Conscious Critters | Amaizing Genome | Black to the Future

ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ DECEMBER 19, 2009

Quantum Programming

Quasar Clue

Megafauna Mystery

Scans' Shortcomings

Exposing flaws in fMRI experiments

$3.95 U.S. | www.sciencenews.org

"As the master craftsman who opened the famous Lincoln Pocket Watch at the Smithsonian, I recently reviewed the the Stauer Hyperion *timepiece. The assembly and the precision of the mechanical movement are superb."*

—George Thomas
Towson Watch Company

Better Than Free
Receive $200 in Stauer Gift Coupons with the purchase of this $195 watch.

Authentic Stauer Historical Reproductions

This Wristwatch is 99% OFF...*and* We Will Negotiate!

Stauer helps you survive today's economy with elegance in a luxury inspired timepiece...and $200 in gift coupons.

It happened whenever I checked the time. It came from waiters, bellmen and strangers on the street. "Nice watch," they would say. If they didn't speak English, they would just point and say "bello" or "magnifique." It happened everywhere on my winter trip through Europe. I remember it clearly because my watch got more attention than my luggage or my empty wine glass. One excited hotel clerk in Madrid pulled back his sleeve to show me the spectacular antique gold automatic he inherited from his grandfather. He tapped its face and said, "1933...What year is yours?" I didn't have the heart to tell him it was a 2009.

Inspired by one of the rarest wristwatches ever made, the Stauer Hyperion allows you the luxury look without the astronomical price tag of an antique. Bidding on the original will set you back at least $600,000! I decided that we could do much better. We had originally estimated that we could save you 99%, but that number has since climbed to 99.97%. And just when it seemed like we were on the verge of giving the watch away–I told them I wasn't finished yet. You need some room to negotiate. That's why, when you buy the Stauer ***Hyperion*** for $195, **I'll include two $100 Stauer Gift Coupons.** I know it sounds crazy, but my job is to give Stauer customers a reason to come back. And 99.97% off AND $200 sounds like as good a reason as any!

The Stauer *Hyperion* blends the best of vintage timepiece design with traditional timekeeping technology to create a 21-jewel automatic movement wristwatch that never needs winding and looks as good as the classics. The ***Hyperion*** features a gold-fused case that surrounds an exquisitely-detailed ivory dial with bold blue numbers and blued, Breguet-style hands. Two separate complications mark the month and day of the week. A sapphire crown completes the elegant look. Secures with a genuine brown leather, crocodile-pattern strap. Water resistant to 3 ATM. Think of it as a golden reminder of the good old days gone by and the new good days yet to come!

A Timely Deal. We are so sure that you will be fascinated by the vintage look of the Stauer ***Hyperion*** watch that we offer a 30-day money back guarantee. If you are not totally impressed, return it for a full refund of the purchase price. Supplies are limited, so order today. A $195 watch with $200 gift coupons...now there's a *Better Than Free* deal that's very timely.

WATCH SPECS:
- Gold-fused case - 21-jewel automatic movement
- Month and day complications
- Croc-embossed leather strap fits 6 3/4"–8 3/4" wrist

Not Available in Stores

Stauer *Hyperion* Watch—~~$295~~
Now* $195** +S&H ***Save $100

***Better Than Free*—Receive $200 in Stauer Gift Coupons with the purchase of the Stauer *Hyperion* Watch**

Call now to take advantage of this limited offer.

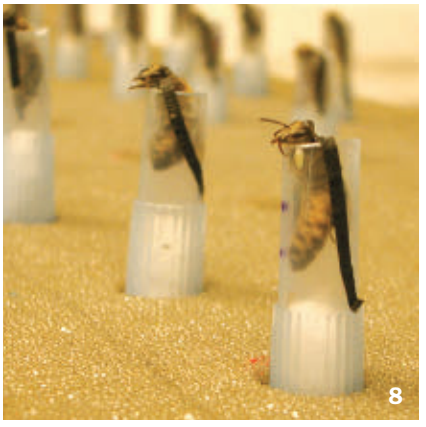
888-201-7065

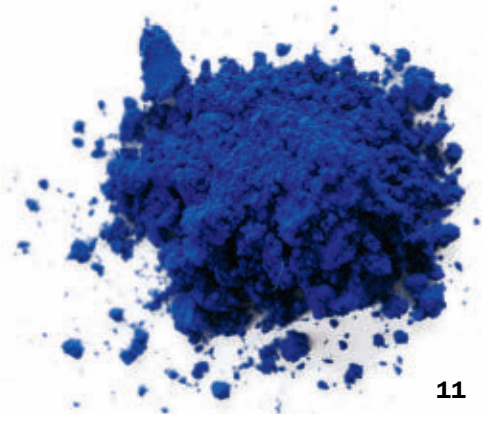
Promotional Code HPW141-01
Please mention this code when you call.

Stauer
14101 Southcross Drive W.,
Dept. HPW141-01
Burnsville, Minnesota 55337
www.stauer.com

Smart Luxuries—Surprising Prices

DECEMBER 19, 2009 • VOL. 176 • NO. 13





ScienceNews

In The News

5 STORY ONE
- Fungus in mammoth dung gives clues to beasts' demise

8 LIFE
- Ants hire fertilizing farmhands
- Killer bees not sharpest tacks

9 GENES & CELLS
- Maize genome's diversity amazes

10 ENVIRONMENT
- Chemical in plastics makes boys' play less boyish
- Peck of pepper virus signals human waste contamination

11 MOLECULES
- Pair of proteins linked to bone loss and hot flashes
- New pigment sings the blues

12 ATOM & COSMOS
- Gravity monster sends gamma-ray blasts

13 MATTER & ENERGY
- No PacMan yet, but first programmable quantum computer solves a slew of problems
- Water and oil do mix, if bouncing

14 BODY & BRAIN
- Clogged arteries date to time of pharaohs
- Malaria becoming resistant to frontline drug
- Low-tech tree shielding guards against deadly Nipah virus

Features

16 TRAWLING THE BRAIN
COVER STORY: Problems with a popular method of neuro-imaging sometimes lead to erroneous conclusions.
By Laura Sanders

22 HUMANS WONDER, ANYBODY HOME?
Brain structures and circuitry suggest to some researchers that consciousness is not just a primate thing.
By Susan Gaidos

Essay

26 A BLACK FUTURE
Revving up the Large Hadron Collider poses no risk of global annihilation but could pave the way to black hole–powered space travel.
By Tom Siegfried

Departments

2 FROM THE EDITOR

4 NOTEBOOK

30 BOOKSHELF

31 FEEDBACK

32 COMMENT
NIH director Francis S. Collins on medical research funding.

COVER An fMRI image shows the brain of the University of Western Ontario's president Amit Chakma as he recalls places on campus.
The University of Western Ontario

ScienceNews MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC

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

EDITORIAL STAFF *managing editor* **Eva Emerson**
senior editor/policy **Janet Raloff**
assistant managing editor **Kristina Bartlett Brody**
news editor **Elizabeth Quill** *associate editor* **Erika Engelhaupt**

astronomy **Ron Cowen**
behavioral sciences **Bruce Bower**
biomedicine **Nathan Seppa**
earth sciences **Sid Perkins**
environment/chemistry **Rachel Ehrenberg**
life sciences **Susan Milius**
molecular biology **Tina Hesman Saey**
staff writer **Laura Sanders**
editorial assistant **Rachel Zelkowitz**
web specialist/editorial secretary **Gwendolyn K. Gillespie**
science writer intern **Lisa Grossman**

DESIGN *design director* **Beth Rakouskas**
assistant art directors **Theresa Dubé, Avik Nandy**

ADVERTISING | CIRCULATION
advertising manager **Judy Lewis** *West, Midwest & DC Metro*
circulation manager **Tosh Arimura**
account executives **Gregg Oehler, Rich Cordero,** *Oehler Media, East;* **Rick Johnson,** *National Brands;* **Jan Mason,** *Online Advertising*
advertising/circulation assistant **Kerwin Wilson** *permissions* **Evora Swoopes**

EDITORIAL, ADVERTISING AND BUSINESS OFFICES
1719 N Street NW, Washington, DC 20036 · Phone (202) 785-2255
Audit Bureau of Circulations
Subscriptions subs@sciencenews.org · ***Editorial/Letters*** editors@sciencenews.org
Advertising/Business snsales@sciencenews.org
Texterity Digital edition provided by Texterity, www.texterity.com
Science News (ISSN 0036-8423) is published biweekly, for $54.50 for 1 year or $98 for 2 years (international rate $80.50 for 1 year or $161 for 2 years) by Society for Science & the Public, 1719 N Street NW Washington, DC 20036. Preferred periodicals postage paid at Washington, DC, and an additional mailing office.
Subscription Department: PO Box 1205, Williamsport, PA 17703-1205.
For new subscriptions and customer service, call 1-800-552-4412.
Postmaster: Send address changes to *Science News*, PO Box 1205, Williamsport, PA 17703-1205. Two to four weeks' notice is required. Old and new addresses, including zip codes, must be provided.

FROM THE EDITOR

Scanning science for news cannot be free from errors

Issue after issue, year after year, *Science News* reports on the latest discoveries presented by scientists in journals, at conferences or by other means, such as website preprint servers. Much care is taken to select science that is properly conducted and soundly analyzed. But it is the very nature of science that many reports from the frontiers of research will later turn out to have been mistaken.

There's no avoiding that problem. It is neither feasible nor desirable to withhold coverage of what scientists think they are finding until later work verifies the initial reports. That would be as silly as a sports magazine refusing to divulge scores of games during the season, then waiting till November to announce the winner of the World Series. Science is an ongoing process, and timeliness in reporting the steps in that process is what distinguishes newsmagazines from textbooks.

Nevertheless, a science newsmagazine owes its readers some attention to more than just the results that scientists announce. In this issue (Page 16), staff writer Laura Sanders pays some of that attention to one of science's biggest newsmakers, functional magnetic resonance imaging. For 15 years or so now, fMRI has been filling the pages of journals with conclusions about the inner workings of the brain, leading in turn to countless news reports about which part of the brain is responsible for what. There is no doubt that fMRI is an enormously powerful tool, permitting scientists to glimpse the mental processes at the heart (and mind) of human experience. With fMRI, much has been learned about how the brain functions. But the fact remains that many fMRI findings have turned out to be like the first-half score of a football game: an often erroneous clue about which team ultimately won.

Many experts in neuroscience and statistics have pointed out flaws in the basic assumptions and methods of fMRI — problems that render many of its findings flat-out wrong. It is no disservice to science to point out these problems, though. Rather it is a source of science's strength that criticisms of its methods are forthcoming from its practitioners. And it's the responsibility of those who cover science news to make sure such criticisms are not ignored when assessing what should be communicated from the research frontiers. —*Tom Siegfried, Editor in Chief*

© Eyebyte/Alamy.

Nutrition Made Clear

Making smart eating choices is essential to living a healthy, happy, and successful life. Now you can finally sort through nutritional misconceptions and replace them with hard science you can understand with **Nutrition Made Clear**.

In 36 in-depth lectures taught by dietitian and award-winning Professor Roberta H. Anding, explore the fundamentals of good nutrition and get a practical and personal guide to applying these fundamentals to your own lifestyle. This course is both a fascinating learning experience and the perfect investment in your personal health—one that will educate, motivate, and reward you for the rest of your life.

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.

Nutrition Made Clear

Taught by Professor Roberta H. Anding
Baylor College of Medicine and Texas Children's Hospital

Lecture Titles

1. Why We Eat What We Do
2. Sources of Nutrition Fact and Fiction
3. Our Underappreciated Digestive Tract
4. It's All about the Calories!
5. Hydration—You Are What You Drink
6. Not All Carbohydrates Are Created Equal
7. Facts on Fiber
8. Protein—An Indispensable Nutrient
9. Fat, Fat Everywhere!
10. Vitamins—Spotlight on C
11. Vitamins A and K—Multitaskers
12. Vitamin E—Fallen Hero; Vitamin D—Rising Star
13. B Vitamin Basics
14. The Major Minerals
15. The Highs and Lows of Sodium and Potassium
16. Iron, Zinc, Selenium—Balance Is Everything
17. Cardiovascular Disease—What Are the Risks?
18. A Heart-Healthy Lifestyle
19. The DASH Diet—A Lifesaver
20. Obesity—Public Health Enemy Number One
21. Healthy Weight Management
22. Metabolic Syndrome and Type 2 Diabetes
23. Dietary Approaches to Weight Management
24. Nutrition and Cancer Prevention
25. Nutrition and Digestive Health
26. Prebiotics and Probiotics in Your Diet
27. Food Safety—It's in Your Hands
28. Demystifying Food Labels
29. Facts on Functional Foods
30. A Look at Herbal Therapy
31. Organic or Conventional—Your Choice
32. Fake or Real—Sugars and Fats
33. Creating Your Own Personal Nutrition Plan
34. Exercise and Nutrition—Partners for Life
35. The Future of Nutrition—Science and Trends
36. Nutrition Facts and FAQs

Order Today!
Offer expires Wednesday, February 17, 2010

ACT NOW!

1-800-TEACH-12
www.TEACH12.com/7sn

Nutrition Made Clear
Course No. 1950
36 lectures (30 minutes/lecture)

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

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

Priority Code: 33347

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

Scientific Observations

"The data does not tell us what to do in setting a standard for testing or paying for [screenings]—ever. We have to base these kinds of decisions on both data and values. How much do we fear getting a disease?… These are as much ethics and policy questions as they are issues of the facts.… There is no reason to doubt the accuracy of the scientists' finding that evidence does not support routine mammography for most women under 50. But there is every reason to doubt that the numbers they compiled will be sufficient to overturn a medical practice that carries so much ethical weight for women." **—UNIVERSITY OF PENNSYLVANIA BIOETHICIST ARTHUR CAPLAN IN A COMMENTARY POSTED ONLINE NOVEMBER 19 ON MSNBC'S WEBSITE ON THE DEBATE OVER WHEN WOMEN SHOULD BEGIN REGULAR MAMMOGRAM TESTING**

Science Past | FROM THE ISSUE OF DECEMBER 19, 1959

LOW-MELTING ELEMENTS MAKE HIGH HEAT MATERIAL — Two chemical elements, both of which will melt in the sun on a hot day, have been combined to produce a material capable of withstanding temperatures up to 1,500 degrees Fahrenheit. Gallium phosphide, a yellow compound resembling ground glass, has been prepared from gallium ... and phosphorus.... The material may be used in building solar-cell power plants for space stations, and tiny rugged electronic parts for missiles, satellites and space probes of the future. So far the Army Signal Corps has built an electronic diode of gallium phosphide which has withstood temperatures seven times higher than those withstood by the now-used silicon and germanium.

Science Future

January 1
The International Year of Biodiversity begins. Find events at www.cbd.int/2010/calendar

January 17–21
The American Meteorological Society hosts its annual meeting in Atlanta. Go to www.ametsoc.org/MEET/annual/index.html

February 18–22
Researchers from across disciplines converge in San Diego for the AAAS annual meeting. See www.aaas.org/meetings/2010

SN Online

www.sciencenews.org

LIFE
A nudge at the right time in an embryonic snail's development can switch the shell's spiral direction. Read "Little push turns snail lefties to righties."

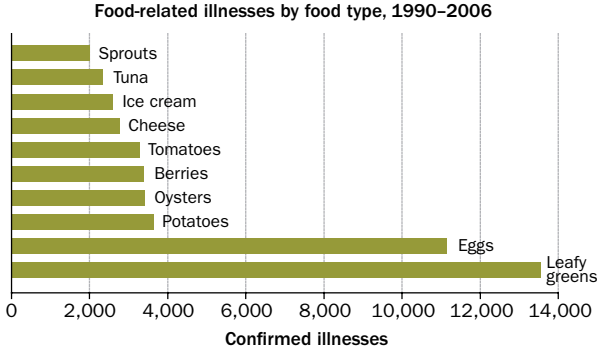
ATOM & COSMOS
Some stars, the sun not included, are just the right size and temperature for life. See "Sun may not be a 'Goldilocks' star."

