

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC JUNE 19, 2010



Genome Swap Bears 'Synthetic' Life

Sea Ice: The Melt of the Matter

Particle Illuminates Cosmic Imbalance

"...classic! The [Stauer] tanzanite are a beautiful shade of violet blue...full of color!" — Praise for Stauer Tanzanite

– PRAISE FOR STAUER TANZANITE FROM C. OF MISSOURI

## Endangered Gem Disappearing

*Tanzanite is found in only one remote spot on Earth, and it's 1,000 times rarer than diamonds. Experts say the mines will soon run dry forever, but today you can own more than 1 carat for Better Than FREE!* 

Time is running out. Geological experts predict the world's supply of tantalizing tanzanite will disappear in a matter of just a few years. Maybe sooner. High-end retailers are raising prices on this rare stone. And gem dealers are in a mad scramble to secure their claim before it's too late. Let them scramble. Our buyer recently secured a huge cache of beautiful rare tanzanite, the precious stone loved for its vivid violet-blue color. Today you can own over 1 carat of this rare stone (1,000 times



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.

rarer than diamonds) in our spectacular *Tanzanite Cluster Ring* with a suggested retail of \$795 <u>for only \$95</u>. Want to learn how to get this magnificent ring for <u>Better Than</u> <u>Free</u>...read on.

Order the exclusive *Tanzanite Cluster Ring* (1 1/s ctw) for \$95 and we'll give you a \$100 Stauer Gift Coupon. That's right. You pay \$95 and you get the Tanzanite Ring AND \$100 toward your next Stauer purchase. This is our impossible <u>Better Than FREE</u> offer.

*It started with a lightning bolt.* One strike set the African plains on fire and uncovered a secret that was buried for more than 585 million years. Tanzanite naturally occurs in only one place on Earth: Tanzania's remote Merelani Hills, in the shadow of Mount Kilimanjaro.

*World's most endangered gem.* Top-quality tanzanites can often fetch higher prices than diamonds. But, once the last purple gem is pulled from that remote spot beneath Kilimanjaro, that's it. No more tanzanite.

**Reserve your piece of gem history.** If you go online right now, you'll find one of the largest retailers selling tanzanite rings for well over \$2,000 each. Ridiculous. Instead, you can secure your own piece of limited-edition tanzanite history at the right price. **Better Than FREE and Guaranteed.** Our **Better Than FREE** offer is so consumer friendly that we have earned an A+ **Rating** with the Better Business Bureau. But, why a \$100 Gift Coupon with your \$95 purchase? It's simple. We want you to come back to Stauer for all of your jewelry and watch purchases. If you are not 100% delighted with your ring, send it back within 30 days for a full refund of the purchase price. Just remember that the odds of finding this stone at this price ever again is like waiting for lightning to strike the same place twice.

#### **JEWELRY SPECS:**

- 1<sup>1</sup>/s ctw tanzanite Ring sizes 5-10
- Rhodium-layered .925 sterling silver setting

## Tanzanite Cluster Ring (1 1/5 ctw)—\$795 \$95 + s&P PLUS

\*<u>Better Than FREE</u>—Receive a \$100 Stauer Gift Coupon with the purchase of the Tanzanite Cluster Ring. *Call now to take advantage of this limited offer.* 

## 1-888-870-7339

**Promotional Code CTR128-01** Please mention this code when you call.

ACCREDITED Stauer has a Better Business Bureau Rating of A+

14101 Southcross Drive W., Dept. CTR128-01 Burnsville, Minnesota 55337

Smart Luxuries—Surprising Prices









# **ScienceNews**

## In The News

## **5 STORY ONE**

• A cell reprogrammed with a man-made genome inches researchers closer to fully synthetic life

## 8 ATOM & COSMOS

- Particle decay hints at why matter rules
- Black hole takes off-center stage
- WISE eyes the Heart and Soul nebulae

## **10 HUMANS**

- Disgust and anger look the same to young kids
- Gene plus bullying ups risk of emotional fallout
- Perfect screen screams
- Ardi may or may not have been one for the trees

## **12 MATTER & ENERGY**

- Ball lightning may be all in your head
- Better solar cell efficiency through quantum effects

## 13 BODY & BRAIN

- Major study of cell phonebrain cancer link inconclusive
- Dementia caregivers face cognitive risks themselves

## 14 LIFE

- Lying to get the ladies
- Why the argonaut got its shell
- New clues point to team of honeybee killers
- Chatty bacteria slow healing

## **Features**

## **16 NOT JUST A HIGH**

COVER STORY: Cannabis compounds show their stuff against a host of medical problems, relieving symptoms far beyond pain and nausea. By Nathan Seppa

## 22 MELTING AT THE MICROSCALE

Studying polar sea ice up close could help scientists understand its disappearance. By Alexandra Witze

## Essay

## 26 LAW & DISORDER

For clues about why the arrow of time appears to point in just one direction, physicists look back to the Big Bang-and before. By Tom Siegfried

## **Departments**

- 2 FROM THE EDITOR
- **4 NOTEBOOK**
- BOOKSHELF

30

- 31 FEEDBACK
- **32 COMMENT Bioethicist Glenn McGee** discusses the latest news of "synthetic" life.



**COVER** Once derided as fringe science, cannabis research has gone mainstream, showing promise in treating multiple sclerosis. Crohn's disease and other disorders. belterz/iStockphoto

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC

PUBLISHER Elizabeth Marincola EDITOR IN CHIEF Tom Siegfried

#### EDITORIAL

MANAGING EDITOR SENIOR EDITOR / POLICY DEPUTY MANAGING EDITOR. NEWS DEPUTY MANAGING EDITOR. FEATURES DEPUTY NEWS EDITOR CONTRIBUTING EDITOR EDITORIAL ASSISTANT ASTRONOMY BEHAVIORAL SCIENCES BIOMEDICINE EARTH SCIENCES ENVIRONMENT/CHEMISTRY LIFE SCIENCES MOLECULAR BIOLOGY STAFF WRITER WEB SPECIALIST/EDITORIAL SECRETARY CONTRIBUTING CORRESPONDENTS

Eva Emerson lanet Raloff Matt Crenson Elizabeth Ouill Erika Engelhaupt Alexandra Witze Rachel Zelkowitz Ron Cowen Bruce Bower Nathan Seppa Sid Perkins Rachel Ehrenberg Susan Milius Tina Hesman Saev Laura Sanders Gwendolyn K. Gillespie Laura Beil, Susan Gaidos, Charles Petit

#### DESIGN

Beth Rakouskas DESIGN DIRECTOR ASSISTANT ART DIRECTOR Theresa Dubé

#### ADVERTISING | CIRCULATION Judy Lewis West, Midwest & DC Metro

ADVERTISING MANAGER CIRCULATION MANAGER ACCOUNT EXECUTIVES

ADVERTISING/CIRCULATION ASSISTANT PERMISSIONS



Tosh Arimura

Kerwin Wilson

Evora Swoopes

Gregg Oehler, Rich Cordero, Oehler Media, East: Rick Johnson, National Brands:

Jan Mason, Online Advertising

BOARD OF TRUSTEES CHAIRMAN Dudley Herschbach VICE CHAIR Jennifer Yruegas SECRETARY Gayle Wilson TREASURER Michela English EXECUTIVE COMMITTEE, AT-LARGE Robert W. Fri MEMBERS 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

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 COMMUNICATIONS COORDINATOR Caitlin Jennings MEMBERSHIP AND COMMUNICATIONS ASSOCIATE Nancy Moulding

EVENTS MANAGEMENT DIRECTOR OF EVENTS Cait Goldberg EVENTS ASSOCIATE Marisa Gaggi

SCIENCE EDUCATION PROGRAMS DIRECTOR Michele Glidden PROGRAM MANAGER. INTEL SCIENCE TALENT SEARCH Caitlin Sullivan DOMESTIC FAIRS MANAGER Laurie Demsev OFFICE MANAGER June Kee DATA MANAGER Jinny Kim VOLUNTEER MANAGER Diane Rashid INTERNATIONAL FAIRS MANAGER Sharon Snyder

INTERNAL OPERATIONS DIRECTOR Harry Rothmann FACILITIES MANAGER Paul Roger LOGISTICS MANAGER Anthony Payne 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

#### 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, D.C. 20036. Preferred periodicals postage paid at Washington, D.C., 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 regis tered as trademark U.S. and Canadian Patent Offices, Printed in U.S.A. on recycled paper.

#### FROM THE EDITOR

## For source of time's arrow, consult a good dictionary



Language is infused with words and phrases that instill in human consciousness a direction for the flow of time. Not just past and future, but words like before, after, earlier, next and then, soon and until. It's hard to make sense about much of anything without slipping in words that allude to a temporal order.

But the mathematical language used by physicists to describe the interplay of atoms and molecules recognizes no such single time direction. Equations for the laws of motion work equally well whether time advances or reverses - in the microworld, time's arrow has two tips. In the world of everyday life, though, a one-way time street originates from a time-free foundation. Trying to explain how has occupied physicists since the late 19th century.

In an essay in this issue (Page 26), I describe one of the more recent efforts to explain time's direction, expounded by Caltech physicist Sean Carroll in a new book (which I review on Page 30). Much of what he has to say has been said previously by others, but there is novelty in his notion that the solution may be found in a time before the birth of the universe. If our universe is just one of many in a vast multiverse, time's arrow can point one way in some, the other way in others. Equations describing two-way time in the microworld therefore simply reflect the convenience that the same math can apply to the physics in any universe you happen to be in, regardless of which way its time flows.

Nobody really knows, of course, if multitudes of universes really exist, or whether time is an illusion, a trick played on brains by the microphysics of their neurons. It may turn out that the time-arrow mystery merely reflects a primitive understanding awaiting deeper insights, and concepts, to pierce the psychological conditioning of time-oriented language.

My favorite observation in this respect came from the late John Archibald Wheeler, a physicist who thought profoundly about explaining the foundations of physical reality. In an interview more than 20 years ago, Wheeler commented on the role of language in complicating his quest.

"We have to learn how to use our words," he said. "It's a fantastic thing – we humans are so easily trapped in our own words. The word time, for instance. We run into puzzles about the concept of time and then we say, 'Oh, what a terrible thing.' We don't realize we're the source of the puzzles because we invented the word." - 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. 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.

Æ



## **How Do Scientists Know What They Know?**

The science wars are a long-running conflict over the status of scientific knowledge that began in ancient Greece, raged among scientists and humanists during the Enlightenment, and has reemerged in today's conflicts between science and religion. In **Science Wars: What Scientists Know and How They Know It**, explore the fascinating history of competing conceptions of scientific knowledge, as well as their implications for science and society. Delivered by award-winning Professor Steven L. Goldman, these 24 in-depth lectures cover an astonishing array of ideas, issues, and thinkers from the dawn of the Scientific Revolution to the complexities of the present day.

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, August 18, 2010

Science Wars: What Scientists Know and How They Know It Course No. 1235 24 lectures (30 minutes/lecture)

DVDs \$254.95 NOW \$69.95

+ \$10 Shipping, Processing, and Lifetime Satisfaction Guarantee

Audio CDs \$179.95 NOW \$49.95 + \$10 Shipping, Processing, and Lifetime Satisfaction Guarantee

#### Priority Code: 39667

THE TEACHING COMPANY<sup>\*</sup> The Joy of Lifelong Learning Every Day<sup>\*\*</sup> Great Professors, Great Courses, Great Value Guaranteed.<sup>\*\*</sup>

## Science Wars: What Scientists Know and How They Know It

Taught by Professor Steven L. Goldman, Lehigh University

#### **Lecture Titles**

- 1. Knowledge and Truth Are Age-Old Problems
- 2. Competing Visions of the Scientific Method
- 3. Galileo, the Catholic Church, and Truth
- 4. Isaac Newton's Theory of the Universe
- 5. Science vs. Philosophy in the 17<sup>th</sup> Century
- 6. Locke, Hume, and the Path to Skepticism
- 7. Kant Restores Certainty
- 8. Science, Society, and the
- Age of Reason 9. Science Comes of Age in the
- 19<sup>th</sup> Century
- 10. Theories Need Not Explain
- 11. Knowledge as a Product of the Active Mind
- 12. Trading Reality for Experience

- 13. Scientific Truth in the Early 20<sup>th</sup> Century
- 14. Two New Theories of Scientific Knowledge
- 15. Einstein and Bohr Redefine Reality
- 16. Truth, Ideology, and Thought Collectives
- 17. Kuhn's Revolutionary Image of Science
- 18. Challenging Mainstream Science from Within
- 19. Objectivity Under Attack
- 20. Scientific Knowledge as
- Social Construct
- 21. New Definitions of Objectivity
- 22. Science Wars of the Late 20<sup>th</sup> Century
- 23. Intelligent Design and the Scope of Science
- 24. Truth, History, and Citizenship



#### SCIENCE NOTEBOOK



## **Scientific Observations**

"I'm part of the generation that read Isaac Asimov and Arthur C. Clarke as science fiction authors. And they were both confident in technological fixes to human situations. That's something that's decreased over time.... Look at the developments over the last 20 years that have made huge progress in medicine, in agriculture, in improving the human condition. Whether those improvements have been implemented becomes a society issue, a

political issue, but the tools are routinely being generated. And how they are managed is going to be more and more important. That's one reason why we should have a scientifically educated population, so people can make their own judgments of how technologies ought to be applied to society." —JOHN GILBEY, AUTHOR OF THE SCIENCE FICTION STORY CATALYST, IN THE APRIL ISSUE OF SYMMETRY

## Science Past | FROM THE ISSUE OF JUNE 18, 1960

USSR USES SABIN VACCINE — The Sabin live polio virus vaccine, developed in the United States but not yet licensed here, is "completely harmless" and extremely



effective, Russian scientists have found. They have already immunized millions of children in the USSR with the live vaccine.... The scientists said they had been particularly careful to study the possibility that the attenuated Sabin strains might turn into dangerous virus forms.

