

SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

MARCH 17, 2007 PAGES 161-176 VOL. 171, NO. 11

online games with a mission
stem cells on the brain
kuiper belt object's family
atlantic squid surprise

www.sciencenews.org



**cultivating
weed
whackers**

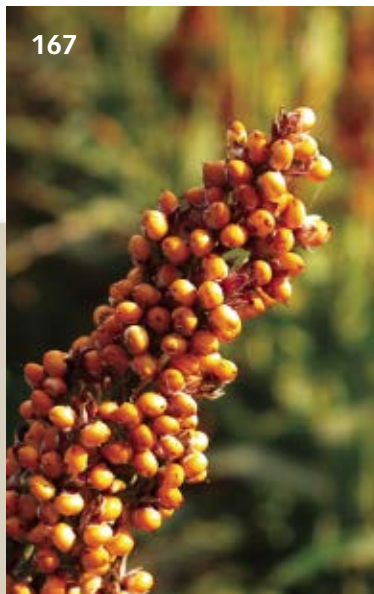
SCIENCE NEWS

MARCH 17, 2007 VOL. 171, NO. 11

Features

167 Herbal Herbicides Weed killers manufactured by Mother Nature
by Janet Raloff

170 Games Theory Online play can help researchers tackle tough computational problems
by Ivars Peterson



167

This Week

163 Stem cells supply missing enzyme
by Brian Vastag

163 Fossil teeth show roots of human development
by Bruce Bower

164 Quantum change, one bubble at a time
by Davide Castelvecchi

164 Pluto-size body has siblings
by Ron Cowen

165 Atlantic mystery squid undergoes scrutiny
by Janet Raloff

165 DNA silencer also controls memory formation
by Patrick Barry

166 Intel Science Talent Search honors high school achievers
by Aimee Cunningham

Of Note

173 Dance of the dead
Hibernation concentrates chemicals

Scrubbing troubles

Emerging bug pilfers DNA

174 EPA council sets priorities
Hey, it's cooler near the sprinklers

Departments

175 Books

175 Letters

Cover Many plants, such as the sorghum shown here, naturally produce chemical agents that keep weeds at bay. Researchers are looking to harness these plants or natural products derived from them to protect crops and reduce the use of synthetic herbicides. (iStockphoto) [Page 167](#)

SCIENCE NEWS is printed in the United States on process chlorine-free paper containing 90% recycled fiber with 30% postconsumer waste.



SUBSCRIPTIONS Subscribe to *Science News*
1 year only \$54.50. Call 1-800-552-4412
or visit www.sciencenews.org

A SCIENCE SERVICE PUBLICATION

PUBLISHER Elizabeth Marincola
EDITOR IN CHIEF Julie Ann Miller
MANAGING EDITOR Keith Haglund
DESIGN/PRODUCTION DIRECTOR Eric R. Roell
PRODUCTION MANAGER Spencer K.C. Norcross
SENIOR EDITOR/ENVIRONMENT/POLICY Janet Raloff
INTERIM WEB EDITOR Ben Harder
MATHEMATICS Ivars Peterson
BEHAVIORAL SCIENCES Bruce Bower
ASTRONOMY Ron Cowen
BIOMEDICINE Nathan Seppa
BOTANY/ZOOLOGY/ECOLOGY Susan Milius
EARTH SCIENCE Sid Perkins
CHEMISTRY/MATERIALS SCIENCE Aimee Cunningham
PHYSICS/TECHNOLOGY Davide Castelvecchi
HEALTH Brian Vastag
MATHEMATICS CORRESPONDENT Erica Klarreich
SCIENCE WRITER INTERN Patrick Barry
COPY EDITOR Linda Harteker
EDITORIAL ASSISTANT Kelly A. Malcom
WEBMASTER Vernon Miller
WEB SPECIALIST/EDIT. SECRETARY Gwendolyn Gillespie
BOOKS Cait Goldberg
ADVERTISING Rick Bates
SUBSCRIPTIONS Christina Smith
TECHNOLOGY DIRECTOR Harry Rothmann

BOARD OF TRUSTEES AND OFFICERS

CHAIRMAN Dudley Herschbach; VICE CHAIRMAN Robert W. Fri; SECRETARY David A. Goslin; TREASURER Frederick M. Bernthal; MEMBERS Jeanette Grasselli Brown; Samuel Gubins; J. David Hann; Shirley M. Malcom; Eve L. Menger; C. Bradley Moore; Ben Patrusky; Anna C. Roosevelt; Vera Rubin; Jennifer E. Yruegas
PRESIDENT Elizabeth Marincola
CHIEF FINANCIAL OFFICER Greg Mitchell

Science News (ISSN 0036-8423) is published weekly on Saturday, except the last week in December, for \$54.50 for 1 year or \$98.00 for 2 years (foreign postage is \$18.00 additional per year) by Science Service, 1719 N Street, N.W., Washington, DC 20036. Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.

POSTMASTER Send address changes to **Science News**, P.O. Box 1925, Marion, OH 43306. Two to four weeks' notice is required. Old and new addresses, including zip codes, must be provided. Copyright © 2007 by Science Service. Title registered as trademark U.S. and Canadian Patent Offices. Printed in U.S.A. on recycled paper. ♻️
Republication of any portion of **Science News** without written permission of the publisher is prohibited. For permission to photocopy articles, contact Copyright Clearance Center at 978-750-8400 (phone) or 978-750-4470 (fax).

EDITORIAL, BUSINESS, AND ADVERTISING

OFFICES 1719 N St. N.W., Washington, D.C. 20036
202-785-2255; scinews@sciencenews.org.

LETTERS editors@sciencenews.org

SUBSCRIPTION DEPARTMENT P.O. Box 1925, Marion, OH 43306. For new subscriptions and customer service, call 1-800-552-4412.

Science News (www.sciencenews.org) is published by Science Service, a nonprofit corporation founded in 1921. The mission of Science Service is to advance the understanding and appreciation of science through publications and educational programs. Visit Science Service at www.sciserv.org.

THIS WEEK ONLINE

<http://blog.sciencenews.org/mathtrek/>

MathTrek A computer scientist uses a mathematical tool to determine whether photographs have been digitally altered.

Brain Fix

Stem cells supply missing enzyme

Implanted stem cells grew into a range of beneficial brain-cell types and greatly extended the lives of mice missing an important enzyme, researchers report. Furthermore, stem cells from mouse brains, from human-fetal brains, and from human embryos proved equally adept at battling the mouse version of Sandhoff disease. In people, that congenital enzyme deficiency is similar to Tay-Sachs disease and causes severe mental retardation and early death.

Evan Y. Snyder, who led the work at the Burnham Institute for Medical Research in La Jolla, Calif., says that the

implanted cells knew exactly how to repair the brain: "Even the dumbest stem cell is smarter than the smartest neurobiologist."

The stem cells created all the major brain-cell types, including active neurons and support cells called astroglia and oligodendrocytes, Snyder's team reports online in *Nature Medicine*.

This "milieu" restored enzyme production and reduced brain inflammation, a hallmark of many neurodegenerative diseases, says Snyder. "We saw a series of actions that try to return [the brain] to baseline."

Dennis Steindler of the University of Florida, Gainesville, says that Snyder is at the forefront of a movement that champions stem cells as "little molecular factories" that might repair and protect brain tissue, not just replace damaged neurons.

Sandhoff disease springs from the lack of the enzyme hexosaminidase (hex), which clears excess lipids from the brain. In the absence of hex, damaging lipids accumulate. Children with Sandhoff disease rarely live past age 6. Some 50 other diseases, including Tay-Sachs, result from similar genetic deficiencies in lipid metabolism. These lysosomal-storage diseases, as they're called, affect about 1 in 5,000 people in the United States.

Mice in the experiment lacked the gene for hex. But the donor cells, implanted at birth, spawned new generations of cells that produced enough hex to enable the host cells to clear lipids. That delayed disease onset and extended life by 70 percent over that of mutant mice not getting the implants.

In the brain areas where the most stem cells settled, the researchers measured hex concentrations at 28 percent of those seen in normal mice. Roughly the same amount of hex appeared, regardless of the implanted cells' origins—whether mouse brains, human-fetal brains, or colonies of human-embryonic stem cells that had been coaxed to grow into neural stem cells.

"The good news was they performed almost identically," says Snyder. With fetal-brain cells, "nature's done the work" of making the cells specialize while in neural cells grown from embryonic stem cells, "the experimenter has done it." However, the cells of embryonic origin were easier to grow in the lab prior to transplantation.

In a new series of experiments, Snyder's group is implanting a second dose of stem cells in mice that had been treated at birth but in which Sandhoff-like symptoms nevertheless had appeared. "This is how I would do it in patients," he says.

The Burnham Institute plans to ask the Food and Drug Administration for permission to conduct a human trial of neural stem cells collected from fetal brains, says Snyder. Stem Cells Inc. of Palo Alto, Calif. is already testing the safety of such cells in children with Batten disease, another lysosomal-storage syndrome. —B. VASTAG

STATS

70%

Life span extension in sick mice getting brain stem cells

lected from fetal brains, says Snyder. Stem Cells Inc. of Palo Alto, Calif. is already testing the safety of such cells in children with Batten disease, another lysosomal-storage syndrome. —B. VASTAG

Ancient Slow Growth

Fossil teeth show roots of human development

An extended period of childhood evolved in people at least 160,000 years ago, according to a new analysis of a fossil child's teeth. That's the earliest evidence to date of a modern-human life history requiring intensive parental care and a wide range of early-life learning opportunities, the researchers say.