HUMANS
Kids can see what adults can't, a new study shows. Read "Visual illusions stump adults but not kids."

EARTH
Major quakes along Washington's coast could rock nearby cities, a study confirms. See "GPS bolsters view that big Cascadia quakes could hit inland."

Science Stats | EAT AT YOUR OWN RISK

Ten riskiest foods regulated by the Food and Drug Administration



SOURCE: S. KLEIN *ET AL.*/CENTER FOR SCIENCE IN THE PUBLIC INTEREST, 2009

For Daily Use

Pairing red wine with seafood is widely recognized as a foodie faux pas. Researchers from Japan have now linked the unpleasant aftertaste often resulting from this combination to the wine's iron content. The team asked seven people to sample scallops and a swig of each of 38 red wines, 26 whites, two sherries and three other wine types. The testers, who had some wine-tasting experience, rated the level of "fishy aftertaste" associated with each wine. Chemical analysis showed that a wine's iron content—rather than its color—most strongly predicted the aftertaste. Blocking the iron made formerly unpleasant wines more palatable in the test, researchers led by Takayuki Tamura of the Mercian Corp., a wine and spirit producer and marketer, report in the Sept. 23 *Journal of Agricultural and Food Chemistry*.

FROM LEFT: PETE WRIGHT; KURODA LAB/UNIV. OF TOKYO

“We put all these pieces together and asked, what can we do with the circuit?” —DAVID HANNEKE, PAGE 13

In the News

Life Killer bees don’t rely on big brains

Genes & Cells A corny genome unveiled

Environment Boys say bye-bye to trucks

Molecules New pigment is blue, so blue

Atom & Cosmos What Cygnus X-3 spews

Matter & Energy Bouncing oil blebs

Body & Brain Mummified heart disease

BARRY ROAL CARLSEN/UNIVERSITY OF WISCONSIN-MADISON

STORY ONE

Spores tell tale of megafauna’s disappearance

Dung fungus finds suggest climate change not to blame

By Sid Perkins

Before North America’s megafauna died out at the end of the last ice age, the creatures’ incessant browsing maintained an open savanna-like landscape.

Evidently, my dear Watson, the climate didn’t do it. Scientists weighing in on a cold case open since the end of the most recent ice age — the massive die-offs of North America’s largest mammals — arrived at that conclusion courtesy of some very tiny clues. The spores of a fungus that thrived in and on those creatures’ dung suggest that changes in habitat didn’t cause the extinctions. As a result, it’s looking more and more like humans played a major role.

In at least some regions, megafaunal populations apparently began to wane several centuries before changes in vegetation that have been linked to a climatic shift occurred, researchers report in the Nov. 20 *Science*. In fact, the team argues, die-offs of large herbivores allowed some forms of vegetation previously suppressed by incessant browsing to flourish in a post–ice age world.

Researchers have long debated what triggered the extinctions that struck North American megafauna between 14,000 and 11,000 years ago (*SN: 12/4/99, p. 360*), and one of the prime candidates has been habitat change caused by a warming climate. The appetites and activities of humans streaming into the continent across a land bridge from Asia provide another possible culprit.

“In North America, there’s a lot of confusion because everything was happening all at once,” says study coauthor Jack Williams, a paleoecologist at the University of Wisconsin–Madison.

The findings are “incredibly exciting ... and are a major step forward in understanding how large herbivores shape the landscape,” says ecologist Diana J. Raper of Oregon State University in Corvallis.

Sediments that accumulated in a lake in Indiana and marshes and ponds in New York provide evidence for the claims of Williams and his colleagues. Looking in that material, the researchers observed long-term trends in the amounts of tree pollen, charcoal bits and spores of fungi from the genus *Sporormiella*. Digestive processes in large herbivores are an integral part of the life cycle of these fungi, and spores have been isolated from the dung of ancient mammoths, Williams says.

Recent studies suggest that when the number of *Sporormiella* spores in a sample of lake sediment is less than 2 percent of the number of grains of tree pollen, it’s a sign that the surrounding area is home to few if any herbivores producing the large quantities of dung required for the fungi to thrive, says Jacquelyn Gill, a paleoecologist at

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

Wisconsin–Madison who is also a coauthor of the new report.

Analyses of sediments pulled from Appleman Lake in northeastern Indiana reveal that the numbers of *Sporormiella* spores began to decline about 14,800 years ago. But it wasn't until 13,700 years ago, more than a millennium later, that the spore-to-pollen ratio dropped below 2 percent, signaling a disappearance of the megafauna from the local area.

Also around 13,700 years ago is precisely when pollen grains from broadleaved trees such as ash and ironwood began to show up in lake bottom sediments in substantial numbers. That's no coincidence, the researchers argue: These presumably tasty trees could flourish only when the megafauna that ate them were no longer present in large numbers.

(The team's data indicate that even without the added pollen from broadleaved trees, the decline in dung would have sent the spore-to-pollen ratio below 2 percent around 13,700 years ago.)

Measurements of charcoal in the sediments indicate that the spread of broadleaved trees boosted the frequency of wildfires in the area, the researchers note. Analyses of sediments taken from waters in New York reveal the same overall trends in the amount of pollen, spores and wildfire-generated charcoal as were found in Indiana, Williams says.

Although the new findings don't totally rule out climate change at the end of the ice age as the cause of the megafaunal extinctions, Williams says, the work does show that substantial population declines began long before the changes in vegetation that some scientists have pinned on climate change and that were previously presumed to have triggered the die-offs.

So now, attention shifts to how humans may have affected megafaunal populations. The presence of butchered mammoth bones at an archaeological site in Wisconsin hints that people inhabited the area between 14,700 and 14,100 years ago, just as the populations of large herbivores were sliding, says Christopher Johnson, an evolutionary ecologist at James Cook University in Townsville, Australia.

But the rise of the Clovis people — a group of Native Americans (presumably big-game hunters) known for the distinctive stone spearheads they made — didn't occur until around 13,300 years ago. That's well after many of the megafaunal extinctions had largely run their courses, he notes.

"It is beginning to look as if the greater part of that [megafaunal] decline was driven by hunters who were neither numerous nor highly specialized for big-game hunting," Johnson writes in a commentary in the Nov. 20 *Science*.

The development of Clovis spearheads, Johnson speculates, may simply have been a technological way to boost hunting efficiency in response to the increasing scarcity of megafauna and their rising wariness of humans.

"That's an interesting idea, but there's not a lot of evidence to support it," says David J. Meltzer, an archaeologist at Southern Methodist University in Dallas. For one thing, he notes, there's no strong correlation between the size of Native American spearheads or arrowheads and the size of the game that was hunted with those stone points. ■

Back Story | DRIVEN TO EXTINCTION

The role of humans in the megafaunal disappearances at the end of the last ice age is still debated, but other extinctions throughout history seem to be clearly related to human settlement.

Giant kangaroo
45,000 years ago
Australia
Within 5,000 years of human settlement, 90 percent of mammal species larger than a house cat, including the giant kangaroo, had gone extinct.

Large Caribbean sloths
4,400 years ago
Caribbean
By 800 years after human settlement, several species of sloths died out — due to either hunting or indirect effects of human presence such as habitat destruction.

Elephant bird
1,000 years ago
Madagascar
Within a millennium of humans' arrival, the island's elephant birds, and other megafauna, were largely gone. Some of the birds may have held out until the 1600s.

Moa
500 years ago
New Zealand
Large flightless moas were quickly hunted to extinction, probably within two centuries of human settlement.

Dodo
About 350 years ago
Mauritius
Within five or six decades of the island's permanent settlement, the dodo was done.

FROM LEFT: MICHAEL LONG/NHMPL/*NATURE*; PATRICIA J. WYNNE; COURTESY OF WIKIMEDIA COMMONS; HEINRICH HARDER; FREDERICK WILLIAM FROHAWK

Santa Furious!

Exclusive Interview: "The Big Jolly" Reacts to Latest Holiday Giveaway from Stauer

For hundreds of years, Santa has been our favorite big man who gives away holiday cheer. He's traveled with miraculous speed from house to house around the globe, leaving surprises under the tree for all. In the world of gift-giving, the man called Claus is legendary. But this year he faces some stiff competition.

Santa puts on a brave face professionally, but it's clear that Stauer's **FREE *Emerald, Ruby & Pearl Earrings*** have got him flustered. In a recent interview, Big Jolly confessed, "I just don't know how they do it. I can't compete with the stuff they're giving away. Pearls? Rubies? Emeralds? Are you kidding me? I'm stuck with wooden sleds and toy fire engines."

An irresistible offer for you. The **FREE *Emerald, Ruby & Pearl Earrings*** feature a luminous, pink freshwater pearl topped with sparkling, faceted beads of genuine ruby (1 ½ ctw) and emerald (1 ctw). Each precious trio is flanked with 18K gold vermeil beads and dangles from gold-filled French hooks. It's hard enough to resist some of the most prized substances on Earth—precious stones that have captivated kings, queens and explorers from the beginning of time. But when the price tag is zero, this combination is almost impossible to resist. Similar designs can be found for $295. But for a limited time, **you can take 100% off!** You pay nothing except basic shipping and processing costs of $25.95, the normal shipping fee for a $200–$300 pair of earrings.

Together, the cultured pearl and rare gemstone earrings make the perfect showcase gift or a stocking stuffer that belongs on top of the stack under the tree. "I hate to admit it," said Santa, "But Mrs. Claus would love these."

The freedom of gift-giving. Behind closed doors at Stauer, another big man is making plans to steal Santa's thunder. Mike Bisceglia, President of Stauer, claims that no one person can monopolize gift-giving. "It's a free country," he said, "Kids love Santa, but maybe this year wives and girlfriends will love Stauer!"

And is he bothered that the white-bearded gentleman from the North Pole doesn't appreciate the competition? Hardly. "Santa doesn't like it? Too bad," Bisceglia said. "Free is a part of the way we do business at Stauer. If Claus has a problem with that, he can wiggle his nose and meet us in court."

Representatives for Mr. Claus claim that Santa's regular holiday route will go on as scheduled and that there are "no plans for legal action." Speaking on behalf of Stauer, Bisceglia added, "Santa and I go way back. Santa doesn't stay mad for long. In a few days we'll hash it out over mugs of hot cocoa. I'll get a wooden sled and Mrs. Claus will get that new pair of pearl, emerald, and ruby earrings." But Bisceglia may be on the naughty list next year.

JEWELRY SPECS:

- Genuine rubies (1½ ctw), emeralds (1 ctw) and cultured pearls
- 18K gold vermeil bead setting
- Gold-filled french hooks

Genuine Ruby, Emerald & Cultured Freshwater Pearl Earrings
***Your Cost*—FREE — pay shipping & processing only.**

Call now to take advantage of this limited offer.

1-888-324-4354

Promotional Code MGE140-01
Please mention this code when you call.

Stauer
14101 Southcross Drive W.,
Dept. MGE140-01
Burnsville, Minnesota 55337
www.stauer.com

Smart Luxuries—Surprising Prices

Life

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

Traditional view of leaf-cutter ants overlooked nitrogen-fixing partner

Bacteria boost nutrients for fungal crops that feed millions

By Susan Milius

Leaf-cutter ants slice foliage into bits (left) to carry back to their nests. There, the ants feed the leaves to fungal gardens (right) that contain nitrogen-fixing bacteria.

No pigs or chickens yet. But the vast farms where leaf-cutter ants raise fungal crops may harbor a crew of previously overlooked farmhands: nitrogen-fixing bacteria.

At least eight species of leaf-cutter ants typically live with bacteria that capture nitrogen from the air and turn it into a form that the ants can use, report Adrián Pinto-Tomás of the University of Costa Rica in San José and his colleagues in the Nov. 20 *Science*. These bacterial helpers might explain how the ants feed up to 8 million workers in a single colony just by harvesting bits of nitrogen-poor leaves and letting a fungus grow on them.

Neither the fungus nor the ants, nor any other multicellular organisms, can use the atmosphere's abundant nitrogen directly. Pinto-Tomás and his colleagues tracked nitrogen's path through ant nests and tested inhabitants for genes active in capturing the nutrient from the air. Molecular tests of the *nifH* gene, which encodes part of a nitrogen-fixing enzyme, confirmed that bacteria living in ant colonies were indeed fixing nitrogen.

Live-in bacteria, particularly of the genus *Klebsiella*, could provide an estimated 45 to 60 percent of the nitrogen in the ants' food, the researchers say.

Fungus-growing ants "have become a model system for studying symbioses and coevolution," says entomologist Ted Schultz of the Smithsonian's National Museum of Natural History in Washington, D.C. "This discovery makes the system that much more interesting and that much more complicated."

Previous work has also proposed the idea — still under debate — that bacteria growing on the ants' bodies secrete weed killers for defending the fungus garden.

When the team analyzed the nitrogen fixers' family tree, strains fell into two distinct groups, raising the possibility that the fixers coevolved as ant farm specialists. And the bacteria's work does benefit the ants. When ant colonies tended farms in sealed chambers with a special mix of nitrogen isotopes in the air, the atmospheric nitrogen signature showed up in the ants, presumably after they ate the fungus or bacteria living in the chamber.

Agricultural ecologist Ford Denison of the University of Minnesota in St. Paul says he'd like to see tests of the effect that extra nitrogen would have on the ants' ecosystem. The study's authors propose that ant farm bacteria could introduce a potentially major source of fixed nitrogen into the environment.

Killer bees not so smart

Note to plotters of world domination: Don't get discouraged about your weaker brains. Though killer bees have readily displaced long-established European honeybees in Central America and the southern United States, the invaders don't outperform the invaded in lab tests of learning and memory, says Margaret Couvillon of the University of Sussex in Brighton, England. About half as many killer bees as honeybees learned to associate a puff of jasmine odor with an upcoming sugar-water reward on the first try (bees shown waiting for puff test), Couvillon and her colleagues report online November 11 in *Naturwissenschaften*. Invaders were also worse at remembering their lesson the next day. "Perhaps learning has a cost," Couvillon says, such as sapping resources from other abilities. "If it were cost-free, wouldn't we all be getting smarter?" Superior odor learning may not explain killer bees' triumph, but their faster rates of growth and reproduction might, Couvillon says. — *Susan Milius*

FROM TOP: JARROD SCOTT, *SCIENCE*/AAAS; MICHAEL POULSEN, *SCIENCE*/AAAS; MARGARET COUVILLON

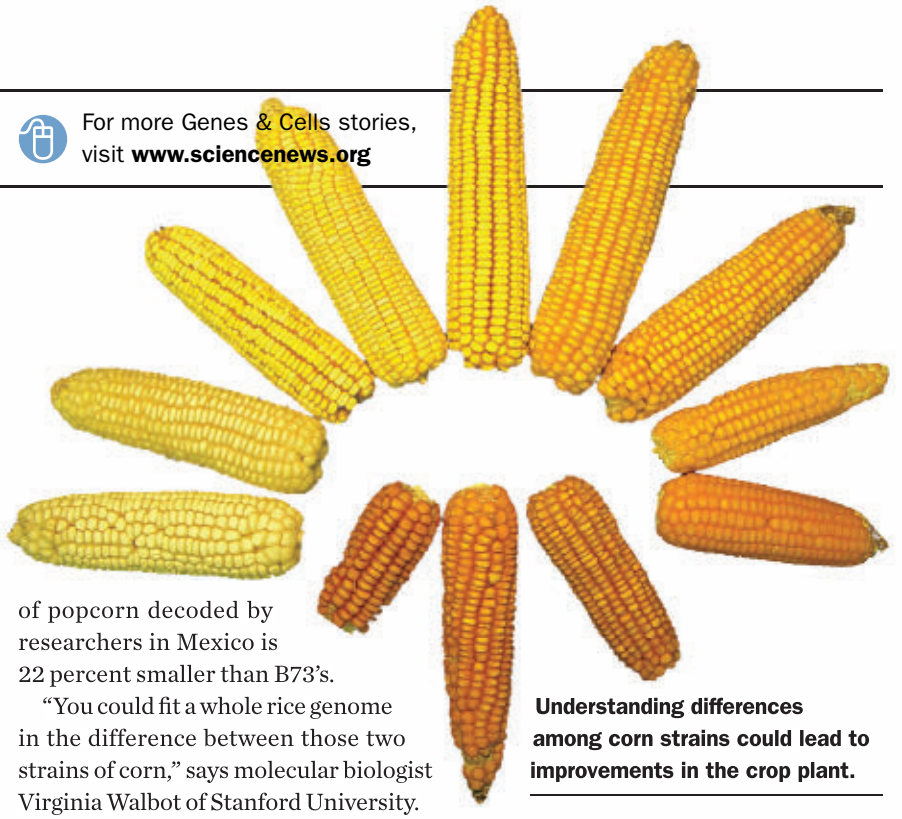
Genes & Cells

For more Genes & Cells stories, visit **www.sciencenews.org**

Corn genome results reveal maze of diversity

Hints on hybrid vigor among genetic findings about maize

By Tina Hesman Saey



Understanding differences among corn strains could lead to improvements in the crop plant.

