SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

MARCH 4, 2006 PAGES 129-144 VOL. 169, NO. 9

this is your brain on food

MS drug now deemed safe

cannibal cricket cravings

high cuisine in ancient peru

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sturgeon

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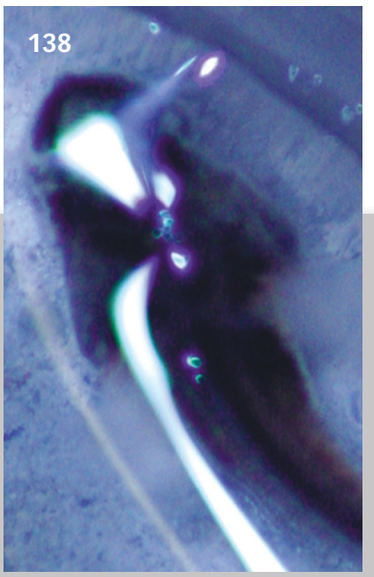

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This Week

Of Note

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Cover This week-old Siberian sturgeon, shown with its reflection, was born at a research center in Florida. Scientists there and elsewhere around the world are rearing sturgeon species and restocking wild populations. New trade restrictions on caviar are intended to protect the species. (J. Balla/*Mote Magazine*) Page 138

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Do Over

New MS drug may be safe after all

An experimental drug for multiple sclerosis (MS) that was approved in 2004, then abruptly yanked off shelves last year because of safety concerns, may get a second chance.

Two studies show that the drug can curb MS symptoms and slow progression of the autoimmune disease over 2 years, the longest tests of this drug to date. A third investigation finds no further cases of the often-fatal complication that sidetracked the drug last year, beyond the three patients who fell ill at that time. All three papers appear in the March 2 *New England Journal of Medicine*.

The drug, natalizumab, was pulled 4 months after its approval by the Food and Drug Administration. Three patients in clinical trials had developed progressive multifocal leukoencephalopathy (PML), a rare nervous system disorder caused by a virus that attacks people with suppressed immunity. The withdrawal came after doctors had written roughly 7,000 prescriptions for natalizumab for MS, rheumatoid arthritis, and an intestinal ailment called Crohn's disease. The drug was marketed as Tysabri by Biogen Idec of Cambridge, Mass., and Elan Corp. of Dublin, which both funded the new studies testing the drug's effectiveness.

The drug combats MS by binding to a protein called alpha-4 integrin on the surface of white blood cells, interfering with their entry into the brain. This thwarts the brain inflammation and nerve damage that these immune system cells trigger, says neurologist Richard A. Rudick of the Cleveland Clinic.

Starting in 2001, Rudick's U.S. team randomly assigned patients to get a monthly infusion of either natalizumab or a placebo. In 2002, researchers in the Netherlands began a similar trial. Together, these tests included 1,859 MS patients. In the U.S. study, all patients also received interferon-beta 1a, a current MS drug.

Over 2 years, the annual relapse rate in patients getting natalizumab was one-third or less in both studies, compared with more than three-fourths among patients getting a placebo.

Natalizumab's relapse suppression "was more robust than that for currently available drugs," says Chris H. Polman, a neurologist at Vrije University Medical Center in Amsterdam.

Magnetic resonance imaging showed that patients in the trials getting natalizumab were less likely to develop MS-type brain lesions than were those getting a placebo or a placebo plus interferon-beta 1a.

In the third study, researchers at the National Institute of Neurological Disorders and Stroke in Bethesda, Md., looked for signs of the virus that causes PML in 3,116 people who had taken natalizumab as part of the two new MS trials and several other trials.

No one aside from the three patients already identified had the disease, says virologist Eugene O. Major of the institute. The new findings indicate that the risk of developing PML while using natalizumab is roughly 1 in 1,000, he says.

All three patients who developed PML were taking natalizumab with other drugs and might have had overly suppressed immune systems, says Allan H. Ropper, a neurologist at Caritas St. Elizabeth's Medical Center in Boston. Natalizumab alone "seems fairly safe, and it's quite potent," he says.

Some doubts persist, however. Neurologist Annette Langer-Gould of Stanford University says that even the 1-in-1,000 risk of PML "seems to outweigh the benefits" that natalizumab would provide many patients. Langer-Gould says that she would consider giving the drug only to MS patients "who are imminently at risk of developing severe disability ... and have failed standard therapies." —N. SEPPA

STATS

250 thousand

Conservative estimate of people in the United States with MS

Cannibal Power

Mormon crickets swarm to eat and not be eaten

What drives the relentless march of Mormon crickets across the landscape is both a craving for food and a reluctance to be cannibalized, says an international research team.

The swarms loom large in the lore of the American West, but scientists hadn't worked out the dynamics of what keeps the insects on the move, says Stephen Simpson of the University of Sydney in Australia. He and his colleagues now report that swarming Mormon crickets are deficient in protein and salt. They march over the countryside in quest of the missing nutrients, but the laggards provide excellent dining for their fellow crickets. Simpson and his colleagues propose in an upcoming *Proceedings of the National Academy of Sciences* that hunger and danger combine to keep Mormon crickets rolling.

"It's terrific to see this work because so little is known about them," says entomologist Darryl Gwynne of the University of Toronto at Mississauga in Ontario.

Mormon crickets generally live mild-mannered lives, foraging at low densities. Sometimes, though, they form a cricket parade several million strong and up to 10 kilometers long. Although these insects can't fly, the crowd can walk and hop 2 km a day.

PNAS

NOURISHING MEAL Mormon crickets that march in a swarm may be replenishing protein and salt when they cannibalize their swarm mates.

Simpson describes a rustling sound as the Mormon crickets swarm forward. "They will crawl over you and nip you too," he says. "There is a horror movie in there for sure."

Simpson and his colleagues suspected that the crowd pushes on when what's left to eat in the current spot doesn't meet their nutritional needs.

The researchers offered swarms in the field various dry insect chows. Insects jostled each other fiercely for the highest-protein choices. High-carbohydrate chows didn't generate enthusiasm.

In another test, swarming crickets crowded around cotton wool soaked in a moderately salty solution in preference to cotton soaked in plain water.

But in the lab experiments, crickets permitted to gorge on their choice of food shifted to a lower-protein, less-salty diet after a day or two.

One of the better ways to replenish proteins and salt is to eat another Mormon cricket, Simpson says. Even a swarming cricket contains more protein and salt than many plants do. Simpson and his colleagues found that crickets that didn't move as fast as others or that had died tended to be eaten by their more mobile compatriots.

"It's the first time cannibalism has been shown as a force in animal group movements," says Simpson.

What drives these swarms had been an old, unanswered question, says Anthony Joern of Kansas State University in Manhattan. "I was really excited by the paper," he says, "because I didn't expect there would ever be an answer." —S. MILIUS

Ancient Andean Maize Makers

Finds push back farming, trade in highland Peru

HIGH TIMES Researchers excavate Waynuna, a site in Peru's Andes Mountains that has yielded evidence of early agriculture and food importing.

Nearly 4,000 years ago, large societies emerged in the Andes Mountains of southern Peru that would culminate 1,500 years later in the rise of the Inca civilization. Now, scientists have the first evidence that these Inca predecessors cultivated maize and imported plant foods from lowland tropical forests located 180 miles to the east.

Researchers have long theorized that ancient Andean civilizations exchanged goods with lowland sites. "Our results provide the earliest direct evidence of an important trade connection between highland and lowland sites in southern Peru," says archaeologist Linda Perry of the Smithsonian Institution's Archaeobiology Laboratory in Suitland, Md.

In the Andean highlands, maize previously had been dated only to 2,500 years ago.

Perry and her coworkers recovered fossilized, microscopic plant remains from soil samples and stone-tool surfaces at a highland site called Waynuna. Much of Waynuna consists of raised farm fields built around 1,200 years ago. However, the researchers focused their search on a house that they have partially excavated. Radiocarbon measurements placed the structure's age at between 3,600 and 4,000 years.

Perry's team identified 1,077 samples of either starch granules or silica-containing plant cells called phytoliths. Both granules and phytoliths come in distinctive forms that enable scientists to discern one plant species from another and to distinguish wild from cultivated plants.