A lower jaw holding several teeth of a nearly 8-year-old early *Homo sapiens* child displayed tooth development comparable to that of same-age European kids today, report anthropologist Tanya M. Smith of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and her colleagues. They employed a new X-ray

technique to peer inside teeth and count layers of enamel that form at regular intervals as teeth develop. Researchers previously had to cut sections out of fossil teeth to probe enamel formation.

Earlier measurements of the decay of radioactive uranium in the fossil, found at a Moroccan site called Jebel Irhoud in 1968, yielded the estimate of when the child lived. In an upcoming *Proceedings of the National Academy of Sciences*, Tanya Smith and her coworkers describe their analysis of the Jebel Irhoud child's teeth.



JAW DROPPER The teeth of a 160,000-year-old *Homo sapiens* child, shown from above in the youngster's lower jaw, have yielded evidence of a prolonged-growth pattern much like that of kids today.

"The [new] study pushes back clear evidence for humanlike growth to 160,000 years ago," remarks anthropologist B. Holly Smith of the University of Michigan in Ann Arbor.

Using a similar X-ray method, another team reported in the Dec. 7, 2006 *Nature* that molar teeth of Neandertals dating to roughly 127,000 years ago developed much as those of modern humans do.

Tanya Smith's team examined an erupted molar, an incisor in the process of erupting, and a canine that had yet to erupt in the jaw of the Jebel Irhoud child. Tallies of enamel layers that typically form every 7 to 9 days as teeth develop, as well as counts of daily growth bands in the enamel, enabled the scientists to estimate that the child died at age 7 years, 10 months.

The extent of tooth eruption and rate of tooth formation in the fossil youngster resembled corresponding measures for European 7-year-olds today, the researchers say. The Moroccan specimen showed relatively few similarities to fossil teeth of

earlier *Homo* species and Neandertals, the team adds.

The X-ray technique used by Tanya Smith's team can now be applied to teeth from an 800,000-year-old *Homo* species found in Spain, suggests anatomist Christopher Dean of University College London. Other researchers have argued that those ancient choppers bear signs of prolonged, humanlike, childhood development, although anthropologists have yet to count enamel layers in the teeth.

Mounting dental evidence suggests that a lengthening of childhood growth began by around 1.6 million years ago in *Homo erectus*, Dean says. However, it's not clear whether the developmental pattern of people today emerged in the first *H. sapiens* about 200,000 years ago or in earlier *Homo* species.

The new, noninvasive approach to fossil-tooth analysis will enable researchers to establish landmarks of dental development for every species of human ancestor, Holly Smith says.

Unfortunately for scientists, human teeth stop forming by early adulthood and don't reflect late-life events, she adds. Mastodon tusks, which grew throughout adulthood, have revealed much about those prehistoric creatures' entire life spans. "If only we had tusks," Holly Smith laments. —B. BOWER

Warming Up to Criticality

Quantum change, one bubble at a time

Physicists have had their first look at how matter transitions into an exotic state known as a Bose-Einstein condensate—an ultracold fluid that displays quantum behavior.

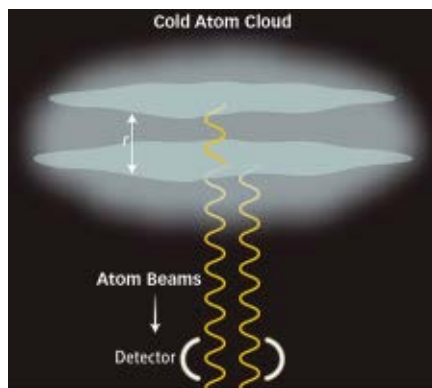
The atoms in a Bose-Einstein condensate share a collective quantum persona that has wave properties at macroscopic scales and can show patterns of interference, just as waves on a pond do. Because the behavior of condensates theoretically can be tuned to simulate the quantum properties of other states of matter, physicists expect to use the condensates to investigate poorly understood phenomena such as high-temperature superconductivity.

Turning a gas into a Bose-Einstein condensate requires confining it in a magnetic

field and chilling it to near absolute zero. Theory predicts that the new state will not appear abruptly. Instead, starting just above the critical temperature, bubbles of condensate will fleetingly form and disappear, increasing in size as the temperature falls. At the critical temperature, the bubbles will merge and the entire system will become a condensate.

Physicists apply the word *criticality* to the phenomenon in which a wide class of transitions has that gradual behavior. For example, a hot metal cooling in a magnetic field becomes a permanent magnet in a similar fashion. Until now, no one had precisely documented the criticality of Bose-Einstein transitions.

In the new experiment, described in the March 16 *Science*, physicists at the Swiss Federal Institute of Technology in Zurich and the University of Cambridge in England magnetically confined a Bose-Einstein condensate of rubidium atoms and let it spontaneously warm, crossing the critical temperature in reverse. The team went to great lengths to keep heat from leaking into its condensate too quickly. In the setup, temperature rose by only 4 billionths of a kelvin per second.



BUBBLING QUANTUM STATES Two streams of atoms drop from slices of a cloud of rubidium into a detector. If the atoms come from the same Bose-Einstein bubble, they'll share a quantum state and show wavelike interference.

To probe the condensate as it slowly transitioned into a regular gas slightly warmer than the critical temperature, the physicists switched off the confining magnetic field at two heights within the condensate. Freed atoms at those locations dropped into a detector instead of flying off randomly. The atoms have so little motion that they "fall like a rock," says team member Michael Köhl, now at Cambridge.

Inside the detector, which can count single atoms, the two overlapping streams of atoms sometimes interfered like waves—for example, canceling each other out so that the detector saw nothing. That could happen only if the atoms had the same quantum state, so they must have come

from within the same bubble of condensate. By varying the distance between the two test locations, the physicists estimated the typical size of the bubbles at any given temperature.

As expected, that size shrank as temperature increased, at a pace consistent with what's known about similar quantum systems such as superfluid helium, Köhl says. "People have looked at either side of the critical temperature, but not at the transition, with this accuracy," he adds.

"Until now, no one thought these experiments could be used to measure critical behavior," says Eugene Demler of Harvard University. He says that the technique opens new possibilities for studying not only Bose-Einstein condensates but also general properties of criticality. —D. CASTELVECCHI

First Family

Pluto-size body has siblings

Shaped like a squashed football, the ice-covered body 2003 EL61 rotates faster and reflects more sunlight than any other object in the outer solar system, is about as big as Pluto, and even has two moons. Now, astronomers have discovered that this fringe object, located beyond Neptune in a region called the Kuiper belt, has another distinction. It's the first Kuiper belt denizen known to have an extended family.

Five smaller members of the belt, although not close to 2003 EL61, have nearly identical surface properties and orbits, Mike Brown of the California Institute of Technology in Pasadena and his colleagues report in the March 15 *Nature*. The researchers suggest that the family arose soon after the birth of the solar system, when a Pluto-size body smashed into 2003 EL61, creating the fragments that Brown's team has found.

The researchers, who discovered 2003 EL61, had already proposed that a giant impactor had pummeled the body. Such a collision could account for the 4-hour rotation of 2003 EL61, as well as its two moons and high density. The density indicates that the object was stripped of most of its ice, leaving just an icy glaze over a rocky core (*SN: 1/14/06, p. 26*).

The familial finding firms up the collision hypothesis and is "a milestone in Kuiper belt science—and by extension, in our understanding of the outer solar system's development," says Alessandro Morbidelli of the Observatory of the Côte d'Azur in Nice, France, in a commentary accompanying the *Nature* report.

Brown and his coworkers surveyed 50 Kuiper belt objects using the Keck I telescope atop Hawaii's Mauna Kea. Their

P. HUEY, FROM E. ALTMAN/SCIENCE

results make a convincing case that five objects are chips off 2003 EL61, says theorist Hal Levison of the Southwest Research Institute in Boulder, Colo. The finding, he adds, “is also pretty shocking.”

That’s because theorists can’t easily account for the collision, Levison says. Some models suggest that the Kuiper belt was once more crowded than it is now and had more-frequent impacts, but those crashes would not have been powerful enough to strip much material from 2003 EL61, he says.

Instead, Levison suggests that both 2003 EL61 and its impactor resided in a region of the outer solar system known as the scattered disk. That area, which intersects but is distinct from the Kuiper belt, consists of energetic objects on highly elongated orbits that are inclined relative to the plane in which the planets circle the sun. Collisions among objects in the scattered disk would pack enough punch to vaporize large chunks and hurl fragments of a battered body into the Kuiper belt, Levison calculates. —R. COWEN

It’s a Girl

Atlantic mystery squid undergoes scrutiny

Three weeks ago, while working the waters south of Key West, Fla., a chartered fishing boat hauled in a surprise: the fresh carcass of a huge squid unlike anything that the people on the boat had ever seen. In fact, according to marine biologists, the gelatinous creature is unlike any known in the Atlantic Ocean.

The fishing boat’s captain sent the squid’s decomposing body to the Mote Marine Laboratory, headquartered in Sarasota, Fla., where cephalopod specialist Debra A. Ingrao has been studying it. When the specimen arrived on Feb. 22, Ingrao promptly sampled its DNA, fixed the carcass with preservatives, and then began a preliminary dissection. She’s sent photographs taken at every step to large-squid experts around the world.

“Most squid are 2 feet long or less,” Ingrao notes. Remains from this one, sporting all eight arms, measured more than 6 feet. And that was after a fin of indeterminate length had been chewed off one end of its body.

Gone, too, were all but stubs of the animal’s two delicate tentacles. The tentacles, which begin at the base of the arms, tend to be around 7 to 12 times as long as a large squid’s mantle, the body part containing most of the organs.