Cue the corny jokes.

Researchers have completed a draft of the maize genome. And while people may quip about the "amaizing" achievement, scientists say the genetic blueprint of one strain of corn reveals serious amounts of genetic diversity and some weighty biology lessons that could lead to improvements in the economically important crop plant.

Papers in the Nov. 20 *Science* and in the online journal *PLoS Genetics* report the draft genome and analyses of the plant's genetic makeup. The work, conducted by many institutions with funding from the National Science Foundation, reveals that corn has an unusual ability to make new genes, lose others, alter activity of its genes and withstand radical genome remodeling. And surprising differences between two strains of corn may provide clues about why hybrids sometimes grow or yield better than parent strains.

Scientists have known that different strains of maize can vary widely in genetic makeup. Although corn was domesticated only 8,000 to 10,000 years ago from the grass teosinte, the genetic diversity between any two strains of corn exceeds that between humans and chimpanzees, species separated by millions of years of evolution. For instance, DNA of the strain B73, the agriculturally important and commonly studied variety decoded by the maize genome project, contains 2.3 billion bases. The genome of a strain of popcorn decoded by researchers in Mexico is 22 percent smaller than B73's.

"You could fit a whole rice genome in the difference between those two strains of corn," says molecular biologist Virginia Walbot of Stanford University.

Much of that difference is due to transposable elements, also known as jumping genes. Transposable elements (transposons for short) are mobile pieces of genetic material that hop around the genome, sometimes taking genes or pieces of genes with them. The genome project discovered new families of transposons, revealing a total of 1,300 such families in maize, says Patrick Schnable, a maize geneticist at Iowa State University in Ames. Transposons and other repeated bits of DNA make up about 85 percent of the maize genome in the B73 strain.

The genetic diversity between two corn strains exceeds that between humans and chimpanzees.

That's an unusually high volume of repetitive DNA, making the decoding effort challenging, says Richard K. Wilson of Washington University School of Medicine in St. Louis. "This was a really tough one," he says.

The large number of repeated stretches meant the popular shotgun approach — relying on computers to assemble a scattershot of DNA fragments from all over the genome into a coherent picture — wouldn't work for corn's code.

Instead, scientists used a slower method similar to that of the Human Genome Project, first putting the pages of corn's genetic instruction book in order and then finding the DNA letters on each page. The $30 million maize project is not entirely finished but has already provided a wealth of knowledge.

B73's genome contains about 32,000 genes, one team reports in *Science*. Transposons have also left pieces of genes scattered throughout the genome. Some of those fragments are active and may help control activity of other genes, Schnable says. The researchers also uncovered evidence that maize strains are creating new genes and losing others. At least 180 of B73's genes are missing from another strain of corn known as Missouri 17, for example. In fact, thousands of segments of DNA found in one strain are completely missing from the other, Schnable and colleagues report in one of the 10 companion articles published in *PLoS Genetics*.

The researchers also describe variation in the number of copies of genes the two strains carry. Some of those gains and losses of genes and other sequences might contribute to hybrid vigor, a condition in which offspring are heartier and better yielding than either parent. Scientists don't know the source of hybrid vigor, but the genome sequence may make it easier to trace, Schnable says.

SCIENCE/AAAS

Environment

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

Chemicals from plastics show effects in boys

Fetal exposure to phthalates linked to less masculine play

By Janet Raloff

Exposures in the womb to a ubiquitous family of industrial chemicals known as phthalates can subtly perturb boys' preferences for certain types of child's play thought to be hardwired in the brain, a new study suggests. The greater a boy's fetal exposure to certain phthalates, the less often he tended to engage in typically masculine play.

Girls' play was unaffected, according to the study, to be published in an upcoming *International Journal of Andrology*.

The reason boys like trucks and girls like dolls relates to fetal differences in brain development, explains Heather Patisaul, a neuroendocrinologist at North Carolina State University in Raleigh. Males develop differently from females — physically and behaviorally — largely through programming by androgens (male sex hormones such as testosterone), she says. In male animals, anything that dampens the testosterone signal during fetal development, such as a chemical or genetic defect, can trigger a subtle demasculinization.

Phthalates can exhibit anti-androgenic activity (*SN: 9/2/2000, p. 152*), says Shanna Swan of the University of Rochester School of Medicine & Dentistry in New York. She and her colleagues investigated whether testosterone-programmed behaviors in young children are undermined by fetal exposure to the pollutants, which are widely used as solvents and as plastic softeners.

Researchers measured phthalates during mid-pregnancy in women participating in a four-state project called the Study for Future Families. Three to six years later, these moms rated play by their children — 74 boys and 71 girls — based on how often in the past month a child had done such things as play house, play at fighting, climb, play with dolls, dress up in girls' clothes or show interest in toy cars.

Boys with the highest fetal exposures to phthalates — particularly to diethylhexyl phthalate, or DEHP, and dibutyl phthalate, or DBP — exhibited lower scores on typical male play (such as playing with toy guns or pretending to play with guns) and higher scores on gender-neutral play (such as puzzles or sports). The results persisted even after accounting for such factors as parents' age and education. DEHP is in plastic tubing, including types used widely in food processing, Swan notes. DBP is a solvent in many cosmetics, including nail polish and hair sprays.

Play in the highly phthalate-exposed boys wasn't "feminized," Swan explains, since they didn't preferentially play with dolls or don dresses. "We'd describe their play as less masculine," she says.

The new study is not the first to link pollutants with alterations in gender-typical play, but it appears to be the strongest, says David Carpenter of the University at Albany in Rensselaer, N.Y.

Kimberly Yolton of Cincinnati Children's Hospital Medical Center considers the new findings "a potentially big deal — primarily because we all have exposure to phthalates." The Pre-school Activities Inventory used to assess these children "is not super sophisticated," the developmental psychologist says. Then again, for this age group, she says, "it really is the only means out there."

Pepper virus tracks human pollution

Plant pathogen could help identify contaminated waters

By Rachel Ehrenberg

A plant virus might edge out the *E. coli* bacterium as a signpost for waters polluted by human waste. Pepper mild mottle virus is widespread in raw sewage, treated wastewater and seawater exposed to wastewater, scientists report in the November *Applied and Environmental Microbiology*.

The pepper mild mottle virus attacks pepper plants and is common in human waste.

PAMELA ROBERTS/UNIV. OF FLORIDA

Sampling for the pepper virus could track human pollution that can spread to coral reefs and other ecosystems, says study coauthor Mya Breitbart of the University of South Florida in St. Petersburg. If the virus can be correlated with disease risk, it may allow for a faster determination of whether a beach should be closed than current methods do, Breitbart says.

The common method for testing waters is to plate the water sample and see what bacteria grow, which often takes 24 hours. "There's always this lag," she says. "It's the classic 'the beach should have been closed yesterday.'"

Scientists don't yet know whether pepper mild mottle in water is a good indicator of the potential for swimmers to get sick. But it does appear to be a good indicator of human pollution: Previous work found the pepper virus in concentrations of 1 million to 1 billion viruses per gram of dry raw sewage. The virus is harmless to people but can be a pathogen in hot, bell and ornamental peppers. The virus makes its way into human waste through food.

Another study from Breitbart's lab, in the November *Environmental Microbiology*, reports that relatives of the pepper virus also persist in reclaimed water.

Molecules

98.4 ± .7 degrees Fahrenheit — Average body temperature for women

98.1 ± .7 degrees Fahrenheit — Average body temperature for men

Study finds a possible protein link between osteoporosis, hot flashes

Bone-growth regulator can also act as a thermostat in mice

By Tina Hesman Saey

Beauty may be only skin deep, but hot goes to the bone.

Proteins involved in breaking down bones may also be part of the body's thermostat, a new study shows. The proteins — a receptor called RANK and the protein that binds to it, called RANKL — turn up the heat to cause fever during infections and also help regulate daily temperature rhythms in female rodents, a study published in the Nov. 26 *Nature* shows.

And the proteins, which are involved in osteoporosis, may also be a source of the hot flashes that many postmenopausal women experience.

Scientists already knew that RANK and RANKL team up to help tear down bones. That demolition is part of normal bone maintenance, and in pregnant women, it also helps free up calcium that in turn is used to solidify fetal bones. The proteins are also part of the signaling pathway that prompts lactation. After menopause, the bone remodeling system may take tearing down too seriously, resulting in osteoporosis. Large-scale clinical trials have recently shown that denosumab, an antibody directed against RANKL, can help protect bones from this breakdown.

Researchers had been surprised to find the protein pair in the brain, says Josef Penninger, an immunologist at the Institute of Molecular Biotechnology at the Austrian Academy of Sciences in Vienna. It is important to find out what the proteins are doing in the brain before giving RANK blockers such as denosumab to millions of women as an osteoporosis therapy, Penninger says.

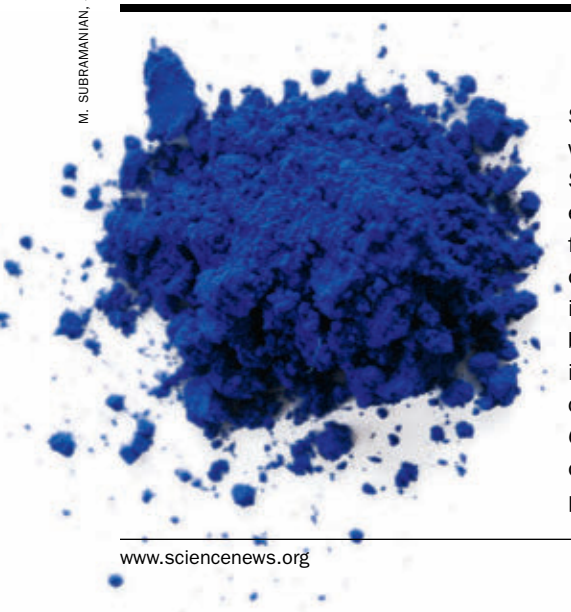
To find the proteins' role in the brain, Reiko Hanada, a member of Penninger's group, injected RANKL into the brains of rats and mice. The rodents stopped moving around and were hot to the touch, both indications of fever. Inhibiting RANKL reduced the animals' fevers.

In the new study, the researchers traced the proteins to neurons and to glial cells called astrocytes in parts of the brain known to be involved in regulating body temperature. From there, the team used some genetics tricks to remove RANK from only the astrocytes. The results showed that fever regulation takes place in the astrocytes.

The pair of proteins also participate in the daily rise and fall of body temperature — at least in female mice. The female mice genetically engineered to lack RANK in their brains had increased body temperatures during the animals' normal daytime sleeping period, a time when their body temperatures usually dip. In humans, a similar temperature dip happens at night. Researchers found no effect of RANK on daily body temperature cycles in male mice.

Body temperature regulation by RANK and RANKL depends in part on female sex hormones made by the ovaries, the study found. The researchers suggest that in humans, rapid changes in activity of the two proteins might lead to hot flashes in postmenopausal women who have lost the steadying influence of estrogen.

"It's really very provocative," says Steven Teitelbaum, a bone cell biologist at Washington University School of Medicine in St. Louis. Denosumab antibodies are too large to get across the protective blood-brain barrier, but researchers should be cautious about making other, smaller molecules. "The clinical message here is that one should be careful of any RANKL blockers that cross the blood-brain barrier."



M. SUBRAMANIAN, SMITH *ET AL.*/JACS

Metal gives pigment the blues

Some scientists really blew it. They accidentally made a new blue pigment by doping white and black compounds with manganese. A team of researchers led by Mas Subramanian of Oregon State University in Corvallis was studying the magnetic and electronic properties of manganese oxides when a tray of samples came out of a furnace bright blue after baking at 1,200° Celsius. "I've never seen a manganese oxide give rise to such beautiful colors," Subramanian says. The group was working with yttrium indium oxide, which is white, and yttrium manganese oxide, which is black. When manganese was added, it created a nice short bond with oxygen atoms in these compounds. These short bonds and the unusual crystalline structures of the compounds yield the blue hue, the team reports in the Dec. 2 *Journal of the American Chemical Society*. Electrons in the doped compounds absorb light in the red-green part of the spectrum, but not in the blue. The new blue (left) may end up in paints and inks, perhaps replacing old standbys that can be toxic or unstable. —*Rachel Ehrenberg*

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

Revving up particles in the cosmos

Cygnus X-3 gamma rays may help explain power of quasars

By Ron Cowen

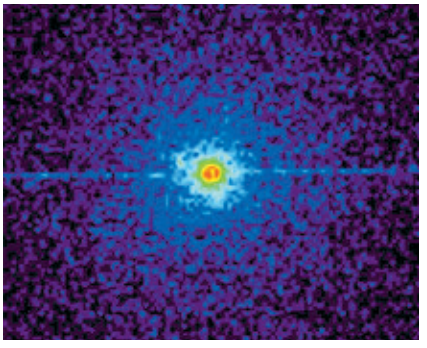
Some 30,000 light-years from Earth, a tiny gravitational monster is tearing material from a companion star, blasting X-rays into space and sporadically hurling out jets of radio-wave–emitting blobs at close to the speed of light.

Two teams have now made the first definitive detection of high-energy gamma rays from this system, a microquasar known as Cygnus X-3. The finding may provide a new window on how this beast — thought to be either a small black hole or a neutron star orbiting an ordinary partner — accelerates charged particles to enormous energies, researchers reported in November at the 2009 Fermi Symposium in Washington, D.C.

Details about the Cygnus X-3 gamma rays may also shed light on how distant quasars pump even greater amounts of energy into space.

Detecting gamma rays from Cygnus X-3 was a feat in itself, made possible by sensitive detectors on two flying observatories. But both teams note that they are most excited about the unexpected clockwork pattern of the gamma-ray emission, which always seems to occur during a lull in high-energy X-rays and just before the onset of powerful radio jets.

The gamma rays, generated by the acceleration of charged particles to extreme energies, may signal "the preparation, the storage of energy for the major radio flares," says Marco Tavani of Italy's Space Astrophysics and Cosmic Physics Institute in Rome. Three times since April 2008, he and his collaborators witnessed the same pattern: "Just one day after the gamma-ray flare — boom! It makes this very major radio flare," Tavani says.



Gamma rays from Cygnus X-3 (shown), a microquasar, offer hints about how it accelerates particles to high energies.

Cygnus X-3 is categorized as a microquasar, and observing it may provide clues to how the more distant quasars, powered by supermassive black holes, accelerate particles to much greater energies. "Microquasars such as Cygnus X-3 are the ideal laboratory for studying the jet phenomena that dominate the most luminous quasars' emissions," comments X-ray astronomer Josh Grindlay of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. Because the emissions from microquasars vary on time scales of days to weeks, rather than decades like quasar emissions, systems such as Cygnus X-3 "are the test bed of choice" for probing quasar activity, he says.

> Systems such as Cygnus X-3 "are the test bed of choice" for probing quasar activity.
>
> JOSH GRINDLAY

Tavani's team has used the Italian Space Agency's AGILE spacecraft to monitor gamma-ray emissions from Cygnus X-3 for the past two years. The findings have been posted online and are scheduled to appear in an upcoming *Nature*.

