on prior purchases. Coupon cannot be bought, sold, or transferred. This coupon cannot be duplicated in any manner including photocopies and computer printouts. Original coupon must be presented in order to receive the discount.

**We Will Beat Any Competitor's Price Within 1 Year Of Purchase!**

**330 STORES NATIONWIDE**

**TO FIND THE STORE NEAREST YOU CHECK:**  
**1-800-657-8001**  
**or [HarborFreightusa.com/scinews](http://HarborFreightusa.com/scinews)**





# Weed killer in the crosshairs

Concerns prompt  
reexamination of  
atrazine's safety

**By Janet Raloff**

**E**ach year, American farmers and turf managers apply some 34 million kilograms of atrazine to quash broad-leaved and grassy weeds. Most treatments go to protect corn, sorghum, sugarcane and cotton, though golf courses sometimes tap the weed killer to maintain immaculate fairways and putting greens.

In recent years, however, questions have surfaced about atrazine's safety, especially after monitoring programs picked up the chemical in drinking water and lab studies demonstrated the pollutant's ability to emasculate — if not deform — amphibians and fish. Last fall, the U.S. Environmental Protection Agency announced it was reopening

U.S. DEPARTMENT OF AGRICULTURE/PHOTO RESEARCHERS, INC.



**With hooded sprayers, farmers can direct herbicide to areas between crops (sorghum shown), limiting possible drift.**

what industry had hoped was a closed chapter on allegations in the United States of atrazine's risks.

Atrazine, an organic compound belonging to the triazine family of herbicides, stops pre- and post-emergent weeds by inhibiting electron transport, ultimately blocking photosynthesis. The EPA reexamined data on the herbicide's putative toxicity four years ago as part of a systematic review of the safety of older pesticides — those initially registered for use before 1984. Atrazine was reregistered — meaning it could continue to be sold — after the EPA concluded that its regulated use could continue without posing undue risks to health and the environment. The chemical is banned by the European Union and, ironically, in Switzerland, where atrazine's leading manufacturer, Syngenta, is headquartered.

In a surprising turnabout, the EPA instructed its Scientific Advisory Panel on pesticides, a group of outside experts, to reevaluate the weed killer's safety through three meetings this year, the first of which took place earlier this month. The panel will review human data and any studies, including animal or test-tube assays, that might suggest risks to people.

EPA admits this new review was prompted by a flurry of recent news stories and critical reports by advocacy groups, which continue to show that large numbers of people are being exposed to atrazine through drinking water (SN: 11/3/01, p. 285) and which offer new data suggesting health concerns.

Among these new criticisms was a report in August by the Natural Resources Defense Council: "Poisoning the Well: How the EPA is ignoring atrazine contamination in surface and drinking water in the central United States." Its analysis of data that the EPA collected — but didn't publicly

release — shows that traces of atrazine frequently pollute not only rivers but also water exiting the tap, oftentimes at concentrations exceeding EPA's 3-parts-per-billion limit for drinking water.

For its part, Syngenta Crop Protection, based in Greensboro, N.C., the largest U.S. producer of atrazine, argues EPA's new review is unnecessary. "After seven Scientific Advisory Panels, 15 years of special review and the reregistration [of atrazine] in 2006, the science stands for itself," says company toxicologist Tim Pastoor. Reviewing the data again "seems over the top," he contends, and poses unnecessary costs to taxpayers.

Yet there are plenty of new data that have not previously been part of any systematic federal review.

### Sentinels of risk

Atrazine's ability to provoke hormonal perturbations in test animals is one of the more dramatic signs of its toxicity to emerge throughout the past decade, says biologist Tyrone Hayes of the University of California, Berkeley. He points to studies from his lab (SN: 11/2/02, p. 275) and by others that have demonstrated that this weed killer can inappropriately — and sometimes quite deleteriously — boost estrogen concentrations in male animals, from rats and fish to frogs and alligators.

The presence of too much estrogen or estrogen at the wrong time can not only alter reproductive development but also can pose cancer risks, so toxicologists have expressed concern over hormonal changes in test animals. Whether atrazine poses such risks to people, however, remains unknown.

Robust data suggestive of hormonal effects, including partial gender reassignment, come from amphibians and fish. And a review in the January *Environmental Health Perspectives* by Jason Rohr and Krista McCoy of the University of South Florida in Tampa includes more than a dozen papers out since atrazine's last regulatory review. The *EHP* review highlights a long list

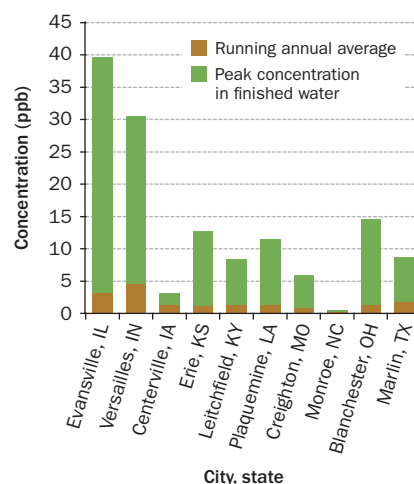
of reproductive and developmental impacts in these animals.

This analysis didn't include all available studies, Rohr acknowledges, because "we had very strict quality criteria," requiring such things as "proper experimental design, proper reporting or application of statistics," and data showing there had been no contamination of supposedly unexposed animals.

Trends observed across the studies that did make the cut indicate that atrazine alters rates of amphibian metamorphosis, reduces immune function in 33 of 43 measures and increases risk of infection in 13 of 16 measures. Exposure to the weed killer altered at least one aspect of gonad structure and function in seven of 10 studies, with some animals exhibiting "sexually ambiguous" gonad tissue. Atrazine also altered sperm production in the two studies that investigated it and changed sex-hormone concentrations in six of seven studies.

This review's findings contradict those reported in a February 2009 paper in *Toxicological Sciences* by Werner Kloas of the Leibniz-Institute of Freshwater Ecology and Inland Fisheries, in Berlin, and his coauthors (one of whom, Alan Hosmer, is a Syngenta employee).

**Cities with highest atrazine levels in drinking water for selected states, 2003–04**



SOURCE: M. WU ET AL./NRDC AUGUST 2009

**Atrazine in drinking water** Data collected on behalf of the U.S. Environmental Protection Agency reveal that several cities have peak atrazine concentrations in drinking water that exceed the agency's 3-ppb limit.

## A troubled past

Industry had hoped that atrazine's regulatory hurdles were over, but new concerns have led to a fresh analysis.

**1947**—The Federal Insecticide, Fungicide and Rodenticide Act requires the registration of all pesticides.

**1958**—Atrazine is first registered.

**1983**—Registration standard for atrazine is issued, and the document notes concern about dietary carcinogenic risks from ground and water contamination.

**1988**—EPA issues a preliminary notification of its intent to initiate a special review under FIFRA based on atrazine's carcinogenic potential.

**1990 to 1992**—Atrazine's registrant takes steps to reduce ground and surface water contamination.

**1991**—Under the Safe Drinking Water Act, the EPA sets 3 ppb as the maximum level of atrazine in drinking water.

**1994**—EPA institutes its special review for triazine pesticides, including atrazine. At the time, atrazine has status as a possible human carcinogen.

**January and October 2003**—EPA concludes in interim reregistration decisions that atrazine is not likely to be a human carcinogen and that there are not sufficient data to confirm or refute the hypothesis that atrazine exposure may impact gonadal development in amphibians. Before reregistration, the Food Quality Protection Act requires an evaluation of food tolerances.

**2004**—European Union bans atrazine.

**April 2006**—In its reregistration decision, the EPA says that there is a reasonable certainty that no harm will result to the general U.S. population, infants, children or other subgroups of consumers from aggregate exposure to cumulative residues of atrazine. Products containing atrazine are eligible for reregistration.

**2007**—EPA concludes that atrazine does not adversely affect amphibian gonadal development.

**2009**—EPA releases atrazine ecological watershed monitoring data following a *Huffington Post* report about atrazine in drinking water.

**2010**—EPA launches a new evaluation of atrazine's safety.

According to Syngenta's Pastoor, the paper by Kloas' team is "the most comprehensive, complete and extensive study ever done on frogs looking at sexual development." Some 3,000 African clawed frogs were exposed to five doses of atrazine spanning four orders of magnitude. "And from that," he says, "it was definitively shown that atrazine has no effect."

Rohr and McCoy omitted most data in that paper from their review, however, arguing its statistical deficiencies made evaluation of the data "impossible."