Most of the plant remains examined came from maize, the researchers report in the March 2 *Nature*. Analyses revealed maize phytoliths from both leaf and cob. The leaf phytoliths provide a strong clue that Waynuna residents cultivated maize, Perry notes.

Many maize-starch granules displayed surface damage consistent with that produced by grinding with stone implements, such as those found at the site.

On one tool, the scientists recovered starch granules of arrowroot. This edible plant grows in lowland forests but not in mountainous regions.

Another stone fragment yielded the starchy remains of a potato. Potatoes can be grown at Waynuna's altitude—about 2 miles above sea level—but Perry's group hasn't determined whether the fossilized residues belong to a wild or a domesticated species. Given the site's location near modern potato and maize farms, "it wouldn't be surprising if [prehistoric] people were growing potatoes at Waynuna," Perry says.

Other investigators previously estimated that potato-starch granules found at Peruvian coastal sites date to between 4,000 and 3,000 years ago.

Waynuna lies near a major source of raw obsidian, a rock that held great symbolic meaning for ancient inhabitants of this region. Obsidian may have been traded for arrowroot and other lowland crops, such as peanuts and manioc, the researchers suggest. They plan to look for additional remains of lowland plants at Waynuna.

The discovery of imported arrowroot at Waynuna fits the theory that interactions among Peruvian coastal, highlands, and eastern-lowlands sites fostered the growth of early Andean societies, comments Yale University archaeologist Richard Burger.

"It's reasonable to suspect that a gradual uphill movement of maize, potatoes, and arrowroot into ever-starker environments transpired long before [their documented use at Waynuna," remarks archaeologist Michael E. Moseley of the University of Florida in Gainesville. —B. BOWER

Gender Gap

Male-only gene affects men's dopamine levels

A gene found only in men is key to regu-lating the brain's production of dopamine, a new study shows. The finding offers a clue to why men are more likely than women to

D. SANDWEISS/UNIV. MAINE

develop dopamine-related illnesses such as Parkinson's disease, schizophrenia, and addiction. Together with another new study, the work suggests that women and men have distinctive dopamine-regulating systems.

The gene, called *Sry*, is found on the Y chromosome and is therefore exclusive to men. *Sry* determines gender, signaling an embryo's gonads to develop into testes rather than ovaries.

Unexpectedly, the gene also performs a function not related to sex, says geneticist Eric Vilain of the University of California, Los Angeles. The researchers found that *Sry* makes a protein that controls concentrations of dopamine, a neurotransmitter produced in a central brain region called the substantia nigra. Dopamine carries signals from the brain to the body that control movement and coordination.

In people with Parkinson's disease, dopamine-producing neurons in the substantia nigra start to die off, and the brain gradually loses control of physical movements. Tremors and eventually paralysis result. Men are 1.5 times as likely as women to develop the degenerative disease.

To test the effect of *Sry*, the researchers suppressed the gene's expression in one side of the substantia nigra of male rats. The rats lost 38 percent of the dopamine-producing neurons on that side, the team reports in the Feb. 21 *Current Biology*. The rats also suffered Parkinson's-like loss of motor function on the side of the body controlled by the altered portion of the brain.

QUOTE

"The mechanisms of control and production of dopamine are just different between men and women."
ERIC VILAIN, University of California, Los Angeles

"What this research implies is that the mechanisms of control and production of dopamine are just different between men and women," Vilain says. He adds that the study provides the first evidence for a nonhormonal factor that produces sex differences in the brain.

Because women's brains also produce dopamine, Vilain suggests that *Sry* "must compensate for something that's present in females and not males."

Estrogens are one possibility, and they could also explain women's apparent advantage when it comes to Parkinson's disease, says neurologist Charlotte Haaxma of Radboud University's Nijmegen Medical Centre in the Netherlands. She notes that men tend to develop Parkinson's at a younger age than women do. Furthermore, women are more likely to develop a milder form of the illness.

At the World Parkinson Congress in Washington, D.C., on Feb. 22 to 26, Haaxma and her team presented data suggesting that estrogens may control dopamine concentrations and stave off the onset of Parkinson's disease. For 96 women with Parkinson's, the team compared estrogen-boosting or -depleting events, such as pregnancies and menopause. The onset of Parkinson's was delayed by an average of 2.7 years per child born, and each year of fertility beyond the group's average age of menopause held off the disease by half a year.

Vilain agrees that these data suggest that estrogen is probably the factor that drives dopamine regulation in women. Investigating such gender differences in the brain, he adds, is "an emerging field." —C. GRAMLING

Unique Explosion

Gamma-ray burst leads astronomers to supernova

Using scores of telescopes, astronomers worldwide are chasing one of the most intriguing stellar explosions detected in nearly a decade. The supernova—a cata-

Smoldered-Earth Policy

Created by ancient Amazonian natives, fertile, dark soils retain abundant carbon

Shortly after the U.S. Civil War, a research expedition encountered a group of Confederate expatriates living in Brazil. The refugees had quickly taken to growing sugarcane on plots of earth that were darker and more fertile than the surrounding soil, Cornell University's Charles Hartt noted in the 1870s.

The same dark earth, *terra preta* in Portuguese, is now attracting renewed scientific attention for its high productivity, mysterious past, and capacity to store carbon. Researchers on Feb. 18 at the annual meeting of the American Association for the Advancement of Science in St. Louis presented evidence that new production of the fertile soil could aid agriculture and limit global greenhouse-gas emissions.

Prehistoric farmers created dark earth, perhaps intentionally, when they worked charcoal and nutrient-rich debris into Amazonian soils, which are naturally poor at holding nutrients. The amendments produced "better nutrient retention and soil fertility," says soil scientist Johannes Lehmann of Cornell.

Charcoal forms when organic matter smolders, or burns at low temperatures and with limited oxygen. Nutrients such as phosphorus and potassium readily adhere to charcoal, and the combination creates a good habitat for microorganisms. The soil microbes transform the materials into dark earth, says geographer William I. Woods of the University of Kansas in Lawrence.

If some of today's Amazonian farmers were to use smoldering fires to produce dark earth rather than clear fields with common slash-and-burn methods, they "would not only dramatically improve soil and increase crop production but also could provide a long-term sink for atmospheric carbon dioxide," says Lehmann.

Slash-and-burn land clearing releases about 97 percent of the carbon that's in vegetation. Smoldering the same fuel to form charcoal releases only about 50 percent of the original carbon, Lehmann previously reported. The rest of that carbon remains in dark earth for centuries.

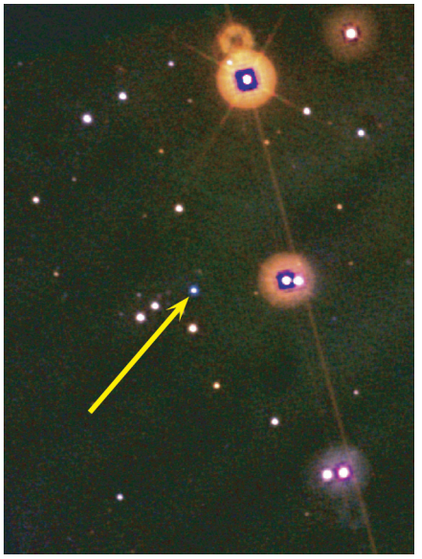
However, dark earth requires extra nutrients, such as those in compost. International agreements on greenhouse gases don't provide financial incentives for farmers to make the effort to create dark earth, Woods says.

Nevertheless, ongoing field experiments in Brazil suggest that the fertility associated with *terra preta* could provide its own incentive, reports Beáta Madari of the Brazilian Agricultural Research Corporation in Rio de Janeiro.

Brazil contains a wide range of dark earths with varying compositions. The scientists found differences between the soils used for ancient backyard gardens, which received more nutrients, and soils from distant fields.

Farmers of the time "certainly would have immediately learned about the properties of that soil, however [it] formed," says anthropologist Michael J. Heckenberger of the University of Florida in Gainesville. But the knowledge about how to make dark earth disappeared after contact with Europeans decimated the indigenous population. —B. HARDER

strophic collapse of a massive star—is one of only a handful of these explosions known to have been heralded by a burst of gamma rays.



KABOOM The arrow above points to the visible-light afterglow of the nearest gamma-ray burst found since 1998. Reddish halos are artifacts.