Ingrao told *Science News* in an interview at Mote that her “rough guesstimate” for this creature’s intact length is 16 to 24 feet. The tentacles were unusually thin and delicate, Ingrao adds.

Last week, after viewing photos of the



LAST RITES Marine biologists examine the head and arms of an unusually large squid. Remains of tentacle (held up in photo at right) are just inches long, but the scientists estimate that the intact specimen might have had 20-foot tentacles.



dissection, Michael Vecchione of the Smithsonian Institution in Washington, D.C., identified glands that secrete a gel that holds new eggs. Therefore, the specimen is female, he told Ingrao.

The glands’ large size suggests that this female was at or near sexual maturity, says Richard E. Young of the University of Hawaii in Honolulu.

Identification of the species “remains quite tentative,” Ingrao notes, although “all information points toward it being *Asperoteuthis acanthoderma*.”

Young notes that “probably fewer than 10” specimens of that species have ever been reported, and all were in the Pacific or Indian Oceans. Confirming *A. acanthoderma* off Florida would be “a huge range extension—into another ocean,” he observes.

“With animals this rare, every new find tells you a little more,” says Martin Collins of the British Antarctic Survey in Cambridge, England. For instance, macerated slop in the specimen’s stomach might identify prey. Furthermore, biologists might estimate the animal’s age by counting daily-growth rings in certain bones in the head.

Although muscular squid zip around to catch food, squid with gelatinous bodies typically float in deep, dark waters and let prey find them, Young says. Pacific *A. acanthoderma* have glowing, prey-alluring pads at the end of their tentacles. Sucker-laden tips on the pads’ ends grab curious prey and hold on until the squid moves in to swallow the food.

At least “that’s what we think happens,”

Young says. “No one has yet seen one of these animals alive.”

Indeed, most of Young’s speculation about *A. acanthoderma* behavior comes from poring over some 15 specimens of a smaller *Asperoteuthis* species. His team will soon publish a report describing and naming that species, which is native to Hawaiian waters. —J. RALOFF

New Memory Manager

DNA silencer also controls memory formation

A chemical process that switches genes off during embryonic development plays a surprising role in memory formation in adult rats, new research shows. It’s the first time that scientists have seen this switching mechanism regulate normal adult cells.

The discovery adds a new layer to the control of gene activity in nerve cells, and it raises the possibility that this mechanism, called methylation, influences gene activity in other cell types as well. “This may be a more routinely used mechanism for triggering cell function,” says lead researcher J. David Sweatt of the University of Alabama at Birmingham.

A developing embryo’s cells become heart, liver, or another cell type by shutting

down DNA that doesn't relate to the cells' eventual functions. Small molecules called methyl groups attach to a region of DNA, causing it to roll up into a tight bundle that can't be transcribed into proteins. This leaves operable only genes that are relevant to the cell's specific function.

Scientists had generally assumed that once the cells became specialized, methylation had finished its job. Aside from remethylating new copies of DNA during cell division, active methylation in adult cells is normally a sign of diseases such as schizophrenia or cancer.

Sweatt and his colleagues taught rats to fear a certain environment by giving them mild electric shocks. When placed

in the same environment a day later, the rats normally froze in apparent fear, demonstrating that they had acquired long-term memories.

The researchers found that as the rats formed these memories, they showed increased activity of a family of enzymes that perform methylation. When the scientists blocked the activity of those enzymes, the rats didn't freeze when returned to an environment where they had received shocks.

Tests showed that the targets of methylation were two genes that affect memory formation: *reelin* and *PPI*. By altering the activity of those genes, methylation may be controlling the formation of new long-term memories, the group reports in the March 15 *Neuron*.

"I think what they're seeing is quite provocative and intriguing," comments Lisa Monteggia of the University of Texas

Southwestern Medical Center at Dallas. "It certainly goes against the dogma that methylation doesn't change in the adult nervous system."

QUOTE



It certainly goes against the dogma that methylation doesn't change in the adult nervous system."

LISA MONTEGGIA,
University of Texas
Southwestern
Medical Center

Although the experiments dealt with relatively simple stimulus-response memory in rats, "there's good reason to believe that similar mechanisms will be involved in higher forms of memory formation in humans," Sweatt says.

While the research explains how methylation affects memory formation, it remains unclear how external conditions—in this case, electric shocks—trigger the methylation. Furthermore, the process

must require the later removal of methyl groups, and scientists know of no enzymes that can do this. Nor do they know of molecular mechanisms that could be doing this methylation and demethylation so quickly, Sweatt says. —P. BARRY

The Next Generation

Intel Science Talent Search honors high school achievers

Using objects that might clutter the basement of any optics-loving physicist, Mary Masterman built a homemade Raman spectra system. This achievement won the 17-year-old from Westmoore High School in Oklahoma City the top prize at the Intel Science Talent Search on March 13.

Scientists use the Raman method to measure the vibrational energy of molecules. Masterman put together a \$300 system consisting of a laser, a digital camera, a variety of lenses, and a prismlike object that disperses light. She tested it on acetone, toluene, and a few household items. Most of her measurements matched those obtained by commercial systems, which can cost up to \$100,000. That sum is equal to the scholarship Masterman won for her first-place finish.

Second place and a \$75,000 scholarship went to John Vincent Pardon, a 17-year-old from Durham Academy in Chapel Hill, N.C. In his mathematical project, Pardon proved that a closed curve can be made convex without permit-

ting any two points on the curve to get closer to one another.

Mathematics research also won the third-place prize, which comes with a \$50,000 scholarship. Eighteen-year-old Dmitry Vaintrob of South Eugene High School in Eugene, Ore., found a connection between different descriptions of certain mathematical shapes.

More than 1,700 high school seniors from across the United States entered the competition, sponsored by Intel Corp. of Santa Clara, Calif. Judges first selected 300 semifinalists and then in January winnowed the field to 40 finalists (*SN*: 2/3/07, p. 70). Science Service, publisher of *Science News*, has been administering the competition since 1942.

Fourth place went to Catherine Schlingheyde, 17, of Oyster Bay High School in New York, who identified proteins of a gene-silencing pathway. Rebecca Lynn Kaufman, 17, of Croton-Harmon High School in Croton-on-Hudson, N.Y., took fifth for a project in which she found a hormonal effect that

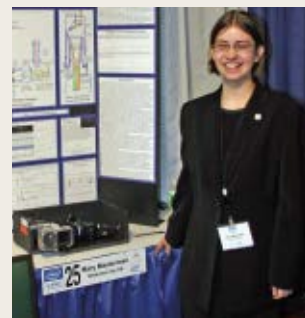
may explain the prevalence of a class of symptoms in males with schizophrenia. Gregory Drew Brockman, 18, of Red River High School in Thompson, N.D., placed sixth for his mathematical project on Ducci sequences. Each of these three competitors won a \$25,000 scholarship.

The seventh- through tenth-place winners each earned a \$20,000 scholarship. They are:

Megan Marie Blewett, 17, of Madison High School in New Jersey, who discovered five compounds that interact with a protein that contributes to multiple sclerosis and amyotrophic lateral sclerosis.

Daniel Adam Handlin, 18, of High Technology High School in Lincroft, N.J., who determined that an inexpensive optical satellite-tracking network can be as accurate as a state-of-the-art radar system.

Meredith Ann MacGregor, 18, of Fairview High School in Boulder, Colo., who studied the mechanisms behind the Brazil nut effect, in which granular particles separate according to size when they're shaken.



WINNING WAY Mary Masterman of Oklahoma City measured the vibrational energy of molecules with a homemade instrument. For her work, she won the top prize—a \$100,000 scholarship—at the Intel Science Talent Search.

Emma Kathryn Call, 18, of Baltimore Polytechnic Institute in Maryland, who designed self-folding microcontainers to encapsulate therapeutic cells.

The remaining 30 finalists each won a \$5,000 scholarship.

Says Intel Chairman Craig Barrett, "When I meet young scientists like Mary, John, Dmitry, and the other Intel STS finalists, I know that the future of American innovation is bright." —A. CUNNINGHAM

HERBAL HERBICIDES

Weed killers manufactured by Mother Nature

BY JANET RALOFF

Certain plants are picky about the company they keep. Once established, walnuts and some sandy shrubs, for instance, create a virtually barren border of ground around them. Many other plants aren't quite so antisocial. They permit numerous species into their neighborhoods, while barring a few plant types.

Chemical defenses play a major role in determining which plants flourish in woodlands, meadows, farms—or even in suburban lawns. Although this herbal warfare has been recognized since Biblical times, its study is “still regarded as a relatively young and immature field of science,” notes Yoshiharu Fujii of Japan's National Institute for Agro-Environmental Sciences in Tsukuba.

Only in the past few decades have scientists focused on the chemical warfare underlying botanical standoffishness. They've demonstrated that many plants manufacture compounds that sicken or kill intruders.

The potential payoff from influencing this defense is huge, notes Alan R. Putnam, a retired Michigan State University horticulturist who spent 18 years studying allelopathy, or plants' chemical defenses against other plants. By inhibiting crop growth, “allelochemicals undoubtedly cost world agriculture billions of dollars annually,” he says. By understanding chemical-defense mechanisms, he argues, “we could put them to work to benefit agriculture.”

Fujii and other agricultural scientists have been working aggressively to identify the defensive chemicals. Some of the researchers look to cultivate plant varieties that naturally keep weeds at bay, while others are scouting for bodyguards that will protect a high-valued crop from nutrient- and light-robbing bullies. A few scientists intend to model new commercial pesticides on the agents that plants naturally produce.