Previous EPA analyses of atrazine safety had access to four earlier reviews of animal data, Rohr notes — all funded at least in part by industry. He maintains that his is the first review that is free of industry involvement. Funding for his assessment came from the EPA, the National Science Foundation and the U.S. Department of Agriculture.

Two rat studies in the November *Toxicological Sciences* point to an apparent stress response that may explain how atrazine could alter reproductive development. EPA scientists showed that the weed killer elevates stress-related hormones such as adrenocorticotrophic hormone, or ACTH.

If levels of this hormone get out of balance in females, it "can interfere with normal regulation of the ovaries and ovulation," notes Ralph Cooper, chief of endocrinology at EPA's laboratory in Research Triangle Park, N.C. This, in turn, "will interfere with fertility," he points out. The hormone changes "indicated to us that the pituitary was responsive to atrazine directly," he says, "by secreting ACTH." Similar changes were seen in exposed male rats, suggesting a possible stress-system mechanism by which atrazine might impair sex-hormone production in males.

The witnessed changes might help explain the impaired reproduction previously linked to atrazine in animal studies, including delayed puberty, impaired fertility and inflamed prostates (in the male pups of exposed female rats), Cooper says. However, he cautions, exposures in his studies, though brief, far exceeded what would ever occur in drinking water.

## Tied together, with caveats

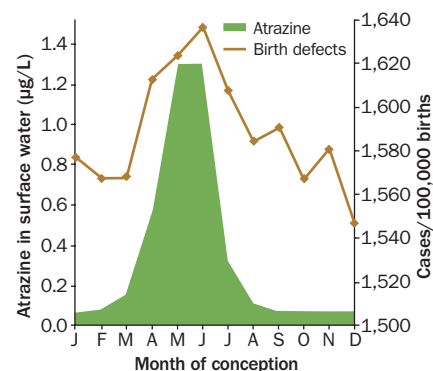
Several studies have linked problems in human newborns to water supplies polluted with atrazine. The limitation of these papers is substantial: The water contained other farm chemicals that might be toxic in high doses as well.

A paper in *Acta Paediatrica* in April 2009, for instance, identified a recurring seasonal increase in U.S. birth defects for babies conceived from April through July. The data, compiled from 1996 to 2002 by the Centers for Disease Control and Prevention, came from an assessment of more than 30 million live births.

Surface-water contaminant measurements by the U.S. Geological Survey during the same years show these months are when concentrations of agricultural chemicals — chiefly nitrate fertilizers and atrazine — peak, says Paul Winchester, a neonatologist at the Indiana University School of Medicine in Indianapolis.

Compared with the rest of the year, Winchester's team found, babies who were conceived from late spring to early

## U.S. birth defects and atrazine, 1996–2002



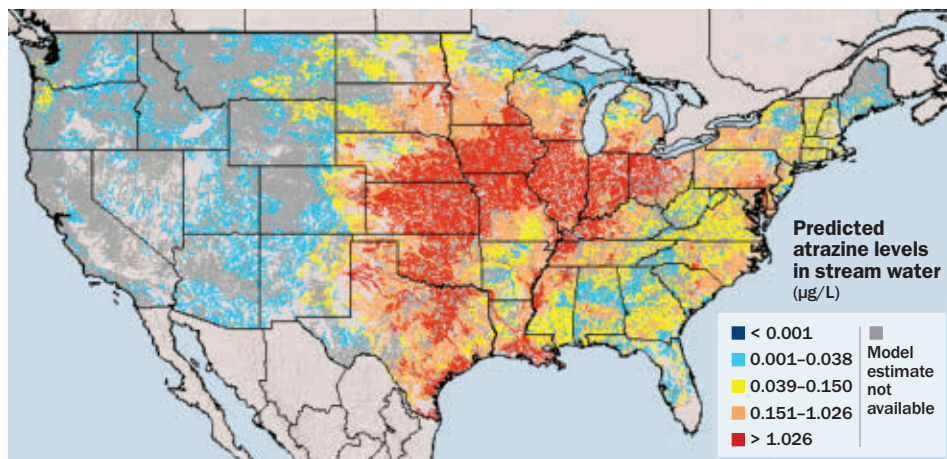
SOURCE: P. WINCHESTER ET AL./ACTA PAEDIATRICA

## Other chemical complicators

Agrochemical	Mean surface water level	
	April–July	Other months
Atrazine (µg/L)	1.31	0.16
Nitrate (mg/L)	1.94	1.65
Pesticides (µg/L)	0.14	0.05

SOURCE: P. WINCHESTER ET AL./ACTA PAEDIATRICA

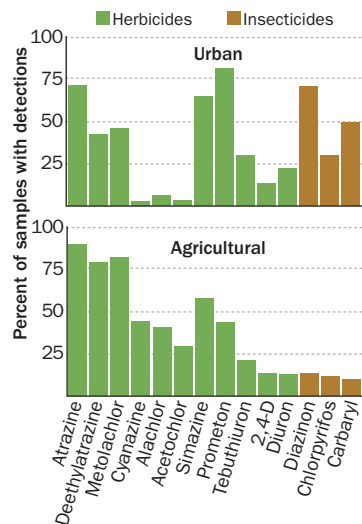
**Unestablished cause** Research has found a positive correlation between levels of atrazine in surface water and birth defects (graph). But the data are muddled because levels of other chemicals (table) are also higher during the start of farming season.



**Atrazine at the surface** The U.S. Geological Survey is developing models that estimate pesticide levels based on monitoring data and watershed characteristics. The map shows the highest 21-day moving average modeled for atrazine concentrations in stream water for 2007. The tables reveal that atrazine and deethylatrazine, a breakdown product, are among the most frequently detected pesticide compounds.

SOURCE: USGS WATERSHED REGRESSIONS FOR PESTICIDES ATRAZINE MODEL AT INFOTREK.ER.USGS.GOV/WARP

**Comparing chemicals in stream water**



SOURCE: "PESTICIDES IN THE NATION'S STREAMS AND GROUND WATER," 1992-2001/USGS

summer showed a 3 percent higher rate of birth defects, such as spina bifida, cleft lip, urogenital defects and Down syndrome. And while a mix of farm pesticides usually showed up in that seasonal runoff into waterways, Winchester observes that "far and away, the most prevalent pesticide — and the one which exceeds safety limits most often — is atrazine." The weed killer's statistically significant association with birth defects is intriguing, he says, and deserves further exploration.

A related investigation linked atrazine concentrations in Indiana drinking-water supplies to the chance that a baby would be very small at birth. "Atrazine concentrations above 0.1 part per billion were associated with, on average, a 17 percent increase in the risk of having a small baby," says Hugo Ochoa-Acuña of Purdue University in West Lafayette, Ind. Such contamination, well below the EPA's 3-ppb limit, can be common. Biweekly drinking-water data suggested that in Fort Wayne, Ind., for example, atrazine concentrations exceed 0.2 ppb on 265 days a year, and exceed 0.5 ppb more than one out of every three days.

Each 1 ppb increase of atrazine in drinking water, for consumption averaged throughout a pregnancy, increased by 15 percent a woman's chance of giving birth to a baby in the lowest 10 percent

of weight for its gestational age. Such babies have a poorer chance of survival.

The weed killer's correlation with low birth weight proved most robust for contamination during a woman's third trimester, the Purdue team reports in the October *Environmental Health Perspectives*. "And that makes sense," Ochoa-Acuña explains, "because most of a baby's growth occurs during the last trimester. So a small effect there would produce a big difference."

As Winchester's group found, many other pesticides tended to coexist with atrazine in water, but their levels weren't nearly as high.

At his agency's February Scientific Advisory Panel meeting, the EPA's Aaron Niman reviewed these and additional new studies correlating the levels of atrazine in drinking water to birth defects and low birth weights. The strength of Winchester's study, he said, "is that it provides for an overall snapshot of trends in both birth defects and atrazine levels in the environment. For this reason, it's useful in hypothesis generation ... [but] can only be used to demonstrate correlation" — not causation.

The study by Ochoa-Acuña's team is "probably the strongest" linking the weed killer to birth outcomes, Niman said, because it offers individual exposure estimates and is able to adjust

for several potentially confounding factors, such as seasonality. Still, Niman acknowledged, there are limitations to even this study. But he also noted that this is to be expected when looking at complex, real-world exposures — not the controlled environments of lab rats.

Overall, researchers concede that no smoking guns exist regarding atrazine risks. Data are suggestive, based on high-dose rodent tests, real-world wildlife exposures and epidemiological surveys of people exposed to a mix of pollutants.