They found the live vaccine to be "completely harmless." There is no "threat of the vaccine strains' reversion to a more virulent state." They advised that the live vaccine be made compulsory, as in the case of smallpox and diphtheria in many areas.

## **Science Future**

#### June 25-29

The American Diabetes Association hosts its annual meeting in Orlando. See professional. diabetes.org

## July 11

A total solar eclipse can be seen in parts of the South Pacific. See viewing times for cities at eclipse.gsfc.nasa.gov

## July 24-27

Clinicians and researchers meet in Vancouver, Canada to discuss heart disease research. See www.cardiologyonline.com

## SN Online

www.sciencenews.org

#### LIFE

Early octopus ancestors were two-tentacled pygmies, new fossils reveal (illustration shown). See "Octopus origins."



## HUMANS

A man can detect the emotions in the scent of his woman and vice versa. See "Making scents of a partner's feelings."

#### **BODY & BRAIN**

Blood vessels in mice pull a defenestration-esque move to ditch clots. See "Tiny blood vessels expel clots by force."

## MOLECULES

Great martinis are not born but made by the interaction of ethanol and water molecules, chemists suggest. See "Vodka's bonds may influence taste."

## Introducing...

Conservation is its own reward, literally. A new species of antpitta, a forest bird, has been discovered and named for American Bird Conservancy president George Fenwick and his family, researchers report in the May 18 *Conservación Colombiana*. The tail of *Grallaria fenwickorum* (shown) spans about 6 centimeters, and the entire bird weighs about



50 grams, a little less than a tennis ball. Though the bird was identified within a protected area in the Andes, it may still need the aid of its human counterpart: Dubbed "Fenwick's antpitta," its conservation status is proposed as "critically endangered."

## Science Stats | OFF TARGET

Energy experts have identified two goals for total U.S. carbon emissions from 2012–2050. Meeting either will take a reversal of current trends.

Projections for U.S. emissions in millions of metric tons per year



PROAVES

# In the News

STORY ONE

## Genome from a bottle turns one bacterium into another

Wholesale DNA swap marks synthetic biology milestone

#### **By Laura Sanders**

sing a made-from-scratch genome, scientists have breathed a new kind of life into a bacterium. The feat, published online May 20 in *Science*, holds promise for designing new organisms that might do things like produce vaccines, synthesize biofuels, purify water or eat spilled oil.

Researchers from the J. Craig Venter Institute carefully stitched together the entire genome of the bacterium *Mycoplasma mycoides* and put it into a different kind of bacterium, *Mycoplasma capricolum*. This unprecedented wholesale genome swap caused the *M. capricolum* cell to switch species. The newly converted cell was nearly identical to the natural *M. mycoides*.

"This was a proof-of-concept experiment showing that we could take the sequence out of a computer, build it and boot it up to make a synthetic cell," says study leader Daniel Gibson of the Venter Institute's campus in Rockville, Md.

This ability to transplant complete genomes from one species to another is "a marvelous piece of work," says bioengineer James Collins, a Howard Hughes Medical Institute investigator at Boston University who was not involved in the study. "This represents an important advance for synthetic biology."

For decades biologists have been sculpting genomes by adding and subtracting bits of DNA, with the goal of gaining control over existing organisms — and even creating new ones.

Scientists at the Venter Institute already knew the DNA sequence of the *M. mycoides* genome. But now they've been able to take the string of A's, T's, G's and C's stored in a computer, build the whole genetic instruction book in test tubes, put it in a cell and show that it works.

One of the major challenges in the new study was figuring out how to knit short

pieces of DNA together in a particular order to create a large genome. Through earlier experiments, the team had found that proteins in yeast cells could quickly assemble large pieces of DNA. "We were amazed that yeast has this capacity, so we tried to push the limits," Gibson says.

After going through three rounds of assembly in surrogate yeast cells with progressively bigger chunks of synthesized DNA, the researchers produced a genome of recordsetting size, clocking in at 1,077,947 DNA letters. This synthetic genome was then introduced into *M. capricolum* cells, Atom & Cosmos Clue to cosmic imbalance Galaxy M87's not-quite-central black hole

**Humans** Faces get gross around age 5 Ardi's status as tree hugger questioned

Matter & Energy Lightning in the mind

Body & Brain Caretakers and dementia

Life Buoyancy via a maritime shell

which began to forget their own characteristics and instead adopt properties, including the protein profile, of the genome-donor species, *M. mycoides*.

"It's still pretty stunning to me that simply by changing the software in the cell, the cell immediately starts this process of converting into another species," says biologist J. Craig Venter. "It's all about how life works, how dynamic it is."

In most ways, the man-made genome was similar to the natural one, with a few important tweaks: The scientists added DNA sequences that the genome needs to survive the yeast-based assembly step and the transfer into its new cell. The team also added sequences encoding a substance that causes a cell to turn blue in the presence of certain drugs, making



A DNA sequence in a newly engineered synthetic genome made recipient cells turn blue under certain lab conditions (colony shown above). This allowed researchers to distinguish the cells with the manmade genome from those that didn't take it up.

SCIENCE/AAAS

#### IN THE NEWS

## For today's top stories, visit SN Today at **www.sciencenews.org**

colonies with the synthetic genome identifiable with the naked eye. And finally, four unique genetic "watermarks" that would unambiguously distinguish an *M. mycoides* cell with synthetic DNA from a naturally occurring cell were included.

So far, Venter and his team haven't engineered any useful properties into the synthetic genome. "This is not so much about parts as it is a chassis to put the parts into," says George Church, a geneticist and technologist at Harvard Medical School in Boston.

Researchers have been tinkering with genes for many years, but the ability to replace an entire genome is different, Venter says. Other studies typically change a small number of genes isolated from bacteria. "Now we start with information in the computer. We start with digital code and create new genetic code from four bottles of chemicals [the A's, T's, G's and C's that make up DNA]. I think that's the biggest philosophical difference."

To some, though, this man-made genome is not technically artificial. "It's a great feat, but I wouldn't call it an artificial organism," Collins says. Synthetic, he contends, implies designed from scratch, not plagiarized from a natural genome. What's more, the experiment required a recipient cell to provide the cytoplasm to hold the transplanted genome. "It's small, but it's an important quibble," Collins says.

To claim the creation of synthetic life, the entire organism must be successfully produced from raw materials, asserts Glenn McGee of the Center for Practical Bioethics in Kansas City, Mo. "The landmark achievement has yet to occur," he says.

Semantics aside, the real challenge will be turning this technology into something useful. Gibson says designing genomes and transplanting them into microorganisms could create special bugs that produce vaccines, other pharmaceutical compounds and biofuels, for instance. Scientists at the



After taking up a synthetic genome based on that of *Mycoplasma mycoides*, cells (shown) adopted the characteristics of their genome-donor species.

Venter Institute are already working with Exxon Mobil to create bugs that slurp up carbon dioxide and convert it into clean fuel. Other applications include designer organisms that could convert wastewater into drinking water and clean up hazardous chemical spills.

Such efforts will require an incredibly detailed knowledge of the biology of the organisms, something scientists currently lack, Collins points out. "At best, we have a rudimentary understanding of these functions," he says.

Making targeted changes to existing genomes may prove just as successful as making organisms from scratch. "If the stated goal is to make useful microor-

ganisms for commercial purposes, there are alternatives already in use," Church says. "It's not absolutely clear that suddenly a lot of people are going to adopt this method.... Nevertheless, it's a big milestone." ■

## Back Story | CRACKING THE CODE

In order to identify organisms with the made-from-scratch genome, researchers at the Venter Institute put four unique DNA sequences into the blueprint to serve as "watermarks." For fun, the team figured out a way to encode all the letters of the alphabet (along with necessary punctuation) using the A's, T's, C's and G's that make up DNA. This feat allowed the team to include secret words and phrases, which you can try to decipher yourself by visiting www.sciencenews.org/ventercode

#### Included in the watermarks:

1. The key to the alphanumeric code.

2. The **names** of members of the research team, including J. Craig Venter.

3. A **quote** from James Joyce's *A Portrait of the Artist as a Young Man*: "To live, to err, to fall, to triumph, to recreate life out of life."

4. A **website address** where those who have solved the code can go to gloat.

**Hint:** In the same way that three genetic letters in DNA code for an amino acid, three genetic letters code for each alphabet letter. That's not necessarily true for punctuation, though.



## Atom & Cosmos

## **Muons offer clue** to why universe isn't just space

Matter-antimatter imbalance hints at need for new physics

## By Ron Cowen

Less than a trillionth of a second after the Big Bang, another tumultuous event unfolded. In a cosmos born with equal parts matter and antimatter - which should have annihilated each other - matter somehow began to dominate.

Physicists now have uncovered a new clue about what caused this fortunate imbalance, which led to the existence of galaxies, planets and people.

The new result is based on seven years of studying trillions of short-lived particles called B mesons produced at the Fermi National Accelerator Laboratory's Tevatron particle collider in Batavia, Ill. Scientists on the Tevatron's DZero experiment have found hints that when B mesons disintegrate, they produce about 1 percent more pairs of muons, a heavy version of the electron, than pairs of the muon's antiparticle, the antimuon. That imbalance, a signature of a phenomenon known as CP violation, may bode well for eventually understanding how matter outstripped antimatter in the universe.

The finding, reported at a Fermilab seminar May 14 and posted online at arXiv.org May 18, also improves the odds that the Large Hadron Collider, the European accelerator that recently superseded the Tevatron as the world's most powerful atom smasher, will discover new elementary particles or other novel physics.

Although small, the 1 percent surplus is 50 times larger than the asymmetry between matter and antimatter predicted for B meson decays by the standard model of particle physics, notes DZero spokesperson Stefan Söldner-Rembold of the University of Manchester in England.

"It was a goose bump situation," says Söldner-Rembold of the moment in early May when he and his 500 DZero collaborators realized what they had discovered. "We were very excited because it means there's some new physics beyond the standard model that has to be within our reach for the asymmetry to be so large."

Although there's less than a 0.1 percent chance that the DZero results are a fluke, by the standards of particle physics the results should be regarded as hints that

still must be confirmed. cautions theorist Yuval Grossman of Cornell University. Söldner-Rembold notes that the DZero findings are similar to an asymmetry in matter-antimatter production discovered in

2008 by another Tevatron experiment, called CDF, but the new results have much less uncertainty.

Theories that might account for the DZero result include supersymmetry, which assumes that each elementary particle in the standard model has an as-yetundiscovered heavier superpartner, notes theorist Marcela Carena of Fermilab, who is not a member of the discovery team. Other possible theories, she notes, include a model in which gravity and other forces operate in extra, hidden dimensions, and the notion of a fourth family of quarks beyond the three known generations (up and down, strange and charm, and top and bottom).

In models with a fourth quark family, the interaction of new, heavy quarks with the known families could lead to a larger matter-antimatter imbalance than in the

> standard model. With supersymmetry, interactions of heavy superpartners with other particles might slightly favor the production of matter over antimatter. In theories with extra dimensions, new force-carrying par-

ticles could cause the added imbalance, Carena says.

"Still, it is difficult to find a theory that can generate this asymmetry without contradicting other experimental results," Carena says. Nonetheless, some new asymmetry source "is needed to explain the matter-antimatter imbalance in the universe, and hence our existence."

For more Atom & Cosmos stories, visit www.sciencenews.org



The DZero detector (shown) at Fermilab's Tevatron accelerator has recorded an excess of matter over antimatter in the decay of particles called B mesons. That excess could help physicists figure out why matter exists in the universe today.





ar **4.1** million suns

Mass of the Milky Way's central supermassive black hole

# Black hole found a little off-center

Displacement could provide clue to history of galaxy M87

## By Ron Cowen

Supermassive black holes are shiftier beasts than astronomers suspected. A new study finds that the giant black hole at the core of galaxy M87 somehow got displaced from the galaxy's center.

Off-kilter black holes "could represent a significant change in our understanding of supermassive black holes, galaxies and the ways in which they may interact with each other," said Daniel Batcheldor of the Florida Institute of Technology in Melbourne.

Sorting through old Hubble Space Telescope observations of M87's core, Batcheldor and colleagues found that its giant black hole, weighing the equivalent of about 6 billion suns, doesn't lie smackdab at the galaxy's center. Rather it is displaced by about 22 light-years, possibly as the result of a merger with another as-yetunknown supermassive black hole in the galaxy. Or the black hole might have been pushed aside by one of the twin central jets of gas and dust that emanate from the core of M87, Batcheldor reported May 25.

The finding, to be described in an upcoming *Astrophysical Journal Letters*, has also been posted online at arXiv.org.

The result is plausible, says Karl Gebhardt of the University of Texas at Austin. But finding M87's true center is difficult because the light associated with the black hole isn't entirely symmetrical and could be confused with the blobs of material ejected by the galaxy's jets.

Theorist Avi Loeb of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., notes that there are several ways the jets could have confounded efforts to determine the galaxy's center. Jets plowing into surrounding gas can generate excess light or even create new stars by shocking the gas.

Astronomers hadn't realized earlier that the giant black hole was off-center because there was little reason to search for such an offset, Batcheldor said.

Most searches for off-center black holes have focused on objects traveling thousands of kilometers per hour. A fast-moving black hole is relatively easy to spot because its velocity has either carried it farther from its galaxy's core or has modified its light spectrum so it stands out from other sources, or both.

Supermassive black holes ejected from a galactic center with velocities of only a few hundred kilometers per second – like the one in M87 – are harder to detect but may be more common.

The most likely explanation for the offset is that the collision of two supermassive black holes at some time in the past 10 billion years kicked the newly merged black hole out of the galaxy's center, Batcheldor and his team suggested.