SWIFT, NASA

The observations confirm that material blasting out from a collapsing star generates a gamma-ray burst. The burst races out into space ahead of the visible, fiery glow from the supernova explosion.

A gamma-ray burst typically lies too far away—billions of light-years—and has an afterglow too bright to permit astronomers to detect the underlying supernova. But the new burst, recorded by NASA's Swift satellite on Feb. 18, resided a relatively close 440 million light-years from Earth. Furthermore, the burst was unusually weak, despite lasting nearly 200 seconds—about 100 times as long as the typical burst.

Within 3 minutes of the burst, dubbed GRB 060218, Swift's visible-light telescope pinpointed the source, in the constellation Aries. Then, the race on was on to find the hidden supernova. On Feb. 21, Alicia Soderberg of the California Institute of Technology in Pasadena and her colleagues succeeded, using the large Gemini South Observatory on Cerro Pachón Mountain in Chile. The supernova is expected to reach its peak brightness around March 5, and amateur astronomers in the Northern Hemisphere with a telescope at least 16 inches across have a good chance of viewing the ongoing eruption.

Watching a supernova unfold so soon after the star erupted—particularly one linked so closely to a gamma-ray burst—is only part of the excitement, says Soderberg. Astronomers calculate that this burst packed only about one-hundredth the energy of more-distant bursts. Its low energy was similar to an even closer burst recorded in 1998. Taken together, the two bursts "imply the existence of a significant population of [faint] gamma-ray bursts that go undetected at larger distances," Soderberg says.

These low-energy events could be 30 times as common as more-powerful bursts, calculates theorist Andrew MacFadyen of the Institute for Advanced Study in Princeton, N.J.

In high-energy bursts, a collapsing star expels jets of material at near-light speeds. Chunks within each jet collide to generate the gamma rays. In contrast, lower-energy bursts may originate from a weaker explosion that drives out lower-speed chunks of material in a more diffuse pattern, MacFadyen suggests. When this material smacks into dust and gas surrounding the star, it generates the lower-energy gamma rays. In either case, the collapsing star becomes a black hole or a magnetar, an extremely dense, rapidly spinning star with an enormous magnetic field.

MacFadyen, who has worked on gamma-ray–burst models for more than a decade, doesn't usually do his work from behind a telescope. This time, however, "I'm personally looking to make friends with someone with a telescope because I really want to see a new black hole or magnetar being formed with my own eyes. This is a rare and special opportunity." —R. COWEN

QUOTE

"There are all kinds of reasons that you would want to be able to control or fine-tune the [release] of peptides ..."
GERALD T. NEPOM, Benaroya Research Institute

Gold-Metal Results

Compounds block immune proteins

Metals such as platinum and gold keep certain proteins from stimulating the body's immune response, a study finds. The results suggest how some metal-based drugs might ease autoimmune symptoms, the researchers say.

They were screening compounds in search of a chemical that would blunt the action of a set of immunological proteins that usually bind to protein fragments, or peptides, from foreign objects such as viruses and bacteria. These class II major histocompatibility complex (MHC) proteins present the peptides to immune cells called helper T cells, which coordinate the body's response. The cells initiate inflammation and the production of antibodies.

As part of the natural regulation of the immune system, the body uses a catalyst to make class II MHC proteins release a temporary cargo before presenting a peptide.

In an autoimmune disease, the proteins present peptides from a person's own body, leading to a self-attack. Brian S. DeDecker of Harvard Medical School in Boston and his colleagues were attempting to find a compound that would "knock the peptide out" of the immune proteins' grasp, thereby reducing an autoimmune response, DeDecker says.

Out of 28,000 compounds examined, the team found only two that interacted with the class II MHC proteins in test tubes. Both compounds contained a soluble, oxidized form of platinum. Initial tests indicated that one of these compounds, a drug called cisplatin, caused the MHC proteins to let go of a tightly bound flu-virus peptide.

The researchers then tested the speed with which cisplatin caused the release. Cisplatin was five times as fast at stripping class II MHC proteins of their peptides as the body's own catalyst was.

"There is a developing understanding that how tightly MHC binds its peptide determines whether you get a T cell response," says team member Lawrence J. Stern of the University of Massachusetts Medical School in Worcester.

The researchers also conducted two test-tube experiments with live T cells. They exposed one group of cells to cisplatin and another to a gold compound not in the initial screening. In both cases, the metals inhibited the T cells' response, the researchers report in an upcoming *Nature Chemical Biology*, suggesting that the compounds disrupt peptide presentation.

The work could lead to new ways to study the mechanism of peptide release, says immunologist Gerald T. Nepom of the Benaroya Research Institute at Virginia Mason in Seattle. "There are all kinds of reasons that you would want to be able to control or fine-tune the [release] of peptides in the binding pocket of the MHC molecules," he says.

But to lead to new therapies, the effect would have to be reversible, he says. "You want to help the arthritis, but you don't want to leave [the patient] susceptible to the flu." —A. CUNNINGHAM

Science and Religion

Explore centuries of scientific and theological thought in 12 riveting half-hour lectures

Two crucial forces have helped shape Western civilization and continue to interact in our daily lives. Contrary to prevailing notions that they must perpetually clash, science and religion have actually been partners in an age-old adventure.

Professor Lawrence M. Principe unfolds a surprisingly cooperative dynamic, in which theologians and natural scientists share methods, ideas, aspirations, and a tradition of disputational dialogue.

St. Augustine warned that it is dangerous for religious people to ignore science: "Many non-Christians are well versed in natural knowledge, so they can detect vast ignorance in such a Christian and laugh it to scorn."

On the other hand, Sir Isaac Newton freely discusses the attributes and activities of God in *Principia Mathematica,* which sets forth his theory of gravity and laws of motion.

These examples represent the traditional relationship of science and religion that is too often obscured by the divisive, hot-headed rhetoric and the gross oversimplifications we often see in today's headlines. Long before the shouting and the sloganeering, scientists and theologians have pursued a unity of truth, and most theologians have agreed with the advice of Galileo's colleague, Cardinal Baronio, that the Bible "tells us how to go to heaven, not how the heavens go."

Once we understand this, we have a new perspective on many present-day controversies. The current antievolution furor, for example, centers on the fixation that Genesis 1 should be taken literally, an issue that had been resolved by theologians long ago. Professor Principe deems it "astonishingly trivial," and shows how science gives theologians powerful tools for enriching, not contradicting, their understanding of ultimate truths.

The Search for Answers

Moving from the early centuries of the Christian era and the Middle Ages to our own day, he exposes the truth about the Galileo Affair and provides a revealing picture of the circuslike Scopes Trial. You will hear St. Augustine's profound ideas about reason and faith, and meet a 19th-century writer whose anti-Catholic diatribe spread myths that persist today.

About Your Professor

Dr. Lawrence M. Principe is Professor of the History of Science and Technology, and Professor of Chemistry at Johns Hopkins University. He received a Ph.D. in Organic Chemistry from Indiana University and a Ph.D. in the History of Science from Johns Hopkins University. He has won several Johns Hopkins teaching awards and the 2004 Francis Bacon Prize from the California Institute of Technology.

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Dr. Lawrence M. Principe is Professor of the History of Science and Technology, and Professor of Chemistry at Johns Hopkins University. He received a Ph.D. in Organic Chemistry from Indiana University and a Ph.D. in the History of Science from Johns Hopkins University. He has won several Johns Hopkins teaching awards and the 2004 Francis Bacon Prize from the California Institute of Technology.

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EAT SMART

Foods may affect the brain as well as the body

BY CHRISTEN BROWNLEE

This is part two of a two-part series on lifestyle and brain fitness.

At family dinner tables around the globe, prodding mothers have dished out the same refrain for decades: "Eat your fish," they say. "It's brain food!" For children picking at crusty fish sticks or blobs of pink poached salmon, the statement raises suspicions. But the message is turning out to be more than just an attempt to get children to clean their plates. Recent research is suggesting that what you eat can influence the function of your brain.

Scientists are providing hints that what you choose to consume or avoid in your daily diet can have consequences on the brain's resiliency in the face of injury or disease. Studies suggest that foods such as fish and a curry spice called curcumin, for example, can give the brain an added edge to stay healthy.