Although there have been charges that Syngenta has hidden troubling data from regulators and the public, Pastoor counters that the company's research "is publicly available," and that "EPA has all of our raw data" for every study. Indeed, he says, "When we submit a study, it undergoes the kind of scrutiny that would rival an Internal Revenue Service review."

So regardless of the concerns that have been circulating in news accounts and reports by public interest groups, Pastoor says he's confident that as long EPA bases its new safety assessment on science, "any further opening up of atrazine's scientific history is welcome." ■

### Explore more:

- The U.S. EPA's atrazine site: [www.epa.gov/opp00001/reregistration/atrazine/](http://www.epa.gov/opp00001/reregistration/atrazine/)





# Of Swine

Scientists study H1N1's past to predict what

**A**s viruses go, H1N1 is a genetic pip-squeak. Like its influenza brethren, it possesses only eight genes. Yet those few genes are telling researchers a complex story about where this newly infamous virus came from, and, more importantly, where it might go.

That story began about a decade ago, when an infectious virus was busily packing pieces of its genetic material together, preparing to burst out of a throat cell and infect other cells in its host pig. This virus was already the result of a genetic shuffle involving a human influenza, an avian influenza and a swine influenza, genetic sleuthing reveals. At the same time, a different virus — itself a mixture of a swine influenza and an avian influenza — was packaging its genetic material in the same cell in the pig's throat.

In an exodus-induced kerfuffle, a wayward piece of viral genome was mistakenly put into the wrong package, creating a virus never before seen. Sometime in the past decade, researchers estimate, the pig harboring this new mix-and-match virus passed it to a human, who launched its spread to thousands of people around the globe.

"The confusion at the beginning was that some of the virus's segments were coming from birds, some were coming from pigs, some were human," says molecular epidemiologist Hossein Khiabani of Columbia University. "What is this? This is a monster."

This dizzying tale of genetic mingling ultimately resulted in the H1N1 influenza strain currently circling the planet. This virus takes its name from its particular versions of two proteins, hemagglutinin and neuraminidase. Although this combination of H and N has appeared before in seasonal influenzas and most memorably in the pandemic flu of 1918, the virus circulating now has qualities that make it distinct enough to demand attention.

Such a history might suggest that today's H1N1 — declared by the World Health Organization on June 11, 2009, to have caused a pandemic — is ready to go hog wild, morphing into new forms that can easily thwart human immune systems and foil drugs. But new evidence, furiously collected during the

virus's year or so on the world stage, hints at a different picture. Instead of a deranged homicidal killer on the rampage, this virus appears to be a more restrained villain.

"It seems that the intrinsic ability of this virus to cause disease is not that different from seasonal viruses," says Ruben Donis, who heads the Centers for

Disease Control and Prevention's molecular virology and vaccines branch, based in Atlanta. But these are early days, he cautions. "This is all based on very preliminary numbers that are subject to change."

Emerging data from human infections and laboratory experiments on this swine-origin H1N1 suggest that the virus spreads no

faster than the seasonal influenzas that circulate every winter. And studies hint that the human immune system has underappreciated advantages in combating the infection. Other research has found that the virus's genome isn't changing at an alarming rate or in important ways. Like accents, the virus has taken on certain regional twangs, but

**Instead of a deranged homicidal killer on the rampage, this virus appears to be a more restrained villain.**

TIM VERNON, LTH NHS TRUST/PHOTO RESEARCHERS, INC.; VIRUS: ERAXION/ISTOCKPHOTO

# and Men

the virus has in store **By Laura Sanders**

none seem to be particularly menacing. Another study in animals finds that the virus didn't jump at the chance to mingle its genetic material with other strains of influenzas, even when the viruses infected the same cells at the same time.

While the virus's genome is missing some of the worst danger signs of past pandemics, it has picked up a few new tricks that might be cause for concern. And just because the virus hasn't yet morphed in a dangerous way doesn't mean it won't. Now that the virus has a huge new playground in the human population, the possibility of its recombining with other influenzas can't be dismissed.

"Once we think we have this virus figured out, the virus shows us otherwise," says influenza expert Daniel Perez of the University of Maryland in College Park.

Predicting exactly what will happen is impossible. The virus may grow up to replace the seasonal flu viruses, or it may grow up to become an additional burden to contend with each winter. It may morph into a dangerous killer. Or it may not change much at all, existing only as a memory of the swine flu scare of '09 and '10.

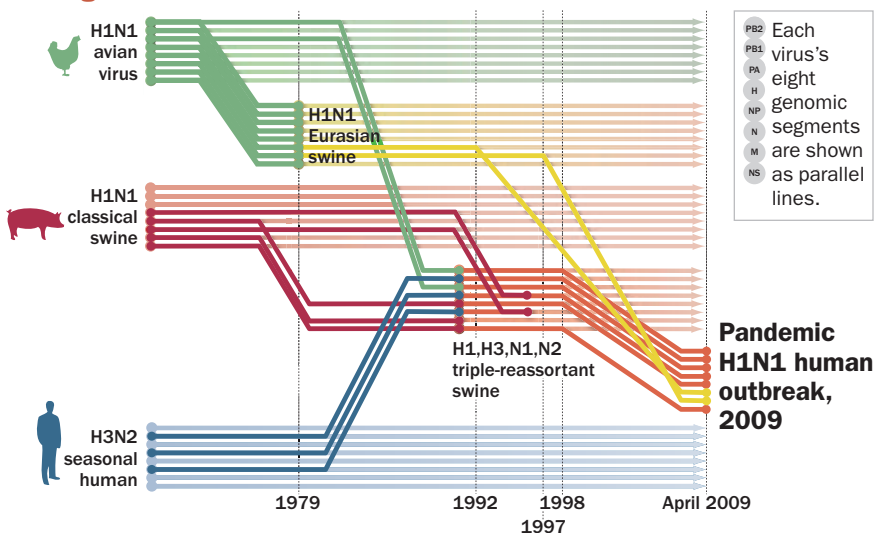
## Around the globe

One of the reasons public health officials are keeping such a close eye on this H1N1 strain is that some important parts of its makeup are unrecognizable to most people's immune systems — presumably setting the stage for it to go ripping and snorting through the global population. But data from animal mod-

els and patient reports suggest that this influenza's movements, propelled by sneezes, coughs and germey door-knobs (see "The skinny on the bacon," Page 26), look more like those of seasonal influenzas than disastrous pandemics of the past.

If the devastating 1918 pandemic flu was an Olympic sprinter, dashing to the

## Tracing the virus shuffle



The current pandemic H1N1 virus is a mix of genomic segments from the H1N1 Eurasian swine flu and a swine flu made up of segments from avian virus, swine virus and seasonal human flu. The chart above shows how each flu virus's eight genomic segments mixed and mingled to get the virus causing the current pandemic.

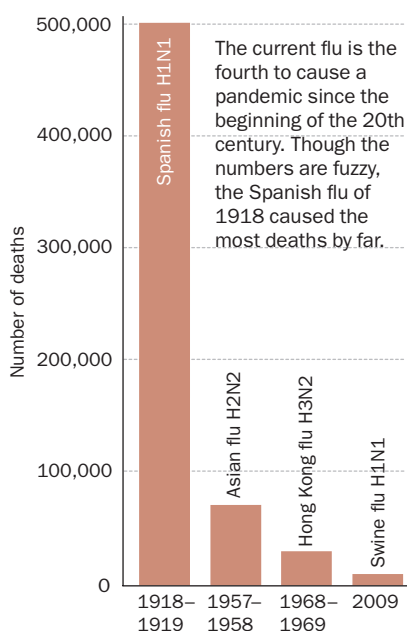
finish line in just seconds, this pandemic strain is “the guy running in Central Park,” says microbiologist Peter Palese of Mount Sinai Medical Center in New York City.

The ways the virus is transmitted, how easily it spreads through contact and how long before symptoms show up are the same as what experts estimate for seasonal and other pandemic flus, says epidemiologist Justin Lessler of Johns Hopkins University in Baltimore, who coauthored a report that appeared in the Dec. 31 *New England Journal of Medicine*. “I don’t think there’s any evidence that this virus is any different,” he says.

Lessler and his colleagues examined an H1N1 outbreak in a New York City high school. From that data, they estimate that the virus moves through the population slightly less efficiently than some previous seasonal influenzas. About 14 percent of people who came in contact with an infected person ended up with influenza symptoms. An infectee develops symptoms in about 1.4 days, a length of time similar to that of other influenzas, the team also reports. And 2.7 days elapse between when an infector feels sick and the newly infected feels sick, too.