Once kicked, a supermassive black hole can spend millions to billions of years oscillating about the galactic center before coming to rest. The displacement of the hole can therefore reveal the merger history of the galaxy, says team member David Merritt of the Rochester Institute of Technology in New York. (i)



## **WISE craft probes Heart and Soul**

A new orbiting observatory has captured the Heart and Soul of its mission. Less than six months after launch, NASA's Wide-field Infrared Survey Explorer, or WISE, has examined two giant bubbles of gas and stars, the Heart nebula (right) and the Soul nebula (left), both about 6,000 light-years from Earth. The craft's infrared sensitivity enabled it to peer more deeply into the cold, dusty regions of each nebula, both sites of intense star formation, than a visible-light telescope could. This image of the nebulae, released May 24, showcases the probe's ability to uncover star formation in regions heavily buried in dust, said Ned Wright of the University of California, Los Angeles, lead researcher for the mission. WISE is devoted to finding cold or dusty objects that emit most of their light at infrared wavelengths. These bodies include not only nebulae like Heart and Soul, but also galaxies millions of light-years from Earth and asteroids in the solar system. So far, the mission has observed more than 60,000 asteroids, about 11,000 of which have never been seen before, said WISE researcher Tommy Grav of Johns Hopkins University in Baltimore. Most lie in the main asteroid belt between the orbits of Mars and Jupiter, but about 50 of them are previously unknown objects with paths taking them close to Earth's orbit. — Ron Cowen 📵

## Humans

# Young kids can't face up to disgust

Until age 5, ability to interpret facial expressions is limited

## By Bruce Bower

**BOSTON** — Young children have a gift for doing things that adults find disgusting. But kids themselves take a surprisingly

long time, until about age 5, to grasp the meaning of adults' facial expressions of disgust, according to evidence presented May 28 at the annual meeting of the Association for Psychological Science.

This conclusion flies in the face of a popular idea that evolution has produced an innate facial expression for this emotion that even infants should comprehend,

said Boston College psychologist James Russell. Theoretically, an ingrained recognition of adults' disgusted expressions would keep youngsters from eating



For longer versions of these and other Humans stories, visit **www.sciencenews.org** 

poisonous and potentially fatal items or putting them in their mouths.

"From that traditional view, it's surprising that kids don't understand facial expressions of disgust until age 5," says Russell. "But we find that, until then, they see a 'disgust' face as being angry."

Russell regards the new results as consistent with his controversial rejection of an influential theory that six emotions built in from birth — happiness, sadness, anger, fear, surprise and disgust — appear

> in distinctive facial expressions displayed by people everywhere. Instead, Russell proposes that two scales of feeling, high arousal to low arousal and positive reaction to negative reaction, provide the building blocks for emotions that get elaborated in each culture.

His team has previously found that most children misidentify feelings expressed in

adults' facial expressions. Even at age 14, a substantial minority still err on this task.

In two new experiments, Russell and colleagues observed that youngsters often

know the meanings of words for emotions before comprehending the meanings of the facial expressions that go with them.

The researchers studied nearly 600 kids, ages 2 to 7, from middle- to upperincome families in the Boston area. Children viewed images on a computer screen of adults displaying the six basic emotional expressions, then assigned faces to boxes on the screen designated for specific emotions, such as an "angry" box.

At age 2, children's accuracy was limited to putting happy faces in a "happy" box. Toddlers treated all negative emotional expressions as being angry.

Shortly after age 3, an appreciation of sad faces emerged. About a year later, kids correctly identified only angry faces as angry. Accurate designations of other facial expressions soon followed, with comprehension of disgust appearing last.

Children may not discern facial expressions of disgust until age 5 but use words synonymous with disgust, such as "gross" and "yucky," much earlier, says psychologist Lera Boroditsky of Stanford University. Kids may use such words in certain situations years before recognizing the facial expression, Russell proposes. (i)

## Gene exacerbates harm of bullying

**Disgust expressions** 

by kids under age 5.

are not well discerned

Dual dose of short genetic variant linked to emotional woes

## By Bruce Bower

There's nothing fair about getting bullied. To add insult to injury, a new study finds that bullied kids who have inherited one form of a stress-related gene develop the most emotional problems.

Symptoms of anxiety, depression and social withdrawal appeared most often in regularly bullied kids with two copies of a short version of the *5-HTT* gene, says a team led by psychologist Karen Sugden of Duke University in Durham, N.C.

One-third of bullied children who had two short copies of the gene displayed emotional problems severe enough to merit mental health treatment. That figure fell to 29 percent for regularly bullied kids with one short copy of the gene and 15 percent for those with two long copies.

By tracking pairs of twins, Sugden and colleagues ruled out the possibility that preexisting emotional problems led genetically vulnerable children to be victimized by bullies. In cases where each twin had two short copies of the 5-HTT gene but only one got repeatedly bullied, emotional difficulties were observed only in the bullied twin, the researchers report in a paper scheduled to appear in the Journal of the American Academy of Child & Adolescent Psychiatry. Other evidence suggests that the short form of the gene, involved in transporting the chemical serotonin in the brain, intensifies emotional reactions to various kinds of stress, possibly by triggering the release of high levels of stress hormones, remarks Stanford University psychologist Ian Gotlib, who was not part of the study team.

His team has found that teenage girls who were socially excluded or lied about by peers showed more signs of depression if they had two copies of the short *5-HTT* gene. Other studies have failed to link the *5-HTT* gene to stress-related emotional problems (*SN: 7/18/09, p. 10*). But most such studies collected data by phone or questionnaire, not in thorough interviews, says psychologist Terrie Moffitt of Duke, a coauthor of the new study. (i)

## Chaos makes a scream seem real

Researchers dissect movies to learn what fear sounds like

## By Rachel Ehrenberg

As horror-flick titles go, *Night of the Living Chaos* and *Rosemary's Nonlinearity* aren't the catchiest. But filmmakers know that chaos — the mathematical kind — is scary. Now scientists know it too.

Filmmakers use chaotic, unpredictable sounds to evoke particular emotions, a team assessing screams and outbursts from more than 100 movies reports online May 25 in *Biology Letters*.

"Screams are basically chaos," says cognitive biologist W. Tecumseh Fitch of the University of Vienna, who was not involved in the study. "The classic example would be a screaming baby on an airplane, the kind you can't ignore and makes your life hell." Cries are harder to ignore when irregular and chaotic, research suggests. Scientists believe that such noises, uttered or roared when an animal is really worked up, can play the crucial communication role of frantically demanding attention.

By exploring the use of harsh sounds in film, scientists hope to get a better understanding of how fear is expressed, says study coauthor Daniel Blumstein of the University of California, Los Angeles.

"Potentially, there are universal rules of arousal and ways to communicate fear," says Blumstein, who typically studies screams in marmots, not starlets.

His team analyzed 30-second cuts from such movies as *Aliens, Goldfinger, Annie Hall, Slumdog Millionaire, Titanic, Carrie* and *The Shining*. Not unexpectedly,



Screeches that devolve into mathematical chaos evoke a visceral response.

horror films had a lot of harsh and atonal screams. Dramas had fewer screams but a lot of abrupt changes in acoustical frequency. Adventure films had a surprising number of harsh male screams.

One bloodcurdling scream has become a film favorite. More than 200 movies have used the Wilhelm scream, named for a character who unleashed it in the 1953 western *The Charge at Feather River*.

## Experts debate hominid habitat

Discoverers dispute claim that Ardi roamed savannas

## By Bruce Bower

An ancient hominid hung out on grassy savannas, not in forests as first claimed, a new study argues. Whether the species trucked across savannas has major implications for understanding how and why human ancestors began walking upright.

The discoverers of the species *Ardipithecus ramidus* disagree with the new study and say that other evidence keeps these hominids in the woods.

When a 4.4-million-year-old partial *Ardipithecus* skeleton was unveiled in October 2009, its owner, dubbed Ardi, was presented as a forest dweller that split time between walking upright and crawling along tree branches (*SN:1/16/10, p. 22*). In this scenario, a two-legged gait had

evolved to support long-distance foraging by males seeking to impress potential mates. But the new analysis, published in the May 28 *Science*, supports a longstanding idea that shrinking African forests spawned the evolution of hominids capable of walking across vast savannas.

In Ardi's neck of the woods, at what is now Aramis, Ethiopia, "there is abundant evidence for open savanna habitats," says geologist Thure Cerling of the University of Utah in Salt Lake City. Ardi could have inhabited a grass- and shrub-covered region in a thin wooded strip that bordered a river flowing through a savanna, Cerling's team suggests.

Cerling and colleagues analyzed data from soil and plant fossils collected by Ardi's discoverers. Forms of carbon in fossil-bearing sediments indicate that tropical grasses covered much of Ardi's home area. Microscopic fossils of such grasses found near Ardi's remains also point to a savanna, the researchers say.

Levels of carbon isotopes in teeth from giraffes and other animals found among

*Ardipithecus* fossils resemble those of browsing animals that range today from woods bordering rivers to savannas, the scientists say, noting that aridity and rainfall estimates for Ardi's ancient homeland are compatible with such a habitat.

In a response in the same issue of *Science*, Ardi's discoverers, including anthropologist Tim White of the University of California, Berkeley, say that no reliable way exists to estimate the extent of savanna in Ardi's corner of East Africa. Fossil and geological evidence indicate that *Ardipithecus* favored wooded areas over savanna patches, in White's opinion.

Groundwater and springs probably deposited fossil wood, seeds and invertebrates near Ardi's remains, White notes. No evidence of an ancient river or lake has been found at fossil sites in that area.

If Ardi's kind frequented savannas, as Cerling's team proposes, a biological mystery emerges, White says. "What were these large-bodied hominids doing out on an open grassland, besides providing meals to resident predators?" (1)

## Matter & Energy

For longer versions of these and other Matter & Energy stories, visit **www.sciencenews.org** 

## 'Ball lightning' may be hallucinatory

A

Magnetic fields in real bolts might trigger brain's visual area

## By Alexandra Witze

Talk about a flash of insight. Lightning strokes could stimulate people's brains and cause them to hallucinate bright blobs of light the same way a magnetic medical procedure does, two physicists propose in an upcoming *Physics Letters A*. That process could help explain some reports of "ball lightning," mysterious float-



"We don't claim to have a solution for the mystery of ball lightning," says study coauthor Alexander Kendl, a plasma physicist at the University of Innsbruck in Austria. "But this is a possible hypothesis."

Lightning forms when electrical charges become separated in a storm cloud and build up electrical potential between them, which is then discharged in the sudden bolt. Lightning strokes typically come in clusters. In some cases, Kendl says, they can come very rapidly, perhaps 20 to 60 strokes, each about 100 milliseconds long, raining down over the course of several seconds.

These rare repetitive strokes, Kendl's team found, generate magnetic fields similar in strength, and in how they rise and decay over time, to those used in a brain-stimulation technique called transcranial magnetic stimulation, or TMS.

TMS applies magnetic fields to the brain to treat conditions such as depression. When the stimulation is applied to the visual cortex, some patients report seeing blobs of light. Such experiences of seeing light when light is not actually entering the eye are known as phosphenes. (The pattern of light you see when you rub your closed eyes is a type of phosphene.)



Evanescent glowing orbs called "ball lightning" have been reported for centuries, but never fully explained.

Others have proposed that ball lightning is hallucinatory, but this study is the first to relate it to a known phenomenon.

Working with graduate student Josef Peer, Kendl calculated that repetitive lightning strokes would trigger phosphenes "astonishingly well." A person would need to be within about 200 meters of the lightning to experience the effect.

Thomas Kammer, a TMS expert at the University of Ulm in Germany, isn't convinced. Patients report many kinds of TMS-induced phosphenes, but they don't generally mesh with descriptions of ball lightning. "I cannot imagine that longlasting visual phenomena as described with ball lightning might be based on induced phosphenes," Kammer says.

Scientists have struggled for centuries to explain ball lightning, often described as a yellowish ball that hovers around eye height for a few seconds before vanishing. Other reports describe ball lightning of various colors moving rapidly, fizzling or even exploding. The diversity of descriptions, Kendl says, suggests ball lightning may be a catchall term describing many different types of experience. (i)

## **Cheating the thermodynamic laws**

Quantum effect could boost maximum efficiency of solar cells

## By Laura Sanders

Atoms in a solar cell coaxed into a curious simultaneous quantum state may convert sunlight into electrical energy more efficiently than previously believed possible, a new study proposes.

The laws of thermodynamics set the upper limit of solar cell efficiency at around 80 percent, says study author Marlan Scully of Texas A&M University in College Station and Princeton University. But this estimate doesn't take some quantum effects into account. Scully's model shows that the ultimate energy efficiency can be pushed even higher.

Photovoltaic cells convert photons of light into electrical energy. In a typical cell, photons hit atoms and knock electrons free, resulting in a roaming electron and an electron-hungry area called a "hole." Ideally, electrons are funneled into a path, creating an electrical current. But sometimes, they fall into a hole and emit a photon, an energy-squandering process called radiative recombination.

In the new work, published May 21 in *Physical Review Letters*, Scully proposes that photon squandering can be curbed through a process called quantum coherence, in which atoms are in two energetic states simultaneously. Applying microwave radiation to the photovoltaic cell can induce this coherence, which diminishes the chances of free electrons finding holes.

The scheme doesn't really cheat the laws of thermodynamics, because creating the coherence requires energy. "The thing he didn't take into account is, what is the energy cost in establishing this coherence?" says Ting Shan Luk of Sandia National Laboratories in Albuquerque.

Scully says he has ideas about how to create coherence without using energy.

## Body & Brain



Average length of a cell phone call in U.S., 1990



a cell phone call

Average length of a cell phone call in U.S., 2008

## Cell phone-cancer study an enigma

Researchers remain uncertain about safety of mobile devices

## **By Janet Raloff**

A new international study of cellular phone use and brain tumors poses an enigma for epidemiologists. Though researchers found elevated risk for users who talked on average more than 30 minutes a day and had used the devices for more than a decade, moderate cell phone users actually had decreased risk compared with landline callers.