On the other hand, a steady diet of high-fat and starchy foods, such as that double cheeseburger from a favorite fast-food joint, may eventually do the brain a serious disservice. On the extreme end of dieting, some research indicates that paring food intake to the bare minimum may protect the brain from a lifetime of everyday insults.

Taken together, these results point in a direction that any kid could have seen coming: Once again, Mom was right.

FISH CURRY Besides a mother's goading, there are plenty of reasons to eat a succulent fillet of fish. The strongest incentive, neuroscientists say, may lie in the growing number of benefits attributed to nutrients known as omega-3 fatty acids, found in small amounts in some plants and in abundance in oily, cold-water fish such as salmon.

Neurosurgery professor Fernando Gómez-Pinilla operates a traumatic brain-injury center at the University of California, Los Angeles (UCLA). Because his past studies suggested that exercise affects how well brains function (*SN: 2/25/06, p. 122*), he wondered whether diet might also change how his patients coped with brain injuries.

Working with rats, Gómez-Pinilla and his colleagues compared the effects of two diets. Both included healthy, low-fat chow. However, one diet contained 8 percent fish oil—the amount people would receive by eating fish about twice a week. After 4 weeks, Gómez-Pinilla's team subjected some of the rats to a mild percussion injury—a knock on the head in a machine specially designed to standardize the force of its blows.

The researchers tested all the animals a week later in a water maze to see how quickly the rats could learn the location of a platform hidden beneath the water's milky surface. They found that brain-injured rats fed the fish oil–supplemented diet found the platform's location in about two-thirds the time it took the injured rats that ate the standard rat chow to do so. Surprisingly, Gómez-Pinilla says, the injured rats fed the fish oil mastered the maze almost as quickly as rats that weren't injured did.

He and his colleagues found that rats that had eaten unsupplemented chow had lower brain concentrations of a protein called brain-derived neurotrophic factor (BDNF). This compound encourages nerve cells to grow and make new connections. BDNF concentrations are typically low after the type of injury that the rats had experienced. In contrast, BDNF concentrations in rats fed fish oil were much like those in rodents that hadn't received brain injuries.

Gómez-Pinilla and other scientists have shown in previous studies that nerve cells produce BDNF when animals exercise. This protein may be a prime player in the neurological benefits that animals get from exercise.

Researchers aren't yet sure how the components of fish oil change BDNF amounts in the brain. However, Gómez-Pinilla says, "eating a diet rich in omega-3 fatty acids could have some of the same [neurological] effects as exercise."

> "Eating a diet rich in omega-3 fatty acids could have some of the same [neurological] effects as exercise."
>
> — FERNANDO GÓMEZ-PINILLA, UNIVERSITY OF CALIFORNIA, LOS ANGELES

Neuroscientist Greg M. Cole, working in another laboratory at UCLA and also at the Veterans Administration Medical Center in Sepulveda, Calif. is finding that supplementing food with just the omega-3 fatty acid DHA—rather than the complex blend of fish-oil ingredients—can dramatically slow neurodegenerative symptoms in mice bred to develop an Alzheimer's-like disease.

In a study published in the March 23, 2005 *Journal of Neuroscience*, Cole's team peered into the brains of Alzheimer's-susceptible mice that had been fed diets either high or low in DHA for about 3 months. They found that mice on the high-DHA diet had only about 30 percent as many deposits of a waxy protein called beta-amyloid—a hallmark of Alzheimer's disease—compared with mice that ate little or no DHA.

Curcumin, a yellow polyphenol that's a component of the curry spice turmeric, has similar effects in reducing the amount of beta-amyloid in Alzheimer's-susceptible mice. Cole's team fed mice a daily dose of curcumin that was similar, in proportion to food intake, to the amount that a person in India typically eats each day. Those mice had about half as many beta-amyloid deposits as did mice that weren't given the spice.

In a study published in the Feb. 18, 2005 *Journal of Biological Chemistry*, Cole and his colleagues reported that curcumin binds to bits of amyloid-beta protein, discouraging them from aggregating into the waxy clumps associated with Alzheimer's symptoms.

He says that both fish oil and curcumin may eventually become widely used in preventing neurodegenerative diseases, while causing few side effects. On the other hand, recently created

drugs for treating neurodegenerative diseases are expensive and often have troubling side effects.

Cole notes that people have been eating fish and curries safely for centuries. "We're interested in these approaches that have cost-effectiveness and safety built into them," he says.

FAT ATTACK Just as fish oil and curcumin seem to aid the brain, other foods—such as those in the typical high-fat, sugary U.S. diet—could take brain health down a notch.

Four years ago, Gómez-Pinilla and his colleagues tested how the typical diet of people in industrialized Western countries affected brain function in rats. The researchers fed half of a group of rats a regular lab diet composed of about 13 percent fat and 59 percent complex carbohydrates, among other nutrients. The other animals received a high-fat and high-sugar (HFS) diet made with 39 percent fat, primarily from lard and corn oil, and 40 percent refined white sugar.

> "Everything we see out there suggests that variety is what we need in our diets."
>
> — CAROL E. GREENWOOD, UNIVERSITY OF TORONTO

After just 2 months, Gómez-Pinilla's team found that animals on the standard diet learned the water-maze task faster than did rats on the HFS diet. When the scientists dissected the animals' brains after a year on the special diets, they found that rats on the HFS diet had less than half as much BDNF as mice on the healthy diet did. The HFS rats also had reduced amounts of several other proteins associated with learning and memory.

In another experiment published 2 years later, Gómez-Pinilla tested how rats on the two diets fared after a mild brain injury such as the one that the rats on the fish oil diets had been subjected to. Animals ate their assigned diet for 4 weeks then received a mild brain injury. In the water maze, both sets of animals had performed equally well before being injured. However, rats fed the HFS diet showed greater deficits in learning the maze a week after their percussion injuries than did rats fed the regular diet.

When the scientists examined the animals' brains, they found that rats on the HFS diet had lower amounts of BDNF than those on the healthy diet did. A shortage of BDNF could underlie the animals' inability to recover from their neurological injuries as well as the other rats did, says Gómez-Pinilla.

"A lot of the problems of consuming this diet become more obvious when animals are exposed to some insult, like a traumatic brain injury," he adds.

Gómez-Pinilla suggests another possible reason for the HFS rats' poor performance: damage in the brain caused by a chemical process called oxidation. Diets high in fat and sugar are also usually high in calories. The more calories an animal eats, the more its body generates free radicals: negatively charged molecular particles that cause oxidation damage in cells, particularly those in the nervous system.

The HFS rats may also have had less brain power because a steady fare of fat and sugar can change how the body responds to insulin, says Carol E. Greenwood, who studies nutrition and aging at the University of Toronto. Animals eating such food can become less sensitive to insulin, the compound that signals cells to take up glucose from the blood for processing into energy.

Low insulin sensitivity effectively starves these animals' cells, including brain cells. Numerous studies by Greenwood's lab and others indicate that a steady diet of such food can decrease an animal's ability to learn and remember.

Furthermore, Greenwood and her colleague Gordon Wincour report in a supplement to the December 2005 *Neurobiology of Aging* that the already poor learning and memory abilities of insulin-resistant people get even worse after they consume a sugary snack, which raises glucose concentrations.

The researchers aren't sure why high glucose concentrations have such a detrimental effect on brain function. "Our instinct at this point is that when glucose gets too high in the blood, it launches a cascade of oxidative reactions. Various components of that cascade may contribute to cognitive deficits," says Greenwood.

ASCETIC EATER Since taking in calories generates damaging free radicals, some researchers have hypothesized that simply eating less may protect the brain from harm. Recent studies support this hypothesis. For example, teams led by neuroscientist Mark Mattson of the National Institute on Aging in Baltimore have shown that cutting back calories in lab animals can reduce the symptoms seen in Huntington's- and Parkinson's-like diseases.

In one experiment, Mattson and his colleagues worked with mice that carried a mutant form of the human *huntingtin* gene. People who have this mutation show a variety of emotional and physical symptoms, such as mood swings and loss of muscle control, generally starting in adulthood. They eventually die of the disease.

Mattson's team gave the Huntington's mice a normal diet for 8 weeks. Then, the researchers began to feed some of the animals only every other day to cut by about 20 percent the number of calories consumed. Other mice were permitted to eat as much as they wanted.