Another study published in the same

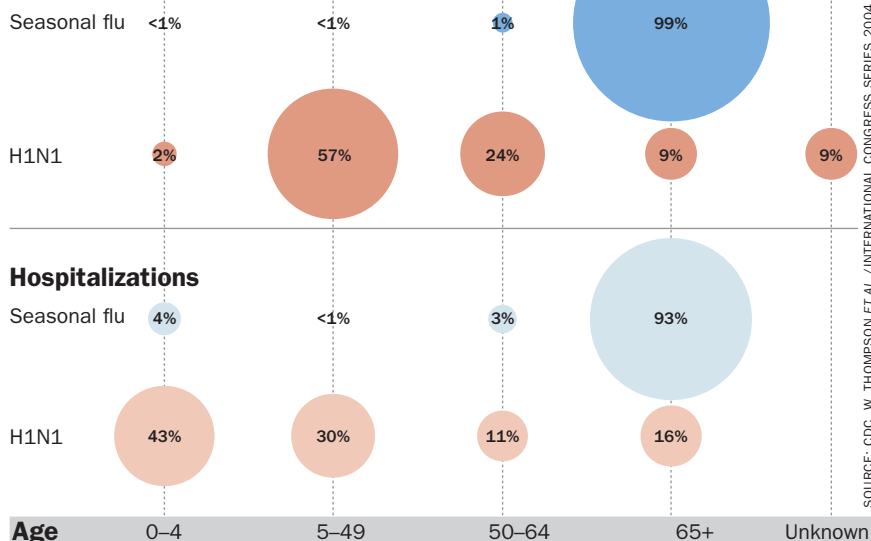
## Pandemic flu deaths in the U.S.



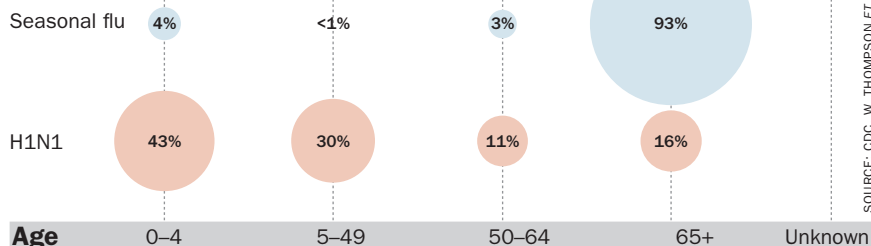
SOURCE: NIAID/CDC

## Who it hits: Seasonal flu versus H1N1

### Deaths



### Hospitalizations



Unlike the seasonal flu, H1N1 targets the young. Though infection rates are hard to come by, early indicators find that young people are more susceptible to infection than older folks. H1N1 hospitalization and death rates from April to June 2009 bear this out.

issue of the *New England Journal* examined household transmission rates and found that the pandemic virus is less likely to move from one person to another than some of the viruses responsible for past pandemics. Simon Cauchemez of Imperial College London and colleagues found that, on average, about 10 percent of people living with a person infected with H1N1 come down with the flu. For seasonal flus, the same measure is anywhere from 10 to 40 percent.

A study in guinea pigs shows similar results. The virus replicates and transmits in the animals at rates close to those of a seasonal influenza strain, Palese and colleagues report in the January *Journal of Virology*.

The key to avoiding infection despite exposure lies with virus-destroying antibodies. These tiny patrollers roam the body on the lookout for harmful particles. When a threat is detected, the antibodies hitch on to the invader and call in other immune system attack dogs to prevent the virus from taking hold.

An inability of antibodies to recognize H1N1’s proteins may explain one of the most ominous pieces of news about this virus: It seems to target young people. The CDC estimates that from April

through December 12, 2009, about 50 million people under the age of 65 became infected, compared with about 5 million people over age 65.

In contrast, seasonal flu typically infects older people. More than 90 percent of deaths from seasonal influenzas occur in people 65 and older, the CDC reports. With the current H1N1 influenza, researchers estimate that people younger than 65 account for more than 80 percent of total deaths.

People born in the earlier part of the 1900s may be protected because their immune systems have seen influenzas similar to the current H1N1 and have developed antibodies against them, while the immune systems of young people have not.

“The prevailing theory — there is not very strong evidence yet, but there is some evidence — indicates that these folks have greater immunity than younger folks,” Donis says. The thinking is that exposure to many viruses primes those immune systems to attack quickly, while young people’s naïve immune systems are caught flat-footed, lacking antibodies to attack this pandemic H1N1.

More studies are needed to fully understand how immune systems defeat

SOURCE: CDC, W. THOMPSON ET AL./INTERNATIONAL CONGRESS SERIES 2004

B. RAKOUSKAS



influenzas. “Immunity is complicated,” Donis says. “How all these mechanisms play out in the guy that is shedding virus, or the person that is shaking hands or breathing in droplets after someone sneezes or coughs, is still a very complicated biological process that we don’t understand completely.” Younger folks are more susceptible than older people to getting the new H1N1 virus, but its overall threat to a young person is still proportionally similar to that of any seasonal flu, Palese says.

The number of deaths from pandemic H1N1 are estimated to be much lower than that of seasonal flus: On average, about 36,000 Americans die from flu-related causes each year, according to the CDC, while the current pandemic is responsible for an estimated 11,000 deaths from April through December.

“It’s the same rate,” Palese says. “That has been really overlooked. It is not more virulent per 18-year-old, or per 25-year-old, than the seasonal one.”

### The inside counts

Another study finds that the virus isn’t as unrecognizable as its outer proteins had led scientists to believe. A hidden familiarity might help people fight the virus once they’ve been infected.

Antibodies latch on to proteins on the outside of virus particles but are unable to detect what’s on the inside of the virus. A different faction of the human immune system is formed by cells that recognize foreign proteins on the outside *and* on the inside of viruses. These cells, a type of T cell, are an underappreciated arm of the immune system and might be doing some of the immune system’s heavy lifting, says Bjoern Peters of the La Jolla Institute for Allergy & Immunology in California.

In a study published December 1 in *Proceedings of the National Academy of Sciences*, Peters and his colleagues addressed how familiar the virus is to the immune system. “We were essentially asking, how is this virus different, from the immune system’s point of view?” Peters says.

As expected, proteins such as hemagglutinin and neuraminidase that decorate

the outside of the H1N1 virus differed from proteins in earlier seasonal viruses, and as a result, were unfamiliar to most people’s antibodies. But proteins on the inside of the virus were quite similar to past influenzas, Peters and colleagues found. Because of this similarity, T cells might be able to quickly begin neutralizing cells once they are infected. “While there’s no immunity against the surface, there’s plenty of immunity against the internal proteins,” Peters says. The same study found that blood samples taken in 2007 from the general U.S. population had some immunity against the pandemic strain, thanks to T cell immunity.

“We believe we have a reason why the incidence of severe disease isn’t that high, based on the fact that people have T cell immunity,” Peters says. “You would expect that this is going to be a very severe, deadly pandemic if you have no immunity. Obviously, as we know, that’s not how it turned out.” A strong

T cell reaction probably reduces the severity of influenza infections, clearing virus-laden cells before symptoms get bad.

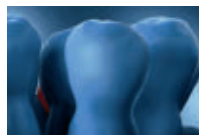
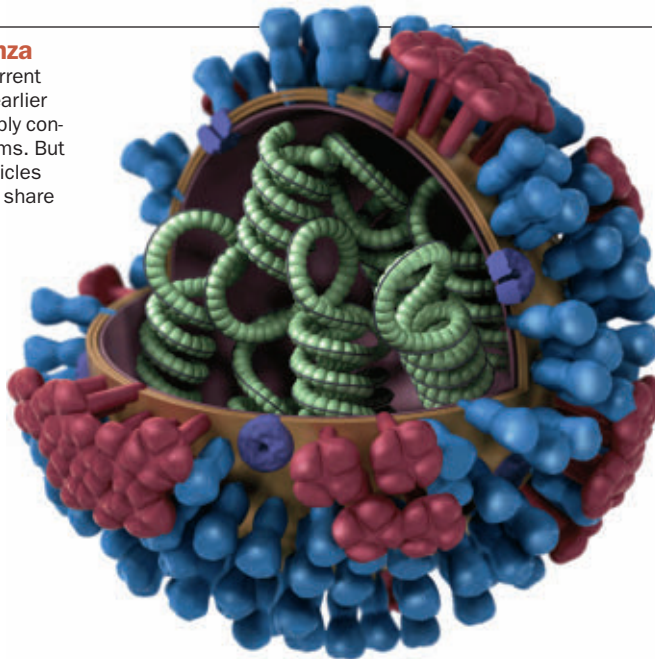
### Not out of the woods

Influenzas are notorious for playing fast and loose with their genomes — mutations are introduced as the virus replicates and gene segments are swapped with other viruses in a process called reassortment. Reassortment is responsible for the repackaging errors that, in part, created the H1N1 pandemic influenza. This genetic recklessness confounds immune systems and worries public health officials.