"This study did not confirm or dismiss the possible association between cell phones and brain tumors. That's the bottom line," says Siegal Sadetzki of Tel Aviv University's Sackler School of Medicine.

Sadetzki and colleagues recruited 21,770 participants from 13 countries (not including the United States) as part of the Interphone study. Researchers analyzed risk for two types of brain tumors, meningiomas and gliomas, and found that only gliomas could be linked to cell phone use, and only to heavy use. Even this association was not ironclad, the researchers report online May 17 in the International Journal of Epidemiology.

Rodolfo Saracci of the National Research Council in Pisa, Italy, and Jonathan Samet of the University of

Southern California in Los Angeles suggest that the conclusions were finessed so as not to alarm cell phone users.

"None of today's established carcinogens, including tobacco, could have been firmly identified as increasing risk in the first 10 years or so since first

exposure," the two write in an editorial that accompanies the new paper. Tumors among the Interphone study's participants were diagnosed between

2000 and 2004-even though widescale cell phone use got under way only in the mid-1990s. Fewer than 5 percent of meningiomas and 9 percent of gliomas seen in study participants occurred among people who had used cell phones for more than 10 years.

minutes

"The question as to whether mobile phone use increases risk for brain cancers remains open," Saracci and Samet say.

The study's authors acknowledge that the jury is still out on cell phone

> safety. Until follow-up data on heavy users come in, Sadetzki recommends that cell owners adopt "the precautionary principle," assuming that some risk might exist and limiting exposures. Tactics might include avoiding long calls, sending text messages

instead of leaving voice messages and using a Bluetooth or other hands-free device to keep a mobile phone farther away from the head.

## **Dementia care** may boost risk

Those who tend sick spouses more vulnerable themselves

#### By Nathan Seppa

Caring for a spouse who has dementia puts elderly people at increased risk of developing dementia themselves, a study finds. The stress of attending to a mentally incapacitated spouse may somehow contribute to the added risk. scientists report in the May Journal of the American Geriatrics Society.

Previous studies have shown that chronic stress increases levels of the hormone cortisol in the body, which can suppress immunity, says study coauthor Peter Rabins, a psychiatrist at Johns Hopkins School of Medicine in

www.sciencenews.org

Baltimore who teamed with researchers at Utah State University in Logan and others to do the study. "It's long been thought that this might have adverse outcomes psychologically and physiologically," Rabins says.

In the new study, researchers assessed the mental status of 1,221 Utah couples who had agreed to be part of a health study that started in 1995. The men averaged age 76 and the women 73 at that point, and 95 percent had been married for more than 20 years. Researchers tracked these couples' mental status for up to 12 years. No participants had dementia at the start.

During the follow-up years, 229 people found themselves caring for a spouse with dementia. Caregivers were six times more likely to develop dementia themselves compared with people whose spouses did not develop dementia. The researchers accounted

for differences in age, education, socioeconomic status and the presence of variants in the APOE gene that increase risk of Alzheimer's disease.

While this is the first study to look at actual dementia risk in this type of spousal caregiver, other research has documented an array of physical and mental problems associated with caregiving. These include depression, sleep problems, less exercise and an unhealthy diet, says Peter Vitaliano, a psychologist at the University of Washington School of Medicine in Seattle, writing in the same issue of the Journal of the American Geriatrics Society. All of these factors may influence dementia risk, he notes.

Some of the increased risk may be due to shared environment. The couples had been married on average for 49 years upon enrollment in the study. But what those shared environmental risk factors might be remains unknown.

"This study did not confirm or dismiss the possible association." SIEGAL SADETZKI

Life

# Deceptive cads of the savanna

Male topi antelopes will lie to keep ladies from leaving

## By Rachel Ehrenberg

As any dating woman knows, men can be dogs — but a new study suggests that antelopes might be a better fit.

Male topi antelopes resort to deception to keep a potential mate around, snorting as if there's a lion nearby when it seems she might wander off. It's the first report of outright mate deception in an animal other than *Homo sapiens*, scientists report in the July *American Naturalist*.

Some birds will feign a broken wing to lure a predator away from their nest, and there are reports of male monkeys and squirrels deceiving other males in the heat of competition. But the male antelope behavior "is the clearest example of tactical deception between mates in animals other than humans," comments Cornell University's H. Kern Reeve, an expert in the evolution of cooperation and conflict in animal societies.

Study leader Jakob Bro-Jørgensen



For longer versions of these and other

Life stories, visit www.sciencenews.org

Male topi antelopes will falsely warn of a predator to keep a female (right) nearby.

discovered the devious behavior while studying topi antelopes at the Masai Mara National Reserve in Kenya. Female antelopes are sexually receptive for one day only, and they spend that day visiting several males, munching grass and mating.

Bro-Jørgensen noticed that when a female started to wander away from a male's territory, the male would look in the direction she was headed, prick his ears and snort loudly — the same snort the antelopes use when they notice a lion, leopard or other predator approaching.

"It was quite funny — it made me laugh," says Bro-Jørgensen, an evolutionary biologist at the University of Liverpool in England. "It's such an obvious lie. Clearly there's no lion."

Suitors in nature often exaggerate their virtues. But this work documents a rare

case in which evolution favors outright lying in the mating game, Reeve says. The cost of the lie is minimal to the male; he merely snorts. But the cost to the female of ignoring the lie could be great: If there truly is a predator nearby, she's dead.

Bro-Jørgensen and colleague Wiline Pangle of Ohio State University in Columbus first observed males when they were making honest snorts. Even when alone, male antelopes snorted when a human approached, suggesting that rather than being a warning to fellow antelopes, a true snort is directed at the predator itself.

This makes sense, says Bro-Jørgensen. If they have enough of a head start, topi antelopes can outrun lions and even cheetahs. By snorting at a cat who thinks it's hidden in the grass, an antelope says, "I see you predator. Give it up."

The researchers also recorded true and false snorts and played them back to female antelopes, to see if the ladies could tell the difference. Judging by their reactions, the females couldn't tell true from false snorts. The clincher that the males were lying to get lucky came from observations of the animals in action. A male antelope secured two to three more chances at mating with a restless female if he pulled the false-snort trick. (i)



## **Argonaut casing offers lift**

After centuries of speculation, biologists have documented a way that female argonauts, which belong to a group of four species closely related to octopuses, use their delicate white shell-like cases. It turns out the animals trap air bubbles in the cases to float at a comfortable depth, Julian Finn and Mark Norman of Museum Victoria in Melbourne, Australia, report online May 19 in Proceedings of the Royal Society B. When Finn maneuvered Argonauta argo females so air escaped from their cases, the animals flailed as if to maintain their orientation and quickly jetted to the water surface. There they rocked their cases and took on air, then positioned body parts to seal in some of the air and jetted downward, leaving behind a trail of bubbles. When the argonauts stopped several meters below the surface, water pressure compressed the remaining air inside the cases enough to counteract the animals' weights, leaving the argonauts floating neutrally buoyant at a chosen depth. — Susan Milius 📵



Portion of U.S. beekeepers affected by colony collapse percent disorder, 2009–2010



Portion, on average, of total hives lost by those beekeepers

## Honeybee death suspects spotted

Colony collapse disorder linked to virus-fungus conspiracy

#### By Eva Emerson

A one-two punch by a gut parasite and viruses may help explain the mysterious decline in U.S. honeybees in recent years.

Bees infected with both the fungal parasite Nosema ceranae and with any one of a family of viruses were more likely to come from declining hives than healthy hives, researchers reported May 25.

The finding represents a new twist in a complex problem termed colony collapse disorder, which has caused severe losses for U.S. beekeepers since 2006. Over a quarter of beekeepers have been affected, according to the Apiary Inspectors of America, an industry group. These beekeepers, including honey producers as well as many who lease out their bees to

pollinate food crops, have reported losing between 30 and 90 percent of their hives.

"We think that Nosema leaves the bees more open to infection by other organisms," said bee researcher Jay Evans of the U.S. Department of Agriculture's Agricultural Research Service in Beltsville, Md., who presented the new results. "Our current thinking is that the Nosema parasite is a precursor to infectious diseases" that lead to colony collapse disorder.

That view represents a shift: In 2007, scientists discussed the role N. ceranae might play in colony collapse, but Evans and colleagues did not find a clear link between the parasite and affected hives.

Only when scientists looked at the N. ceranae pathogen, which causes "bee diarrhea" among other symptoms,

in combination with members of the Dicistroviridae family of viruses did a strong correlation show up, Evans said.

Eric Mussen, an apiculturalist at the University of California, Davis, says it's hard to tell if a virus or Nosema or some other bee stressor is the colony collapse culprit. "You find viruses in healthy colonies," he says. "But I presume that if you have a parasite it would definitely affect the bees' ability to deal with the virus. That makes sense to me." 📵



Bees may fall prey to a fungal parasite and viruses in cases of colony collapse.

## **Healing slowed** by bacteria talk

Blocking microbial signaling might help close skin wounds

#### **Bv Eva Emerson**

Chatter between bacterial cells may stall healing of skin wounds, and sabotaging that chitchat could offer another way to battle infection, new research suggests.

Making Pseudomonas aeruginosa bacteria deaf to each other's talk would offer a kind of antibiotic therapy that doesn't kill bacterial cells but rather strikes at their ability to attack human cells en masse, Jasper Jacobsen of the Statens Serum Institute in Copenhagen said May 24.

When P. aeruginosa infects human tissue, the bacteria coordinate their offensive using a method called quorum sensing. As the number of bacteria present grows, signaling molecules involved in quorum sensing build up. These signaling molecules bind to proteins encoded by two master quorum sensing genes: lasR and *rhlR*. This switches on the production of a battery of compounds secreted by the bacteria to promote infection. The two genes are also involved in the creation of a biofilm - a layered bacterial growth that is harder for the immune system to combat than free-floating microbes.

Jacobsen and colleagues compared secretions released by a normal strain of P. aeruginosa with those from a strain in which the two quorum sensing genes had been turned off. "We wanted to see whether this 'language' could impair wound healing in cells," he said.

The researchers arranged human skin cells in lab dishes with a gap in the middle to model a skin gash. Secretions from normal bacteria reduced the ability of skin cells to fill the gap (a key process in wound healing called migration) substantially more than secretions from the strain with disabled quorum sensing genes.

Most affected were cells called keratinocytes, which form the outermost layer of people's skin. In these, normal strain secretions led to substantially less cell migration - about 55 percent wound closure compared with 75 percent for the altered strain. The normal strain also decreased migration of fibroblast cells, which are abundant in the skin layer below, but to a lesser extent. Neither strain substantially affected cell growth or the migration of skin endothelial cells.

P. aeruginosa is a leading cause of opportunistic infections in people, including in burns and in wounds. A number of candidate drugs designed to target the proteins encoded by the P. aeruginosa quorum sensing genes are under study, said Pete Greenberg, a microbiologist at the University of Washington in Seattle. He said the new study is the first he is aware of that looks specifically at wound healing and quorum sensing.

"They showed it blocks wound healing, at least in a petri dish," he said. "Now they need to try to use some of the experimental inhibitors to see if that [would restore] healing." 📵

# Not just a high scientists test

Scientists test medicinal marijuana against MS, inflammation and cancer By Nathan Seppa In science's struggle to keep up with life on the streets, smoking cannabis for medical purposes stands as Exhibit A.

Medical use of cannabis has taken on momentum of its own, surging ahead of scientists' ability to measure the drug's benefits. The pace has been a little too quick for some, who see medicinal joints as a punch line, a ruse to free up access to a recreational drug.

But while the medical marijuana movement has been generating political news, some researchers have been quietly moving in new directions — testing cannabis and its derivatives against a host of diseases. The scientific literature now brims with potential uses for cannabis that extend beyond its wellknown abilities to fend off nausea and block pain in people with cancer and AIDS. Cannabis derivatives may combat multiple sclerosis, Crohn's disease and other inflammatory conditions, the new research finds. Cannabis may even kill cancerous tumors.

Many in the scientific community are now keen to see if this potential will be fulfilled, but they haven't always been. Pharmacologist Roger Pertwee of the University of Aberdeen in Scotland recalls attending scientific conferences 30 years ago, eager to present his latest findings on the therapeutic effects of cannabis. It was a hard sell.

"Our talks would be scheduled at the end of the day, and our posters would be stuck in the corner somewhere," he says. "That's all changed."

## **Underlying biology**

The long march to credibility for cannabis research has been built on molecular biology. Smoking or otherwise consuming marijuana — Latin name *Cannabis sativa* — has a medical history that dates back thousands of years. But the euphoria-inducing component of cannabis, delta-9-tetrahydrocannabinol, or THC, wasn't isolated until 1964, by biochemist Raphael Mechoulam, then of the Weizmann Institute of Science in Rehovot, Israel, and his colleagues. Within two decades, other researchers had developed synthetic THC to use in pill form.

The secrets of how THC worked in the body lay hidden until the late 1980s, when researchers working with rats found that the compound binds to a protein that pops up on the surface of nerve cells. Further tests showed that THC also hooks up with another protein found elsewhere in the body. These receptor proteins were dubbed CB1 and CB2.

A bigger revelation came in 1992: Mammals make their own compound that binds to, and switches on, the CB<sub>1</sub> receptor. Scientists named the compound anandamide. Researchers soon found its counterpart that binds mainly to the CB<sub>2</sub> receptor, calling that one 2AG, for 2-arachidonyl glycerol. The body routinely makes these compounds, called endocannabinoids, and sends them into action as needed.

"At that point, this became a very, very respectable field," says Mechoulam, now at Hebrew University of Jerusalem, who along with Pertwee and others reported the anandamide discovery in Science. "THC just mimics the effects

of these compounds in our bodies," Mechoulam says. Although the receptors are abundant, anandamide and 2AG are short-acting compounds, so their effects are fleeting.