Those eating fewer calories showed their first symptoms of the Huntington's-like disease an average of 12 days later than the other group did. Mice eating restricted diets also lived longer. At 21 weeks, all the free-eating mice had died from the disease. However, 60 percent of those on the restricted diets were still alive.

When researchers dissected the animals' brains, they found that the animals on the every-other-day diets had less atrophy and fewer clumps of the mutant huntingtin protein than the free-eaters did.

Mattson has had similar success by decreasing the calorie intake of monkeys with a Parkinson's-like disease.

After feeding some of the monkeys 30 percent less food over 6 months, Mattson's team found that those animals had fewer symptoms of the disease, such as muscle tremors and rigidity, compared with monkeys that ate as much as they wanted. Examination of the animals' brains showed that those that ate fewer calories had higher concentrations of dopamine, even though the majority of their dopamine-producing neurons had died.

USE YOUR BRAIN Mattson says that the reason calorie restriction seems to save neurons probably extends beyond simply protecting them from free radicals. Eating less cuts energy to all the body's cells, including those in the brain.

This mild stress makes brain cells more active and triggers production of protective proteins, such as BDNF and heat-shock protein. Mattson suggests that the lightly stressed neurons tend to cope better with more-severe stress—such as that imposed by neurological disease—than cells of animals on a steady diet do.

"When you put animals on dietary restriction, some studies suggest that their brains are more active because they're apparently looking for food," says Mattson.

While caloric restriction seems to protect animals from neurological diseases, Mattson notes that people rarely want to cut back so stringently. So, should they just eat fish curries every night while conscientiously avoiding fast-food fare?

"That's the kind of talk that raises the hair on the backs of nutritionists," says Greenwood. Different foods have different benefits, and studies show that patterns of food consumption influence health. "Everything we see out there suggests that variety is what we need in our diets," she concludes.

She argues that in laboratory studies, it's difficult to separate effects of different diets on the brain from the diets' effects on the rest of the body. Nevertheless, a healthy diet seems to be good all around. "The idea is that by taking care of your body, your brain also benefits," she says.

Now, that's an idea that any mom would approve. ■

SAVING STURGEON

Ancient fish face increasingly tough times

BY JANET RALOFF

On a fine spring day alongside a Wisconsin river, several biologists wrestle a muscular, 120-pound fish onto her back and straddle her. The moves wouldn't be out of place in a rodeo. As the team restrains her, one member massages her swollen belly, working her eggs out of a release vent and into a plastic pail. The late-April scene occurs as, throughout the northern Midwest, water temperatures climb above 56°F (13°C) and lake sturgeon swim upstream to spawn. In several rivers, biologists such as these give Mother Nature an assist.

"This is the highlight of my year," says Steven J. Fajfer, who supervises propagation of lake sturgeon for the Wild Rose (Wis.) Fish Hatchery.

His team starts by netting several males, each about 20 pounds and 4 feet long. Gentle hands slide down each animal's belly to eject its sperm before the fish is returned to the water, Fajfer explains.

Then, the real heavy lifting begins. The researchers scout for a 55- to 75-inch female of this species (*Acipenser fulvescens*) splashing along cobbled edges of the river. After hoisting her ashore, the biologists apply their rodeo moves to extract her eggs and then return the big mama to her stream.

Fajfer or one of his colleagues divides her eggs among a series of buckets and adds water and the freshly collected sperm. For the next 2 to 4 minutes, he explains, "we'll gently stir the eggs with our hands"—until they turn sticky, a sign that the eggs are fertilized. Later, the eggs are hauled to the hatchery where the young will emerge and be coddled for up to a year. Finally these juveniles and those from other rivers will be released, most into their natal streams.

Globally, many wild sturgeon get their start in life with substantial human help. The heroic interventions are likely to increase as populations of sturgeon species, precarious everywhere, continue to spiral downward.

ASSISTED REPRODUCTION — Ural River beluga and other sturgeon (left) were netted on a spawning run in Kazakhstan upstream of the Caspian Sea, and later released. Their eggs were fertilized by hand and the resulting fry raised in a hatchery until old enough (right) for restocking.

S. CROWNOVER, SEAWEB/CAVIAR EMPTOR

Today, most sturgeon populations exist as tiny fragments of their abundance just 30 years ago, and many populations face possible—even probable—extinction. The caviar trade has driven overfishing, but environmental changes also threaten sturgeon survival.

"It's not too late to save most sturgeon species," says Ellen K. Pikitch of the Pew Institute for Ocean Science in Miami. However, doing so will require large investments in captive rearing, law enforcement, political action, and research. "It won't be easy," she says.

LIVING FOSSILS For some 200 million years, sturgeon have been cruising the planet's rivers and seas, notes Phaedra Doukakis of the Pew Institute's New York office. The 25 species remaining today don't look much different from their Jurassic ancestors.

All still have mouths at the bottom of their snouts and thin beards of whiskerlike barbels that can detect trace concentrations of waterborne chemicals.

Like the skeletons of similarly ancient sharks, a sturgeon's frame is made of cartilage, not bone. However, running from behind a sturgeon's gills to its tail fins are five rows of sharp, diamond-shaped bumps. Called skutes, these bumps are bone protruding through the fish's skin, explains sturgeon physiologist Molly A.H. Webb of the Bozeman (Mont.) Fish Technology Center.

Sturgeon also resemble sharks in that they mature slowly. Males may be 12 years old and females 25 years old before they spawn for the first time. Then, the individual won't spawn again for 3 to 5 years. This rate of reproduction is slow, but it can continue for up to 60 years.

Sturgeon share reproductive characteristics with both fish and amphibians, Webb notes. For instance, frog sperm have an acrosome, a structure that releases enzymes that penetrate the outer membrane of eggs during fertilization. Fish eggs, in contrast, have a tiny hole—a micropile—that a sperm must find and enter. Sturgeon show both acrosomes and micropiles.

Also unique: Males have vestigial oviducts—channels for moving eggs—notes Diana Papoulias of the U.S. Geological Survey in Columbia, Mo. Moreover, she observes, unlike in other fish, the "oviducts" in both males and females are unconnected to the gonads.

There's plenty that biologists still don't know about reproduc-

tion in these fish. Those data gaps make it difficult for caviar harvesters, hatchery managers, aquaculture operators, and conservation biologists to be effective.

BLACK PEARLS Because caviar—sturgeon roe—commands up to $150 per ounce, connoisseurs expect quality eggs. Although sturgeon fishers could, in theory, harvest the pearly black roe as Fajfer's team does, the product wouldn't taste good, observes Serge I. Doroshov of the University of California, Davis. Biochemical processes associated with ovulation induce off flavors and alter the texture of the roe.

"So, to get caviar," he explains, "you have to extract the entire ovaries, killing the fish."

Today, legal harvests of wild sturgeon total some 3,000 metric tons (t) per year—down from a 1977 peak of more than 30,000 t, according to a survey of sturgeon trends reported by Pikitch, Doukakis, and their colleagues in the September 2005 *Fish and Fisheries*. This decline represents diminishing stocks of fish throughout the Northern Hemisphere, not less fishing, the researchers say.

They also point out that these tallies don't include illegal harvests. According to data reported late last year by Switzerland and the European Union, policing agencies in Europe have seized 12 t of illegal caviar since 2000. Since that egg tonnage represents fish carcasses rivaling the annual tonnage of fish caught legally, poaching probably exceeds legal harvests, Pikitch concludes.

Her team examined the sturgeon catches from 70 percent of the major fisheries in the world. The scientists found a drop of at least 85 percent from peak production.

Wild harvests are prohibited for several of the sturgeon species most endangered with extinction, such as the pallid (*Scaphirhynchus albus*).

On Jan. 3, officials administering the Convention on International Trade in Endangered Species (CITES), announced that the treaty will from now on prohibit international commerce in all sturgeon from the Caspian Sea basin, the Black Sea–lower Danube River basin, and the Amur River basin of Russia and China.

A trade ban from these basins—the world's major caviar-exporting areas—must now be enforced by all of CITES' 169 signatory nations, including the United States. The restrictions remain in effect in each basin until the exporting nations there agree on quotas and management programs and supply data to CITES showing that their fishing and research activities aren't jeopardizing sturgeon populations, says David H.W. Morgan, who heads scientific support at CITES' headquarters in Geneva.