Early results from animal studies suggest that pandemic H1N1 isn’t eager to reshuffle its genetic deck, even when the influenza is infecting the same cell as another virus at the same time — a prime opportunity for gene segments to get combined in new ways. Perez and his colleagues infected ferrets with

### Anatomy of influenza

Some aspects of the current H1N1 virus differ from earlier type A influenzas, possibly confounding immune systems. But all influenza A virus particles (generic version shown) share some features.



**Hemagglutinin** helps a virus break into cells. Changes in the protein may dictate what organisms a virus can infect.



**Neuraminidase** helps a newly formed virus particle escape from an infected cell and is a target for antiviral drugs.



**M2 ion channels** allow protons to enter the virus particle, leading to the release of genetic material in the cell.



**RNA** (with associated proteins) is held on the inside of the virus and carries the virus’s genetic instructions.

seasonal influenzas and the H1N1 strain and found no signs of new viruses, the team reported online August 25, 2009, in the non-peer-reviewed journal *PLoS Currents: Influenza*.

The results don't mean that those viruses aren't exchanging genes, Perez says, as low levels of reassortment could go undetected. Perez and his colleagues are currently testing more and different versions of the virus for their propensity to mix. Scientists don't yet understand why only some viruses reassort and under what conditions they do so.

So far, sequences of virus from infected people don't show signs of reassortment, either, Perez says. "Epidemiological data suggests that there are not reassortments happening, at least not this season," he says. "That doesn't mean that next season, things might not change a little bit. It's a question that's always an open question. We don't have an answer for that."

Researchers have, however, already pinpointed genetic changes, mutations acquired during the virus's replication,

that enhance its ability to make copies of itself in human cells.

Bird influenzas typically have the amino acid glutamate at a particular spot in a specific protein. This glutamate, says virologist Andrew Mehle of the University of California, Berkeley, dampens avian viruses by keeping them from replicating well in human and swine cells. To researchers' surprise, H1N1—which obviously has no problem prodigiously replicating in humans—carries this bird-like glutamate. But Mehle and colleague Jennifer Doudna, also of UC Berkeley, might be able to explain this.

The researchers found two different mutations that are able to overcome the hindering glutamate, allowing the pandemic virus to reproduce easily in humans. These mutations represent "a new and unusual strategy compared to what usually happens," Mehle says. Avian influenzas with these changes were able to replicate better in human and swine cells, Mehle and Doudna report December 15 in *Proceedings of the National Academy of Sciences*.

**Although researchers' best guesses are improving as detailed molecular and genetic data and doctors' reports pour in, divining the virus's future is impossible.**

Molecular epidemiologist Martha Nelson of the National Institutes of Health in Bethesda, Md., and her colleagues compared the genetic sequences of H1N1 from around the world to see if the virus had taken on other genetic changes as it copied itself. The team's analysis, published online November 5 in *PLoS Currents: Influenza*, finds that the virus shows slight regional differences. On the basis of these differences, Nelson and colleagues divided it into seven distinct clades. None of the differences among clades seem to be ominous, though, Nelson says. "In the grand scheme of things, these clades are still very closely related," she says. Likewise, scientists at the World Health Organization report that all of the sequenced H1N1 clades are very similar to the original strain, rendering the H1N1 vaccine—designed to combat the original sequence of the virus—accurate and effective.

As the pandemic virus spreads to more people around the world, the diversity among clades may disappear as they mingle with each other, Nelson adds. "We'll have to wait for the next round of data to see if it's more mixed."

Although researchers' best guesses are improving as detailed molecular and genetic data and doctors' reports pour in, divining the virus's future is impossible.

"This is a new virus," Palese says, but it is still subject to the same rules and regulations as other influenzas. "Never predict anything," he says, "but I would argue that it will change like the other seasonal influenzas have in the past." ■

#### Explore more:

- CDC site: [www.cdc.gov/H1N1FLU](http://www.cdc.gov/H1N1FLU)
- WHO site: [www.who.int/crs/disease/swineflu/en](http://www.who.int/crs/disease/swineflu/en)

### The skinny on the bacon

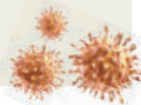
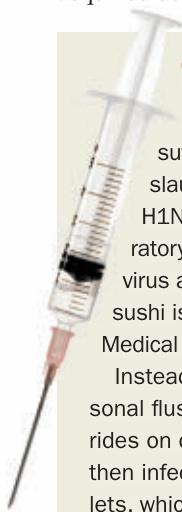
The current pandemic, known to many around the world as swine flu, suffered an image problem in its early days. Misinformation led to mass slaughters of pigs in misguided attempts to halt the virus's spread. The H1N1 virus can't be transmitted by eating pork: The virus infects the respiratory tract of pigs, not the edible muscle or fat, and cooking deactivates the virus anyway. So the risk from eating infected pork is nil, unless pig throat sushi is on the menu, says Peter Palese, an influenza expert at Mount Sinai Medical Center in New York City.

Instead, the current H1N1 influenza travels in the same way as most seasonal flus—through the air and on virus-laden surfaces. Flu viruses hitch rides on droplets expelled from sneezes and coughs, float through the air and then infect a person when inhaled. Dry wintry conditions lead to smaller droplets, which can persist in the air for hours, Palese says.

Flu viruses can also move from person to person through contact, such as handshaking or doorknob turning. The good news is that most influenzas, including this one, are relatively fragile outside of a host. H1N1 doesn't survive long on surfaces outside of the body and can be easily destroyed with disinfectants.

Precautions such as frequent hand washing can slow the virus's spread, but Palese says avoiding every tiny particle of influenza is often impossible. "The best way to prevent influenza, whatever way it's being transmitted, is vaccines," Palese says. "That's the bottom line."

To find an H1N1 vaccine, go to [www.flu.gov](http://www.flu.gov). —Laura Sanders



Now I can safely  
take a bath again...  
...and it's more  
affordable  
than ever.



## *Introducing the redesigned Neptune® Upright Bath Lift, a better way to regain your independence and stay in the home you love.*

The Neptune Upright Bath Lift has enabled thousands of people to rediscover the simple pleasure and therapeutic benefits of taking a bath without the danger of slipping and falling. This extraordinary product caught on fast, but the relatively costly technology left many high and dry. We sent our engineers back to the drawing board with a simple mission... create a high-quality lift at an affordable price. Through improved technology and more efficient manufacturing techniques, we achieved our goal. The result is a bath lift that maintains our high standards for durability and safety, at an all-time low price that is within most people's budgets.

Do you remember when taking a refreshing, relaxing, and rejuvenating bath was something you looked forward to... not avoided? For millions, getting older and losing mobility has meant giving up the use of their bathtub. Some resort to sitting in a chair in the shower; others are forced to take "sponge baths" at the sink. Worse yet, some have to get caregivers and loved ones to lower them into the tub. Now, there's a better way.

The Neptune Upright Bath Lift is so easy. Just put the chair into the tub. The high-quality suction cups hold it in place. You simply sit on the transfer flap and swing your legs into the tub. Press the button on the fully water proof remote, and the chair lowers to the bottom of the tub. When you are done, press another button and the chair returns you to the top of the tub. The

remote contains a powerful rechargeable battery that operates up to seven up/down cycles, and a light indicates when it needs to be recharged. Simply unclip the remote and plug it into any outlet to charge. The smart-chip technology in the remote will not allow

the Neptune Upright Bath Lift with our exclusive 30-day home trial. If you are not completely satisfied for any reason, simply return it for a refund of the product purchase price. Call now!



it to lower you if there is not sufficient power to raise you back up.

Are you missing the luxury and benefits of a good soak in the tub? Call now, and our knowledgeable product experts will tell you how you can get started. Call today, and we'll let you try

### Soak Your Aches & Pains Away

- **firstSTREET** exclusive— not available in stores
- Durable construction and powerful motor
- Comfortable seat and self-adjusting transfer flaps
- Chair raises to 17" and lowers to 3"
- Fits almost any bathtub
- Uses a rechargeable battery, so there is no risk of shock

### Neptune® Upright Bath Lift

Call now for our lowest price!