“Public awareness of environmental hazards from synthetic herbicides has opened new doors for scientists working on allelopathy to develop safe, environmentally friendly, and more produc-

tive farming methods,” says Fujii, president of the International Allelopathy Society.

No plant is yet marketed for its allelopathic potential, notes Francisco A. Macias of the University of Cadiz in Spain. However, his group and others are identifying and boosting weed-fighting activity in plants ranging from wheat and rice to lawn grasses and mustards. Macias says that such work may eventually slash the economic, labor, and environmental costs associated with society's current heavy reliance on commercial herbicides.



TURF KING — Weeds infect a patch of fine fescue (top), but roots of the variety known as Intrigue (bottom) exude allelochemicals that keep weeds in check.

ON GUARD The goal of Putnam and others when they began exploring allelopathy for agricultural gain was the cultivation of plants that could defend themselves without the help of commercial pesticides, produce rich yields, and cost little more than conventional varieties.

By these criteria, Leslie A. Weston of Cornell University has already found some winners. When the weed scientist screened a host of fine-fescue grasses, she identified several that appear to be a lawn manager's dream. They create dense carpets of bright green grass that grow slowly, so they need little mowing. They also resist disease, tolerate shade or full sun, and inhibit at least 20 of the most common urban weeds, thereby needing no help from herbicides.

Weston's group found that the best performers among those fescues make ample use of allelopathy. Their roots exude copious amounts of m-tyrosine—an unusual variant of a common amino acid. Weeds readily absorb m-tyrosine, mistaking it for the nutritious tyrosine. Their roots soon become deformed and stunted, and death quickly follows.

Of the many fescues that exude the toxic amino acid, a few are stellar performers. One, known as Intrigue, generally keeps a planted field 95 percent weedfree without use of supplemental herbicides, Weston notes. This cultivar has been marketed for years as a low-maintenance turf. But only recently has Weston's team demonstrated allelopathy's central role in the fescue's weed-controlling prowess. Reports of this work are slated to appear in several journals later this year.

Weston's program will next address whether the fescues will share their turf with other grasses or instead chemically muscle them out.

Besides these ornamental grasses, most cereal grains examined—which include rice, wheat, corn, and barley—exude one or more allelochemicals. Some of the oldest research on allelopathy focused on rice.

Currently, most rice growers around the world experience serious weed problems, often having to put up with yield-robbing interlopers that have become resistant to commercial herbicides. A few rice varieties, however, have shown unusual success at poisoning some of their most pesky competitors, such as a weed called barnyard grass.

In years when weather conditions are especially favorable, certain experimental varieties of rice can be grown without herbicides, notes David Gealy of the U.S. Department of Agriculture's rice-research center in Stuttgart, Ark. At other times, those plants need assistance from herbicides but require far smaller quantities than conventional rice cultivars do.

However, rice plants must also perform well in the field, the mill, and the kitchen. One of the most weed-suppressive varieties that Gealy's group has studied has been a disappointment in those regards. Despite amazing weed control, plant stalks of the variety known as PI312777 tend to fall over during storms and the seeds break during milling.

However, Gealy's team has found that some hybrid rice varieties suppress weeds well under special planting regimens. So, too, do some noncommercial Chinese-derived lines in the U.S. federal germplasm collection. The role of allelopathy in their weed-fighting performance has not, to date, been evaluated, he notes.

BODYGUARDS The findings on allelopathy explain, in part, why some crops do better when they aren't continuously planted in a field, but are instead included in a rotation cycle with sorghum, mustards, or other plants. Scientists have recently found that some of the most effective of these alternative species produce abundant weed-killing chemicals.

USDA's Natural Products Utilization Research Unit in University, Miss., focuses on a suite of allelochemicals produced by sorghum. The plant releases them as an oily secretion known as sorgoleone.

"Only the root hairs produce it, and they exude it as quickly as it's made," explains Stephen O. Duke, a plant scientist on the project. "In fact," he says, "we think that the last step in [sorgoleone's] synthesis occurs as it's leaving those root hairs"—which is fortunate because it's toxic even to its parent plant.

Duke describes sorgoleone as a controlled-release herbicide, entering the environment gradually and only as needed. USDA has genetically altered sorghum for enhanced sorgoleone production and expects to field-test that crop in a couple of years.

A rotational-cropping cycle that includes sorghum might offer organic farmers, who don't use synthetic pesticides, an all-natural option for controlling weeds. Alternatively, Duke notes, farmers might sparingly interplant sorghum with wheat to let sorgoleone protect both crops.

Duke's team is considering altering the genetic machinery of other plants so that they will also make sorgoleone. In some cases, that capability might require only a fine-tuning of a plant's existing make-up. For instance, Duke notes, rice "has most of the genetics to do this already."

Stephen Machado of Oregon State University in Pendleton has been screening other crop plants that fight weeds. In the January/February *Agronomy Journal*, he suggests that organic farmers might plant meadowfoam (*Limnanthes alba* Hartw.)—

a plant grown for the multipurpose oil that it yields—between higher-value plantings. In soil, meadowfoam's allelochemical—glucolimnanthin—degrades into several compounds.

As another protective measure, farmers might apply to their fields the mealy waste that's left after meadowfoam's seeds have been pressed to extract their oil. Machado is exploring whether this meal, which is rich in glucolimnanthin, can act as an all-natural herbicide.

Chemicals produced by the brassica family—which includes cabbages, mustards, and the rapes from which growers harvest canola oil—also fight weeds. For the past 18 years, Matthew J. Morra of the Uni-

versity of Idaho in Moscow has been investigating whether these plants can be rotated with other crops to improve the soil and thereby serve as "green manures."

Brassicas contain glucosinolates throughout their tissues, Morra reports. Once those tissues are crushed—by a feeding insect or a plow's blade—an enzyme in the plant converts the glucosinolates into powerful allelochemicals called isothiocyanates. In the soil, an isothiocyanate can degrade into any of half a dozen different compounds, some even more potent against weeds than the chemicals the plant initially released. Moreover, Morra found that some of the brassicas release nitrogen, which fertilizes the soil, at the same time that they whack weeds.

Morra notes that his university has a patent pending for the use of mustards to fight weeds.

THE NEW GUARD Beyond identifying plants as a source of potent herbicides that may be appropriate for organic agriculture, some scientists

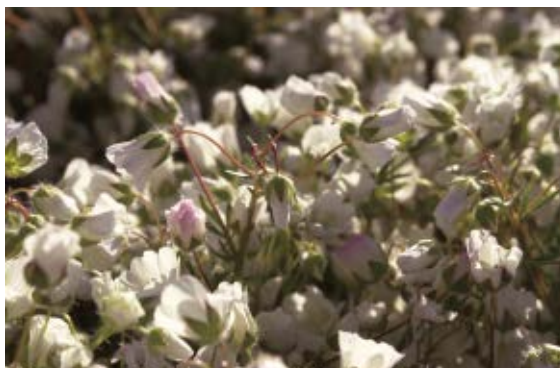
are exploring different strategies.

Macias and his group, for example, are studying natural allelochemicals as models for new synthetic herbicides. To design commercial analogs of allelochemicals, the researchers are starting with chemicals found in soil around the roots of wheat, corn, and other grains. Although DIBOA and DIMBOA—the compounds released by wheat—are allelopathic, their degradation products can be even more so, the researchers reported in the Feb. 22, 2006 *Journal of Agricultural and Food Chemistry*. The most potent breakdown product identified, which is known as APO, is also unusually long-lived. It can persist in soil for 3 months.

Recently, Macias began tinkering with DIBOA's structure. One of its natural breakdown products, DDIBOA, at trace levels kills 100 percent of target weeds. Adding a short chain of carbon



MAYDAY! MUSTARD — Chemicals found in most parts of the mustard plant, especially its roots and seed meal, have strong weed-killing activity. Weeds grow more profusely in plain dirt (left) than in soil treated with meal (right).



FIGHTING FOAM — Roots of meadowfoam (*Limnanthes alba* Hartw.), a plant grown for its multipurpose oil, release a weed-killing chemical. Seed meal left over after oil extraction might be useful as a herbicide.

atoms to the molecule can increase its weed-fighting potency 1,000-fold. Changing a few atoms within a ring-shaped feature of the molecule increases that potency 100-fold more, so that even smaller amounts kill weeds.

The Cadiz researchers are in the process of patenting these new super-DIBOAs. Macias expects to launch field trials of some of the compounds next month. Fortunately, his group has found, the parent plant is virtually immune to these new analogs. It detoxifies them by the same means through which it neutralizes APO and natural chemicals derived from DIBOA.

Three major agrochemical companies are working with the Cadiz team to investigate the development of new herbicides based on APO and DIBOA variants. One goal is to coat crop seeds with these weed killers.

Scientists applying another strategy note that plants tend to make allelochemicals only after receiving signals of an apparent invasion by weeds or other pests. Biological chemist John A. Pickett of Rothamsted Research in Harpenden, England, and his colleagues intend to use those signaling agents to fool a crop into acting as if it were under siege.

Many plants generate *cis*-jasmone in response to weeds. Pickett's group found that this signal, in turn, triggers allelochemical production by grains and many other plants. One could "directly treat a crop with *cis*-jasmone, which is what we would probably do in Europe or the United States," Pickett says.

For developing countries, Pickett favors a less costly approach. "We'd like to get plants to naturally switch *cis*-jasmone on earlier than they do now—perhaps at the first sign of attack by pests," he says. Scientists could create hypersensitive

plants of either the crop species or monitor plants whose sole function would be to signal neighboring crop plants to ramp up their allelochemical defenses.

Currently, Pickett notes, "we're working with the British Wheat Breeders Association to develop plants with a more potent [allelopathic] response to *cis*-jasmone."