The ban doesn't, however, apply to farmed sturgeon.

FARM-FRESH EGGS Over the past 2 decades, enterprising aquaculture developers anticipated the current wild-sturgeon shortage and took up farming the caviar producing fish. Today, three such farms for white sturgeon (*Acipenser transmontanus*) are operating successfully outside Sacramento, Calif.

Aquaculturists there started in the early 1990s with 200 locally caught fish. The farms today annually produce close to 10 t of caviar, roughly equivalent to Russia's legal harvest of wild roe, says Doroshov, who has been a consultant since the project began.

Caviar production has proved "very artisanal," he notes. A roe harvest's flavor and texture depend on what the fish has eaten, the temperature and quality of the water it lived in, and how the eggs were processed after harvest. It's taken a while, but caviar from these farms has come to impress importers enough that the product is now sold throughout Europe at prices near those for wild roe.

The Mote Marine Laboratory in Sarasota, Fla., has been investigating aquaculture of a different fish, the Siberian sturgeon (*Acipenser baeri*). The lab's commercial-scale demonstration tanks now house 65 t of sturgeon—including some 24,000 weighing at least a pound.

Mote's oldest female Siberian sturgeon are now 5 years old, "and we're expecting some caviar this year," says project leader Jim Michaels. With their customized food and accommodations, farmed sturgeon mature at roughly triple the rate of wild fish.

A side benefit of sturgeon farming, Michaels and Doroshov note, is that the study of fish in aquaculture is paying rich dividends in knowledge about the biology of wild stocks too imperiled for researchers to capture for examination.

STRESSED SICK While overfishing has historically posed the greatest threat to sturgeon species, several environmental trends are also seriously stressing stocks, even some that are no longer fished.

A biological imperative drives spawning sturgeon to swim far upstream from the ocean, inland sea, or lake that they inhabit while they're not spawning. Over the past 150 years, however, people have been altering rivers. Some portions are deepened and straightened to facilitate barge traffic; others are dammed. These public works projects are now haunting government agencies charged with protecting sturgeon, notes Webb.

For instance, reshaping shipping channels removes slow-current areas where sturgeon feed. Altered rivers can also scour away the bottom-dwelling animals that the fish consume. Dams gate off some spawning regions, collect silt that buries previously rocky sturgeon haunts, and limit how well a river flushes out pollutants.

Scientists are beginning to see effects of these changes. For instance, fisheries biologist Grant W. Feist at Oregon State University in Corvallis and his colleagues examined 174 near-mature white sturgeon hauled in during sport fishing on various stretches of the Columbia River. Fish in one section had access to the ocean; the rest were separated from the ocean by dams. Sturgeon that never have access to the ocean still move upriver to spawn. In the December 2005 *Environmental Health Perspectives*, the team reports disturbing anomalies in some fish, especially those trapped within dammed segments of the river.

GENDER SURPRISE — At spawning time, the belly of a normal female shovelnose sturgeon (top) is full of black eggs. However, a growing share of males in polluted waters are hermaphrodites (bottom), inappropriately bearing scores of eggs and testes (yellow) containing mature sperm.

PAPOULIAS/USGS

Blood from fish in the impounded stretches, especially from these behind the largest dam, tended to exhibit the highest concentrations of DDT, polychlorinated biphenyls, and other pollutants.

Immature females behind two smaller dams had much more vitellogenin, an egg-yolk protein, in their blood than the scientists had expected. Males, which normally have no vitellogenin, also showed measurable concentrations. Such an inappropriate feminization of males and young females has been witnessed in other fish species exposed to industrial, agricultural, and pharmaceutical pollutants (*SN: 12/10/05, p. 381*). Three sturgeon also carried both mature ovaries and mature testes, something that's never observed in normal fish.

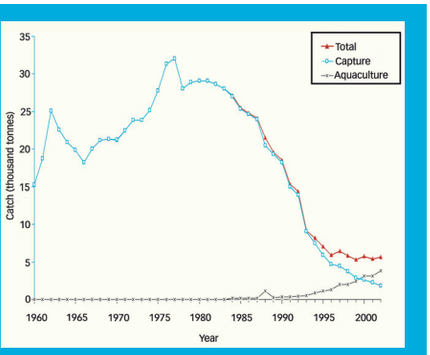
Enzyme concentrations in the most-tainted fish indicated that their livers were fighting toxins in the animals' bodies. However, one

of the enzymes also breaks down male sex hormones. Feist told *Science News* that this would suggest that if the condition persists once the males reach maturity, they "won't be able to produce sperm."

Halfway across the continent, in polluted stretches of the Missouri and Mississippi rivers, Papoulias sees disturbing numbers of "major reproductive pathologies" in adult shovelnose sturgeon (*Scaphirhynchus platorynchus*). Some males had testes full of sperm and also ovaries riddled with mature eggs. Some females' eggs were undergoing cell division although they hadn't been fertilized by sperm. A few females hosted tumors—ones likely triggered by inappropriate egg activation. Still other females were resorbing eggs, as the fish do when they're stressed or can't spawn.

Papoulias has unearthed a handful of reports by other scientists chronicling similar impairments in the region's shovelnose sturgeon. "What's scary," she says, "is that the incidence of these changes appears to be rising." In the shovelnose species, 10 percent or more show major reproductive abnormalities.

She has described her findings to sturgeon researchers overseas. "My Russian colleagues don't even raise an eyebrow," she observes. "They say that they see reproductive abnormalities and tumors all of the time, usually in very polluted regions."



PLUMMETING NUMBERS — Graph shows world catch of wild sturgeon peaking in late 1970s, then crashing precipitously. By 2000, within the total tonnage of harvested sturgeon, farmed sturgeon exceeded the reported wild catch.

PIKITCH ET AL. FISH AND FISHERIES 2005

STURGEON PROSPECTS One might expect that the new caviar ban would immediately give sturgeon a respite from overfishing. However, many biologists are pessimistic.

Pikitch has worked with sturgeon-conservation programs in central Asia. She says that many sturgeon-exporting nations are too poor to police poaching, much less monitor the health of sturgeon stocks in a scientific manner.

Moreover, notes Morgan, some sturgeon hatchery-and-restocking programs are financed in part by taxes on caviar sales. "So, you could have a catch-22 situation," he says. Severely curtailed trade will dry up the money for restocking as poaching soars.

Another limitation on the ban's effectiveness is that illegally caught caviar might be branded as a farmed product, Morgan notes.

Eight years ago, Doukakis and her colleagues performed genetic tests on caviar purchased in New York City. Somewhere between 25 and 30 percent of the time, caviar had been mislabeled with respect to species," she says. Sometimes, caviar of a highly endangered species was labeled as a species that was legal to capture.

What's more, wildlife inspector Sheila Einsweiler of the U.S. Fish and Wildlife Service in Arlington, Va., says that state officials are reporting an effect on U.S. sturgeons in response to CITES' pressure on the Caspian and Black Sea caviar trade. There's been an increase in the legal harvest of U.S. stocks, she says, as well as a boost in illegal catches.

"The United States is going to have to step up enforcement efforts to prevent pressures caused by the new ban," Pikitch says. However, she adds, "we can't give up working directly in the Caspian and other exporting regions to ensure survival of their sturgeon in the wild."

"Clearly," she concludes, "we have to remain vigilant on all fronts." ■

OF NOTE

BEHAVIOR

Babies show budding number knowledge

Before they start to talk, babies can recognize the difference between two and three entities, a new study suggests.

Most 7-month-old infants match the number of faces that they see talking—whether two or three—with the number of voices that they hear, without any training, say Kerry E. Jordan and Elizabeth M. Brannon, psychologists at Duke University in Durham, N.C. The researchers studied 20 babies who were held by their mothers in front of two video monitors. One screen showed two women mouthing the word "look" and the other showed three women doing the same. All five women spoke repeatedly for 1 minute. A loudspeaker played either two or three women's voices saying "look" in synchrony with one of the video images.

Fourteen babies preferred looking at the video in which the number of women matched the number of voices, Jordan and Brannon report in an upcoming *Proceedings of the National Academy of Sciences*. On average, infants looked at matching displays for nearly 22 seconds, compared with 14 seconds for mismatched displays. —B.B.