In contrast, when a person consumes cannabis, a flood of THC molecules bind to thousands of CB<sub>1</sub> and CB<sub>2</sub> receptors, with longer-lasting effects. The binding triggers so many internal changes that, decades after the receptors' discovery, scientists are still sorting out the effects. From a biological standpoint, smoking pot to get high is like starting

up a semitruck just to listen to the radio. There's a lot more going on.

Though the psychoactive effect of THC has slowed approval for cannabisbased drugs, the high might also have brought on a serendipitous discovery, says neurologist Ethan Russo, senior

medical adviser for GW Pharmaceuticals, which is based in Porton Down, England. "How much longer would it have taken us to figure out the endocannabinoid system if cannabis didn't happen to have these unusual effects on

From a biological

standpoint.

smoking pot to

get high is like

starting up a

semitruck just to

listen to the radio.

There's a lot more

going on.

human physiology?"

#### **Beyond the pain**

Today smoked cannabis is a sanctioned selftreatment for verifiable medical conditions in 14 U.S. states, Canada, the Netherlands and Israel, among other places. It usually requires a doctor's recommendation and some paperwork.

People smoke the drug to alleviate pain, sleep easier and deal with nausea, lack of appetite and mood disorders such as anxiety, stress and depression. Patients not wanting to smoke cannabis can seek out prescriptions for FDAapproved capsules containing cannabis

Sanctioned smoking Though smoked cannabis has not been approved by the Food and Drug Administration, its use for medical purposes has been sanctioned by law in 14 states (shown in green, year given). Different states apply their own restrictions, some of which are highlighted.



compounds for treatment of some of these same problems.

Research now suggests that multiple sclerosis could join the growing list of cannabis-treated ailments. More than a dozen medical trials in the past decade have shown that treatments containing THC (and some that combine THC with another derivative called cannabidiol, or CBD) not only ease pain in MS patients but also alleviate other problems associated with the disease. MS results from damage to the fatty sheaths that insulate nerves in the brain and spinal cord.

"MS patients get burning pain in the legs and muscle stiffness and spasms that keep them awake at night," says John Zajicek, a neurologist at the Peninsula College of Medicine and Dentistry in Plymouth, England. Patients can take potent steroids and other anti-inflammatory drugs, but the effects of these medications can be inconsistent.

Pertwee has analyzed 17 trials in which MS patients received some form of cannabis or its derivatives. Reports from the patients themselves, who didn't know if they were getting real cannabinoids or a placebo in most of the trials, show improvements in muscle spasticity, sleep quality, shakiness, sense of well-being and mobility. Pertwee, who is also a consultant for GW Pharmaceuticals – which makes a cannabinoid drug that is delivered in spray form, called Sativex – reviewed the findings in *Molecular Neurobiology* in 2007.

Sativex was approved in Canada for MS in 2005 after studies (some included in Pertwee's analysis) showed its success in relieving symptoms of the disease. GW Pharmaceuticals expects clearance for MS treatment in the United Kingdom and Spain this year. Later, the company plans to seek U.S. approval of Sativex for cancer pain.

Zajicek's team has also compared MS patients who received a placebo with patients receiving either a capsule containing THC or one with THC and CBD. Both of the cannabis-based drugs outperformed a placebo, and the researchers are now working on a multiyear MS trial.

Calming symptoms such as muscle spasticity and pain is useful, Zajicek says, but the true value of cannabinoids may exceed that. "To me, the really exciting stuff is whether these drugs have a much more fundamental role in changing the course of MS over the longer term," he says. "We've got nothing that actually slows progression of the disease."

#### **Fighting inflammation**

CBD, the same cannabis component that proved beneficial alongside THC for MS, may also work on other hard-to-treat

**Expanding its reach** Scientists are investigating cannabinoids' potential against previously unconsidered medical problems—including inflammation, Crohn's disease and MS (shown below).



diseases. Tests on cell cultures and lab animals have revealed that CBD fights inflammation and mitigates the psychoactive effects of THC.

Crohn's disease, which can lead to chronic pain, diarrhea and ulcerations, could be a fitting target for CBD. In Crohn's disease, inflammatory proteins damage the intestinal lining, causing leaks that allow bacteria in the gut to spread where they shouldn't. This spread leads to a vicious cycle that can trigger more inflammation.

Karen Wright, a pharmacologist at Lancaster University in England, and her colleagues have found that CBD inhibits this inflammation and can reverse the microscopic intestinal leakiness in lab tests of human cells. Adding THC doesn't seem to boost the benefit, Wright reported in December 2009 in London at a meeting of the British Pharmacological Society. The results bolster earlier findings by Wright's team showing that cannabinoids could improve wound healing in intestinal cells.

CBD's anti-inflammatory effect may work, at least in some cases, through its antioxidant properties — the ability to soak up highly reactive molecules called free radicals, which cause cell damage.

In the brain and eye, CBD slows the action of microglia, immune cells that can foster harmful inflammation when hyperactivated by free radicals. Working with rats whose retinas were induced to have inflammation, biochemist Gregory Liou of the Medical College of Georgia in Augusta and his team found that CBD neutralized free radicals, preventing eye damage. This finding could have implications for people with diabetes who develop vision loss.

Apart from being an anti-inflammatory and antioxidant, CBD tones down the psychoactive effect of THC without eliminating its medical properties. CBD also mutes the occasional anxiety and even paranoia that THC can induce. This has been welcome news to scientists, who consider the "buzz" of cannabis little more than psychoactive baggage.

But CBD has paid a price for this antiupper effect. "CBD has essentially been



## Cancers with documented sensitivity to cannabinoids

Tumor type	Effect
Lung carcinoma	Decreased tumor size, less cell proliferation
Glioma	Decreased tumor size, programmed cell death
Thyroid epithelioma	Decreased tumor size, less cell proliferation
Lymphoma/leukemia	Decreased tumor size, programmed cell death
Skin carcinoma	Decreased tumor size, programmed cell death
Uterus carcinoma	Less cell proliferation
Breast carcinoma	Less cell proliferation
Prostate carcinoma	Programmed cell death
Neuroblastoma	Programmed cell death

SOURCE: GUZMÁN/NATURE REVIEWS 2003

**Tumor suppression** In patients with aggressive brain tumors, THC seems to knock down MMP-2 (green in images above left), an enzyme that facilitates cancer's spread by breaking down tissues. Cannabinoids also affect other cancer cells in rodents and in lab-dish experiments (see table).

bred out of North American black market drug strains," Russo says. People growing cannabis for its recreational qualities have preferred plants high in THC, so people lighting up for medical purposes, whether to boost appetite in AIDS patients or alleviate cancer pain, may be missing a valuable cannabis component.

## **Cannabis versus cancer**

With or without CBD, cannabis may someday do more for cancer patients than relieve pain and nausea. New research suggests THC may be lethal to tumors themselves.

Biochemists Guillermo Velasco and Manuel Guzmán of Complutense University in Madrid have spent more than a decade establishing in lab-dish and animal tests that THC can kill cancer of the brain, skin and pancreas.

THC ignites programmed suicide in some cancerous cells, the researchers reported in 2009 in the *Journal of Clinical Investigation*. The team's previous work showed that THC sabotages the process by which a tumor hastily forms a netting of blood vessels to nourish itself, and also keeps cancer cells from moving around. THC achieves this wizardry by binding to protein receptors on a cancerous cell's surface. Once attached, the THC induces the cell to make a fatty substance called ceramide, which prompts the cell to start devouring itself. "We see programmed cell death," Velasco says. What's more, noncancerous cells don't make ceramide when they come into contact with THC. The healthy cells don't die.

Many compounds kill cancer in a test tube and even in animals, but most prove useless because they cause side effects or just don't work in people. The Madrid team is now seeking funding to test whether cannabis derivatives can kill tumors in cancer patients. In an early trial of nine brain cancer patients whose disease had worsened despite standard therapy, the scientists found that THC injections into tumors were safe to give.

Early reports from other research groups suggest that THC also fights breast cancer and leukemia. "I think the cancer research is extremely promising," Russo says. "Heretofore, the model for cancer was to use an agent that's extremely toxic to kill the cancer before it kills you. With cannabinoids, we have an opportunity to use agents that are selectively toxic to cancer cells."

## Looking ahead

Testing of cannabis and its derivatives has also begun on type 1 diabetes, rheumatoid arthritis, stroke, Tourette syndrome, epilepsy, depression, bipolar disorder and schizophrenia. Pertwee is particularly optimistic that cannabis will help people with post-traumatic stress disorder. Experiments in rats show that THC "speeds up the rate at which the animals forget unpleasant experiences," he says. And a recent study in people with PTSD showed that THC capsules improved sleep and stopped nightmares.

Despite these heady beginnings, medical cannabis still faces an uphill climb. Although some states have sanctioned its use, no smoked substance has ever been formally approved as a medicine by U.S. regulatory agencies. Smoking cannabis can lead to chronic coughing and bronchitis, and smoking renders a drug off-limits for children, Mechoulam notes.

THC pills don't have these downsides, but the drugs have received only lukewarm acceptance. Despite smoking's drawbacks, "it is seen as better because you can regulate the amount of THC you're getting by not puffing as much," says pharmacologist Daniele Piomelli of the University of California, Irvine. Capsules can cause dizziness and make it hard to focus. "Patients suffering from neuropathic pain or depression don't want to be stoned — they want relief," he says.

Controlled, randomized trials that seek to clarify whether smoked cannabis delivers on its medical promise — with acceptable side effects — have been hard to come by. But scientists in California have recently concluded several studies in which patients with severe pain received actual cannabis cigarettes or cannabis cigarettes with the cannabinoids removed.

In one trial, researchers randomly assigned 27 HIV patients to get the real thing and 28 to get fake joints. All the patients had neuropathic pain, in which neurons can overreact to even mild stimuli. About half of the people getting real cannabis experienced a pain reduction of 30 percent or greater, a standard benchmark in pain measurement. Only one-quarter of volunteers getting the placebo reported such a reduction.

"That's about as good [a reduction] as other drugs provide," says Igor Grant, a neuropsychiatrist at the University of California, San Diego, who is among the scientists overseeing the trials.

While such studies provide evidence that smoked marijuana has medical benefits, future trials are more likely to explore the benefits of cannabis derivatives that don't carry the baggage that smoking does.

Ultimately, the fate of medical cannabis and its derivatives will rest on the same make-or-break requirements that every experimental medicine faces — whether it cures a disease or alleviates its symptoms, and whether it's tolerable.

"We have to be careful that marijuana isn't seen as a panacea that will help everybody," Grant says. "It probably has a niche.... We can't ignore the fact that cannabis is a substance of abuse in some people." ■

#### **Explore more**

 A. Hazekamp and F. Grotenhermen.
"Review on clinical studies with cannabis and cannabinoids
2005–2009." Cannabinoids. 2010.

## **Getting cannabis in**

When most people think of medicinal cannabis, smoking comes to mind. Though smoking works quickly and allows users to regulate their intake, it's hardly a scientific approach: Cannabis quality is often unknown, and inhaling burned materials is bad for the lungs. These and other drawbacks have spawned new ways to consume medical marijuana.

Some people inhale cannabis by using a device that heats the plant without igniting it. This vaporization unleashes many of the same cannabinoid compounds as smoking does, without the combustion by-products, researchers say. Anecdotally, patients report that the effect is prompt, on a par with smoking.

Because cannabis derivatives can pass through the lining of the mouth and throat, a company called GW Pharmaceuticals has devised a spray product called Sativex. This drug contains roughly equal amounts of two key cannabinoids—THC and CBD—plus other cannabis components in an alcohol solution. A dose of Sativex is sprayed under the tongue; no smoking required.

In the face of these options, the "pot pill" seems almost passé. But capsules of synthetic THC exist. One called Marinol has been approved in the United States since 1985, and another called Cesamet was cleared more recently. Doctors can prescribe the drugs for nausea, vomiting, loss of appetite and weight loss. Though sales of capsules have increased recently, many users complain of psychoactive side effects and slow action. — Nathan Seppa

Name of drug	Ingredients/ delivery	Where approved	Uses	Drawbacks (partial list)
Marinol (dronabinol)	THC/capsule	United States, Canada	Nausea, weight loss, appetite stimu- lant	Needs to be swallowed, slow to act, psychoactive effects
Cesamet (nabilone)	THC/capsule	United States, Canada, United Kingdom	Nausea, weight loss, appetite stimu- lant	Needs to be swallowed, slow to act, psychoactive effects
Sativex	THC, CBD and other cannabi- noids/spray	Canada	Cancer pain, multiple sclerosis	Contains alcohol that can irritate the mouth
Cannador	THC and CBD/ capsule	Not approved	Tested against multiple sclerosis and other diseases	Needs to be swallowed, slow to act
Cannabis, hashish, marijuana	THC and 60-plus other cannabinoids/ typically smoked or heated into a vapor and then inhaled	Not approved as a drug but sanctioned for medical use in 14 U.S. states, Canada, the Netherlands, Israel	Nausea, appe- tite stimulant, pain, anxiety, depression and other ail- ments	Lung irritation from smoke, variable dos- ing, psycho- active effects, increased heart rate, decreased blood pressure

## Medical marijuana's various forms

## The Luxury Revolution. 5 Carats of Rubies FREE

Why would a jewelry company give away a pair of 5-Carat Genuine Ruby Earrings? We have a really good reason...

You pay too much for jewelry. Way too much. But you don't have to. Not any more. Stauer has changed the rules and launched a luxury revolution. But talk is cheap. I want you to see for yourself. That's why I'm giving away this stunning pair of **5-Carat Ruby Drop Earrings** for FREE. Five full carats of the world's most passionate precious gemstone... our gift to you. That's a \$195 value for <u>FREE</u>!

We're doing things to fine jewelry prices that have never been done before. It's no secret that high-end retailers aren't exactly thrilled with our offers. But we're not out to please them. Stauer is addicted to making you happy. We can't help ourselves. But today you can.