Several members of the other team, which observed Cygnus X-3 with the Fermi Gamma-ray Space Telescope, declined to comment on their work before its publication in *Science*. The Fermi team's findings "are completely consistent" with those recorded by AGILE, Tavani says.

The gamma rays observed by AGILE were in the form of flares at energies of about 100 million electron volts. Follow-up radio observations by Tavani's team, along with comparisons with X-ray observations by NASA's Swift satellite, revealed that the flares preceded radio jets and occurred during a decline in high-energy X-rays from Cygnus X-3.

"This is a complete change from previous models," Tavani asserts. Neutron stars and black holes (both thought to power microquasars) can have strong magnetic fields, and Tavani envisions a mechanism in which a magnetic field stores an enormous amount of energy. This energy first accelerates charged particles and prompts them to emit gamma rays. Then the magnetic gate opens, and radio-emitting blobs are pushed out of the system. "The radio jets are the manifestation of what happened before" with the gamma rays, he suggests.

Fermi observations also show that the intensity of the gamma rays varies on a 4.8-hour cycle, known from X-ray observations to be the time it takes for the ultradense member of the Cygnus X-3 system to orbit its partner star. The 4.8-hour signature confirms that the gamma rays come from Cygnus X-3 rather than from another source in the same patch of sky.

"It is an interesting result, but I also think that it's still not clear in detail how the gammas are produced," comments Tod Strohmayer of NASA's Goddard Space Flight Center in Greenbelt, Md. "Nevertheless, it is giving us another tool to study these extremely energetic beasts, and that's exciting."

Both the radio jets and the gamma-ray flares are infrequent, Tavani notes. That could explain why observations in the 1980s of trillion-eV gamma rays in the Cygnus region were never confirmed. It's possible that those detections were of strong but fleeting gamma-ray flares, Grindlay says.

NASA, SRON, MPE

Matter & Energy

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

Physicists find effective recipe for programmable quantum computer

Beryllium ion system tackles 160 random processing tasks

By Laura Sanders

Using a few ultracold ions, intense lasers and some electrodes, researchers have built the first programmable quantum computer. The new system, described in a paper online and to be published in *Nature Physics*, flexed its versatility by performing 160 randomly chosen processing routines.

Earlier versions of quantum computers have been restricted to a narrow window of specific tasks. To be more generally useful, a quantum computer should be programmable, in the same way that a classical computer must be able to run many different programs on a single piece of machinery.

The new study is "a powerful demonstration of the technological advances towards producing a real-world quantum computer," says quantum physicist Winfried Hensinger of the University of Sussex in Brighton, England.

Researchers led by David Hanneke of the National Institute of Standards and Technology in Boulder, Colo., based their quantum computer on two beryllium ions chilled to just above absolute zero. These ions, trapped by an electromagnetic field on a gold-plated alumina chip, formed the quantum bits, or qubits, analogous to the bits in regular computers represented by 0s and 1s. Short laser bursts manipulated the beryllium ions to perform the processing operations, while nearby magnesium ions kept the ions cool and still.

Hanneke and colleagues programmed the computer to do operations on a single beryllium ion and on both of the beryllium ions together. In the quantum world, a single qubit can represent a mixture of 0 and 1 simultaneously, a state called a superposition. A laser pulse operation could change the composition of the mixture in the qubit, tipping the scales to make the qubit more likely to become a 1 when measured.

Both of the qubits together could be entangled, a situation where the two qubits are intimately linked, and what happens to one seems to affect the fate of the other. Different combinations of one- and two-qubit operations made up various programs. "We put all these pieces together and asked, what can we do with the circuit?" Hanneke says.

Hanneke and colleagues chose 160 programs for the quantum computer to run. "We picked them, quite literally, at random," Hanneke says. "We really wanted to sample all possible operations."

The researchers ran each program 900 times. On average, the quantum computer operated accurately 79 percent of the time, the team reported. "Getting this kind of control over a quantum system is really interesting from a physics perspective," Hanneke says.

Earlier research had estimated that to be useful, a quantum computer must operate accurately 99.99 percent of the time. Hanneke says refinements may improve the system's fidelity.

Experimental physicist Boris Blinov says that one of the most exciting things about the new study is that the quantum computer may be scaled up. "What's most impressive and important is that they did it in the way that can be applied to a larger-scale system," says Blinov, of the University of Washington in Seattle. "The very same techniques they've used for two qubits can be applied to much larger systems."

D. TERWAGNE *ET AL.*/ *CHAOS*

How to mix oil and water

Scientists in Belgium have uncovered a new way to shake things up. Violent bouncing of a water droplet coated with oil causes some of the oil layer to move inside and fracture into many oily globs. In a paper published in the December *Chaos*, researchers at the University of Liège call this microemulsion of oil and water "the mayonnaise droplet." From earlier experiments, researchers knew that on a bed of oil, blobs of oil will bounce several times. Denis Terwagne and colleagues wanted to know what would happen to an oil-coated water droplet if the bouncing was prolonged. To find out, the team constructed a moving base that would quickly raise and lower an oil bed, similar to using a pingpong paddle to keep a ball bouncing up and down. When the oily droplet hit the oil surface and deformed, some of the outer oil layer was ushered into the interior of the droplet (above, left). Subsequent bounces shattered this interior oil glob, creating a thoroughly mixed oil-in-water-in-oil droplet (above, right), the researchers found. Understanding the forces that govern the mayonnaise droplet may help scientists design new microfluidic systems. —*Laura Sanders*

Body & Brain

For more meeting stories, visit **www.sciencenews.org**

Heart disease plagued ancient Egyptians, too

CT scans of mummies reveal evidence of clogged arteries

By Laura Beil

The curse of the mummy may truly be fatal. An examination of mummified bodies has revealed that ancient Egyptians suffered from hardening of the arteries in surprising frequency, suggesting blame for heart disease extends beyond the modern culprits of smoking, fast food and the remote control.

Full-body CT scans of 22 mummies dating from 2,000 to 3,500 years ago turned up 16 with hearts or arteries preserved enough to study. Of those, nine had evidence of blockage from atherosclerosis. "This disease has been around since before the time of Moses," said Randall Thompson of the Saint Luke's Mid America Heart Institute in Kansas City, Mo. Thompson and colleagues reported the findings November 17 and in the Nov. 18 *Journal of the American Medical Association*.

Scans of mummies between 2,000 and 3,500 years old show buildup of fat, cholesterol and calcium in arteries.

Others have X-rayed famous mummies, but "no one has ever put a series of ancient people through modern CT scans," Thompson said.

The research team decided to conduct the study after two members — Gregory Thomas of the University of California, Irvine and Adel Allam of the Al Azhar Medical School in Cairo — visited the Museum of Antiquities in Cairo. The nameplate for Merenptah, who ruled around 1200 B.C., claimed that he had suffered from atherosclerosis.

On CT scans, buildup of fat, cholesterol and calcium inside artery walls looks as distinct for the dead as the living, the team reported. Among the eight people in the sample who had lived past age 45, seven had signs of clogged arteries. The most ancient mummy to have suffered from heart disease, Lady Rai, died in her 30s around 1530 B.C. She was a nursemaid to Queen Amrose Nefertari.

This doesn't mean modern risk factors have no bearing on heart disease, said Robert Bonow of Northwestern University's Feinberg School of Medicine in Chicago. "Patients should not take this as evidence that they shouldn't worry about preventing heart disease because it's been around a long time," he said.

MEETING NOTES

Obese people misjudge body size

About 12 percent of people who are classified medically as obese believe they have a healthy body size and do not need to lose weight, a new study indicates. The results, reported November 17, suggest that physicians cannot assume that obese patients realize the health implications of excess weight.

The research involved members of the Dallas Heart Study, which is tracking a cross section of almost 6,000 people in Dallas County, Texas, mainly from a largely minority and urban population. After asking participants to classify their body size as below normal, normal or above normal, the researchers found that about one of every eight obese people rated their body size as normal and healthy. Yet 35 percent of those who misjudged their size had high blood pressure, 15 percent had high cholesterol and 14 percent had diabetes.

Obese patients who misperceived their body size were also less likely to see a physician. "Perception affects behavior," said Tiffany Powell of the University of Texas Southwestern Medical Center at Dallas. — *Laura Beil*

Runners' stressed hearts

Even though studies have found that marathoners can experience changes in heart structure and function consistent with cardiac damage, the runners aren't necessarily having small heart attacks, researchers reported November 18.

Justin Trivax and colleagues from the William Beaumont Hospital in Royal Oak, Mich., studied 25 healthy men and women who participated in the Detroit marathon. Just after the race, the heart's right atrium had swollen an average of about 20 percent in each runner, while the right ventricle had enlarged about 25 percent. In addition, the volume of blood the right ventricle could squeeze out with each contraction had dropped by about 15 percent.

But advanced magnetic resonance images taken just after the runners finished the race did not show any evidence that parts of the heart were suffering damage or lacking blood flow. In addition, levels of alarm enzymes in the blood did not ebb and flow with the patterns of an ongoing heart attack. All of the observed changes subsided within three to six months, Trivax said. — *Laura Beil*

BOTH IMAGES: MICHAEL MIYAMOTO

350 million People worldwide who contract malaria each year (estimated)

1 million Number who die from malaria each year

Malaria resists toughest medicine

Strain that challenges frontline drug shows signs of spreading

By Nathan Seppa

Malaria that is resistant to the best available drug is more widespread in Southeast Asia than previously reported, new research shows. The worrisome finding suggests that travelers could carry this strain of the malaria parasite to other parts of the globe and unwittingly spread it, scientists reported November 19.

The frontline drug, artemisinin, is the most potent medication for malaria. Signs of malarial resistance to the drug have surfaced over the past several years in Cambodia (*SN: 11/22/08, p. 9*). The new findings confirm that resistant malaria has now cropped up in more places. It has appeared in Vietnam and at two spots along the borders of Myanmar (formerly called Burma) with Thailand and China.

"Things are changing. There's no doubt the signs are concerning," said Robert Newman, director of the Global Malaria Programme at the World Health Organization in Geneva. He added that these signals need further verification.

Patients in these areas take longer on average to overcome a malaria infection when given a standard combination of artemisinin and another antimalarial. This lag results from slower clearance of the malaria parasites from the blood, said WHO's Pascal Ringwald, a medical officer who presented the update.

Patients who remain ill for longer stretches despite treatment need extra medication to recover and are also more likely to have fatal cases, Ringwald said.

Malaria is caused by a single-celled parasite that infects the blood. Symptoms include fever, headache, chills, anemia and a swollen spleen. Mosquitoes spread the parasite from person to person.

Malaria has a history of becoming resistant to drugs. The new reports are disheartening because artemisinin normally packs a considerable wallop. Although it is a short-acting drug that gets cleared from the body in a few hours, it makes the most of its time — driving down parasite levels dramatically.

Using artemisinin alone invites resistance. So the standard therapy teams it with one of the longer-acting drugs, said Christopher King, a physician and epidemiologist at Case Western Reserve University in Cleveland.

New flashes of resistance may have arisen because combination treatment isn't always available. And since artemisinin can be bought over the counter in parts of Asia, people don't always follow guidelines for pairing artemisinin with another drug, King said. Also, taking artemisinin for a fever that isn't caused by malaria can allow resistant strains of the parasite to take hold, Newman said.

Artemisinin is derived from the sweet wormwood bush. The bush's leaves have been used as a folk remedy for 2,000 years in Asia but fell out of use in the 20th century with the use of modern drugs.

Tree skirts guard sap from Nipah

Shields help prevent spread of deadly virus by fruit bats

By Nathan Seppa

Simple bamboo skirts attached to date palms can protect the trees' tasty sap from contamination by fruit bats. In so doing, the low-tech devices may prevent the spread of the lethal Nipah virus, researchers from Bangladesh reported November 21.

Nipah virus is a relatively new pathogen, first identified in 1999. The virus can spread from person to person but is more likely to pass from an animal to a person. Fruit bats — known as flying foxes and common in Southeast Asia — can carry the virus without being sickened by it.

"This is basically a bat virus that occasionally spills over into other animals," including humans, says study coauthor Stephen Luby of the Centers for Disease Control and Prevention in Atlanta and the International Center for Diarrheal Disease Research, Bangladesh in Dhaka.

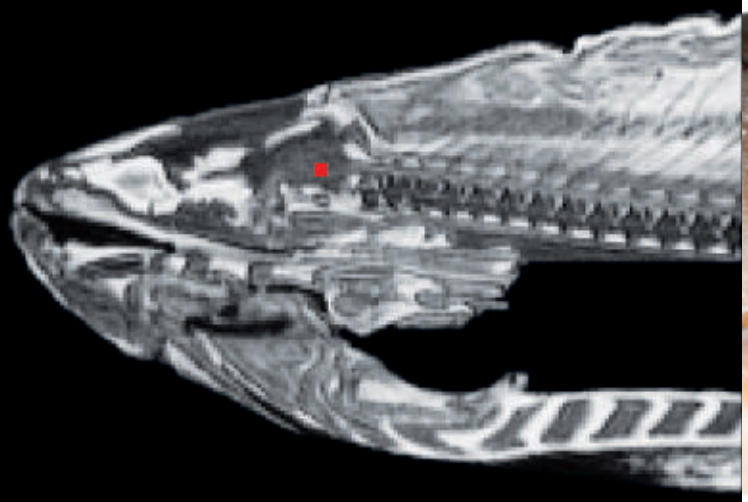
In Bangladesh, people harvest date palm sap by shaving part of the trunk, slicing a groove in it and attaching a collection pot. Researchers have found that fruit bats sully the sap with saliva or urine that drips down the trunk into the pots.

Nipah virus can cause encephalitis infections that prove fatal in about three-fourths of cases, says veterinarian M. Salah Uddin Khan of the ICDDR-Bangladesh.

M. SALAH UDDIN KHAN

In Bangladesh, bamboo shields keep tasty palm sap from being tainted by fruit bats that can spread Nipah virus.

Some villagers use handwoven bamboo skirts to cover part of the trunk and the top of the pot. Scientists tested whether the skirts prevented sap contamination using motion-activated infrared cameras to track bats' nocturnal visits. Sap from unprotected palms was tainted 85 percent of the time, but palms with properly placed skirts yielded clean sap.



Trawling the brain

New findings raise questions about reliability of fMRI as gauge of neural activity

By Laura Sanders

The 18-inch-long Atlantic salmon lay perfectly still for its brain scan. Emotional pictures — a triumphant young girl just out of a somersault, a distressed waiter who had just dropped a plate — flashed in front of the fish as a scientist read the standard instruction script aloud. The hulking machine clunked and whirred, capturing minute changes in the salmon's brain as it assessed the images. Millions of data points capturing the fluctuations in brain activity streamed into a powerful computer, which performed herculean number crunching, sorting out which data to pay attention to and which to ignore.

By the end of the experiment, neuroscientist Craig Bennett and his colleagues at Dartmouth College could clearly discern in the scan of the salmon's brain a beautiful, red-hot area of activity that lit up during emotional scenes.

An Atlantic salmon that responded to human emotions would have been an astounding discovery, guaranteeing publication in a top-tier journal and a life of scientific glory for the researchers. Except for one thing. The fish was dead.

The scanning technique used on the salmon — called functional magnetic

C. BENNETT/UCSB

A region of a dead Atlantic salmon's brain appeared to glow with activity (red) in response to emotional scenes. Statistical checks corrected the spurious findings.

ANDREYUU/ISTOCKPHOTO

resonance imaging — allows scientists to view the innards of a working brain, presumably reading the ebbs and flows of activity that underlie almost everything the brain does. Over the last two decades, fMRI has transformed neuroscience, enabling experiments that researchers once could only dream of. With fMRI, scientists claim to have found the brain regions responsible for musical ability, schadenfreude, Coca-Cola or Pepsi preference, fairness and even tennis skill, among many other highly publicized conclusions.

But many scientists say that serious issues have been neglected during fMRI's meteoric rise in popularity. Drawing conclusions from an fMRI experiment requires complex analyses relying on chains of assumptions. When subjected to critical scrutiny, inferences from such analyses and many of the assumptions don't always hold true. Consequently, some experts allege, many results claimed from fMRI studies are simply dead wrong.