NO BULL'S-EYE Scientists haven't yet hit the target in developing allelopathic weed fighters. Current methods are neither precise nor potent enough, Morra says.

Weed scientist Regina G. Belz of the University of Hohenheim in Stuttgart, Germany, agrees, noting that allelopathy may not defend a plant that's also besieged by harsh weather, poor nutrition, or bad soil.

In most cases, however, Belz says that allelopathy probably offers the most environmentally friendly approach to tackling weeds.

It also has another major advantage, Macias says: novelty. Among commercial herbicides, "we have not seen one with a new mode of action in the last 30 years," he notes. Most products work by inhibiting photosynthesis.

Some plants, however, produce allelochemicals that simultaneously poison weeds by three or more mechanisms, all different from those employed by commercial herbicides. Moreover, a single chemical may poison in more than one way, Macias adds.

Because it's unlikely that weeds will quickly overcome multiple vulnerabilities, allelopathic weed control may keep its potency longer than existing single-action commercial chemicals do, Macias argues.

"With allelopathy, our guiding philosophy is simple," he says. "Learn from nature." ■



CEREAL KILLER — In many grain plants, root hairs, such as these of sorghum, exude herbicidal agents directly into the soil.

F. DAYAN/USDA-ARS

Swim At Home™



The elegant solution to crowded pools, difficult schedules, flip-turns and staying fit.

Now you can swim whenever you like, on your own schedule, at your own perfect pace. No traveling, no crowded pools, **no heavy chlorine**. Just your own 8' x 15', technologically advanced "counter current" pool, where you swim or exercise against a **smooth current** that's fully adjustable to any speed or ability.

Modular construction means **many sizes** and options are available.

The Endless Pool® is simple to maintain, **economical to run**, and easy to install inside or outdoors. Call us or visit our web site for more information.



**Call 800-233-0741, Ext. 5720
for our free DVD or Video
www.endlesspools.com/5720**



Already own a pool?
Ask about the
FASTLANE®
by Endless Pools, Inc.

When exercise is a pleasure, fitness is easy...

GAMES THEORY

Online play can help researchers tackle tough computational problems

BY IVARS PETERSON

I'm online wrapped up on the ESP Game, and I'm finding it hard to stop. As each round ends, I'm eager to try again to rack up points. The game randomly pairs players who have logged on to the game's Web site (www.espgame.org). Both players see the same image, selected from a large database, but they can't communicate directly. Each player types in words that describe the image. When the words match, both players earn points and move to the next image. Each round lasts 150 seconds and displays up to 15 images. I keep hoping that my invisible, anonymous partner's thoughts are in sync with mine—all the better to rise on the list of top players.

I'm having fun, but there's more to this game than meets the eye. To its inventor, computer scientist Luis von Ahn of Carnegie Mellon University in Pittsburgh and his colleagues, the game provides an innovative way to label images with descriptive terms that make them easier to find online.

Most of the billions of images on the Web have incomplete captions or no labels at all, von Ahn says. Accurate labels would improve the relevance of image search results and make the information in images accessible to blind users. However, computers aren't good at looking at images and determining what's in them, and it's boring for a person to label images.

"The ESP Game turns the tedious task of entering words that describe an image into something that's fun," von Ahn says.

Moreover, the game is addictive, he admits. Since it debuted in late 2003, more than 100,000 people have registered to play. Some players spend more than 40 hours a week accumulating points at the site.

Last fall, Google licensed the game and created its own version, called Google Image Labeler (images.google.com/imagelabeler/). "Image-search quality remains a top priority for Google," says a company spokesperson.

The ESP Game is just the beginning of turning playtime to profit. Von Ahn is working on several new games to solve other problems, such as locating objects in images, filtering content, translating languages, accurately summarizing text passages, and developing common sense.

"Computers are really good at solving certain kinds of problems," says Ben Bederson of the Human-Computer Interaction

Lab at the University of Maryland at College Park. "This offers the opportunity to solve problems that computers just can't do."

"People around the world spend billions of hours playing computer games," von Ahn says. "We can channel all this time and energy into useful work to solve large-scale computational problems and collect the data necessary to make computers more intelligent."

PICTURE PUZZLES Von Ahn first thought of harnessing human brainpower for computational purposes when, as a graduate student, he was working on a security scheme to help the Internet company Yahoo! solve a problem. Yahoo! permits people to sign up for free e-mail accounts, memberships in groups, and other services. However, people can take advantage of the system by using computer programs called bots to sign up hundreds of accounts automatically and then use the accounts to distribute the uninvited mass mailings known as spam.

Working with Carnegie Mellon's Manuel Blum and others, von Ahn looked for a task that people could do easily but that computers would find difficult.

Suppose, for example, that a computer-generated image contains seven different words, randomly selected from a dictionary and displayed so that they overlap and appear against a complex, colored background. A person can almost always identify at least three of the words. A computer

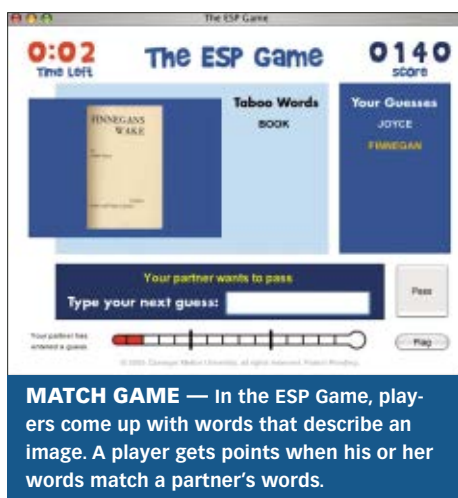
program would typically recognize none of them. Blum coined the word *captcha* to describe such tasks. The word stands for "completely automated Turing test to tell computers and humans apart." Traditionally, a Turing test is one in which a person asks questions of two hidden respondents and, on the basis of the answers, guesses which of them is a person and which is a computer. In the case of a captcha, a computer generates the test and judges responses to it, but, if given the test, another computer can't pass it.

Many online companies now use captchas to control registration, confirm transactions, check voting in online polls, manage the sale of concert tickets, and other tasks.

While thinking about things that people can do but computers can't, von Ahn realized that he could take advantage of human capabilities to solve problems such as image labeling. "I toyed around with a lot of possibilities until the ESP Game came about," he says.

It took months to go from idea to working prototype to final version, as von Ahn and his colleagues incorporated various features to make the game more useful and more fun. For example, some images have lists of one or more taboo words, which players can't use. This encourages players to go beyond the most obvious descriptive terms.

"Depending on the image, we can easily end up with 30 words,



MATCH GAME — In the ESP Game, players come up with words that describe an image. A player gets points when his or her words match a partner's words.

on average,” von Ahn says. He also collects data on the frequency with which players type in different words—information that may be helpful for improving image searches. He expects those data to be valuable also to sociologists and other researchers.

Von Ahn suggests that the game could be varied, for example, by permitting players to choose what sorts of images they want to see. If someone is interested in cars, images of cars will appear more often. “If you see images of things that you’re interested in, you’ll probably be able to give better labels,” von Ahn says. Instead of simply describing a vehicle as a car, a player could go further to identify it as a specific model. It’s a way of harnessing expertise that players might have.

Bederson offers one suggestion for making the game more appealing. “I would much, much rather play with people I know,” Bederson says. “The gaming world has shown that games get much more engaging, and people spend much more time playing them and getting into them more deeply, when they have relationships with the people they’re playing.”

As currently configured, the ESP Game is a cooperative venture. “You can turn it into a competitive game as well,” von Ahn says, which may appeal to different types of people.

WHERE’S WALDO? The ESP Game can’t determine where in an image an object is located. Such location information would be helpful for training and testing computer algorithms for recognizing objects.

To approach this problem, von Ahn came up with a game that he called Paintball, in which players shoot at objects in an image. “That was a flop,” he says. “It wasn’t fun.”

Peekaboom (www.peekaboom.org), which debuted in the summer of 2005, succeeds where Paintball failed. Two randomly paired players are assigned the roles of Peek and Boom. Peek starts with a blank screen, while Boom sees an image and a related word that had been assigned by players in the ESP Game. To provide a clue to Peek, Boom clicks somewhere on the image. Then, a small piece of the image appears at that location on Peek’s screen. Peek then types in a guess for the word. Boom can see Peek’s guesses, say whether Peek is hot or cold, and provide other hints. When Peek correctly identifies the word, the players switch roles and go on to the next image-word pair. The players continue for 4 minutes.

Rapid identifications lead to high scores, so Boom has an incentive to reveal only the areas of an image necessary for Peek to guess the given word. So, if the word is “dog”, and an image has a dog and a cat, Boom would send only those parts representing the dog. Over the course of many rounds, researchers end up with a sense of which pixels belong to which object in any given image.

Von Ahn’s latest game to go live, Phetch (www.peekaboom.com/phetch), is an Internet scavenger hunt in which players look for images that fit certain descriptions. One player, called the narrator, types out a description of a picture randomly retrieved from a database containing 1 million Web images. Then, two-to-four other players, the seekers, use a built-in browser to find the image.

In each 5-minute round, the narrator receives points for each successful search and loses points if he or she decides to bypass an image that seems too difficult to describe. The first seeker to find the image receives points and becomes the narrator for the next image.

“It sounds like work,” von Ahn says, “but people seem to enjoy it.” In a week of testing, 130 Phetch players generated 1,400 captions. Players spent an average of 32 minutes with the game, but some played for up to 10 hours in a single session.