## Why 100% Off Makes Sense

**Why would any jeweler give away FREE ruby earrings?** Because we don't thrive as a company by selling you only one pair of earrings. Our mission at Stauer is to revolutionize the jewelry business and change the way you think about luxury. It doesn't have to cost a fortune. Maybe you always assumed that the gift of jewelry was something you could only afford once or twice a year. You were probably right, but that's only because you were shopping in the wrong place. There's a better way to buy. *And we can prove it.* 



I spend my year circling the globe in search of the best prices on the rarest stones. When I buy, I buy big. Last year Stauer was among the largest buyers of carat-weight emeralds in the world and we're on track to do the same with rubies. Because we don't have to worry about retail costs or celebrity endorsements, we can afford to get a little creative. And we must be doing something right, because last year, our business was up 38% while

the economy suffered and fellow jewelers struggled. But don't take our word for it. Ask our satisfied customers who have helped us earn a rare <u>A+ rating from the Better Business Bureau</u>.

## Reserve Your Rubies Today

**Seeing is believing.** All the words in the world can't do the job of 5 carats of ravishing ruby up close. Each of your Ruby Drop Earrings feature three faceted teardrops of genuine ruby, bezel-set in 14K gold-fused sterling silver. Each gem has been gently color-enhanced to coax out the richest reds of the world's most passionate stone. Each drop is connected with golden links, allowing for maximum swing and sparkle. The earrings attach with swooping French hooks.

"I wasn't just impressed... I was floored. Absolutely beautiful."

— Praise for Stauer Rubies from I.R. in California

**Introducing "Better Than FREE" Shipping.** Call today to reserve your FREE pair of **5-Carat Ruby Drop Earrings** (you only pay a shipping & processing fee of \$19.95). Of course, if I had my way, we'd ship them to you at no charge. Unfortunately, the rising cost of gas and freight makes that impossible. But what I can do is send you a bonus to make up the difference. That's right, order today and I'll include a **\$20 Stauer Gift Coupon** with your FREE Earrings, than makes this **Better Than Free**! Due to its outrageous nature, this offer is *strictly limited to one pair per shipping address*. Viva la Luxury Revolution!

## **IEWELRY SPECS:**

- 14K gold-fused wire - 5 carats of genuine rubies - 2" in length

Ruby Drop Earrings (5 ctw) \$195 <u>Your Cost</u> FREE — pay shipping & processing only. Ruby Drop Necklace (20 ctw) \$129+ S&P

**Ruby Drop Necklace** and <u>Bracelet</u> (30 ctw) **\$129**+ S&P Call now to take advantage of this extremely limited offer.



Please mention this code when you call.





Smart Luxuries—Surprising Prices

# Meiting at the microscale

## Studying sea ice close-up may improve climate models By Alexandra Witze

arth's northern polar cap is disappearing at unprecedented rates. To understand why, researchers are getting up close and personal with ice.

Using satellites, scientists get a broad perspective on how the skin of sea ice atop the Arctic Ocean shrinks, on average, just a little bit more every summer. But zooming down to within a few meters of the surface brings some important little things into view. In particular, "microphysical" properties of the ice, such as how salty water percolates through it, turn out to play a surprising role in ice behavior.

Yet most models of melting don't incorporate information about sea ice microphysics. So some researchers are pushing to learn more about the ice's physical properties and to include the findings in next-generation analyses. "It's clear that we need to do better in terms of understanding and predicting the fate of the polar ice cap," says Kenneth Golden, a mathematician at the University of Utah in Salt Lake City who studies sea ice. "Monitoring transport processes in the sea ice is critical for understanding climate change." New studies of ice microphysics at both poles may help. Already, measurements taken from an icebreaker in Antarctica are illuminating how the flow of salt water — called brine — affects the electrical conductivity of sea ice. Computer models are exploring how algae and other living creatures influence its physical properties. And studies off the coast of Alaska are quantifying how meltwater can pool atop the ice or drain through it, changing how much heat from the sun the ice reflects or absorbs.

Studying sea ice microphysics is challenging, in part because of the sheer complexity of the material. Unlike the freshwater ice found in glaciers or lakes, sea ice is a complicated mix of pure ice, brine, air and solid salts. How those materials are distributed within the ice changes constantly as temperature, salinity and other factors rise and fall.

"We haven't tackled these complexities in modeling the ice cover, but I think we're at a place where we can make a lot of progress," says Marika Holland, a climate modeler at the National Center for Atmospheric Research in Boulder, Colo.

The work could eventually have practical implications for those who monitor changing sea ice conditions, such as native communities relying on ice for hunting walrus or shipping companies wanting to know when they can send freight through an ice-free Northwest Passage.

The alarming rate at which the Arctic ice cap is shrinking is triggering much of the new research. Since 1979, the amount of ice covering the Arctic Ocean in September, at the end of the melt season, has dropped more than 11 percent per decade. In 2007 Arctic ice reached its smallest minimum ever observed, at about 4.2 million square kilometers — a level scientists call "shocking" (*SN*: 10/13/07, p. 238). The two summers since then have both seen a larger September ice cap, but the longterm trend of decline is unmistakable, Holland says.

In the Southern Hemisphere, the sea ice pack that rings Antarctica has not shown a similar decline, perhaps because of the anchoring land mass at the center. Still, the basic principles governing sea ice physics are the same in both north and south.

## **Inner-ice flows**

Golden's studies aboard Antarctic icebreakers have led to new insights into ice microstructure (*SN: 8/12/00, p. 106*). In the mid-1990s, he reported finding an "on/off" switch that controls permeability in sea ice — that is, how the salty water



lying under and around a floating piece of ice can begin to circulate into it.

Assuming the fraction of sea ice made up of brine is about 5 percent, below temperatures of about  $-5^{\circ}$  Celsius, the brine cannot percolate up through the ice. Above that critical temperature, though, the fluid begins to flow, an observation Golden dubbed the "rule of fives." The warmer it gets, the more permeable the ice becomes. Fluid flow picks up, with pockets of brine connecting and forming channels. Because salt lowers the melting point of ice, the amount of brine influences when ice starts melting in the summer and freezing again in the winter.

More recently, Golden and colleagues have studied pack ice off the coast of East Antarctica. Salt water contains ions, or charged particles, of elements such as sodium and chlorine, and the presence of those ions means that electricity conducts more readily through salt water than through freshwater. Golden's team has used electrical conductivity as a sort of proxy for studying brine's flow. In a paper now under review, the scientists report working out the mathematics of the electrical conductivity of sea ice off Antarctica. Further calculations building on the field observations, the team writes, "lay Climate models predict declines in Arctic sea ice (above), but rarely do such calculations consider what happens at the ice-water interface (far left).

the groundwork for relating the fluid and electrical properties of sea ice."

Observations in the Arctic support this relationship between fluid and electrical properties. Hajo Eicken, a sea ice specialist at the University of Alaska Fairbanks, has been working for years in the young "landfast" ice that abuts the shore off Barrow, Alaska. He and his colleagues have shown how ice microstructure changes over the course of

A history of loss On average, the Arctic ice cap has been shrinking since satellite observations began three decades ago. Overall ice extent at the end of the melt season, in September, has shrunk, bottoming out in an all-time low in 2007 (graph). Though 2009 saw an increase over 2007, the ice extent was still well below the 1979–2000 average. Much of the thicker, older ice has also disappeared over time (maps).



a season, such as during the spring warming. At the start of the season, when temperatures are still quite cold, electricity appears to flow upward from the ice-water interface. But electricity doesn't start to flow laterally until temperatures warm up and, presumably, permit brine pockets to connect horizontally as well as vertically.

#### **Sloshing and pooling**

Such discoveries can help explain the behavior of another key player in the sea ice regime: life. Fluid within sea ice sustains a large community of organisms, including algae, bacteria and worms.

Ice algae in particular are a major component of the Arctic's marine food web. They endure harsh winters in the nooks and crannies of sea ice, and when temperatures rise in spring, the life expands rapidly throughout the ice's lower layers. When the ice melts completely, it releases algae into the ocean, where plankton and other creatures feed on the photosynthetic organisms in a massive bloom of biological activity.

The presence of algae alters sea ice in a number of ways, such as producing chemicals that can depress the freezing temperature of ice, or darkening the ice so that it absorbs more sunlight. Yet the interplay has hardly been studied, in part because biologists and physicists rarely mix. "All our global climate models are missing this physics," says Cecilia Bitz, a modeler at the University of Washington in Seattle.

Bitz is trying to change that, and in preliminary work she has modeled in one dimension how fluid flow affects algae within sea ice. Much work remains to be done, and one of the biggest challenges is modeling convective flow within the ice structure, she reported in February in San Diego at a meeting of the American Association for the Advancement of Science. Still, such

studies could eventually illuminate how life affects the microphysics of sea ice all year, including during the melt season.

Melting ice also plays another important role in the ecosystem – changing the albedo, or reflectiveness, of the ice surface. This "ice albedo effect" is

**Life at the boundary** An array of critters, not just the iconic polar bear, make their homes in and on the sea ice. Crustaceans, worms, bacteria and algae reside within the brine channels that form in the sea ice, as depicted below. During the spring and summer especially, algae concentrate in the ice's lower layers, pooling organic material there. These organisms are known to sculpt their habitats, and though much research still needs to be done, scientists suspect that such residents may have an important effect on yearly changes in sea ice extent.







**Salty meet up** Computer renderings of a lab-grown sea ice crystal show how brine pockets (gold) connect to form channels as temperatures increase from  $-15^{\circ}$  Celsius (top) to  $-6^{\circ}$  C (middle) to  $-3^{\circ}$  C (bottom). The amount of brine flowing through the ice can affect melting and freezing rates.

one of the great unknowns in climate physics, as researchers struggle to understand what causes the ice surface to change its reflectivity (*SN: 11/12/05, p. 312*). Pure ice, like a white rooftop, reflects nearly all sunlight back into space. Open water, like an expanse of asphalt, absorbs much more radiation and hence heats up quickly. Melt ponds atop the sea ice are somewhere in between – darker tlighter than water

than ice but lighter than water.

"There's not a simple binary system of snow-covered ice and open water," Donald Perovich, a sea ice specialist at the U.S. Army Cold Regions Research and Engineering Laboratory in Hanover, N.H., said at the AAAS meeting. "There's a mosaic of ice and melt ponds and open ocean."

How melt ponds form and spread is, of course, controlled by the microphysics of the sea ice — in particular its permeability, or how readily fluid can move within it. Once the summer melt season starts, ponds can appear and disappear within a matter of days, changing rapidly in size. Each one alters the albedo of the ice cap, and even small changes in albedo can have a big impact on how ice survives the melt season.

As part of the studies off Barrow, Eicken and colleagues have been monitoring how melt ponds and their albedos evolve over time. Much, it turns out, depends on the type and age of ice involved. For instance, on first-year ice – frozen over just one winter – meltwater pools to about 2 or 3 centimeters thick, says Eicken. But on multiyear ice – which has piled up year after year without melting away in the summer — meltwater ponds are only about 1 centimeter deep, meaning they are lighter than the ponds on younger ice. "Is there something we're missing about the permeability structure that allows water to pool in first-year ice?" asks Eicken.

For now, the answer seems to be maybe. One way to make progress on such questions may be to once again pull back on perspective, leaving the world of ice microphysics and zooming out to a full view of the ice cap.

Here, too, researchers have much to do. In particular, scientists lament the lack of regular measurements of ice thickness across the Arctic ice cap. Such observations can help distinguish between thinner first-year ice and thicker multiyear ice, which behave very differently from each other. But there are few options for obtaining this data reliably.

NASA's ICESat mission gauged ice thickness by bouncing a laser beam off the surface of the snow and measuring the time it took to return. But ICESat ceased operations last fall after six years, and its replacement is not due to fly until at least 2015. The European Space Agency's newly launched CryoSat-2 mission is taking up some of the slack with its own radar altimeter instrument. NASA is also flying research airplanes in the IceBridge mission over some regions of the Arctic.

Pulling all these views together will give polar scientists a much fuller picture of the sea ice situation. And all will be looking to see what this year's summer melt season brings, to forecast how much time they may have left to study the ice at all.

## Explore more

- K.M. Golden. "Climate change and the mathematics of transport in sea ice." Notices of the American Mathematical Society. May 2009.
- National Snow and Ice Data Center's page on Arctic sea ice: nsidc.org/ arcticseaicenews/
- Sea ice outlook: www.arcus.org/ search/seaiceoutlook/



Each September, polar scientists get the number they've been betting on all summer: how small the Arctic ice cap will get that year.

At the end of the summer melt season, sea ice covers only a fraction of the Arctic Ocean compared with the ice's winter reach. In September 2007 ice reached a record low, covering about 4.2 million square kilometers—about 23 percent less than the previous record minimum, in 2005. Few researchers had seen the 2007 record low coming.

So in 2008, scientists began putting together predictions for what the upcoming summer might bring. International teams of researchers submit to a central organizer their "outlooks," which include a number—how small they expect the Arctic ice cap to get that year—and a rationale for that number. Reports are due by June and updated monthly throughout the summer to incorporate information about changing ice conditions. This June will mark the third annual effort.

So far, the project has primarily shown how hard it is to predict sea ice cover. Many factors determine how much ice exists from year to year, from oceanic heating patterns to wind and water conditions that can either pile up ice into sturdy blocks or break it apart and flush it out of the Arctic Ocean basin.

For instance, all of the project teams underestimated how much ice would remain in September 2009. The median estimate was 4.6 million square kilometers, but the final number was 5.36 million square kilometers, in large part because of weather patterns in August and September that kept things chilly across large parts of the basin.

This spring, Arctic sea ice reached its maximum on March 31 (above), the latest date recorded for a maximum since satellite measurements began in 1979. The late maximum probably won't affect the September minimum much, since most of that ice is thin first-year ice on the southern fringes that will melt away quickly once temperatures rise, says Arctic expert Walt Meier of the National Snow and Ice Data Center in Boulder, Colo. "What really is key is how much of the thick ice we have," he says. "We have more thick ice than we did the last couple of years at this point." As of late May his team's predictions for the 2010 minimum had not been released publicly, but Meier says that this year's ice might look similar to that in 2009—not the dramatic low seen in 2007.