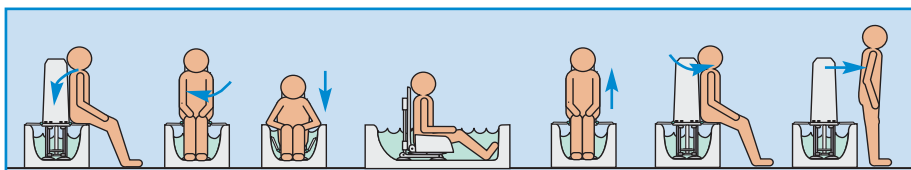
Please mention promotional code 40084.

**1-888-432-8058**

**firstSTREET**  
for Boomers and Beyond®

1998 Ruffin Mill Road  
Colonial Heights, VA 23834

[www.neptunelift.com](http://www.neptunelift.com)





# Quantum on Quantum

## Entangled photons validate Feynman's vision for simulating nature

By Charles Petit

**A**lmost three decades ago, Richard Feynman — known popularly as much for his bongo drumming and pranks as for his brilliant insights into physics — told an electrified audience at MIT how to build a computer so powerful that its simulations “will do exactly the same as nature.”

Not approximately, as digital computers tend to do when faced with complex physical problems that must be addressed via mathematical shortcuts — such as forecasting orbits of many moons whose gravity constantly readjusts their trajectories. Computer models of climate and other processes come close to nature but hardly replicate it. Feynman meant *exactly*, as in down to the last jot.

Now, finally, groups at Harvard University and the University of Queensland in Brisbane, Australia, have designed and built a computer that hews closely to these specs. It is a quantum computer, as Feynman forecast. And it is the first quantum computer to simulate and calculate the behavior of a molecular quantum system.

Much has been written about how such quantum computers would be paragons of calculating power should anybody learn to build one that is much more than a toy. This latest one is at the toy stage, too. But it could become just the thing for solving some of the most vexing problems in science, the ones Feynman had in mind when he said “nature” — those problems involving quantum mechanics itself, the system of physical laws governing the atomic scale. Inherent to quantum mechanics are seeming paradoxes that blur the distinctions between particles and waves, portray all events as matters of probability rather than deterministic destiny and place a particle in a state of ambiguity that makes it potentially two or more things, or in two or more places, at once.

Reporting in the February *Nature Chemistry*, the Harvard group, led by chemist Alán Aspuru-Guzik, developed the conceptual algorithm and schematic that defined the computer's architecture. Aspuru-Guzik has been working on such things for years, but he didn't have the hardware to test his ideas. At the University of Queensland, physicist Andrew G. White and his team, who have been working on such sophisticated gadgets, said they thought they could make one to the Harvard specs and, after some collaboration, did so. In principle the computer could have been rather small, “about the size of a fingernail,” White says. But his group spread the components across a square meter of lab space to make adjustments and programming easier.

Within the computer's filters and polarizers and beam splitters, just two photons at a time travel simultaneously, their particle-like yet wavelike natures playing peekaboo in clouds of probability, just as quantum mechanics says they should.

Quantum computing's power stems from the curiosity that a qubit — a bit of quantum information — is not limited to holding a single discrete binary number, 1 or 0, as is the bit of standard computing. Qubits exist in a limbo of uncertainty, simultaneously 1 and 0. Until the computation is done and a detector measures the value, that very ambiguity allows greater speed and flexibility as a quantum computer searches multiple permutations at once for a final result.

Not only do the two photons serving as qubits in this device have this mix of quantum identities, a state formally called superposition, they are also “entangled.” Entanglement is another feature of quantum mechanics in which the properties of two or more superposed particles are correlated with one another. It is a superposition of superpositions, in which

the state of one photon is connected to the state of the other despite the particles' separation in space. Entanglement enhances the ability of a quantum computer to explore simultaneously all possible solutions to a complex problem.

But with just two photons as its qubits, the new quantum computer cannot tackle quantum behavior involving more than two objects. So, the researchers asked it to calculate the energy levels of the hydrogen molecule, the simplest one known. Other methods have long revealed the answer, providing a check on the accuracy of doing it with qubits. Corresponding to the two wavelike photons rattling fuzzily along in the computer, the hydrogen molecule has two wavelike electrons binding its two nuclei — each a single proton.

Benjamin Lanyon, who is now at the University of Innsbruck in Austria, and the Queensland team programmed the equations that govern how electrons behave near protons into the computer by tweaking its arrangement of filters, wavelength shifters and other optical components. Each piece of optical hardware corresponds to the logic gates that add, subtract, integrate and otherwise manipulate binary data in a standard computer. The researchers then entered initial “data” corresponding to the distance between the molecule’s nuclei — a driver of what energies the electrons might be able to take on when the molecule is excited by an outside influence.

The photons were each given a precise angle of polarization — the orientation of the electric and magnetic components of their fields — providing the researchers with a way to enter data into the computer. On the first run of a calculation, the second photon shared a piece of data via its entanglement with the first and, going at the speed of light, emerged from the machine with the first digit of the answer. In an iteration process, that digit was then used as data for another run, producing the second digit — a process repeated for 20 rounds.

By following — some would say simulating — the same weird physics as do the electrons of atomic bonds themselves, the computer’s photons got the permitted energies correct to within 6 parts per million.

“Every time you add an electron or other object to a quantum problem, the complexity of the problem doubles,” says James Whitfield of Harvard, a coauthor on the paper. “The great thing,” he adds, “is that every time you add a qubit to the computer, its power doubles too.” In formal language, the power of a quantum computer scales exponentially with its size (as in number of qubits), in step with the size of quantum problems. In fact, says Aspuru-Guzik, a computer of “only” 150 qubits or so would have more computing power than all the supercomputers in the world today, combined.

Whitfield is near completion of his studies to be a theo-

retical chemist. A goal is, eventually, to be able to calculate the energy levels and reaction levels of complex molecules bound together by scores or even hundreds of electrons. Even in problems with just five or so electrons, the challenge of computation by standard means has grown so exponentially fast that standard computers cannot handle it.

The new work is “great, a proof of principle, more evidence that this stuff is not pie in the sky or cannot be built,” says chemist Birgitta Whaley of the University of California, Berkeley. “It is the first time that a quantum computer has been used to calculate a molecular energy level.”

And while most of the publicity received by quantum computers has marveled at the potential power to break immense numbers into their prime factors — a key to cracking secret codes and thus an issue of national security — “this has major implications for practical uses with very broad application,” Whaley says. These uses might include the

ability, with less trial and error, to design complex chemical systems and advanced materials with properties never before seen.

Scaling the machine up to five, 10 or hundreds of qubits will not be easy. In the end, photons are unlikely to serve as qubits because of the difficulty of entangling and monitoring so many of them. Electrons, simulated atoms called quantum dots, ionized atoms or other such particles may eventually form the blurry hearts of quantum computers. How long from now? “I’d say less than 50 years, but more than 10,” White says.

In a striking bit of symmetry to go with using a quantum computer to solve a quantum problem, the latest work resonates with Feynman’s original idea in another way. At that talk at MIT — published in 1982 in the *International Journal of Theoretical Physics* — Feynman not only suggested the basis for such a computer, he also drew a little picture of one. It included two little blocks of the semitransparent mineral calcite to control and measure the photons’ polarizations. Looking at the diagram of the device built recently by the University of Queensland team reveals, sure enough, two calcite beam displacers.

Whatever shade of Richard Feynman flickers still in the entanglements of the universe, were it made to collapse into something corporeal, perhaps it would be smiling. ■

*Charles Petit is a freelance writer based in Berkeley, Calif.*

### Explore more

- B.P. Lanyon et al. “Towards quantum chemistry on a quantum computer.” *Nature Chemistry*. February 2010.
- R.P. Feynman. “Simulating physics with computers.” *International Journal of Theoretical Physics*. June 1982.



**As Richard Feynman once envisioned, calcite is a key part of a quantum computer.**

## The Hidden Brain

Shankar Vedantam

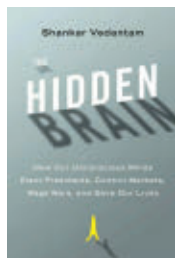
A crowd watches passively as a man brutally beats a woman on a Detroit bridge. An investor selects a company solely on the basis of an easy-to-read ticker symbol. A worker in a burning building wastes precious seconds asking others whether to evacuate. The decisions these real-life people made may sound cruel or stupid, but to be fair, Vedantam says, they weren't thinking consciously. They were thinking with their hidden brains.