From the results of multiple games, researchers can select the best single caption for an image, determined by factors that include how quickly the image was retrieved. The intention is to provide captioned images to people who are visually impaired.

“You’re never going to get a paragraph that you would get out of *Moby Dick*,” von Ahn says. “The language that you get is similar to the language that you get out of instant messaging. But, at the end of the day, when you look at the caption, you get a really good idea of what’s in the image.”

COMMON SENSE Von Ahn’s newest venture, now under development, is a game called Verbosity. It aims to build a database of common-sense facts—statements about the world that are known to and accepted by most people.

Researchers have long sought to collect common knowledge. In the Open Mind: Common Sense Project

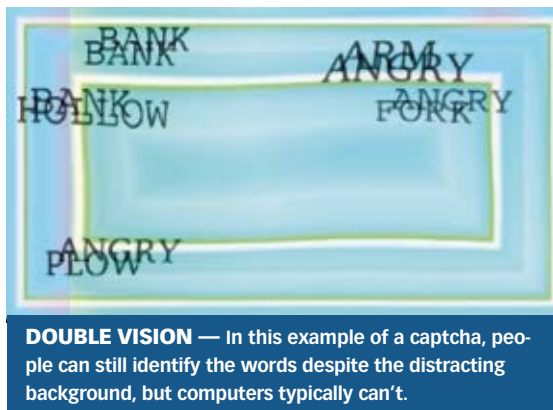
(openmind.media.mit.edu) at the Massachusetts Institute of Technology (MIT), for example, Internet users enter statements that they consider facts into a database of bits of information. Other activities include explaining why a statement is true, giving a cause-and-effect relationship, and paraphrasing a sentence.

The database currently holds more than 600,000 entries, linking many different objects, concepts, and actions. These entries may be used to train reasoning algorithms, which try to make inferences about the world. Scientists view such algorithms as a step toward making computer programs more intelligent.

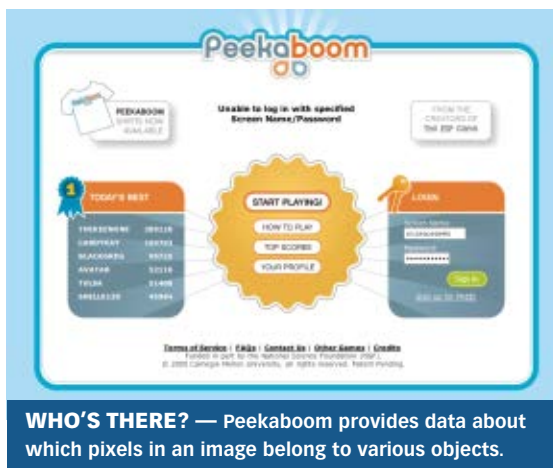
In von Ahn’s game, one player gets a word and sends hints about it to the other player. The hints take the form of sentence templates with blanks. Suppose the word is “car” and the sentence template is, “It’s a type of _____.” The first player could then send the hint, “It’s a type of vehicle.” Another template might be, “You use this for _____.” The hints would constitute facts about cars.

This game isn’t yet ready for prime time because it’s tough to come up with an appropriate set of sentence templates. “To be useful to us, they have to be unambiguous, and they’ve got to be fun,” von Ahn says.

Verbosity is a great idea, says Henry Lieberman, a member of the Commonsense Computing group at the MIT Media Lab. Von Ahn, Lieberman says, is “a very clever game designer.” Junia Anacleto, who runs an Open Mind project in Brazil, recently created a game that uses knowledge in the MIT common-sense database to generate clues for a guessing game called “*O Que É?*” (“What Is It?”). Teachers can customize the game to focus on specific topics.



DOUBLE VISION — In this example of a captcha, people can still identify the words despite the distracting background, but computers typically can’t.



WHO’S THERE? — Peekaboom provides data about which pixels in an image belong to various objects.

Inspired by von Ahn's work, Dustin A. Smith, one of Lieberman's students, designed a computer game called Common Consensus, based in part on the structure of a venerable television game show called *Family Feud*. This Web-based game collects and validates common-sense knowledge about everyday goals. For example, a question might ask, "What are some things that you would use to watch a movie?" The players would reply with a list of objects, such as a DVD player or an iPod. The more players who mention the same object, the more points they get.

ART OF FUN Some aspects of creating what von Ahn describes as "games with a purpose" are more art than science. There's no simple formula for making something fun, for example.

"That's something that still requires a lot of creativity," von Ahn says. "The only way that we know that something is fun is to try it." Moreover, people may not agree on what's fun, and what's fun today may not be fun tomorrow.

All von Ahn's games have a time limit. "It makes players go faster, which is what I want," von Ahn says. "It gives me more data."

Von Ahn has also noticed that keeping the time short increases participation. Given 5- and 10-minute versions of a game, a 5-minute round is played more often, and more people play the game for longer than 10 minutes.

Cheating can bias or taint the results in which researchers are interested. "I worry about it a lot," von Ahn says. "Before launching a game, I think very carefully about any way that I can imagine of cheating, and I come up with mechanisms to stop it."

Bederson says that von Ahn "has done an admirable job at addressing these issues. I don't think there's any evidence that people have been able to subvert these systems."

With all these factors to consider, developing a successful game can take as long as 18 months.

Von Ahn is developing a Web site that only features games in which players provide useful data for researchers. The most popular, well-known games would attract visitors, who might then be tempted to try other games.

Von Ahn sees applications of this sort of game beyond computer science and artificial intelligence. "It could be a new business model," he suggests. "Rather than charging people to play your games, you let them play for free, and your business is the data that the games collect."

Bederson is already looking toward games of the future. "The big

challenge is how to scale this approach up to more-complex problems," he says. Examples of such problems include summarizing or explaining literature, providing services in ways that meet an individual's particular needs, or handling situations in which the truth isn't known—all tasks that require human judgment.

Fun isn't the only way to tap human brainpower. "People want to help the world, and they typically don't know how," Bederson says. "They're often willing to do really hard things if they have legitimate reasons to think that they are doing good in the world."

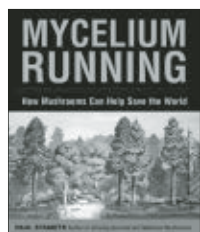
Imagine what people might be willing to tackle through a combination of entertainment and personal fulfillment. ■



VON AHN



FUNGI PERFECTI



Mycelium Running: How Mushrooms Can Help Save The World

By Paul Stamets. This book is a manual for the mycological rescue of the planet. Based upon the premise that habitats and humans (animals) have immune systems, and that mushrooms are the beneficial bridges for both, *Mycelium Running* marks the dawn of a new era: the use of mycelial membranes for ecological health. Linking mushroom cultivation, permaculture, ecoforestry, bioremediation and gardening, mycologist Paul Stamets makes the case that mushroom farms can be reinvented as healing arts centers, steering ecological evolution for the benefit of humans living in harmony with its inhabitants. Moreover, *Mycelium Running* has

chapters on nutrition, medicinal properties, log and stump culture, natural culture, using easy to use and low-tech techniques, and much more. Softcover, 352 pages, with over 350 color photographs.

This is the first book to give the Kingdom of the Fungi its proper place in the scheme of things. It is the most important book on nature that I've seen in years."

—Gary Lincoff, author of *The National Audubon Society Field Guide to North American Mushrooms* and former president of the North American Mycological Association

"Stamets has done a unique public service. This visionary and practical book should be an instant classic in the emerging science of how to use nature's wisdom and fecundity to rescue the earth and ourselves from the unwelcome consequences of human cleverness."

—Amory B. Lovins, CEO, Rocky Mountain Institute

"This is the kind of book I love: highly factual and practical and mixed with the spiritual content that sets the great writers apart from all the rest."

—John Norris, former deputy commissioner and COO of the US FDA, founder of The Bioterrorism Institute and member of adjunct faculty, Harvard School of Public Health

"In his respectful and casual way, Paul brings depth and clarity to the complexity of fungi and its place in the natural order, all the while engaging us in fungi knowledge for healing our planet."

—Guujaaw, President of the Haida Council, Haida Nation

Phone: (800) 780-9126

— www.fungi.com —

Fax: (360) 426-9377

ASTRONOMY

Dance of the dead

The neutron star XTE J1739-285 is the burned-out remains of what was once a brilliant celestial body. Now, astronomers have evidence that it's the fastest-spinning stellar corpse known.

X-ray observations indicate that the neutron star spins 1,122 times a second, about 30 percent faster than the previous record holder, report Phil Kaaret of the University of Iowa in Iowa City and his colleagues in the March 10 *Astrophysical Journal Letters*.

NASA's Rossi X-ray Timing Explorer discovered the neutron star in 1999 when it emitted bursts of X rays. After several years of quiescence, it began sending out new bursts in 2005. Studies of other neutron stars had shown that variations in the brightness of X-ray bursts indicate the stars' rotation rates.

Late last year, the Rossi telescope found oscillations indicating that XTE J1739-285 was spinning faster than any neutron star previously observed. Since then, the star has again quieted, and scientists are waiting to observe more bursts to confirm the high spin rate, Kaaret and his team say.

The maximum rotation of a neutron star would reveal its composition, notes Kaaret. For instance, an interior composed solely of electrons and protons squeezed together into neutrons can't be compressed as much as more-exotic particles can and so can't rotate as rapidly. Additional studies of the spin rates of neutron stars might let astronomers rule out some estimates of the objects' compositions. —R.C.

ENVIRONMENT

Hibernation concentrates chemicals

Some pollutants build up in grizzly bears even as they doze through the winter, tests of the animals' hair and fat indicate.