Marika Holland, a climate modeler at the National Center for Atmospheric Research in Boulder, likens the forecasting exercise to the early days of predicting the El Niño climate pattern. Unreliable decades ago, El Niño predictions have improved to the point that today planners use them regularly.

The Arctic outlook project hopes one day to have similarly useful forecasts for sea ice. In the meantime, the project has started issuing a much smaller-scale forecast for regional use. The new "walrus outlook" predicts coastal sea ice patterns for the upcoming week, for use by native hunters. *—Alexandra Witze* 

# Law & Disorcer

## Physicists keep trying to explain why time flows one way

## By Tom Siegfried

n a famous passage from his 1938 book *The Realm of Truth*, the Spanish-American philosopher George Santayana compared time to a flame running along a fuse. The flame's position marked the present moment, speeding forward but never backward as the fuse disappeared behind it. "The essence of nowness," Santayana remarked, "runs like fire along the fuse of time." Each spark along the fuse represents one of the "nows" that transform the future into the past and "combine perfectly to form the unchangeable truth of history."

It's far from a perfect analogy. A flame flitting along a wire doesn't fully capture the quirky features of time that perplex physicists pondering relativity and quantum mechanics, for example. But Santayana's sparks do illustrate one of time's most enduring and puzzling properties — its irreversibility.

Time always, always marches forward into the future. You can travel into the future just by breathing, but the past is accessible only in memories and other records. Time flies in one direction — like an arrow — and never makes a U-turn. Popcorn never unpops, eggs never unscramble and you can't put an exploded stick of dynamite back together again.

"This difference between the past and the future shows up in physics, it shows up in philosophy, it shows up in biology and psychology and all these different things," says theoretical physicist Sean Carroll of Caltech. "The arrow of time absolutely pervades the way that we think about the universe."

But peculiarly, the physical laws governing the universe do not recognize this temporal imperative. Equations describing the forces that guide matter in motion work just as well going backward in time as forward. A microworld video of bouncing molecules would need time stamps to distinguish forward from reverse — on a molecular scale, time has no direction. In the big world of bouncing basketballs, though, the clock is always running, and its hands never reverse the direction of their rotation.

For more than a century, the emergence of time's arrow from time-blind laws of nature has confused physicists and philosophers alike. And even though it seems that more solutions for this mystery have been proposed than apps for the iPhone, new attempts at explanation continue to appear as regularly as clockwork. Some of the latest proposals suggest that time's mystery may be an essential subplot in an even grander drama involving the origin of the cosmos itself.

## Time gets messy

Although there's no complete agreement on the precise source of time's arrow, most experts concur that it has something to do with entropy, the ever-increasing disorder of things required by the second law of thermodynamics. As time goes by, disorder increases (or at least stays the same) in any system isolated from external influences.

Sadly, though, explaining time's arrow by appeal to the second law alone doesn't solve the puzzle. Sure, rising entropy defines a direction of time, but only until everything is in a state of equilibrium — in technical terms, all messed up. And as the Austrian physicist Ludwig Boltzmann explained in the 19th century, "all messed up" is by far the most probable way for things to be. It should be an enormously lucky break, like drawing a royal flush on every hand in an all-night poker game, for the entropy of the universe to be perceptibly less than the maximum amount possible. So by all odds, everything should already be all messed up — and there should therefore be no arrow of time.

But that's not the way the universe is. As messy as things are, they aren't as messy as they could be, and so the fuse of cosmic time can continue to burn. In other words, entropy in the universe was low enough in the past to have plenty of room to keep getting higher, and it is that quest toward disarray that drives time's arrow in its singular direction. Explain-

ing time's arrow requires not only the second law, then, but also some reason why entropy used to be so much lower — specifically, why it was low when the universal clock began ticking with the lighting of the cosmic fuse in the Big Bang.

"Trying to understand why you can mix cream into coffee but not unmix them takes us back to the Big Bang, takes us back to questions of the origin of our observable universe," Carroll said in February in San Diego at the annual meeting of the American Association for the Advancement of Science.

#### **Before the Bang**

From the instant of the Big Bang, about 13.7 billion years ago, space has been expanding. Invoking this expansion to explain the flow of time in daily life has become a standard strategy for solving time's mystery. That approach dates to half a century ago, when astronomer Thomas Gold was apparently the first to link the thermodynamic arrow of time defined by the second law to the cosmic arrow defined by the Big Bang–induced expansion.

In various forms, this approach argues that expanding space allows entropy to increase however low or high it started. Even if entropy starts high, expansion permits it to grow even higher. Consequently it continues to rise, and the universal clock keeps on ticking.

Carroll, though, in his new book *From Eternity to Here*, points out (as others have before him) that this solution simply assumes the existence of time's direction without explaining it (see Page 30). Basically it just defines the Big Bang as a point in the "past" from which time flows in one direction. That scenario does not preserve the parity between the two time directions found in the universe's basic equations. Finding a complete explanation, Carroll proposes, will require reaching even farther back into time, to before the Big Bang.

"You often hear cosmologists say that the Big Bang is the moment when space and time began, there's no such thing as before the Big Bang," Carroll said at the AAAS meeting. "The truth is the Big Bang is the moment where our understanding ends. We don't know what happened before the Big Bang, but it's absolutely possible that something did."

In fact, many cosmologists today seriously study the possibility that all sorts of things happened before the Big Bang,



Some theories propose that the known universe is just a baby bubble of spacetime that budded off a preexisting space. Other baby universes might have formed the same way, but some with time flowing in the opposite direction, preserving time symmetry for the entire cosmos. and that the universe it created is just one among a multitude of distinct spacetime bubbles, coating the surface of eternity like the froth on a mug of beer (SN: 6/6/09, p. 26). This complex "multiverse" could contain countless individual universes, each born in a Big Bang of its own in the form of a baby bubble that then severed the umbilical wormhole linking it to a primordial emptiness.

That emptiness, Carroll suggests, would be a high-entropy environment technically known as de Sitter space. "Empty," however, does not convey a precisely correct description. Because of quantum physics – specifically, the Heisenberg uncertainty principle - an utterly empty space is impermissible. Fluctuations of energy are unavoidable, and on rare occasion one such fluctuation will be huge enough to burst a whole new spacetime bubble into existence - a baby universe. That baby could expand into just the sort of thing that human physicists see in the one bubble they can examine from within.

"Every so often a fluctuation will make a little dollop of universe here,

dominated by energy that makes it expand really, really fast," Carroll explained. "That energy can stick around for a while before it turns into ordinary matter and radiation, and the whole scenario would look just like our Big Bang."

In this way, the high-entropy empty spacetime that existed before the Big Bang can always increase its entropy even more — by giving birth to a baby universe. Although the baby would have low entropy, the total entropy of the system (mother de Sitter space plus baby) would be higher, preserving the second law. After pinching itself away from the mother space, the low-entropy baby will expand and the second law will drive a direction of time as the baby's entropy rises. Eventually, the baby universe's entropy will reach a maximum, becoming just like its timeless de Sitter space parent. And then it could give birth to baby universes of its own.

"As time evolves, you pop universes into existence – a baby universe comes into existence, expands and cools, and for a moment, there's an arrow of time," Carroll said. "The moment is several trillion years."

Best of all, that scenario can happen in both directions of time, because de Sitter space can spawn many spacetime

bubbles. Any one bubble has an arrow of time going in only one direction, but another bubble's arrow could point the opposite way. Overall, time symmetry would be preserved.

Occupants of any given bubble would always believe the Big Bang creating their bubble was in their past. From the view of a superobserver outside of it all, though, it would be clear that time moves in both directions, just as the laws of physics always indicated.

"The point is that the whole shebang, the whole multiverse, is symmetric with respect to time overall," Carroll said.

## **Beyond the law**

He cautions that this idea is just a proposal; rigorous proof awaits considerable progress in cosmologists' calculational prowess. And it is only one of many ideas for reconciling

timeless physical laws with time's directional arrow. Physicist Lorenzo Maccone of MIT, for instance, points out that the second law actually does allow both directions of time. But anything happening in the reverse direction would leave no trace, no record or even a memory. (If you scrambled some eggs and then time reversed itself, not only would the eggs unscramble, but the nerve cells in your brain would be restored to their previous condition, wiping out your knowledge of the original scrambling.) So if time did flow backward, nobody would be aware of it anyway, Maccone proposed in a paper published last year in *Physical Review Letters*.

Still, even this approach, Maccone has acknowledged, does not explain why the level of entropy in what scientists perceive to be the past started out so much lower than what the entropy is today.

To add yet another complication, solutions to time's riddle invoking the second law of thermodynamics might depend on the validity of the second law itself. Explaining time with the aid of the second law might not work so well if that law turns out to be wrong.

It is widely considered unforgivable heresy to doubt the second law, thanks in part to a famous passage declaring its infallibility by the British astrophysicist Sir Arthur Eddington (who, incidentally, coined the phrase "the arrow of time"). Nevertheless, in recent years the second law has been challenged as vigorously as health care reform and Arizona's anti-immigration legislation.

In his 2002 book *A New Kind of Science*, for instance, mathematician Stephen Wolfram cited computer simulations that he claimed were evidence that the second law is simply wrong. Others have sought loopholes in the law by examining various scenarios, especially where quantum effects come into play.

"Over the last 10-15 years an unparalleled number of chal-

lenges has been proposed against the status of the Second Law of Thermodynamics," Italian physicist Germano D'Abramo notes in a recent issue of *Physics Letters A*. During that time, more than 50 such papers have appeared in the refereed literature, he writes.

But regardless of the second law's ultimate fate, to all appearances time's fuse continues to burn in one direction, and considerable expenditure of scientific effort continues in an attempt to explain it. Considering all the time that has passed without a foolproof solution, it seems highly likely that some pieces of the time-direction puzzle remain missing. And that's not so shocking. Physics has, to put it bluntly, failed in its efforts to explain several serious mysteries despite decades of effort.

ANTHONY LEGGETTdecades of effort.<br/>In the 20th century, the great scientificPhysi-<br/>revolutions of relativity theory and quantum mechanics<br/>opened enormous windows into the intricate inner workings<br/>of nature. But many of the deepest questions still remain<br/>unanswered. What is the universe mostly made of? A type of<br/>matter of unknown identity plus an equally mysterious form<br/>of energy present in all space with an unexplainable level<br/>of density. Are the large-scale laws (basically gravity) ulti-<br/>mately incompatible with the quantum laws of the micro-<br/>world? Nobody wants to believe that, but efforts to combine<br/>gravity and quantum physics never quite succeed.

Simmering in these issues is a sense among some scientists that the 21st century will produce another revolution of Einsteinian magnitude — it's just a matter of time. And some suggest that solving the mystery of time's arrow might require (or enable) such a revolution. Among this group is Nobel laureate Anthony Leggett, a University of Illinois physicist who spoke at the AAAS meeting.

"If and when we get a really, really major revolution," Leggett says, "comparable to relativity say, or quantum mechanics, sometime in the next few decades in physics, then a large ingredient in that revolution will be radical revision of our ideas about the arrow of time." ■

#### Explore more

"If and when we

get a really, really

major revolution,

comparable to

relativity say,

or quantum

mechanics ... then

a large ingredient

in that revolution

will be radical

revision of our

ideas about the

arrow of time."

■ For more resources about how physicists and philosophers understand time, visit www.sciencenews.org/arrowoftime



# **SOON TO BE EXTINCT!**

More than 33% of the last Silver Tigers are gone. Don't miss your chance to own one.

It's the newest (and last) in a series of 12 Chinese Zodiac Silver Dollars from Australia.

Each 2010 Tiger contains one Troy ounce of 99.9% silver, and features an image of the world's largest cat in stunning, shimmering relief.

We're an official distributor for Australian Tiger Silver Dollars. We bring these Silver Tigers to you at our best direct-from-the-mint price.

And that's a big savings. In fact, you can get these 2010 Silver Tigers at up to **39% off** what they're selling for elsewhere.

Don't wait. Expect a complete and rapid sell out.

## Buy more and you save even more!

- One 2010 Australia Tiger Silver Dollar for \$38.95 + s/h
- 3-4 for only \$36.95 each + s/h
- 5 or more for only \$31.95 each + s/h Save \$7 each Includes 30 Day Money-Back Guarantee

Toll-Free 24 hours a day



Offer Code YTD110. Please mention this code when you call.



14101 Southcross Drive W., Dept. YTD110, Burnsville, Minnesota 55337 www.GovMint.com

Prices and availability subject to change without notice. Note: GovMint.com is a private distributor of worldwide government coin issues and is not affiliated with the United States government. Facts and figures were deemed accurate as of February 2010. GovMint.com, 2010



## From Eternity to Here: The Quest for the Ultimate Theory of Time Sean Carroll

Scientists have never been able to clearly explain why the laws of physics, on paper, work equally well forward or backward in time (see essay on Page 26) yet real life offers only a one-way street into the future. Innumerable books have been written about the conundrum of time's direction, or "arrow," but none



have succeeded in answering the question to everyone's satisfaction. So now there's another one.

Caltech physicist Sean Carroll's articulate exposition avoids any preten-

sion of solving the problem. Instead, he tells a rich story of the various attempts to track time's arrow to its source, which clearly has something to do with the second law of thermodynamics. That law requires the amount of disorder, or entropy, in a closed system to stay the same or increase over time

## until reaching its maximum possible level. Time marches forward because entropy in the past was lower than now. But that explanation merely restates the problem by defining "the past" as a time of lower entropy. Explaining time's arrow, Carroll asserts, requires explaining *why* entropy was so low at the Big Bang.