"It's a dirty little secret in our field that many of the published findings are unlikely to replicate," says neuroscientist Nancy Kanwisher of MIT.

A reanalysis of the salmon's postmortem brain, using a statistical check to prevent random results from accidentally seeming significant, showed no red-hot regions at all, Bennett, now at the University of California, Santa Barbara, and colleagues report in a paper submitted to *Human Brain Mapping*. In other words, the whole brain was as cold as a dead fish.

Less dramatic studies have also called attention to flawed statistical methods in fMRI studies. Some such methods, in fact, practically guarantee that researchers will seem to find exactly what they're looking for in the tangle of fMRI data. Other new research raises questions about one of the most basic assumptions of fMRI — that blood flow is a sign of increased neural activity. At least in some situations, the link between blood flow and nerve action appears to be absent. Still other papers point out insufficient attention to insidious pitfalls in interpreting the complex enigmatic relationship between an active brain region and an emotion or task.

Make no mistake: fMRI is a powerful tool allowing neuroscientists to elucidate some of the brain's deepest secrets. It "provides you a different window into how mental processes work in the brain that we wouldn't have had without it," says Russell Poldrack of the University of Texas at Austin.

But like any powerful tool, fMRI must be used with caution. "All methods have shortcomings — conclusions they support and conclusions they don't support," Kanwisher says. "Neuroimaging is no exception."

BOLD assumptions

fMRI machines use powerful magnets, radio transmitters and detectors to peer into the brain. First, strong magnets align protons in the body with a magnetic field. Next, a radio pulse knocks protons out of that alignment. A detector then measures how long it takes for the protons to recover and emit telltale amounts of energy. Such energy signatures act as beacons, revealing the locations of protons ensconced in specific molecules.

fMRI is designed to tell researchers which brain regions are active — the areas where nerve cells are abuzz with electrical signals. Scientists have known for a long time how to record these electrical communiqués with

electrodes, which can sit on the scalp or be implanted in brain tissue. Yet electrodes outside the skull can't precisely pinpoint active regions deep within the brain, and implanting electrodes in the brain comes with risks. fMRI, on the other hand, offers a nonintrusive way to measure neuron activity, requiring nothing more of the subject than an ability to lie in a big tube for a while.

But fMRI doesn't actually measure electrical signals. Instead, the most common fMRI method, BOLD (for blood oxygen level–dependent), relies on tiny changes in oxygenated blood as a proxy for brain activity. The assumption is that when neurons are working hard, they need more energy, brought to them by fresh, oxygen-rich blood. Protons in oxygen-laden hemoglobin molecules, whisked along in blood, respond to magnetic fields differently than protons in oxygen-depleted blood. Detecting these different signatures allows researchers to follow the oxygenated blood to track brain activity — presumably.

"There's still some mystery," Bennett says. "There are still some things we don't understand about the coupling between neural activity and the BOLD signal that we're measuring in fMRI."

Researchers use BOLD because it's the best approximation to neural activity that fMRI offers. And for the most part, it works. But a study published in January in *Nature* reported that the link between blood flow and neural activity is not always so clear. In their experiments, Aniruddha Das and Yevgeniy Sirotin, both of Columbia University, found that in monkeys some blood changes in the brain had nothing to do with localized neuron firing.

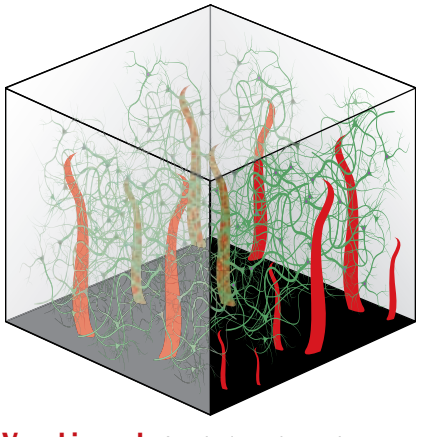
Das and Sirotin used electrodes to measure neuronal activity at the same time and place as blood flow in monkeys who were looking at an appearing and disappearing dot. As expected, when vision neurons detected the dot and fired, blood rushed into the scrutinized brain region. But surprisingly, at times when the dot never appeared and the neurons remained silent, the researchers also saw a dramatic change in blood flow. This unprompted change in blood flow occurred when the monkeys were anticipating the dot, the researchers found. The imperfect correlations between blood flow and neural firing can confound BOLD signals and muddle the resulting conclusions about brain activity.

Mass action

Another fMRI difficulty arises from its view-from-the-top scale. Predicting a single neuron's activity from fMRI is like trying to tell which way an ant on the ground is crawling from the top of the Washington Monument, without binoculars. The smallest single unit measured by BOLD fMRI, called a voxel, is often a few millimeters on each side, dwarfing the size of individual neurons. Each voxel — a mashup of volume and pixel — holds around 5.5 million neurons, calculates Nikos Logothetis of the Max Planck Institute for Biological Cybernetics in Tübingen, Germany. Assuming that the millions of neurons in a voxel perform identically is like assuming every single ant on the National Mall crawls north at noon.

"fMRI is a measure of mass action," Logothetis says. "You almost have to be a professional moron to think you're saying something profound about the neural mechanisms. You're nowhere close to explaining what's happening, but you have a nice framework, an excellent starting point." BOLD signals could reflect many different events, he says. For instance, some neurons send signals that stop other neurons from firing, so increased activity of these dampening neurons could actually lead to an overall decrease in neuron activity.

Kanwisher points out that words such as "activity" and "response," mainstays of fMRI paper titles, are intentionally vague. Pinning down the details from such a zoomed-out view, she says, is impossible. "What exactly are the neurons doing in there? Is one inhibiting the other? Are there action potentials? Is there synaptic activity? Well, we have no idea," she says. "It would be nice to know what the neurons are doing, but we don't with this method. And that's life."



Voxel innards A typical voxel contains a dense tangle of neurons and other kinds of brain cells (green) and blood vessels (orange). Blood vessels make up a relatively small amount of a voxel, but BOLD fMRI analyses assume that changes in blood flow represent the coordinated activity of millions of neurons.

T. DUBÉ, ADAPTED FROM N. LOGOTHETIS/*NATURE* 2008

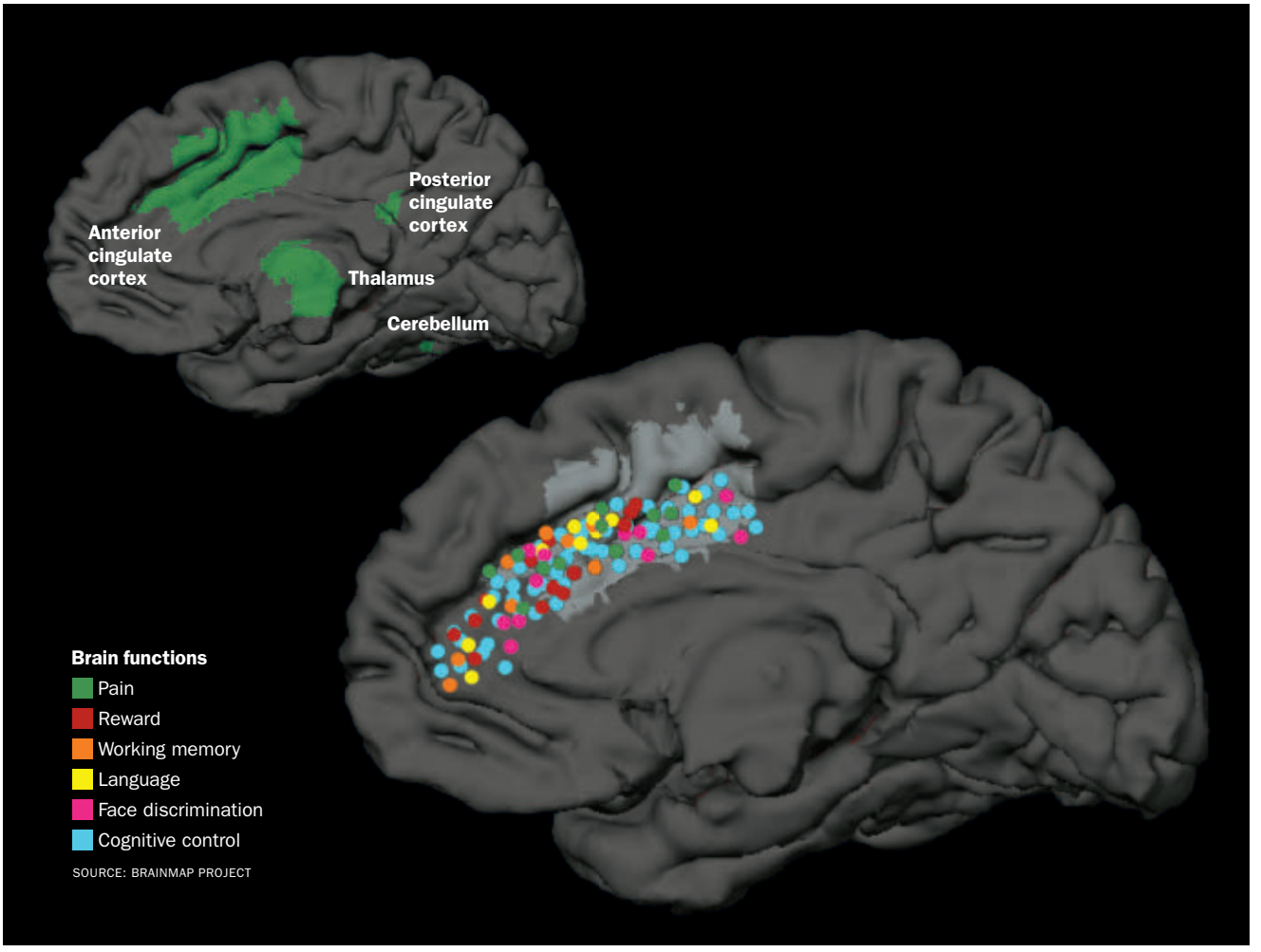
Inadvertent mischief

After BOLD signals have been measured and the patient has been released from the machine, researchers must sort the red-hot voxels from the dead fish. Statistics for dealing with these gigantic data sets are so complex that some researchers outsource the analyses to professional number crunchers. Choosing criteria to catch real and informative brain changes, and guarding against spurious results, is one of the most important parts of an fMRI experiment, and also one of the most opaque.

"It's hellishly complicated, this data analysis," says Hal Pashler, a psychologist at the University of California, San Diego. "And that creates great opportunity for inadvertent mischief."

Making millions, often billions, of comparisons can skew the numbers enough to make random fluctuations seem interesting, as with the dead salmon. The point of the salmon study, Bennett says, was to point out how easy it is to get bogus results without the appropriate checks.

Bennett and colleagues have written an editorial to appear in *Social Cognitive and Affective Neuroscience* that argues for strong measures to protect against false alarms. Another group takes the counterpoint position, arguing that these protections shouldn't be so strong that the real



ANGELA LAIRD/UNIVERSITY OF TEXAS HEALTH SCIENCE CENTER AT SAN ANTONIO, JENNIFER ROBINSON/SCOTT & WHITE MEMORIAL HOSPITAL

Not so simple Most brain regions and mental tasks don't match up one-to-one, confounding the interpretation of fMRI results. For example, pain activates many regions throughout the brain (upper left, labeled green regions). One such region, the anterior cingulate cortex, is also activated by many other functions (lower right brain), such as reward, face discrimination, working memory and aspects of language.

results are tossed too, like a significant baby with the statistical bathwater.

One of the messiest aspects of fMRI analysis is choosing which part of the brain to scrutinize. Some studies have dealt with this problem by selecting defined anatomical regions in advance. Often, though, researchers don't know where to focus, instead relying on statistics to tell them which voxels in the entire brain are worth a closer look.

In a paper originally titled "Voodoo correlations in social neuroscience" in the May issue of *Perspectives on Psychological Science*, Edward Vul of MIT, Pashler and colleagues called out 28 fMRI papers (of 53 analyzed) for committing the statistical sin of "nonindependence." In nonindependent analyses, the hypothesis in question is not an innocent bystander, but in fact distorts the experiment's outcome. In other words, the answer is influenced by how the question is asked.

One version of this error occurs when researchers define interesting voxels with one set of criteria — say, those that show a large change when a person is scared — and then use those same voxels to test the strength of the link between voxel and fear. Not surprisingly, the correlation will be big. "If you have many voxels to choose from, and you choose the largest ones, they'll be large," Vul says.

In a paper in the May *Nature Neuroscience*, Nikolaus Kriegeskorte of the Medical Research Council in Cambridge, England, and colleagues call the nonindependence issue the error that "beautifies" results. "It tends to clean things up at the expense of a veritable representation of the data," Kriegeskorte says.

Digging through the methods sections of fMRI papers published in 2008 in *Nature, Science, Nature Neuroscience, Neuron* and the *Journal of Neuroscience* turned up some sort of nonindependence error in 42 percent, Kriegeskorte and colleagues report in their paper. Authors "do very complicated analyses, and they don't realize that they're actually walking in a very big circle, logically," Kriegeskorte says.

Kanwisher, who just cowrote a book chapter with Vul about the nonindependence error, says that researchers can lean too heavily on "fancy" math.

"Statistics should support common sense," she says. "If the math is so complicated that you don't understand it, do something else."

The problem with blobology

An issue that particularly irks some researchers has little to do with statistical confounders in fMRI, but rather with what the red-hot blobs in the brain images actually mean. Just because a brain region important for a particular feeling is active does not mean a person must be feeling that feeling. It's like concluding that a crying baby must be hungry. True, a hungry baby does cry, but a crying baby might be tired, feverish, frightened or wet while still well-fed.

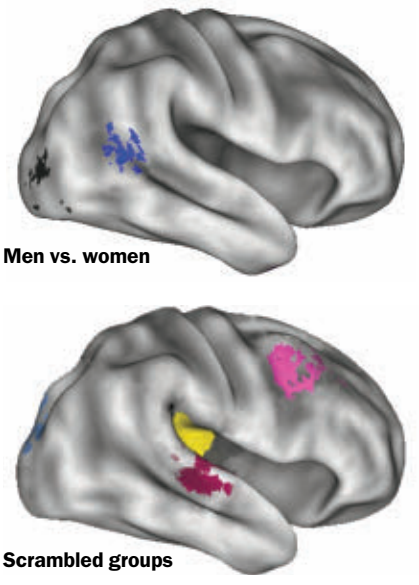
Likewise, studies have found that a brain structure called the insula is active when a person is judging fairness. But if a scan shows the insula to be active, the person is not necessarily contemplating fairness; studies have found that the insula also responds to pain, tastes, interoceptive awareness, speech and memory.

In most cases, the brain does not rely on straightforward relationships, with a specific part of the brain responsible for one and only one task, making these reverse inferences risky, Poldrack points out.

"Researchers often assume that there are one-to-one relations between brain areas and mental functions," he says. "But we don't actually know if that is true, and there are many reasons to think that it's not." Inferring complex human emotions from the activity of a single brain region is not something that should be done casually, as it is often is, he says.

Sometimes, reverse inference is warranted, though, as long as it is done with care. "There's nothing wrong with saying there's a brain region for x," Kanwisher says. "It just takes many years to establish that. And like all other results, you establish it, and it can still crash if somebody presents a new piece of data that argues against it."

Marco Iacoboni of the University of California, Los Angeles and colleagues drew heat from fellow neuroscientists for a *New York Times* op-ed in November 2007 in which the team claimed to have ascertained the emotional states of undecided voters as they were presented with pictures of candidates. For instance, the researchers concluded that activity in the anterior cingulate cortex meant that subjects were "battling unacknowledged impulses to like Mrs. Clinton." Poldrack and 16 other neuroscientists quickly wrote their own editorial, saying that the original article's claims had gone too far.



Uninterpretable brains In language tasks, men and women showed brain activation in 13 different regions (two shown, top). But when the groups were scrambled, 14 brain regions (three shown, bottom) differed in activity between the random groups, suggesting that fMRI findings need to be replicated.