NANOTECHNOLOGY

Tiny ticker

Researchers have demonstrated that they can control how frequently a DNA-based nanodevice changes between two forms. Their "nanometronome" is the first example of such control over a single DNA molecule, the team contends.

The device consists of four strands of DNA, which in water assemble into a clover-shape structure. In the presence of magnesium ions, the assembly randomly switches between two stable, X-shaped forms, each with different strands paired into helices. The "ticking" rate between the two forms is mere milliseconds, the team reports.

To control the rate of ticking, Taekjip Ha of the University of Illinois at Urbana-Champaign and his colleagues added a short, overhanging DNA chain to one end of two of the strands. The two short chains complement each other. In the first DNA form, they can't reach each other. In the second DNA form, they are close together and so pair up. This stabilizes the form and lengthens the amount of time it keeps this shape, Ha says.

The researchers measured the ticking-rate change with a technique called Förster resonance-energy transfer. They attached two fluorescent dye molecules at the same ends that had the overhanging DNA. In the first DNA form, when the dye molecules were far apart, they fluoresced green. But when the dye molecules were close together in the second DNA form, they fluoresce red.

As the group reports in an upcoming *Nano Letters*, adding one DNA chain link, or base pair, to each overhanging sequence increases the lifetime of the red-fluorescence signal by a factor of three. The device may someday lead to a sensor that can detect a single base pair difference in a target-DNA sequence, Ha says. —A.C.

TECHNOLOGY

A dim view of biologic and chemical agents

A new type of sensor that uses tiny optical lenses may someday detect the first signs of disease or chemical contamination in blood or other liquids.

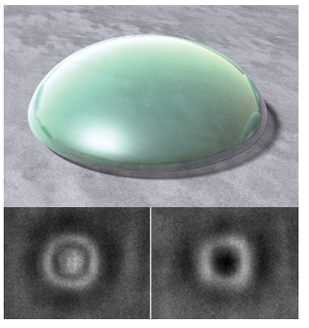
Each microscopic lens, less than half the diameter of a red blood cell, undergoes a change in optical properties when it encounters even a small amount of specific biomolecules or chemical compounds.

Chemist L. Andrew Lyon of the Georgia Institute of Technology in Atlanta and his colleagues made the lenses from spheres of hydrogel, a water-absorbent mesh of polymer molecules. By chemical means, the scientists wove into the outer layers of the mesh molecular complexes designed to bind to certain molecules.

Adhered to glass, each microsphere flattens into a hemispherical lens with a specific focal length. When fluid flows over the microspheres, the molecular complexes partially detach from the lens and snag target molecules. That process disrupts the hydrogel's surface, and water enters and swells the lens. The expansion alters the lens' focal length and diminishes transmitted light, Lyon says.

Because these changes typically occur within minutes, the microlenses may someday be used for on-the-spot diagnoses of infections or other conditions currently detected by time-consuming lab tests.

The lens findings appear in the Feb. 20 *Angewandte Chemie*. —P.W.



GEORGIA TECH.

SWELL SENSOR Gel-based optical microlenses such as the one in this artist's depiction (top) swell when they're triggered by specific compounds. Swelling changes the transmitted light from bright (bottom left) to dim (bottom right).

TECHNOLOGY

Making the most of chip fabrication

For more than 40 years, the microelectronics industry has made ever-smaller, usually-cheaper, and more-powerful circuits using one set of basic manufacturing methods. Scientists now report that tweaks to a key optical process improve those methods. The advances may be enough to permit conventional manufacturing practices to meet the demand for the smaller-than-ever circuits for a decade or so.

In one step in fabricating chips' transistors and other components, manufacturers project patterns of light onto silicon wafers. Defining the smallest components requires short-wavelength light. Currently, the industry uses 193-nanometer-wavelength laser radiation to make wires and other circuit parts as thin as 90 nm.

Shorter-wavelength radiations pose major challenges, so chip makers began exploiting a microscopy trick—putting a layer of water between a lens and the wafer. The water slows the 193-nm light and thereby shrinks its wavelength. However, this technique is only enough to meet demands for the next 7 years, industry forecasts indicate. By then, wire widths will have shrunk to 32 nm.

On Feb. 20, scientists from IBM Almaden Research Center in San Jose, Calif., and JSR Micro of Sunnyvale, Calif., presented an experimental pattern-making system that uses an unidentified light-slowing liquid instead of water. The system yielded wires an average of only 29.9 nm thick. Unveiled at a chip-technology conference, the findings suggest that even skinnier components lie ahead, the scientists say.

OF NOTE

The liquid, developed by JSR Micro, slows light about 12 percent more than water does. A quartz prism—instead of a typical glass lens—also beefed up the pattern-making system, says IBM physicist Donald S. Bethune, who codeveloped the system. —P.W.

ASTRONOMY

Chasing a stellar blast

An exploding star recently discovered in a nearby galaxy may be a milestone in the study of type 1a supernovas.

In this past decade, astronomers have used these stellar explosions, produced when an elderly star called a white dwarf blows up, to determine that the universe is expanding at an accelerating rate. But despite the importance of these events, no one knows exactly how white dwarfs explode.

Because the newfound supernova, dubbed SN 2006X, erupted in a nearby, highly studied galaxy, it could provide a wealth of information. Amateur astronomers in Japan and Italy independently found the supernova on Feb. 4. At the time of the discovery, the supernova was only one-thousandth as bright as its home galaxy, Messier 100, which lies about 60 million light-years from Earth. But over the next 2 weeks, the supernova's glow increased 25-fold.

Using the Very Large Telescope in Paranal, Chile, Dietrich Baade of the European Southern Observatory in Garching, Germany, and his colleagues have been measuring SN 2006X's brightness since its discovery. They announced their findings in a Feb. 23 press release. —R.C.

CLIMATE

Closed pores mean more fresh water

Global temperatures may be on the rise, but plants are drinking and sweating less water. This plant-tissue response to increased carbon dioxide in the atmosphere is having a significant trickle-down effect, a new study finds.

Plants control carbon dioxide intake by opening and closing tiny pores, called stomata, in their leaves. During photosynthesis, they open the stomata to take in carbon dioxide and, inevitably, release some water vapor in the process. How much water is lost when plants sweat, or transpire, in this way affects how much water the plants pull out of the soil.

With more carbon dioxide in Earth's atmosphere, "plants are becoming more efficient" and opening their stomata less, says climate scientist Peter Stott of the Hadley (England) Centre for Climate Prediction and Research. However, the carbon dioxide effect on transpiration, well-known in the laboratory, has been overlooked in models that parcel fresh water among the atmosphere, rivers, and oceans.

To gauge the relative importance of the transpiration change to global freshwater flow, Stott and his colleagues compared actual river-runoff data from the past century with runoff calculated in models that take account of climate change, solar radiation, deforestation, and carbon dioxide–driven changes in transpiration.

The calculations show that reduced plant transpiration played a significant role in the past century's observed increases in river runoff, the team reports in the Feb. 16 *Nature*.

"It's a good study," says climate scientist Damon Matthews of the University of Calgary in Canada. "To be able to say how the biosphere is changing as a result of elevated carbon dioxide—and to detect that in runoff records—is surprising." —C.G.

MEETINGS

American Association for the Advancement of Science
February 16–20, St. Louis, Mo.

EARTH SCIENCE

China's deserts expand with population growth

Carried forward by winds and sandstorms, the dunes of northern China are expanding at an unprecedented rate, Chinese researchers say. Human activities are primarily responsible for desertification of the arid and semiarid grasslands of the area, they conclude.

The average rate of desert expansion in the region was 3,600 square kilometers per year during the 1990s, compared with 1,560 km^2 annually during the late 1950s, says Tao Wang of the Chinese Academy of Sciences in Lanzhou.

"Most [desertification] has resulted from human acts," Wang says. He notes that the desert's area and the region's population have expanded proportionally during the past 50 years. Nearly 300 million people live in and around the 385,700 km^2 that have become desert since human civilization arose in the region.

In a wind tunnel simulation of land changes, Wang and his colleagues found that economic activities typical of the region increase the rate of topsoil erosion by a factor of 4 to 10. Intensified cultivation, overgrazing, and clearing of vegetation for fuel are among the contributing activities, Wang says.