He suggests that unknown universes exist, some with an arrow of time pointing in the opposite direction. Thus the whole "multiverse" of universes has overall time symmetry, while the universe that humans inhabit travels along its entropy-driven one-way street. In describing how this might happen, Carroll provides many entertaining and intuitively graspable descriptions of bizarre phenomena, from the weirdness of quantum entanglement to the birth of baby universes out of nothingness. To be sure, time's arrow remains something of a mystery, but much of the physics surrounding the paradox is demystified for the diligent reader by Carroll's expressive account. – *Tom Siegfried* Dutton, 2010, 438 p., \$26.95.

## The Whale: In Search of the Giants of the Sea

#### Philip Hoare

People impressed by the size of dinosaurs should be *really* enthralled by whales: These aquatic mammals include the heftiest creatures ever to have lived, and they still share the planet with us.

In his chronicle of the leviathans, British biographer Philip Hoare tells both of his childhood fascination with whales and his recent snorkeling among them. Part travelogue and part history lesson, the book is peppered with facts about all sorts of cetaceans, from diminutive porpoises and unicorn-horned narwhals to massive blue whales.

But the biggest slice of this literary and artistic tour of the cetacean world is dedicated to the sperm whale, the largest predator ever to have roamed the Earth, and to the whaling industry that pursued these beasts and inspired Herman Melville to write *Moby-Dick*. Before the discovery and widespread use of petroleum and natural gas, oil from sperm whales lit major cities from London to New York, making the whaling port of New Bedford, Mass., the richest city in America for a while.



By weaving literary threads with excerpts from the unpublished journals of 19th century whalers, Hoare takes readers on a virtual ride in whale boats of old. From there, he chronicles the

birth of the conservation movement and humans' shifting relationship with whales. The creatures remain mysterious, he notes — after all, people saw Earth from space before underwater photography revealed whales in their habitat. — *Sid Perkins HarperCollins, 2010, 453 p., \$27.99.* 



#### **Natural Computing**

Dennis Shasha and Cathy Lazere Next-generation computers using biological approaches could revolutionize fields

from finance to pharmacology. *W.W. Norton, 2010, 268 p., \$16.95.* 



## Nonsense on Stilts: How to Tell Science from Bunk

Massimo Pigliucci A philosopher examines science and pseudoscience in med-

icine, climate change and more. Univ. of Chicago Press, 2010, 332 p., \$20.



How Pleasure Works: The New Science of Why We Like What We Like Paul Bloom Neuroscience, psychology and economics

inform what makes something—or someone—pleasurable. *W.W. Norton,* 2010, 280 p., \$26.95.



## The Ptarmigan's Dilemma

John Theberge and Mary Theberge The forces of ecology and genetics combine to drive evolution and

organize life as it is today. *McClelland* & Stewart, 2010, 416 p., \$28.95.



#### Deadly Kingdom: The Book of Dangerous Animals

Gordon Grice The animal kingdom offers myriad ways to kill a human, this sur-

vey of lethal tactics shows. *Random House, 2010, 324 p., \$27.* 

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

## FEEDBACK

#### **Call for caution**

"Bar codes may check out next" (*SN:* 4/24/10, p. 14) describes a new ink that would enable a full grocery cart to be quickly checked out electronically. Hurrah? Undoubtedly the amount of radio frequency per package would be minimal. However, if much of our food were handled that way, and people used it for years, the exposure might be significant. What would be the effect on our health and the environment?

We thought plastics were wonderful; they are, but are now in our blood and mothers' milk. Flame retardants have their own litany of problems, including, as you note, appearing in falcon eggs (SN: 4/24/10, p. 12). Cell phones are fabulous, but what are they doing to children's brains? How many wonderful inventions, thoughtlessly applied, have "unintended consequences"? Before this new ink is used, surely some cautious research is warranted.

Lesley Alexander, Santa Barbara, Calif.

## More correct correction

In case 87 readers haven't already pointed it out, the "Correction" in the May 8 issue (*SN: 5/8/10, p. 32*) has another mistake: "... Jupiter's largest moon, Io." Of course, Ganymede is Jupiter's largest moon, and Callisto is larger than Io as well.

K.A. Boriskin, Bellingham, Mass.

The reader is correct: Io is the third largest Jovian moon. — Ron Cowen

## Twins not immune to differences

Regarding the article "Identical twins differ at gut level" (*SN: 4/24/10, p. 9*): It seems that many researchers fail to take into account the unique genetics of the acquired immune system when studying identical twins. Although each identical twin inherits the same germ line DNA, both B and T cells not only rearrange that DNA but also add (and delete) nongenome encoded nucleotides to genes to make antibodies or T cell receptors, independently of antigen exposure. Have the authors considered the possibility of immune-driven variations in gut microbe diversity in identical twins? Jennifer L. Bankers-Fulbright, Minneapolis, Minn.

How the immune system and the gut microbiome shape each other is a good question "and one we are fascinated by," says study author Jeffrey Gordon of Washington University School of Medicine in St. Louis. All the details aren't in, but he says it is clear that changes in the immune system can alter the gut microbiota, and vice versa. "These are reciprocal and dynamic relationships," which are now under intensive study by his and several other research groups, Gordon says. — Laura Sanders

Send communications to: Editor, Science News, 1719 N Street, NW, Washington, D.C. 20036 or editors@sciencenews.org. Letters subject to editing.



New book profiles 20+ of the planet's most active volcanoes and features: news; science; stats; maps; photos; alert status.

Available wherever books are sold. nationalgeographic.com/books





- Gently holds your head in position.
- Small & Compact.
- Fits all head sizes.
- Allows you to lean to one side.
- Far superior to the doughnut pillow.



Never Travel Without It! www.aerosleeper.com



Save time, save money and give the magazine that covers science in a biweekly, user-friendly format.

www.sciencenews.org/gift

## JOURNEY INTO THE HEART OF HISTORY

Creating unique journeys led by renowned scholars since 1983

Cyprus & Malta • Ethiopia • American Southwest Iran • Oman • Maya World • Cambodia & Laos • China Easter Island • Syria • Turkey • Egypt • England Italy • India • Jordan • the Crusades • Scotland • Peru



## Glenn McGee



I think

it's really

dangerous

for us to have

to say over

and over ...

**"synthetic life** 

is coming ... "

when in

fact that's

not what

happened.

For more Comment, visit Columns at **www.sciencenews.org** 

## In synthetic life, the can is as important as the Coke

A paper published online May 20 in Science touted the creation of the world's first synthetic cell by researchers from the J. Craig Venter Institute who assembled a bacterial genome from scratch and used it to reprogram an existing organism (Page 5). The accomplishment is a major advance in the burgeoning field of synthetic biology, which tinkers with natural cells and organisms to answer basic research questions and solve environmental, medical and other problems. This rapidly expanding field brings with it significant ethical and practical issues. Glenn McGee of the Center for Practical Bioethics in Kansas City, Mo., and editor in chief of the American Journal of Bioethics recently talked with Laura Sanders about what the new accomplishment means – and what it doesn't.

## What conditions have to be met to show that life has been created? Have those conditions been met?

There's two pieces.... One is, is it actually the case that the thing you produced can be described as being the thing that that genome makes? And there's a really good reason why they'd say, "Well look, we have." If the thing didn't deconstruct and immediately form some [tumor] and go wild and crazy like in the movie *The Fly* and become some nutty combination, then you're entitled to make the claim about whether or not the thing is sufficient, at least in the short term, to do all the things that this cell would do.

On the other hand, there's the other problem.... I don't think you can claim this until you have demonstrated that you can produce the unbelievably complex cellular machinery.... This has been a barrier for more than a decade for this group. And they always say, "Well, we're going to work on that stuff later," but you just can't. The number of issues involved not in just reprogramming the cell, but in producing ultimately what they have to do to produce synthetic life – you have to produce the whole enchilada.

That wouldn't be true if I said I'd produced synthetic Coca-Cola. Nobody would complain that the can was taken from real Coke. If I say I've synthesized Coke, which would be a big deal, and

someone says, "Well, no you didn't, because you didn't make the can," they'd have to prove that the can was a really important part of Coke. Synthesizing a genome is a matter of making the claim that you've successfully produced a thing that you know is at least the Coke.

In this case, the can is half the battle. And they haven't done the can yet. So I think it's early.

Would you say that J. Craig Venter and his colleagues are exaggerating what they have done? It's a bit like if I invented the shoestring and said I was closer to Nike. I mean, yeah, maybe, a little. But

it's not up to me to quantify whether I am. And I don't think that our ordinary peer review system is operating very effectively in terms of making sure that those claims are judged by the standards of cellular biology.

They do a very good job, but if it ain't what it says it is, then let's don't call it that.... Don't go calling stuff "synthetic" when there is no definition of synthetic life. And it's up to you to be responsible about using that word carefully. Don't go using it as a poster to attract attention to research that is still very much in progress.

Wow, I sound really down on this. It's exciting research.

## What are some of the ethical issues involved in this work?

I'm an ethicist and the fact that I work on this stuff is a function of the fact that there are real ethical issues here. The term "synthetic life" is almost as incendiary as the term "cloning." And

> in some ways it's more incendiary, because ... a lot of this work has been done on weaponizable viruses, including work by this group, including even the initial work they did. People don't have to have a whole lot of imagination to see that with every step forward here, there are enormous risks, including the publication of stuff.

From an ethics standpoint, I think it's really dangerous for us to have to say over and over and over again in like 20 different news cycles over the past 10 years "artificial life is coming" and "synthetic life is coming and it's going to be printed out on laser

printers or produced from suitcase kits," when in fact that's not what happened. The landmark achievement is yet to occur.

It confuses people. We've got a public that's already terrified of scientists. They hate intellectuals. The devil in just about every single movie these days is a scientist, whether it's *Iron Man* or more direct stuff like *Gattaca*. The people fear this kind of science.

I'm talking about the public's perception. And the public shouldn't drive scientific inquiry. But it will if we scare the bejeebers out of them by using inflated language at every new step in synthetic life. ■



# Finally, a cell phone that's... a phone!

"Well, I finally did it. I finally decided to enter the digital age and get a cell phone. My kids have been bugging me, my book group made fun of me, and the last straw was when my car broke down, and I was stuck by the highway for an hour before someone stopped to help. But when I went to the cell phone store, I almost changed my mind. The phones are so small I can't see the numbers, much less push the right one. They all have cameras, computers and

a "global-positioning" something or other that's supposed to spot me from space. Goodness, all I want to do is to be able to talk to my grandkids! The people at the store weren't much help. They couldn't understand why someone wouldn't want a phone the size of a postage stamp. And the rate plans! They were complicated, confusing, and expensive... and the contract lasted for two years! I'd almost given up when a friend told me about her new Jitterbug phone. Now, I have the convenience and safety of being able to stay in touch... with a phone I can actually use."

## Questions about Jitterbug? Try our pre-recorded Toll-Free Hotline I-877-745-1432.

**The cell phone that's right for me.** Sometimes I think the people who designed this phone and the rate plans had me in mind. The phone fits easily in my pocket, but it flips open and reaches from my mouth to my ear. The display is large and backlit, so I can actually see who is calling. With a push of a button I can amplify the volume, and if I don't know a number, I can simply push one for a friendly, helpful operator that will look it up and even dial it for me. The Jitterbug also reduces background noise, making the sound loud and clear. There's even a dial tone, so I know the phone is ready to use.

**Affordable plans that I can understand** – **and no contract to sign!** Unlike other cell phones, Jitterbug has plans that make sense. Why should I pay for minutes I'm never going to use? And if I do talk more than I plan, I won't find myself with no minutes like my friend who has a prepaid phone. Best of all, there is no contract to sign – so I'm not locked in for years at a time or subject to termination fees. The U.S. – based customer service is second to none, and the phone gets service virtually anywhere in the country.

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.

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



New Red phone shown Also available in White and Graphite.

**Call now and get a FREE GIFT.** Try Jitterbug for 30 days and if you don't love it, just return it. Why wait, the Jitterbug comes ready to use right out of the box. The phone comes preprogrammed with your favorite numbers, and if you aren't as happy with it as I am you can return it for a refund of the purchase price. Call now, the Jitterbug product experts are ready to answer your questions.





Jitterbug Cell Phone Call now for our lowest price. Please mention promotional code 40357. **I-877-545-6374** www.jitterbugdirect.com

SAMSUNG

NO

IMPORTANT CONSUMER INFORMATION: All rate plans require the purchase of a Jitterbug phone and a one-time set up fee of \$35.00. Coverage and service is not available everywhere. There are no additional fees to call Jitterbug's 24-hour U.S. Based Customer Service. However, for calls to an Operator in which a service is completed, minutes will be deducted from your monthly balance equal to the length of the call and any call connected by the Operator. plus an additional 5 minutes. Rate plans do not include government taxes or assessment survice includes [overnment taxes or assessment survice] and fees are subject to change. Savings are based on marketing materials from nancinally available cellular companies as of June, 2010 (not indig family share plans). The full price of the Jitterbug Phone will be refunded if it is returned within 30 days of purchase, in like-new condition, and with less than 30 minutes of usage. A Jitterbug Phone purchased from a retail location is subject to the return policy of that retail location. The Jitterbug Phone is a registered trademark of GreatCall, Inc. Samsung is a registered trademark of Samsung Electronics America, And its related entities. Created together with worldwide leader Samsung. (Ler VI) is restriced.

Amy Chyao Age 16 Richardson, Texas, USA 2010 Gordon E. Moore Award Winner

## The world loves a winner. Especially one who helps change it.

Congratulations to Amy Chyao, winner of the first-ever Gordon E. Moore Award at the Intel International Science and Engineering Fair. Just like Intel's co-founder—for whom the award is named—she and the 1,600 other participants from around the world inspire us with their intellectual curiosity and creative thinking. And that never changes. Learn more at intel.com/inside.



Sponsors of Tomorrow.

© 2010 Intel Corporation. Intel, the Intel logo, Intel Sponsors of Tomorrow 🍽 and Intel Sponsors of Tomorrow logos are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.