Hibernating bears don't drink, eat, or excrete waste, so food- and waterborne contaminants neither enter nor leave their bodies. Nevertheless, chemical concentrations in the animals' fat may change as they use up that energy source.

The body converts some compounds into

water-soluble metabolites that get excreted in urine. In a slumbering grizzly, such metabolites might accumulate.

Researchers led by Peter S. Ross, a Sidney, British Columbia-based mammal toxicologist with the government agency Fisheries and Oceans Canada, tested 11 grizzlies in the fall of 2003 and 14 others the following spring. In the March 15 *Environmental Science & Technology*, Ross, Jennie Christensen, and their colleagues report that many pollutants increased in concentration in body fat, while some decreased.

For example, the overall concentration of polychlorinated biphenyls (PCBs) more than doubled. Polychlorinated diphenyl ether concentrations increased by 58 percent. However, concentrations of certain PCBs and other contaminants declined, suggesting that they had been metabolized.

Some of the pollutants whose concentrations increased in shrinking fat stores—but none that decreased—are typically metabolized by an enzyme that may be suppressed during hibernation, the researchers found.

Ross' team notes that the bears' diets created two distinct contamination patterns in the fall—one in fish-eating bears and another in bears living far from water. The distinctive patterns blurred during hibernation, as metabolic processes erased the differences in pollutants within the bodies of bears in the two groups. —B.H.

CHEMISTRY

Scrubbing troubles

Triclosan, an antibacterial agent found in many soaps, may increase a person's exposure to a potentially toxic chemical, new research suggests.

Although there is little evidence of any benefit from using antibacterial soaps instead of regular soaps in the home, people in the United States employ around 1,500 kilograms of triclosan each day in kitchen and personal-care products.

Previous research has shown that triclosan reacts with chlorine, the most common disinfectant for drinking water. The resulting by-products include chloroform, suspected to cause cancer. Chloroform also forms when chlorine reacts with organic material in water.

Environmental chemist Peter J. Vikesland and his coworkers at the Virginia Polytechnic Institute and State University

in Blacksburg wondered how much chloroform arises when a person washes dishes or showers with a triclosan-containing product. The researchers tested several antibacterial liquid soaps in purified water and tap-water samples from Atlanta and Danville, Va., by adding a quarter of a gram of soap per liter of water and measuring the reaction products after 1 minute.

The scientists plugged their results into a formula to predict a person's chloroform exposure. Use of triclosan-containing products could boost the chloroform reaching a person's skin or airways by 15 to 40 percent over the chemical's allowable concentration in tap water, the researchers report online and in an upcoming *Environmental Science & Technology*.

To determine people's actual exposures to chloroform during dishwashing or showering will require further studies, notes Vikesland. But with the potential for additional chloroform exposure from antibacterial soaps of questionable benefit, "people should think about what they are using and whether they actually need it," he says. —A.C.



BEARS' BURDEN Grizzlies concentrate some pollutants in their fat even while they fast during hibernation.

BIOMEDICINE

Emerging bug pilfers DNA

A bacterium that's spreading in U.S. hospitals and on the battlefields of the Middle East has filched some of its most dangerous genes from other bacteria, say researchers who sequenced the bug's genome.

In 2004, the Centers for Disease Control and Prevention reported that 240 U.S. soldiers in the Middle East had suffered antibiotic-resistant bloodborne infections due to *Acinetobacter baumannii*. Stateside hospitals have also reported a rise in stubborn infections from the bug. According to previous research, it kills up to 75 percent of the people it infects.

Michael Snyder and his colleagues at Yale University sequenced the genome of the more virulent of the two known strains of *A. baumannii*. Using a new technology called high-density pyrosequencing, the team decoded the genome in a few weeks.

The genome includes 28 stretches of DNA that match sequences found in other organisms. Fully 17 percent of *A. baumannii*'s genome appears to have been imported, says Snyder, who compares the bug's genome to a pair of old, patched jeans.

OF NOTE

The researchers say that the pilfered DNA gives the bug much of its tenacity and that it includes genes that produce toxic substances and defeat antibiotics.

The research appears in the March 1 *Genes & Development*. —B.V.

NANOTECHNOLOGY EPA council sets priorities

A white paper released Feb. 15 by the Environmental Protection Agency's Science Policy Council outlines the agency's nanotechnology-research needs. The group calls for continued research into the ecological and health risks of nanotechnology, prevention of pollution by nanomaterials, and nanotechnology to benefit the environment.

For example, the report suggests that the agency support research on nanotechnology's uses in green energy and in environmental remediation. It also recommends a long list of projects to assess risks from nanotechnology, including tracking the fate

of nanomaterials in the environment and measuring people's exposures and the effects that follow.

Included is a plan from EPA's Office of Research and Development for how the agency should pursue these research recommendations over the next 5 years.

Initially, EPA would focus on the environmental fate of nanomaterials such as carbon nanotubes. Such studies will require further development of monitoring and detection methods, according to the report. The agency will use these data to assess exposures of wildlife and people. Next, it will focus on examining health and ecological effects. Finally, the agency will concentrate on ways to manage the risks of nanotechnology. —A.C.

CLIMATE

Hey, it's cooler near the sprinklers

Extensive agricultural irrigation can significantly affect local climate and may be masking the effects of global warming in some areas, a new study suggests.

In arid and semiarid regions, irrigation enables farmers to grow crops that wouldn't naturally thrive. But adding large volumes of water to normally dry ground changes the climate in many ways, says

Lara M. Kueppers, an ecosystem scientist at the University of California, Merced. For example, irrigation typically darkens the soil, which then absorbs more heat. The resulting increase in evaporation cools the air and boosts humidity, she notes.

Kueppers and her colleagues used computer models to estimate the climatic effects of irrigation in California, where farmers provide extra water to around one-twelfth of the state's land. One set of simulations depicted modern land use, and another set simulated only natural vegetation.

During a simulated 20-year period, August daytime-high temperatures at irrigated sites were on average 7.5°C lower than they would have been if they'd been covered with natural vegetation, says Kueppers. In those irrigation-cooled areas, humidity increased an average of 25 percentage points.

Applied to California as a whole, these results imply that irrigation keeps the average August temperature about 0.38°C lower than it would otherwise be. That's about the same amount of greenhouse gas-triggered warming that some climate models suggest will occur in coming decades, the researchers note in the Feb. 16 *Geophysical Research Letters*. If the extent of irrigated farmland declines in the future because of water shortages or urban sprawl, irrigation's evaporative cooling effect probably will decrease as well. —S.P.

EXCLUSIVELY ONLINE

MathTrek: Cutting a Pie Is No Piece of Cake

Mathematicians find that slicing a pie into fair pieces is harder than divvying up a sheet cake.

Read it here:

www.sciencenews.org/articles/20070310/mathtrek.asp

Food for Thought: Marlin Crash May Be Worse Than Reported

A newly identified species of billfish resembles white marlins so closely that its presence might be masking how decimated Atlantic stocks of the marlin really are.

Read it here:

www.sciencenews.org/articles/20070310/food.asp

WWW.SCIENCENEWS.ORG
SCIENCE NEWS ONLINE



EXPLORE YOUR WORLD,
UP CLOSE



www.sciencenewsforkids.org

Books

A selection of new and notable books of scientific interest

ATLAS OF BIRD MIGRATION: Tracing the Great Journeys of the World's Birds

JONATHAN ELPHICK, ED.

One of the hallmarks of the change from summer to winter is the north-south migration of birds, as bil-



lions of them leave their remote, northern breeding grounds for warmer locales. But these journeys are only a partial picture of bird migration worldwide. Elphick, with the help of other bird observers, uses vivid images, maps, and computer re-

creations to document the migration patterns of winged voyagers everywhere. Migration evolved as continents and glaciers shifted, altering the landscape and changing the ancestral environments of birds across the globe, the authors assert. The writers shed light on this process and then turn to details of modern migrations. The authors show the migration patterns of North American and Eurasian birds, birds from the far Northern and Southern Hemisphere, and migratory sea birds. *Firefly*, 2007, 176 p., color images, hardcover, \$35.00.

THE END OF THE WILD

STEPHEN MEYER

Conservationist Meyer, a professor of political science, asserts that humanity has already dealt an irreversible blow to the world's wildlife. People are making many parts of the world more hospitable than ever to the minority of plants and animals that



thrive in continually disturbed, human-dominated environments. But the rest of the species are becoming what Meyer calls relics and ghosts. Relics are the ones that can survive only by concerted efforts to preserve them in special refuges. Ghosts are doomed species that can't adapt fast enough to resist human pres-

ures. Meyer reviews current conservation efforts and explains why he thinks even these are inadequate to preserve most wildlife. Humanity must undergo an ethical transformation to lessen its footprint on Earth and take dramatic strides to preserve the wild things that remain, he insists. *MIT Press*, 2006, 97 p., hardcover, \$14.95.

AMERICAN GREEN: The Obsessive Quest for the Perfect Lawn

TED STEINBERG

Maintaining the ideal lawn is a constant battle against crabgrass, drought, weeds, and lawn-destroying vermin. For many people, this means the marshaling of gas-powered machines, potent fertilizers, and nasty herbicides. As toxic as that combination might sound, many homeowners wage this war with enthusiasm, writes historian Steinberg. He examines the evolution of people's obsession with

the perfect lawn and reveals how turf grass, which isn't native to North America, became the most popular crop in the United States. He traces the



lawn's history from colonial days, when the Pilgrims transplanted turf from England, to its proliferation among post-World War II conformist suburbanites. With humor and wit, Steinberg reveals the whimsical side of lawn care. This obsession with turf, however, has a darker side, in its

dependence on pesticides and fertilizers, the author says. Steinberg offers suggestions for a more balanced approach to lawn care. *Norton*, 2006, 295 p., b&w photos, paperback, \$16.95.