Iacoboni counters that reverse inference has a valuable place in research, as long as readers realize that it is a probabilistic measure. "A little bit of reverse inference, to me, is almost necessary," he says.

Careful language and restrained conclusions may solve some of the issues swirling around fMRI interpretations, but a more serious challenge comes from fMRI's noise. Random fluctuations masquerading as bona fide results are insidious, but the best way to flush them out is simple: Do the experiment again and see if the results hold up. This built-in reality check is time-consuming and expensive, Kanwisher says, but it's the best line of defense against spurious results.

A paper published April 15 in *NeuroImage* clearly illustrates the perils of one-off experiments. In an fMRI experiment, Bradley Schlaggar of Washington University in St. Louis and colleagues found differences in 13 brain regions between men and women during a language task. To see how robust these results were, the researchers scrambled the groups to create random mixes of men and women. Any differences found between these mixed-up groups could be chalked up to noise or unknown factors, the researchers reasoned. The team found 14 "significant" different regions between the scrambled groups, undermining the original finding and rendering the experiment uninterpretable.

"The upshot of the paper is really a cautionary one," Schlaggar says. "It's easy and common to find some group differences at some statistical threshold. So go ahead and do the study again."

In many ways, fMRI has earned its reputation as a powerful neuroscience tool. In the laboratories of capable, thoughtful researchers, the challenges, exceptions and assumptions that plague fMRI can be overcome. Its promise to decode the human brain is real. fMRI "is a great success story of modern science, and I think historically it will definitely be viewed as that," Kriegeskorte says. "Overwhelmingly it is a very, very positive thing."

But the singing of fMRI's praises ought to be accompanied by a chorus of caveats. fMRI cannot read minds nor is it bogus neophrenology, as Logothetis pointed out in *Nature* in 2008. Rather, fMRI's true capabilities fall somewhere between those extremes. Ultimately, understanding the limitations of neuroimaging, instead of ignoring them, may propel scientists toward a deeper understanding of the brain. ■

Explore more

- fMRI 4 Newbies: psychology.uwo.ca/fmri4newbies
- Craig Bennett's blog: prefrontal.org/blog
- Nikos Logothetis. "What we can do and what we cannot do with fMRI." *Nature*. June 12, 2008.

S.K.Z. IHNEN *ET AL./NEUROIMAGE* 2008

Bags of Vintage U.S. Silver Coins Saved From Govt. Melt-Down!

GovMint.com is releasing to the public bags of historic U.S. silver coins not seen in circulation for decades. They are priced not by the rarity of the individual coin but by silver weight...in full size Quarter Pound, Half Pound and One Pound bags.

Valuable Collector Coins

Every U.S. silver coin bag is guaranteed to contain a Quarter, Half, or Full Pound in Troy (precious metal) weight. But that's just the beginning. 100% of them are valuable U.S. collector coins and have premium value above and beyond the silver! Every coin will have a numismatic collector grade of Very good or higher with FULL dates and mint marks — Guaranteed!

Guaranteed in Every Bag

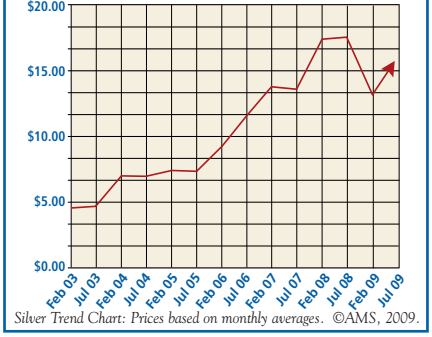
- Walking Liberty Half Dollar (1916-1947)
- Franklin Half Dollar (1948-1963)
- Kennedy Half Dollar (1965-1970)
- Roosevelt Dime (1946-1964)
- Washington Quarter (1932-1964)
- Mercury Dime (1916-1945)
- Barber Dime (1892-1916)

All Silver — All GUARANTEED!

Long-Lost Silver Hidden for Decades

Imagine if you could step back in time to hold in your hands the historic U.S. silver coins from a half century ago. How much would they be worth? Hundreds of millions of dollars of these precious coins were officially melted down by the government decades ago, until at last they were gone. Our coins today are nothing but copper, nickel and zinc. All surviving American silver coins are becoming more sought-after with each passing day.

Price of Silver on the Rise



Silver Trend Chart: Prices based on monthly averages. ©AMS, 2009.

Coins shown larger than actual size

Cash In On the Silver Market Now

Today, demand for vintage U.S. silver coins is near all-time highs, with record-breaking prices. Dealers report one of the strongest coin markets since the 1970s! What's more, the price of silver itself is roaring upward, reaching prices not seen for years. Will it rocket past the $50 per ounce mark it set in 1980? Time will tell, but thousands of savvy coin buyers are now stashing away old U.S. silver coins, anticipating a bright future.

Order Today Before Prices Go Higher

Our supply of historic U.S. silver coins is very limited and the supply continues to shrink. While there is no guarantee, we think these precious survivors are sure to be appreciated in years to come and will make a treasured gift or legacy for your children.

NOTICE: Due to recent increases in the price of silver, coins cannot be guaranteed at this special price, and the price is subject to change without notice. Supplies are limited, call now to avoid disappointment.

Order Risk Free!

You must be 100% satisfied with your bag of silver coins or simply return it via insured mail within 30 days of receipt for a prompt refund (less s&h).

FREE Morgan Dollar for First 50 Callers

The first 50 callers will also receive this FREE authentic Pre-1922 Morgan Silver Dollar with each half pound of silver coins you order! CALL NOW!

Order More To SAVE More

Quarter Pound Bag U.S. Silver Coins $99*

Half Pound Bag $182* SAVE $16
(Plus BONUS Morgan Silver Dollar!)

Full Pound Bag $359* SAVE $37
(Plus BONUS *Two* Morgan Silver Dollars!)
**Plus shipping and handling*

Toll-Free 24 hours a day
1-888-201-7661

Offer Code MBS163
Please mention this code when you call.

GovMint.com
YOUR ONE BEST SOURCE FOR COINS WORLDWIDE

14101 Southcross Drive W., Dept. MBS163
Burnsville, Minnesota 55337

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 May 2009. ©GovMint.com, 2009

BBB ACCREDITED BUSINESS

BILL O'LEARY/*THE WASHINGTON POST*

To prevent Shania the octopus from becoming bored, keepers at the National Aquarium in Washington, D.C., gave her a Mr. Potato Head filled with fish to snuggle. Researchers are now looking beyond behavior into the brain for signs of awareness in birds and invertebrates.

Humans wonder, anybody home?

Brain structure and circuitry offer clues to consciousness in nonmammals

By Susan Gaidos

One afternoon while participating in studies in a University of Oxford lab, Abel snatched a hook away from Betty, leaving her without a tool to complete a task. Spying a piece of straight wire nearby, she picked it up, bent one end into a hook and used it to finish the job. Nothing about this story was remarkable, except for the fact that Betty was a New Caledonian crow.

Betty isn't the only crow with such conceptual ingenuity. Nor are crows the only members of the animal kingdom to exhibit similar mental powers. Animals can do all sorts of clever things: Studies of chimpanzees, gorillas, dolphins and birds have found that some can add,

subtract, create sentences, plan ahead or deceive others.

To carry out such tasks, these animals must be drawing on past experiences and then using them along with immediate perceptions to make sense of it all. In other words, some scientists would say, these animals are thinking consciously.

Many people (some scientists among them) would like to believe that consciousness sets the human mind apart from the rest of the animal kingdom. But whether in humans or other creatures, behavioral signs of cognizance all arise from the tangled interactions of neurons in the brain. So a growing number of scientists contend that animals with brain structures and neural circuitry similar to humans' might experience something like human awareness, even if a bit less sophisticated.

Still, everyone agrees that consciousness is one of science's great unsolved mysteries. Something goes on in the heads of people when they are seeing, thinking or feeling that does not occur during dreamless sleep. For two decades or so, researchers have been conducting studies to see what kinds of brain activity match up with those specific experiences.

Drawing on this information, scientists are now poised to explore the possible presence of consciousness in animals. Neurobiological information gleaned from studies of brain activity, together with studies of animal behavior, may help scientists identify various types of conscious states in animals, says neurobiologist David Edelman of the Neurosciences Institute in San Diego. He and collaborator Anil K. Seth outlined a framework for probing animal consciousness in the September *Trends in Neurosciences*.

"In many cases, we still know nothing about the brain areas that would control consciousness in a particular animal," Edelman says. "But we now have data in the human domain that suggests where to look and what to look for."

Past studies have shown that specific monkey brain structures do what they do in humans when the animals engage in certain activities, such as tracking objects in their visual field. "This raises the intriguing question whether conscious experience requires the specific structure of human or primate brains," biologist Donald Griffin wrote in *Animal Minds: Beyond Cognition to Consciousness* in 2001.

But today, Edelman says, most neuroscientists agree that consciousness probably correlates with the degree of complexity of the nervous system, not just a specific brain architecture. And studies are exploring self-awareness beyond monkeys and apes, even beyond mammals.

Recent studies of bird brains reveal that avian gray matter is more similar to mammalian brains than not — a fact that might explain why many kinds of birds are able to manufacture tools (*SN: 8/29/09, p. 5*), solve mathematical problems (*SN: 4/25/09, p. 15*) and communicate in ways that even some primates can't. And new work suggests that some invertebrates with wildly different brain structures, such as octopuses, have elaborate nervous systems and show high intelligence. They use tools, exhibit play behavior and have distinct personalities.

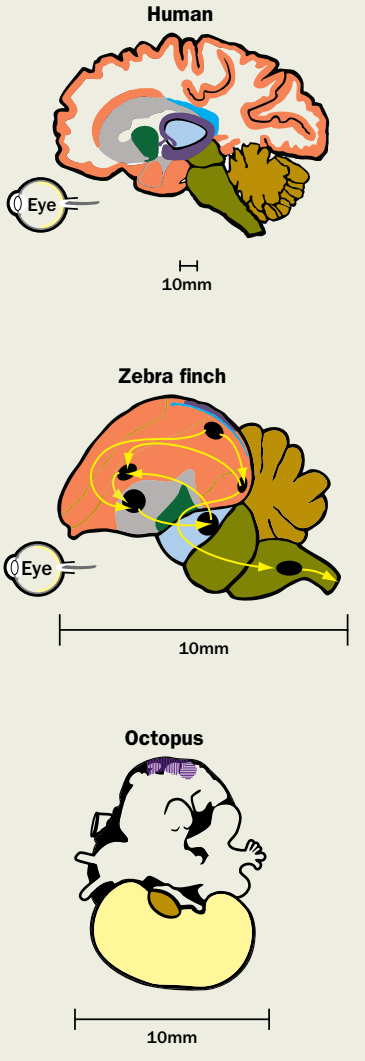
Studies designed to probe the conscious states of animals with various brain architectures may help scientists better understand the mechanisms underlying consciousnesses and how such levels of awareness evolved. John David Smith, a psychologist at the University at Buffalo of the State University of New York, says it's important to keep in mind that consciousness is not an all-or-nothing event. "It didn't just wink on like a fuse box in a house getting switched on," he says. "There are levels and gradations of the capacity, and I think we have to bear that in mind."

A consciousness loop

Everyone has an idea of what being conscious means, but nobody seems to be able to define it. In the 17th century, French philosopher and mathematician René Descartes declared that mind and body are separate, leaving the debate over the nature of consciousness to philosophers and theologians. Today scientists reject that notion, viewing

Brain-on-brain comparisons

In an effort to find signs of consciousness, scientists are identifying analogous structures (same coloring) among the brains of humans, birds, octopuses and other animals. The cortex, hippocampus and thalamus are believed to be involved in generating awareness. Once such structures are identified, researchers can look for similarities in neural circuitry (yellow arrows represent a vocal learning pathway in the zebra finch).



D. EDELMAN

consciousness as arising from the activity of neurons in the brain.

The late Francis Crick, who shared a Nobel Prize for the discovery of DNA's structure, helped pioneer studies on the neural basis of consciousness. Working with his longtime collaborator, neuroscientist Christof Koch of Caltech, Crick argued that consciousness is synonymous with awareness — all forms of awareness — and that only by examining neurons and their interactions could scientists accumulate the kind of empirical knowledge needed to create a scientific model of it.

Edelman likens conscious experiences to "scenes" in which sensations, perceptions, thoughts and feelings are unified into a picture of the world. Higher-order consciousness — the kind that humans have — may include context that helps shape the experience, such as inner dialog, implicit expectations and voluntary control of thought and action. Such high-level cognizance makes people aware that they are aware. Primary consciousness, on the other hand, requires no self-reflection but does require a neuronal circuit capable of combining attention and short-term memory, Edelman says.

"It's the ability to take in sensory information and form memories — whether those memories persist for tens of seconds or minutes — that allows one to interact in a meaningful way," Edelman says.

Scientists are working to identify the neurological mechanisms that knit sensory input and memory into a unified perception. One possible mechanism is a curious electrical rhythm in the brains of animals exposed to sensory stimuli. Known as gamma oscillations, the waves reflect the synchronous activity of large interconnected networks of neurons firing together roughly 40 times per second. This beat spreads across the brain and seems to be especially strong when animals are concentrating on a single object — such as they might when tracking the scent of their favorite prey.

More recent studies of human brain activity show that consciousness creates other frequencies of oscillation that can be detected using an electroencephalograph, or EEG. In 2005, Edelman and colleagues published a paper in *Consciousness and Cognition* outlining a series of studies showing that recordings taken during tasks such as memorization or problem solving reveal a circuit of neural activity running in loops between the thalamus, known to help control alertness, and the cerebral cortex, the brain's outer layer where sensory stimuli enter.

The presence of such activity is considered a correlate of human consciousness, rather than a direct measure, because "it's hard to know the exact instant a person is being conscious," Edelman says. "Still, 99 percent of the time if you're scanning a person and they're responding to something and they're aware of something, that signature appears reliably."

Such EEG patterns and cortical-thalamic interactions serve as a convenient reference point to probe for potential conscious states in other animals, he says. Birds, for example, don't have a cortex, but recent findings on the structure of avian brains do reveal a robust higher-processing center intricately wired to deal with information in a similar way.

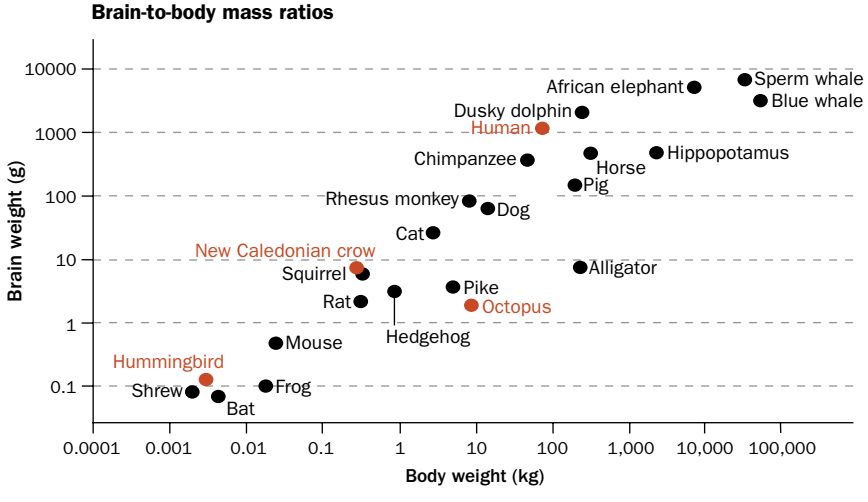
Singing in the brain

Bird brains have long had a bad rep, and until recently were considered to consist of one large basal ganglia forebrain and a few "primitive" structures. In 2005, Duke University neuroscientist Erich Jarvis showed this isn't the case at all. In reviewing the neuroanatomy of birds, he noted that there is a higher-processing center — similar to humans' cortical area — in the brains of all vertebrates, including birds, fish, reptiles and mammals. This area, critical for reasoning and remembering, is organized differently in birds and in mammals. In mammals, it appears as layered cells in the cortex, while in birds it is organized as clustered cells, Jarvis and colleagues pointed out in *Nature Reviews Neuroscience*.