"The hidden brain" is a shorthand term that Vedantam, a science journalist for *The Washington Post*, has coined to help readers grasp what is by definition obscure: the unconscious. This collection of cognitive and emotional processes does much of the brain's routine work, he says.

Vedantam interweaves anecdotes and research descriptions to explain how the hidden brain makes these unconscious evaluations, which include mental shortcuts that may have helped human ancestors make

quick decisions. Early chapters illustrate small ways the hidden brain tugs at behavior, and later sections address larger social and political issues, from racial bias to suicide bombings and groupthink during disasters.

The book's basic premise, that the unconscious steers decision making, is supported by research dating back at



least to Freud. But when discussing social issues such as racial bias, the author can rely heavily on anecdotes or accept controversial interpretations of research at face

value if they support his premise.

Yet even when Vedantam makes mental leaps in his interpretations, his compelling narrative pulls readers along and raises important questions. And in the end, this exploration is likely to leave readers a bit more mindful of what could be influencing their own behavior. — *Erika Engelhaupt*  
*Spiegel & Grau*, 2010, 270 p., \$26.

## Get Me Out: A History of Childbirth

Randi Hutter Epstein

The "me" in the title of Epstein's book refers not only to the baby, but also to any mother who might want out of the medical way of giving birth prevalent in Western culture today.

After saying that the book's guidance "should pique your curiosity to think about the medical maze in a different sort of way," Epstein describes child-



birth from the 1600s to the present, ultimately tackling how modern medicine influences the way women conceive and give birth.

Epstein, a medical journalist who is also trained as a physician, offers revealing and sometimes disturbing insight into the medicalization of childbirth: the suffering female slaves

endured in the 1800s as unwitting test subjects for early gynecological devices; the business maneuvering and resulting financial success by the inventors of the forceps; and the financial posturing required before ultrasound replaced harmful X-rays in viewing fetuses during prenatal care. Such stories certainly need to be told.

Lessening the power of Epstein's otherwise vivid narrative and authoritative tone are hints of opinions and judgments that are never clearly stated. In describing "freebirthers" — women who choose to give birth at home without a doctor or midwife — Epstein alludes to her personal view: "Seeing the videos and talking to women who have gone the unassisted route is so inspiring."

But these missteps mar only slightly an otherwise fascinating and powerful recounting of conception and childbirth. — *Kristina Bartlett Brody*

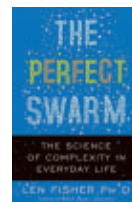
*W.W. Norton & Co.*, 2010, 302 p., \$24.95.



## Isaac Newton on Mathematical Certainty and Method

Niccolò Guicciardini

A science historian analyzes Newton's philosophy of mathematics. *MIT Press*, 2009, 422 p., \$55.



## The Perfect Swarm: The Science of Complexity in Everyday Life

Len Fisher

Complex systems often stem from an accumulation of simple patterns. *Basic Books*, 2009, 260 p., \$22.95.



## Perfect Rigor: A Genius and the Mathematical Breakthrough of the Century

Masha Gessen

How a mathematician solved a seemingly unsolvable problem and turned down the million-dollar prize. *Houghton Mifflin Harcourt*, 2009, 242 p., \$26.



## A Bird-Finding Guide to Costa Rica

Barrett Lawson

The country with the highest percentage of preserved land in the world has many

birding opportunities, described here by location. *Cornell University Press*, 2009, 365 p., \$29.95.



## The Tree Rings' Tale: Understanding Our Changing Climate

John Fleck

Young adults can learn how scientists use tree rings to document

climate change. *University of New Mexico Press*, 2009, 91 p., \$21.95.

**How to Order** To order these books or others, visit [www.sciencenews.org/bookshelf](http://www.sciencenews.org/bookshelf). A click on a book's title will transfer you to Amazon.com.



# Science Educators Inform. Educate. Inspire.

Help your students understand and appreciate science and the vital role it plays in human advancement! Make every issue of **ScienceNews** available to your students as part of your science class curriculum.

- Minimum 10 copies per order
- 4 issues (8 weeks) per order
- Each issue will be shipped directly to your classroom.

Shipping and handling charge included for continental U.S. shipping addresses. (Please contact Science News Classroom bulk program for shipping information concerning other locations.)

For further information, please contact Tosh Arimura (202) 785-2255 ext. 133, or send e-mail to: tarimura@societyforscience.org



## Discover the Universe!

### Fun for the Whole Family!

**Expertise:** OPT has the most dedicated, knowledgeable astronomy staff!

**Selection:** We have the largest selection of astronomy equipment in the industry!

**Price:** We are competitively priced!

**JOIN THE OPT REWARDS  
PROGRAM® AND SAVE!**



OPTtelescopes.com | 800.483.6287

[www.jewelrydesignsformen.com](http://www.jewelrydesignsformen.com)

Fine jewelry featuring meteorite in gold and platinum  
831.336.1020



The Nine Planets Ring

A free spinning band of Gibeon Meteorite in 18k gold set with 9 gemstones representing the 9 planets



Slide through the airlock for an out of this world immersive full-dome experience in space, over the earth, or through the human body.

Best value portable planetarium: 100+ around the world  
[www.discoverydome.com](http://www.discoverydome.com)

# Louis Lanzerotti



For more Comment, visit COLUMNS at [www.sciencenews.org](http://www.sciencenews.org)

## Assessing the state of U.S. science and engineering

*Every two years, the National Science Board reports to the president and Congress about the state of the science landscape. This year's Science and Engineering Indicators report was presented to the White House on January 15.*

*The chairman of the board's Science and Engineering Indicators committee, physicist Louis Lanzerotti of the New Jersey Institute of Technology in Newark, recently spoke with staff writer Laura Sanders about how the lay of the science land has changed.*

### Overall, is this report good news, bad news or interesting news?

Overall, I view these data as good. The United States is still very strong in research and development, and I think the data show that. But they also demonstrate that there are areas we need to look at and adapt to. The rest of the world is catching up to us in many instances — China and some of the Far East countries, for example.

### In what ways are others catching up?

For example, the United States expends approximately 2.7 percent of its gross domestic product every year on research and development. Japan has always exceeded that over the last 10 years or more with an investment of about 3.4 percent of its GDP. South Korea has now crossed Japan, and as of 2007, is spending about 3.5 percent of its GDP on research and development. So both of those lead the United States in terms of their expenditure of GDP. Since 1996, China has increased its percentage of research and development expenditures from about 0.6 percent to currently about 1.5 percent of GDP, and it continues to rise rapidly.

In the Asian countries — Malaysia, Singapore, Thailand — these [big increases] occur because there's a much larger annual percentage increase in those countries. The annual percentage

increase from 1996–2007 in China has been over 20 percent.... Those countries are emphasizing science and engineering as a basis for economic welfare for the population and economic growth.

### Were there any big surprises or trend reversals in the two years?

No, I think not. If you look at our digest, you'll see that the trends are basically continuing: the growth of the Asian economy, the United States and Japan staying the same, the growth from South Korea. Those trends are all about the same.

One trend that did uptick a little in the last couple of years, which is interesting, is an uptick of the performance of basic research by industry in the United States. There had been a rather continual decline of basic research by industry.... In the United States, our research and development is supported approximately two-thirds by industry and one-third by the federal government. But the federal government supports basically 60 or 70 percent of all basic research, and the rest is supported by others — foundations and within industry (a rather smaller portion). And the industry portion of funding of basic research has declined steadily since around 1990, but there has been a slight uptick since around 2006 or 2007.

### Are these trends here to stay? Is there a sense that the trends will reverse?

It's hard to project. But I think some projection might be possible, or at least some discussion might be possible. The trends are a reflection of globalization of research and development

and of corporate interest around the world — globalization on the part of not just United States companies, but of foreign companies as well. And I think these trends are an indication of that. The board will have a policy document based upon a portion of these data.

It'll be issued in mid-February, and it's related to the topic of globalization and the implications that has for our national efforts in research and development. At that time the board will be making some statements regarding globalization and its influence on the trends that you allude to.

### What did you find out about the public perception of science?

The interesting thing is that the perception of science and of engineering remains really very high in the United States....



**The American public has a very strong view of the importance of science and engineering for our country.**

Those who think it's a very positive element of our American life ... the percentage of the population who believes that is very high. It's of the order of 75 to 80 percent, versus those who think that it's a detriment for society, which are 10 percent or less. There have been some blips in that trend up and down by a few percent over the years, but if one does a sliding mean through all that data, one finds that that trend is basically a constant. The American public has a very strong view of the importance of science and engineering for our country. I think a very important point is that scientists rank as high in public respect as do firefighters. They're second only to firefighters. ■

*For the full report, go to [www.nsf.gov/statistics/seind10](http://www.nsf.gov/statistics/seind10)*





A.