BRAINTEASER PHYSICS: Challenging Physics Puzzlers

GÖRAN GRIMVALL

For the past 27 years, Grimvall, a professor of physics at the Royal Institute of Technology in Stockholm, has authored the puzzle column in a Swedish journal for engineers. In this book, he seeks to



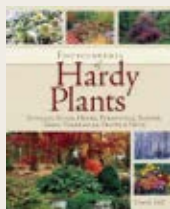
expand his audience geographically and professionally by presenting 57 physics-themed brain-teasers to a general readership. Ever wonder whether it's better to walk or run to escape the rain? Or what your body's volume is? Grimvall presents these and other puzzles ranging from easy problems for physics novices to

advanced quizzes for readers with technical backgrounds. Each problem's solution is included at the end of each chapter, along with Grimvall's comments on how physicists solve such problems in their everyday work. *Johns Hopkins Univ. Press*, 2007, 162 p., b&w illus., paperback, \$23.00.

ENCYCLOPEDIA OF HARDY PLANTS: Annuals, Bulbs, Herbs, Perennials, Shrubs, Trees, Vegetables, Fruits & Nuts

DEREK FELL

Gardeners who live in cold climates and wish to keep plants more than a few months each year face the challenge of selecting and caring for plants that can survive well into or through the winter. Fell, a writer and gardener, provides an illustrated refer-



ence to more than 700 hardy plants. The guide's introduction includes information on conditions that determine whether certain plants will survive—mainly the temperature extremes of geographical zones. Included are world and U.S. maps of these hardiness zones. Fell briefly

describes his own garden, Cedaridge Farm in Pennsylvania, the backdrop for many of the book's colorful photos of individual plants and groupings. Next, Fell lists and describes the hardy plants, arranged in the categories of annuals, bulbs, herbs, perennials, shrubs, trees, and edibles. For each plant, the author cites appropriate hardiness zones, gives a physical description, and notes garden-design factors. Plant placement, pairings, and propagation tips are included in most entries. *Firefly*, 2007, 224 p., color photos, hardcover, \$29.95.

LETTERS

Disputable thesis

"Counterintuitive Toxicity: Increasingly, scientists are finding that they can't predict a poison's low-dose effects" (*SN*: 1/20/07, p. 40) took a wrong turn into Hormesis Swamp. The hormesis thesis has been thoroughly discredited by all major radiation organizations and professional societies, and its past conferences have been sponsored by tobacco companies and the U.S. Air Force.

LYNN HOWARD EHRLE, PLYMOUTH, MICH.

Fat or fit city?

Regarding "Weighing In on City Planning: Could smart urban design keep people fit and trim?" (*SN*: 1/20/07, p. 43), there are also suspected connections between high-impedance commuting and blood pressure, commuting and unhealthy exposure to air pollution, and commuting and back problems and anxiety. Combined with the effects of auto emissions on global warming, one would think that national debates on sprawl and mass transit are long overdue.

JULIA JORGENSEN, HOUSTON, TEXAS

I think there could be some truth to the thesis, but I would urge caution in imposing dictates to change the current situation. Obesity is also growing in European cities without any significant change in settlement patterns. Perhaps a better idea would be to *reduce* restrictions on commercial and retail development in residential areas. The idealized, mixed-use village of generations past was largely the result of unregulated order.

ELOISE HEDBOR, SOUTH HERO, VT.

Does it make a difference where you were brought up? If I'm born in a small, country town where everyone knows everyone, the community is safer, there are more open spaces, and children ride bikes or play baseball, I grow up being more active. Then, should I later move to urban sprawl, I may be more inclined to look for ways to continue my active lifestyle. Likewise, if I grow up where there are fewer open spaces and a less safe environment, I simply don't get used to activity. I use my car to drive everywhere and tend toward being more sedentary.

CARI CORBET-OWEN, NAPA, CALIF.

SEND COMMUNICATIONS TO:

Editor, Science News

1719 N Street, N.W., Washington, D.C. 20036

or editors@sciencenews.org

All letters subject to editing.

HOW TO ORDER Visit <http://www.sciencenews.org/pages/books.asp> to order these books or others. A click on the link under a book will transfer you to Barnes & Noble's internet bookstore. Sales generated through these links contribute to Science Service's programs to build interest in and understanding of science.



sciencemall-usa.com

Science Mall shopping

How To Order: VISA, MC, AMEX, Check, MO postage not included

Great new samples of Lightning-Fused sand available on our website at: www.sciencemall-usa.com



Lightning Striking Tree
A fabulous picture of a great force of nature - lightning! Size: 24" X 36", Laminated - Order # JPT-lightning Cost: \$ 15.95, also available framed. Many new lightning-fused sand samples on website!

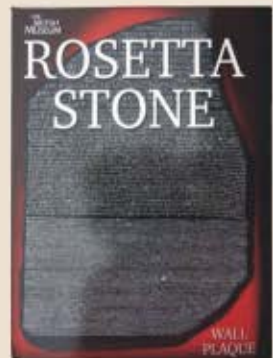


Dangerous Insects of the World - Poster 26 insects are graphically illustrated on this 26 1/2" W X 38" L poster. Habitat; method of contact; symptoms and treatments are discussed. Comes laminated, Copyright 2007 Order #JPT-0146, Cost: \$25.95; Order#JPT-0148, 2 for \$50



Noah's Ark - Wild Animal Panorama Poster - Beautiful artwork by Japanese artist Haruo Takino, same artist as the Dinosaur Panorama poster. Size: 64.375"L X 22.75"W Laminated Order#JPT-4683 Cost: \$38.00; Dinosaur Panorama Poster Order#JPT-dinopan, Cost \$38

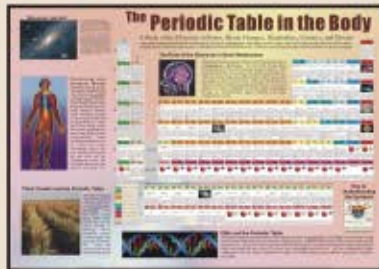
This elegant **Paua Shell Necklace** is unique to New Zealand. A commoner name for it is the "abalone" shell. The Paua shell is easily among the most colorful shell in the world and its shimmering rainbow of colors and iridescence make it among the most sought-after for "elegant wear" jewelry. Comes with a 20" gold braided chain. 14K gold wire wrapped pendant is hand sculpted in a cosmic spiral design. Size: 2 1/8" X 1 1/8"W... Order # JPT-1033... Cost: \$95, including display box. Paua shell earrings and matching pendant...JPT-1040 - \$185, including elegant display case.



Rosetta Stone Wall Plaque - Replica
Size: 12 3/8" X 10 5/8"
JPT-Rosetta, Cost: \$85



New! Special Price - RMS Titanic Shipwreck Coal The Titanic coal is suspended in four different designs of jewelry. These hand-fashioned blown glass pendants have the precious shipwreck coal sealed safely inside. All are between 1.1 inches and 1.38 inches in length. Each comes with a braided cord that will adjust to fit all neck sizes and is suitable all ages. Each is accompanied by a certificate of authenticity. Order #JPT-titan-list style... either an Anchor, Cross, Dolphin. Teardrop unavailable. Cost: \$24.95 each; or #JPT-5555 - 2 for \$40



The Periodic Table in the Body poster discusses each of the elements on the Periodic Table in relation to how the body uses them. It helps us understand how the elements are used by bones, blood, metabolism, genetics, and disease. The chemical makeup of the human body, plant growth, DNA, and the role of the elements in brain metabolism are discussed. Full color, laminated, 28"W X 38"H poster, Copyright 2007 Order #JPT-4191 Cost \$28.95; #JPT-8171, 2 for \$50



Sterling Butterfly Wing Pendants
Various Sizes and Origins on our website at: www.sciencemall-usa.com
Available from various world locations such as Peru, Indonesia, and many more!
Prices \$28.95 - \$60



New! Allende Meteorite Pendant - 14k gold pendant with information on this classic, ancient meteorite. Size: 3/4" diameter and comes with 20" gold braided chain. Very Limited quantity. Order #JPT-22108 Cost \$325.00



Sumerian Medical Tablet - Reproduction of the earliest known prescription written in cuneiform. A detailed booklet comes with the tablet and gives a translation and history. The original was found a Nippur (c. 2100 B.C.). Size: 6" X 3" X about 3/4" thick. Comes with an adjustable walnut wood easel stand. Order # JPT-sumer, Cost: \$69.95

Unique Meteorite Pendant NWA 869 has lot of chondrules and is very showy! Comes with information & authenticity. Size: 1" X 1" Sterling Silver pendant comes with braided sterling silver chain 20". For the person that wants something "out of this world." #JPT-metpndt...\$85.00, #JPT-7771... 2 for \$150



Mammoth Ivory Rose Pendant
This exquisite, delicately carved Ivory Rose Pendant is wrapped in 14K gold. Comes with 20" braided gold chain. The pendant comes with certificate of authenticity and its history. It is the perfect gift for birthdays or other special occasions. Rose pendant size 1" diameter, rose earrings size 3/8" diameter. Order #JPT-rose, \$185 Order jewelry set - with earrings, pierced ears or clips, #JPT-1733...\$360 for the set.

How To Order: VISA, MC, AMEX, Check, MO postage not included

Science Mall-USA.com
P.O. Box 1864
Dubuque, IA 52004-1864

Toll Free: 800-720-5451
sciencemall-usa.com

Free Human Genome Poster with every order over \$45