Ann Butler, a neuroscientist at George Mason University in Fairfax, Va., says that before Jarvis' studies, many people thought the layering of cells, such as is found in the human cortex, was required to carry out complex behavior. Now scientists think that is not necessarily the case.

"For some reason, people think that because birds are far away from their genetic relationship to humans, that they're one of the last groups of animals in which you should look for consciousness," says Butler, who is working to identify neural features that may be capable of rendering consciousness in birds. "But I'm going to argue that they're probably one of the first."

Big brains and small brains Some scientists look to brain-to-body mass ratio as a sign of intelligence. Humans and dolphins have larger ratios, while the hippopotamus and blue whale have smaller brains than expected for their body size. New Caledonian crows beat out some mammals; octopuses, despite being invertebrates, rival some mammals.



SOURCE: GERHARD ROTH AND URSULA DICKE/*TRENDS IN COGNITIVE SCIENCES*, MAY 2005

Butler says Jarvis' studies explain why some birds, such as the famous African gray parrot Alex, can do things that were once thought specific to primates, such as recalling events from distinct times or places. In a survey of the literature on neuroanatomy and behavior in birds, published in October 2006 in *The Biological Bulletin*, Butler and her colleagues pointed to studies showing that birds can carry out sophisticated cognitive processes generally associated with mammals, including the ability to play games in which they intentionally deceive others or the ability to design and make tools.

"Studies show some birds will hide objects differently when another animal sees them hide it, suggesting that the bird who was hiding an object is aware of other animals' thought processes," she says. "In most people's minds, that can be defined as a conscious behavior."

Though scientists have yet to find evidence in birds of the cortical loops associated with conscious states in humans, Jarvis' studies have revealed at least one brain pathway with similarities to a pathway involved in human speech. His group found that in birds with vocal learning abilities — songbirds, parrots and hummingbirds — the brain structures for singing and learning to sing are embedded in areas controlling movement. Human brain structures for speech also lie adjacent to, and even within, areas that control movement.

Jarvis says the findings, reported in March 2008 in *PLoS ONE*, suggest that the brain pathways used for vocal learning evolved out of the same pathways that power limb and body movements. Because these brain areas serve a similar function in birds and humans, the areas may be a logical place to initiate neurobiological studies of consciousness in birds.

Invertebrates join big brain club

While birds and mammals share many neurological features, assessing conscious states in invertebrates, such as cuttlefish and octopuses, is more difficult. Unlike in mammals, where a large central brain is connected to a relatively small spinal cord, the octopus nervous system is divided into three parts. The two largest parts, the optic lobes for the eyes and the nervous system of the arms, sit outside the central brain capsule.

Alex, an African gray parrot who died in 2007, was the subject of 30 years of scientific study. He learned more than 100 words before his death and could distinguish colors and numbers.

MARK WILSON/*BOSTON GLOBE*/LANDOV

Despite this weird anatomy, octopuses share one brain trait with mammals and birds: They have a high brain-to-body mass ratio. Scientists have speculated that a bigger brain, when expressed as a percentage of body mass, may mean higher intelligence. And octopuses do seem to be one of the most intelligent invertebrates around. Studies show that they can easily learn and adapt new techniques for opening the shells of their favorite prey — clams and mussels — and can use clues to navigate through mazes.

Psychologist Jennifer Mather of the University of Lethbridge in Canada, who has studied octopuses for more than 35 years, says that the octopus brain is not just larger than that of most invertebrates, but also has areas dedicated to learning and memory. "That's the kind of thing we humans have," she says.

Although scientists have some general knowledge about cephalopod brain anatomy, they have limited knowledge about how it works, Edelman says. With Graziano Fiorito of the octopus behavioral biology laboratory at the Stazione Zoologica Anton Dohrn in Naples, Italy, Edelman is developing a recording system to collect EEG data and other brain signals as the creatures respond to visual cues.

"No matter how differently organized the brain is, there are fundamental properties — signaling, electrical activity, properties of certain kinds of neural networks — that are universally disposed across any animal who is able to have a conscious experience," Edelman says. "The trick, with the octopus, will be to figure out where to tap into those signals."

Considering how far removed cephalopods are, evolutionarily speaking, from mammals and birds, Edelman says studying these creatures may give researchers a broader perspective on consciousness.

"Cephalopods may be that one example of animals where we can show a true case of convergence, in the sense that conscious states may have appeared in these animals long before they appeared in mammals or in the birds," he says.

That consciousness could arise several times over the course of evolution, appearing in distant lineages with different brain structures, is not at all surprising, scientists say, considering such states seem to emerge in species facing similar social and physical challenges.

Butler adds that scientists need to use caution in limiting the study of consciousness only to animals with highly developed cognitive systems.

"You can't rule out consciousness where you don't have complex behavior," she says. "So what we need to do is identify a few places where it might be found, look to see what neural features there are, and then look to see if those are present across the board." ■

Susan Gaidos is a freelance science writer based in Maine.

Explore more

- D.B. Edelman and A.K. Seth. "Animal consciousness: a synthetic approach." *Trends in Neurosciences*. September 2009.

A black future

Without destroying the Earth, the Large Hadron Collider might help humans explore the cosmos

By Tom Siegfried

Shortly after the first of the year (if not already), the Large Hadron Collider — the most powerful particle accelerator ever built — will smash protons together at record energies. If the Earth remains intact, doomsayers will once again have been falsified. Every time they forecast the demise of the planet, those prophets of Earthly annihilation prove themselves no more foresightful than mortgage bankers or phony psychics.

This time, the fear of physics focuses on the prospect that the LHC, housed in a tunnel circling beneath the Swiss and French countryside outside Geneva, will condense mass-energy densely enough to create small black holes. Since black holes gobble up any matter that enters them, digesting it in a bottomless gravitational pit, perhaps Geneva, then France and Switzerland, the rest of Europe and the entire planet might all be swallowed and then shredded to subatomic smithereens, a handful of litigious LHC critics have contended.

Do not worry, physicists respond. But not because the LHC is hopelessly incapable of producing anything so dreadful as a baby black hole. To the contrary, many physicists actually hope very much that the LHC will indeed produce black holes — too small to be dangerous, of course, but desirable as a sign of new physical phenomena to study (*SN: 9/26/09, p. 22*). After all, the LHC may be the only way scientists can learn the deepest secrets of the universe — how it began, what it's made of, why there's such a thing as mass.

Others, though, may question whether the LHC is worth any risk at all — whether anything it might find out would really matter to humankind. The answer is yes. In fact, humankind's future may depend on what the LHC discovers. And it's a future in which black holes could play a starring role.

In this context, the future is the future envisioned by the visionaries of science fiction, the future in which the human race explores the galaxy. Sober analysis of this plan inevitably concludes that the ability to power long-range, human-occupied space vehicles exceeds earthly energy capabilities. But one proposal on the books (actually, the physics website arXiv.org) identifies a strategy that might make the science fiction future possible. Interstellar spaceflight, in this scenario, would depend on harnessing the power of the tiny black holes that scare the quarks out of people who fear the LHC.

Hawking power

In a paper online at arXiv.org/abs/0908.1803, physicist Louis Crane and collaborator Shawn Westmoreland explore the criteria for building black hole–powered starships.

"We think the possibility should be studied carefully," they write, "because it would have profound consequences for the distant human future, which no other proposal based on currently known physics could duplicate."

In a tunnel outside Geneva, the Large Hadron Collider will smash protons so energetically that tiny black holes might be produced in the process.

MAXIMILIEN BRICE/CERN

Currently known physics is, in fact, a source of great pessimism for advocates of long-distance space travel. Living things are acutely vulnerable to cosmic rays and other radiation streaming through space. Any starship capable of protecting its crew would require immense amounts of shielding, on the order of 400 metric tons for a single capsule. That's a prohibitive amount of mass for a craft so small; for shielding to be a reasonable fraction of the size of a ship, you need to scale up.

"It therefore becomes more economical to think of a larger vessel, weighing many thousands of tons, in which a group of people could live indefinitely," write Crane and Westmoreland, of Kansas State University. But there seems to be no way to supply the energy required to accelerate a craft that huge to the substantial speeds needed for interstellar exploration.

Star Trek enthusiasts might note that matter-antimatter annihilation seems to work just fine for the *Enterprise*. And in principle, Crane and Westmoreland agree, antimatter fuel could produce starship power. But the problem lies in making the antimatter to begin with, a process which itself would consume enormous amounts of energy. It's kind of like the problem with the much-hyped future hydrogen economy. Hydrogen isn't a source of energy, it's a means of storage. You still need a lot of energy to get the hydrogen in the first place. Same with antimatter.

But there is another source of cosmic-class power that could perhaps be exploited to drive space vessels: the energetic emissions from black holes. That strategy does not leap immediately to mind, perhaps because black holes have the reputation of swallowing up mass and energy (famously confining even light). But as Stephen Hawking (a *Star Trek* fan himself) discovered, physics permits (and therefore requires) a black hole to emit "Hawking radiation" — particles and photons that slowly diminish the black hole's mass as they stream away. Left on its own, with no source of food, a black hole shrinks as surely as a helium balloon with a pinhole leak.

Here's the best part: The smaller a black hole gets, the faster it shrinks. So a very small black hole spews out very large amounts of energy. A very, very small black hole — much smaller, say, than even an atom — would emit enough energy to, well, power a starship. Such black holes would release a much higher percentage of the energy used to make them than does either hydrogen or antimatter.

Just possible

Black holes produced at the LHC would not be any good for starship fuel. They would be so small that their decay would take only a tiny fraction of a second, which is also why they pose no danger of breaking the doomsayers' perfect record of being wrong. But perhaps it is possible to create a black hole a little bigger, one that would produce a sufficient amount of

Hawking radiation, for long enough, to drive a massive vessel across space to reach other stars in a reasonable time.

Prospects for success in that quest depend on the ability to compute precisely how much Hawking radiation a black hole releases. It's not easy math. Most textbooks use rough approximations that may badly underestimate the true black hole energy output. Using more sophisticated approaches, Crane and Westmoreland conclude that a black hole with the proper propellant properties might indeed be consistent with the laws of physics. "It seems that making an artificial black hole and using it to drive a starship is just possible," Crane and Westmoreland write.

Their calculations suggest that a black hole a few attometers or so across (an attometer is a nano-nanometer, smaller than a proton), with a mass on the order of a million metric tons, could provide large amounts of power for decades before shrinking to nothingness and disappearing in a final explosive poof. Making black holes of that magnitude would require an elaborate and massive bank of gamma-ray lasers, powered by a gigantic solar panel orbiting the sun. Converging laser beams would concentrate energy densely enough to create the black hole (somewhere in the vicinity of the sun), which would then be harnessed to a space vessel equipped with a parabolic dish to focus the black hole's energetic emissions. Steering a black hole is no problem, Crane and Westmoreland say: "It is only necessary to scatter radiation off the black hole to impart momentum to it." It's basically pretty simple.

But there's a catch, of course. It turns out that the amount of power a subatomic-sized black hole produces depends on details of the physics of quantum gravity. And a complete theory of quantum gravity is precisely what today's scientists don't have. They need the LHC to provide essential clues.

> "The minds of physicists can think of all kinds of possibilities."
>
> STEVEN WEINBERG

More specifically, the black hole power output that Crane and Westmoreland calculate may be realistic only if cosmic physics incorporates a mathematical framework known as supersymmetry. Established laws of particle physics, describing the quarks and leptons that make up matter and the bosons transmitting forces between them, are rooted in mathematical symmetry principles. Symmetry enforces the requirement that the laws of physics apply equally to everybody, no matter where in the universe they live or how fast they are moving or spinning. Supersymmetry takes those laws a step further: In a sense, says Nobel laureate Steven Weinberg of the University of Texas at Austin, supersymmetry acts at "right angles" to the standard symmetries of physics. In practical terms, that means supersymmetry's math implies that for every known subatomic matter particle the universe should provide a corresponding forcelike particle, and for every force particle there should exist a matterlike partner.

An opportunity for nature

Supersymmetry, Weinberg emphasizes, is the kind of principle that physicists seek to guide them in their search for a deeper understanding of nature.

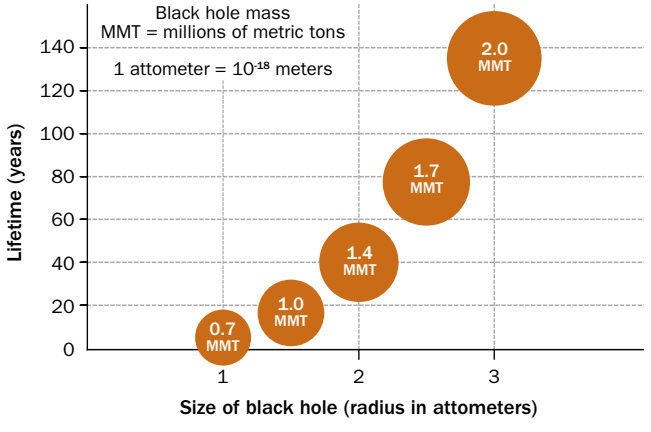
"The minds of physicists can think of all kinds of possibilities," Weinberg said in Austin at a recent symposium sponsored by the Council for the Advancement of Science Writing (*SN Online: bit.ly/higgs_lhc*). "When we speculate aimlessly, the results are likely to be not very interesting. It's when there are physical principles that narrowly restrict our speculations, so that new ideas can only take one or a very limited number of forms, that we begin to think we've discovered something that's an opportunity that nature probably didn't pass up. Most of us have this feeling about supersymmetry."

If supersymmetry particles exist, they have remained undetected, implying that they are too massive to have been created by experiments on Earth to date. Potentially, though, the LHC has sufficient power to produce such particles. If it succeeds, physicists will have received a major clue in their quest to solve the mystery of quantum gravity, and the prospect of building black hole spaceships (before the world comes to an end) will grow substantially brighter.

But as things stand, nobody knows for sure if supersymmetry is correct. That's why the LHC is so important.

"There isn't any one standard supersymmetry theory," Weinberg points out. "That means either we're missing something about supersymmetry which will be revealed to us when it's discovered, or the whole idea is wrong and it won't be discovered. And we just don't know. But this is certainly one of the targets for the LHC. And I would say it's the most important target." ■

Mass and lifetime of subatomic-sized black holes



Black Hole Power Tiny (but massive) black holes could emit prodigious amounts of energy, enough to power a spaceship, for years or decades. Larger black holes last longer but would be harder to make.

SOURCE: L. CRANE AND S. WESTMORELAND, ARXIV.ORG/ABS/0908.1803

Now I can safely take a bath again…

…and it's more affordable than ever.

Call now and save $200.00

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

Every year, it's the same. Fall and Winter bring not only colorful leaves and lower temperatures, but also aches and pains. The Neptune Upright Bath Lift has enabled thousands of people to rediscover the simple pleasure and therapeutic benefits of taking a bath without the danger of slipping and falling. This extraordinary product caught on fast, but the relatively costly technology left many high and dry. We sent our engineers back to the drawing board with a simple mission… create a high-quality lift at an affordable price. Through improved technology and more efficient manufacturing techniques, we achieved our goal. The result is a bath lift that maintains our high standards for durability and safety, at an all-time low price that is within most people's budgets.

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

The Neptune Upright Bath Lift is so easy. Just put the chair into the tub. The high-quality suction cups hold it in place. You simply sit on the transfer flap and swing your legs into the tub. Press the button on the fully water proof remote, and the chair lowers to the bottom of the tub. When you are done, press another button and the chair returns you to the top of the tub. The remote contains a powerful rechargeable battery that operates up to seven up/down cycles, and a light indicates when it needs to be recharged. Simply unclip the remote and plug it into any outlet to charge. The smart-chip technology in the remote will not allow it to lower you if there is not sufficient power to raise you back up.

Are you missing the luxury and benefits of a good soak in the tub? Call now, and our knowledgeable product experts will tell you how you can get started. Call today, and we'll let you try the Neptune Upright Bath Lift with our exclusive 30-day home trial. If you are not completely satisfied for any reason, simply return it for a refund of the product purchase price. Call now!