"This exquisite set of vivid green, lab-created emeralds are some of the best I've ever seen"

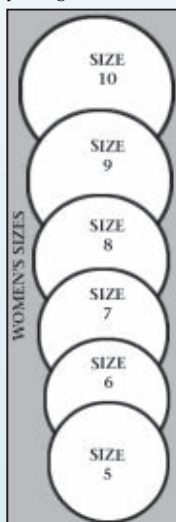
— JAMES T. FENT,  
Stauer GIA  
Graduate Gemologist

## Going "Green" Just Got More Glamorous

*A stunning 4-carat lab-created emerald ring layered in luxurious platinum... for UNDER \$200!*

Centuries ago, ancient Greek alchemists tried – and failed – to reproduce the rare beauty of natural emeralds. But much more recently, one man finally upstaged Mother Nature with the world's first scientifically-created emerald. His success shocked the gem world and Stauer is proud to shock it again with our spectacular Platinum-Layered *Scienza™ Emerald and DiamondAura® Verde Ring*.

**Recreating nature's masterpiece.** The young scientist's breakthrough was so remarkable that when he visited Fifth Avenue to show off his gorgeous green cache, jewelry clerks assumed the stones were stolen and called the NYPD. And ever since Stauer has spent millions of dollars on building *Scienza™* emeralds, the process for growing large extraordinary stones from scratch has only improved. And the technology behind our *Scienza™* jewelry results in the greenest green you've ever seen... a stone that would surely make history's greatest alchemists jealous!



### USING THE RING SIZE CHART

Place one of her rings on top of one of the circle diagrams. Her ring size is the circle that matches the inside diameter of the ring diagram. If her ring falls between sizes, order the next larger size.

The mineral composition, heat and pressure of *Scienza™* are all controlled in the laboratory, so the scientifically-grown emeralds have more luster and brilliance than most mined stones. *Scienza™* emeralds are identical to the natural gem in most every way: color, sparkle, hardness, and composition. The one big difference is price.

**The classic glamor of green.** Cleopatra adored them. The world's royalty sent explorers across oceans to find them. Few gemstones seize the imagination like the almighty emerald. And you can see that same timeless magic in the sparkle of our platinum-layered *Scienza™ Emerald and DiamondAura® Verde Ring*. The stunning, 4-carat *Scienza™* lab-created emerald centerpiece is a dramatic emerald-cut set in platinum-layered, .925 sterling silver. Both shoulders sparkle with a dozen lab-created *DiamondAura®* baguettes and 30 brilliant rounds, an explosion of fiery white edged by exquisite silverwork.

If ever the lab-created variety of a gemstone could be said to improve on nature, the emerald is it. Free of the myriad of tiny cracks which blemish

most natural emeralds and can only be concealed by cosmetic techniques, our treatment-free, lab-created version delivers the luxury look for much less.

**Our "evergreen" guarantee.** If you're not completely impressed by the platinum-layered *Scienza™ Verde Collection*, simply return it for a complete refund of your purchase price. But once you "go green" with such a decadent display of lab-emerald enchantment, it's hard to go back!

### JEWELRY SPECS:

- 4 carat scientifically grown ring emerald
- Platinum-layered .925 sterling silver setting
- Emerald-cut stones

### Scienza™ lab-created Emerald and DiamondAura® Verde Collection

A. Ring (4 ¾ ctw)—~~\$595~~ **\$195**

B. Earrings (6 ½ ctw)—~~\$495~~ **\$225**

C. Necklace (5 ¾ ctw)—~~\$595~~ **\$195**

Complete Set—~~\$1,685~~ **\$585**

**Save \$1,100** Set includes ring, earrings and necklace.

Specify ring whole size 5-10 when ordering.

Call now to take advantage of this limited offer.

**1-888-324-6512**

**Promotional Code EVC141-01**

Please mention this code when you call.



B.



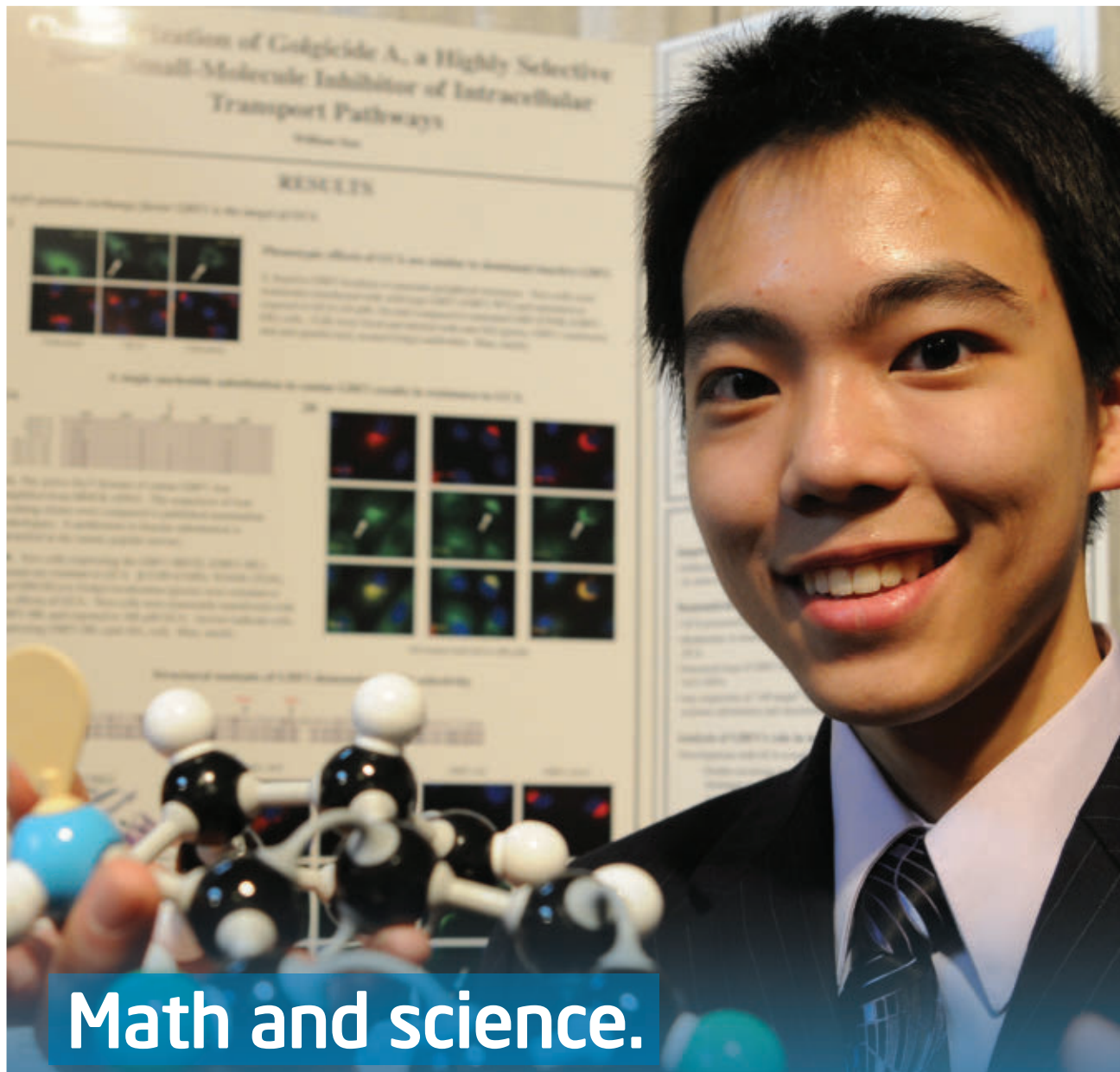
C.

**Stauer**

14101 Southcross Drive W.,  
Dept. EVC141-01  
Burnsville, Minnesota 55337  
[www.stauer.com](http://www.stauer.com)

*Smart Luxuries—Surprising Prices*





# Math and science. The common denominators of world-changing innovation.



Sponsoring the Intel Science Talent Search, a program of Society for Science & the Public, is just one of the ways Intel supports excellence and innovation in science, technology, engineering, and mathematics.

To learn more, visit: [www.intel.com/education/sts](http://www.intel.com/education/sts)



Sponsors of Tomorrow.™