Northern China has been grappling with desertification for decades. Control measures, such as irrigating strips of vegetation along desert highways to block sand dunes from blowing onto the roads, have been employed in less than a quarter of the desertified area. —B.H.

OCEANOGRAPHY

Corals don't spread far from their birthplaces

Creating protected marine areas in one part of the Caribbean won't replenish distant coral reefs in the region, according to genetic research.

Because free-swimming coral larvae don't appear to spread far from their points of origin, protected "coral gardens" at intervals of more than 100 kilometers would be too far apart to repopulate all depleted reefs in the region in our lifetimes, says Steve Palumbi of Stanford University.

"Coral gardens will need to be on every major island," he says.

He and Steven Vollmer of the Smithsonian Tropical Research Institute in Panama studied the DNA in 262 samples of staghorn coral from the Bahamas to Panama and the Yucatán peninsula to Curaçao. They judged the corals' relatedness by the degree of genetic similarity among the samples.

They found that related corals live in "local villages" that are separated by no more than 100 km and sometimes as little as 2 km. The genetic differences among villages indicate that larvae produced in one locale rarely become established in another, the researchers report.

Establishing "more conservation [areas] on smaller scales would probably do you more good than ... protecting one large location," Vollmer concludes.

Palumbi and Vollmer are now examining their data in the context of ocean-circulation patterns to understand how currents influence coral genetics. —B.H.

Books

A selection of new and notable books of scientific interest

CELIAC DISEASE: A Hidden Epidemic

PETER H.R. GREEN AND RORY JONES

Celiac disease affects up to 1 percent of the world's population but is diagnosed in far fewer people because its symptoms masquerade as those of many other diseases. Gastrointestinal problems, fatigue, headaches, joint pain, and itchy skin are among the symptoms of this hereditary autoimmune disorder of the small intestine. In the disease, the immune system reacts inappropriately to gluten, or wheat protein. Green, director of the celiac disease center at Columbia University, and Jones, a science writer, describe the biological mechanisms behind celiac disease, explore why the condition is underdiagnosed, and offer advice for a person wondering whether he or she has it. The authors include a primer on autoimmune diseases and tips for dealing with the stressful symptoms of celiac disease, analyzing the possible effects of a gluten free diet on each symptom. ***HarperCollins, 2006, 352 p., hardcover, $22.95.***

COFFEE: A Dark History

ANTONY WILD

The history of coffee is as rich and dark as its brew, once known as the "wine of Araby." The bean's extensive cultivation and worldwide popularity echoes capitalistic and political development in both the third world countries that produce coffee and the wealthy nations addicted to its stimulating effect. All told, the coffee industry employs around 100 million people, from the Central American planter to the barista at the now-ubiquitous corner coffee shop. Wild examines how this most-scientifically scrutinized of foodstuffs developed into the popular commodity it is today. He also presents coffee production's darker side, including its link to slavery and colonialism in Brazil, Africa, and the tropics of the New World; its deleterious effect on the environment; and many coffee manufacturers' exploitation of farmers. Wild examines the public relations push by coffee makers to overcome some of these negative associations. ***Norton, 2005, 344 p., hardcover, $25.95.***

THE ROCK FROM MARS: A Detective Story on Two Planets

KATHY SAWYER

In 1996, President Bill Clinton held a press conference celebrating Martian rock 84001 that, as he put it, "speaks the possibility of life." This proclamation launched a media frenzy about the implications of life on Mars and a new wave of scientific scrutiny. Twelve years earlier, the rock lay at the bottom of the world on an Antarctic ice sheet, where it was discovered, 16 million years after its arrival, by geologist Roberta Score. From there, it found a home at NASA's Johnson Space Center as just another meteorite, until a happenstance examination by geochemist Donald Mittlefehldt. He and his colleagues recognized that this rock originated from beneath Mars' surface, that it was older than any Earth rock, and that it contained an abundance of carbonates, which are found most commonly on Earth in fossil beds. Further scrutiny by geologist Daniel McKay would lead to the unprecedented proclamation that these carbonates were evidence of ancient life on Mars. Sawyer reveals the subsequent controversy that would forever alter how scientists approach the question of extraterrestrial life. She recounts the veil of secrecy surrounding the work at NASA, the leaks to the press about the landmark suggestion of Marian life, and the work by some scientists to discredit that suggestion. ***RandomHouse, 2006, 416 p., b&w plates, hardcover, $25.95.***

THE NAMING OF NAMES: The Search for Order in the World of Plants

ANNA PAVORD

Modern botanical taxonomy, the systematic naming of plants, arose out of necessity: Early-17th-century apothecaries needed to know whether the herbs going into their medicines were the real deal. A mistake could prove deadly to a patient and harmful to an apothecary's business. Over the following centuries, and especially during the Renaissance, European scholars developed a universal method of naming plants not only for the sake of druggists but also to instill a sense of order on the natural world. Pavord, an author and gardening correspondent, recounts the rich history of plant taxonomy from its beginnings with the Greek philosopher Theophrastus in the third century B.C. From there, credit can be spread among enterprising European and Arab scholars, physicians, gardeners, and meticulous and artistic plant illustrators. Replete with high-quality reproductions of historic plant paintings and sketches, this thorough account will appeal to readers interested in the often-overlooked history of botany. ***Bloomsbury, 2005, 471 p., color prints, $45.00.***

CONVERSATIONS ON CONSCIOUSNESS: What the Best Minds Think about the Brain, Free Will, and What It Means to Be Human

SUSAN BLACKMORE

Consciousness. Where does it come from? Is it somehow separate from the human brain? Can the brain itself comprehend it? Blackmore, a lecturer in psychology at the University of the West of England, poses these and other intriguing questions to some of the top thinkers in philosophy and brain studies. In each interview, the author gets to the heart of the struggle to explain subjective experience in objective, scientific terms. Francis Crick, Daniel Dennett, John Searle, David Chalmers, and others describe the fundamental ideas behind the study of consciousness, including free will, the separation of mind and body, artificial intelligence, and conscious versus unconscious experience. ***Oxford, 2006, 274 p., b&w illus., hardcover, $23.00.***

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LETTERS

Impure thoughts

Epidemiologist Scott Davis warns, "Melatonin supplements are not regulated" the way drugs are. ... "There may be all kinds of impurities and contaminants" ("Bright Lights, Big Cancer: Melatonin-depleted blood spurs tumor growth," *SN: 1/7/06, p. 8*). Are you really going to tell me that you aren't going to take melatonin—if you're convinced that it might lower your chance of getting cancer by as much as 50 percent—because you are afraid of impurities?

JAMES STREET, OAKLAND, CALIF.

Daydream on

It seems to me irresponsible even to float the idea, as neurologist David M. Holtzman does, of chemically suppressing idle thought and daydreaming in people ("Alzheimer Clue: Busy brain connections may have downside," *SN: 1/7/06, p. 3*). Who can claim a basis for clinical discrimination of "bad" idle thought and daydreaming from the "idle thought" of intuitive problem solving and poetic imagination? More of human existence is at issue than the scourge of Alzheimer's.

DENNIS SCHMIDT, FALMOUTH, MASS.

In the article, scientists drew the conclusion that busy brain connections may have the downside of producing "amyloid beta, the waxy protein implicated in Alzheimer's disease." I don't see why the following conclusion wasn't reached: Idle brains may have a downside. In the described study, it was lack of directed thought, not busy, directed thought, that seemed to use the same areas of the brain involved in Alzheimer's disease. Other studies show that people who use their brains actively seem to be protected from the disease.

ELIZABETH OSCANYAN, PHILOMONT, VA.

Print addition

"Stone Age Footwork: Ancient human prints turn up down under" (*SN: 1/7/06, p. 3*) brought a strange conundrum to mind. If Paleolithic man was in Australia 40,000 years ago, why were the aboriginal people still living in the Stone Age when the first Europeans arrived? There were advanced cultures in the Americas by 100 B.C.E., whose ancestors had arrived by 12,000 to 15,000 years ago.

NORBERT EDWARDS, BUFFALO, N.Y.

Why modern civilizations appeared where they did remain unclear. Aboriginal cultures were every bit as complex as those elsewhere and adapted to an incredibly harsh environment. —B. BOWER

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