Soak Your Aches & Pains Away

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

Neptune® Upright Bath Lift

Call now for our lowest price!

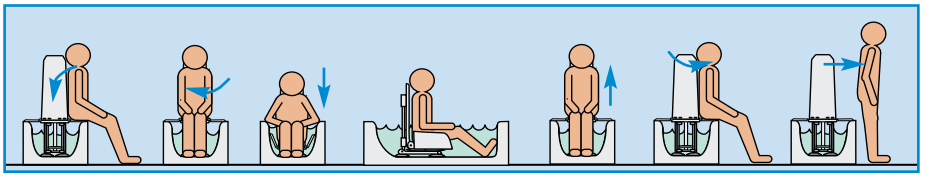
Please mention promotional code 39405.

1-888-639-6869

*first*STREET
for Boomers and Beyond®

1998 Ruffin Mill Road
Colonial Heights, VA 23834

www.neptunelift.com



Over the Coasts: An Aerial View of Geology

Michael Collier

Natural forces typically take their sweet time sculpting Earth's surface, sometimes millions of years. But where the land meets the sea, land can be shaped quickly, as revealed in dramatic, ever-changing scenery. In evocative words and stunning images, aerial photographer and geologist Michael Collier chronicles changes that have occurred — and are occurring — along North American coasts: the Atlantic, the Pacific, the Great Lakes and the Gulf of Mexico.

In his new book, the latest in his *Aerial View of Geology* series, Collier begins his tour along the Gulf Coast. There, prodigious amounts of sand and sediment — much of it flushed from America's heartland by the Mississippi River — line the shore from Texas to the Florida Keys.

Next he proceeds to the long, low barrier islands along the Carolinas, which contrast sharply with Maine's craggy headlands, where long-gone glaciers scoured terrain down to bedrock.

While hurricanes, ice and tectonics were some of the main forces shaping shores in ancient times, today humans play an increasingly dominant role.

The effects of human activity aren't always immediate, but Collier's images show that such influences can be long-lasting. A photo of the northern end of San Francisco Bay reveals sediments choking now-unsightly marshes. Much of that material was mobilized in the Sierras during the California Gold Rush more than 150 years ago, he notes. The vivid text accompanying the beautiful photographs make *Over the Coasts* as much an informative geology primer as it is an attractive coffee-table book. — *Sid Perkins*

Miyaka Press, 2009, 120 p., $34.95.

Something Incredibly Wonderful Happens: Frank Oppenheimer and the World He Made Up

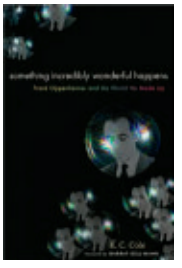
K.C. Cole

In a deeply personal and moving narrative, science writer K.C. Cole tells the story of the younger, less famous brother of J. Robert Oppenheimer. Cole chronicles the life of her friend and mentor Frank Oppenheimer during his transition from newly minted physicist, to atomic-bomb researcher whose career was destroyed by McCarthyism, and then to cattle rancher and teacher.

Cole's conversational tone sweeps readers through the events that led Oppenheimer to ultimately create a world of his own: the Exploratorium, a revolutionary science museum in San Francisco dedicated to thinking, tinkering and rumpuses of all sorts.

To Oppenheimer, play was serious business. Cole describes how this philosophy formed the bedrock of the untamed museum. In it, exhibits on springs and bathroom-window optics came with instructions such as, "Mess around with the brass controls to see if you can make this thing do something."

Cole captures Oppenheimer's inquisitive spirit with vivid anecdotes, such as the time he stayed up past midnight with his young son to dissect a pig's head on the kitchen floor, and the time he took his high school students to the junkyard just to take things apart.



Cole uses the Exploratorium to show Oppenheimer's views on exploration. She recounts a favorite Frank-ism: "If we stop trying to understand things, we'll all be sunk." The book leaves an impression of a man whose ideas about science and life continue to inspire inquisitive tinkerers, deep thinkers and explorers of mysteries. — *Laura Sanders*

Houghton Mifflin Harcourt Trade, 2009, 416 p., $27.

The Religion and Science Debate: Why Does It Continue?

Harold W. Attridge, ed.

Scholars from the humanities and natural and social sciences discuss the interminable tensions between religion and science. *Yale Univ. Press, 2009, 221 p., $16.*

Mythematics: Solving the 12 Labors of Hercules

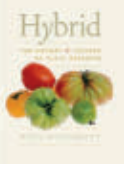
Michael Huber

Math could have saved the ancient hero time and muscle, a professor writes. *Princeton Univ. Press, 2009, 183 p., $24.95.*

The Greatest Science Stories Never Told

Rick Beyer

True stories about scientists show that the path to innovation is rarely straightforward. *Harper, 2009, 224 p., $19.99.*



Hybrid: The History & Science of Plant Breeding

Noel Kingsbury

Breeders have taken an active role in plants' reproduction throughout human history. *Univ. of Chicago Press, 2009, 493 p., $35.*

Gems and Gemstones: Timeless Natural Beauty of the Mineral World

Lance Grande and Allison Augustyn

Gemstones are more than pretty baubles. Gems and their geological features are depicted in text and beautiful photographs. *Univ. of Chicago Press, 2009, 369 p., $45.*

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.

Plan for a long stay

Lawrence Krauss' idea of staying permanently on Mars (*SN: 10/10/09, p.4*) is fascinating, but criticism by John F. Fay and Jeffry Mueller (Feedback, *SN: 11/21/09 p.29*) missed important information. Krauss too missed the best of all scientific comparisons. Regarding the travel to the American continent by the Pilgrims: the "capital P" Pilgrims did not expect it to be easy to live in the New World. But it was significantly harder than they expected when their ship ended up at a location much farther north than they had intended.

The contention that the Pilgrims knew that the American environment could sustain them was proved false when they found themselves unprepared for how much the environment of the New England coast differed from the coast of Virginia. Indeed, their information and assumptions were so poor that, without the knowledge of farming and fishing they gained from observing and meeting people native to the area, they might all have died.

Perhaps Krauss should compare a group's one-way trip to Mars with those intrepid scientists who explored and now live year-round in Antarctica. The goal is the same: the opportunity to learn new things about a hostile environment. The reality of survival is the same: It will rely on superb initial information about the environment, detailed scientific planning of what to take and how to use what is already there, and dependence upon contact with the sending community through electromagnetic means and a physical means of resupply and possible return. Just how foreign and isolated Antarctica is was shown several years ago when a researcher was found to have cancer and could not be treated there or "rescued" because transportation could not reach her quickly (she treated herself and survived). This setting and its rigors are what we need to study to consider setting up long-term bases and long-term stays on Mars.

Doinna Foster Myer, Ladson, S.C., and Marion, Texas

Evolutionarily speaking

I was taken aback by the title of the article "Climate change offsets evolution to shrink the wild sheep of St. Kilda" (*SN: 8/1/2009, p.12*). It's not that climate change "overcame the evolutionary effect," as phrased in the article. The selection regime has changed for the population due to the environmental changes associated with climate change. Evolution is happening, not being overcome. The interview with Eugenie Scott (p. 32) in the same issue points out that scientists must use the right language when talking about evolution. In this case, science presentation must be careful to "talk" in biologically correct language.

J. Roger Eagan, Queensbury, N.Y.

The Scientific Observation by Kevin Padian (*SN: 10/24/2009, p. 4*) concludes, "If we spent more time in our textbooks talking about how tetrapods came up on land, how birds evolved from dinosaurs, how whales went back into the oceans, the average American would not be so vulnerable to the claims of creationists." Interestingly, on the very next page, the following sentence is found: "That find suggests that a very old plant figured out how to make a particular type of resin that modern relatives get credit for." In my opinion, "figured out" seems to reflect a creationist or intelligent design perspective more than an evolutionary perspective. I believe there are many other ways this point could have been made using language more consistent with the concept of evolution.

Richard Wielkiewicz, Saint Joseph, Minn.

Training generalists

The article "A place removed from 'the pressure of received ideas'" by Murray Gell-Mann (*SN: 9/12/2009, p. 32*) reminds me that I have wondered for years how it would be possible to develop a higher level of "generalists" in addition to developing primarily higher level "specialists" as we do in our present teaching of the sciences in institutions of higher learning. Creating interdisciplinary teams for solving major problems seems the most logical way to develop fresh approaches, but we have no system for training leaders for such groups. With atomic energy release, we were fortunate to have [J. Robert] Oppenheimer, who could communicate with specialists in more than one field. Specialization tends to insulate one from finding parallels in other regimens that could be applicable in one's own field. The Santa Fe Institute [that Gell-Mann describes] might be a small answer to recognition and development of individuals who could eventually provide such leadership. Even just one or two successes would make the effort worthwhile.

Roger Otto, San Mateo, Calif.

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

Francis S. Collins

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

Funding science research as a sustained enterprise

On August 17, Francis S. Collins was sworn in as the 16th director of the National Institutes of Health. In addition to identifying genes that contribute to diseases such as cystic fibrosis, Huntington's and type 2 diabetes in his own research laboratories, Collins led the Human Genome Project. At the Society for Neuroscience annual meeting in October in Chicago, Collins discussed NIH funding and answered questions from reporters, including Science News *writers Tina Hesman Saey and Laura Sanders.*

In introducing the NIH budget, Collins said: "We had this remarkable deluge of funding from the Recovery Act. And the response to that in terms of applications coming to NIH ... was just overwhelming. When the dust all settled, of course, we weren't able to fund more than a small percentage of these great ideas.... The exciting part was this outpouring of creativity from the scientific community."

Could the $10.4 billion NIH received from the Recovery Act hurt prospects for funding?

If you go back a few years to the doubling that happened to NIH between 1998 and 2003, we then hit a flat budget period for the next five years.... Many of those arguments we heard were, 'Well, you got yours.'... I do think there's a risk that that might also happen in this circumstance after such a remarkable infusion of those $10 billion.

But science is not a 100-yard dash. It's a marathon. And certainly science projects don't operate on two-year cycles. To rev up the engine of biomedical research only to take away the fuel seems like an unfortunate circumstance, to say the least. And what we're hoping for are good scientific outcomes.

One of the things we're working on very hard at NIH is to try to document what the Recovery Act has made possible, to point to specific projects ... those are down payments on what needs to be a more sustained enterprise.... To fall off a cliff at this point, just as we're picking up speed, is not going to be the way to make the most of what those Recovery Act dollars made possible.

What are the current projections for the NIH fiscal year 2011 budget?

There are none.... One of the things I think we all agree with is that science doesn't resonate very well with feast-or-famine kind of circumstances. These ups and downs in funding can actually be quite painful and disruptive for projects and for investigators. And yet we may be in one of those circumstances where we had a considerable bolus of opportunity with the Recovery Act. And given that the economy is still struggling, there's not a great deal of optimism that that trajectory can be sustained.

Science is not a 100-yard dash. It's a marathon. And certainly science projects don't operate on two-year cycles.

What is NIH doing to support and encourage investigators at the early stages of their careers, especially when more lucrative or stable careers are available elsewhere?

That's a topic of great concern at NIH. I think all of us have seen this as one of the highest priorities in terms of our support of science. You can't look at the current circumstances and not worry about the trends in terms of what's been happening as far as young people's interest in science and their ability to join in, get on the on-ramp, and have a successful career in biomedical research. That was particularly heightened during the five years of flat budgets, when overall success rates of all grantees began to fall. And that made it particularly difficult for early-stage investigators to feel optimistic after a couple of failed grant applications where they just missed the cutoff....

One [grant] that is funded through the common fund, called the New Innovator Award, is aimed at trying to pull in investigators who have not previously received an R01 [Research Project Grant Program] grant from NIH, and specifically to attract those who have created out-of-the-box ideas, to tell them that the door is open — we're really interested in hearing what you have to offer.

Another thing NIH has done across the board, and all the institutes have agreed to do this as of last fall, is to set up a system so that the success rates for early stage investigators are kept at the same level as for experienced investigators. If you don't have something of that sort, then those who have not previously been in the system may not have as much preliminary data, may not have as much experience in terms of grantsmanship and may not be recognizable names to their colleagues, so may not fare as well.

I must say we've also begun to take some flak for this. There was a piece in the *New York Times* ["Debate flaring over grants for research," September 21] from the established investigator perspective that said we've gone too far.... Some of the very productive, mid-career folks are feeling like they're not getting a fair shake.... Obviously these problems are worse when budgets are tight. ■

NIH

Special holiday offer!

There's nothing like Jitterbug.

If you're looking for the perfect holiday gift this year, consider the facts. Jitterbug is the first cell phone experience designed specifically to make calling easy. Starting with the Jitterbug J, we've partnered with worldwide leader Samsung to design a high-quality cell phone that takes the hassles out of calling with our Jitterbug EasyDial™ keypad and by eliminating complicated menus and confusing icons. Although many have tried to imitate the Jitterbug experience, they simply can't match our personalized services. Call our Jitterbug Operators day or night and talk to a real person based right here in the United States. We'll greet you by name, connect your calls, and even update your Phone Book with you on the line.[1]

Only our Jitterbug customers enjoy the freedom to choose from our helpful services like SimpleText Messaging, Roadside Assistance and no-questions-asked Handset Replacement. What's more, Jitterbug LiveNurse provides you with registered nurses, on-call anytime day or night, to answer questions and give you advice for your health and well-being. **LiveNurse has been awarded "Hottest Mobile Consumer Application" and for a limited time, is available free on our most popular plans.**[3] Our affordable rate plans start at just $14.99 per month,[2] and with all plans there are no contracts or termination fees. Jitterbug makes gifting easy, call today and we will include a free car charger with activation, a $24.99 value.[4] For more information, visit us online at jitterbug.com. Your friends at Jitterbug would like to wish you and your loved ones **Happy Holidays.**

Questions about Jitterbug?
Try our pre-recorded Toll-Free Hotline
1-877-770-9005

- Plans start at just $14.99 per month[2]
- No contracts, no termination fees, no prepaid hassles
- Large keypad makes dialing easy
- Powerful speaker delivers clear sound
- No complicated menus or confusing icons
- Live, 24-hour Jitterbug Operators greet you by name, connect calls and update your Phone Book[1]
- Nights and Weekend Minutes

100% U.S. Based Customer Service

Also available in white.

FREE GIFT
Order now and receive a **FREE Car Charger** with activation, a $24.99 value![4]

CTIA 2009 HOT FOR THE HOLIDAYS HOTTEST MOBILE CONSUMER APPLICATION

Start now and save up to $300 a year.

Monthly Minutes	50	100	200	New
Monthly Rate	$14.99	$19.99	$29.99	New
Monthly Minute Carry Over	60 Days	60 Days	60 Days	New
Night/Weekend Minutes	—	—	500	New
Operator Assistance	24/7	24/7	24/7	
Long Distance Calls	FREE	FREE	FREE	
Nationwide Coverage	YES	YES	YES	

Other plans available. Ask your Jitterbug expert for details.

jitterbug®

Created together with worldwide leader Samsung. SAMSUNG

1-888-666-0354
Please mention promo code 39351
jitterbug.com

firstSTREET for Boomers and Beyond®
1998 Ruffin Mill Road
Colonial Heights, VA 23834

Get the Last Morgan

The world's most collected silver dollar is arguably the famous U.S. Morgan Dollar of "Wild West" lore. Minted from silver mined at Nevada's historic Comstock Lode, the Morgan series was originally struck from 1878 to 1904. Due to a Silver Act passed by Congress, it was resurrected for one more year in 1921 before it was replaced later that year by the Peace Dollar.

Now you can get the Last-Ever Morgan in beautiful Brilliant Uncirculated condition. Millions of these .900 silver coins were officially recalled and melted by the U.S. government, and millions more were worn out or damaged in circulation. Today, key dates—like this 1921 specimen—are especially popular and make a perfect addition to any collection. Order yours now, while our supplies last!

Hurry! Call our toll-free number between 7:00 a.m. and 7:00 p.m. (Central) before these Last Morgan Silver Dollars are gone for good!

Just $39.95! (plus S&H)

800-585-9240 **Ext 6408**

New York Mint
Edina, Minnesota