SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

APRIL 15, 2006 PAGES 225-240 VOL. 169, NO. 15

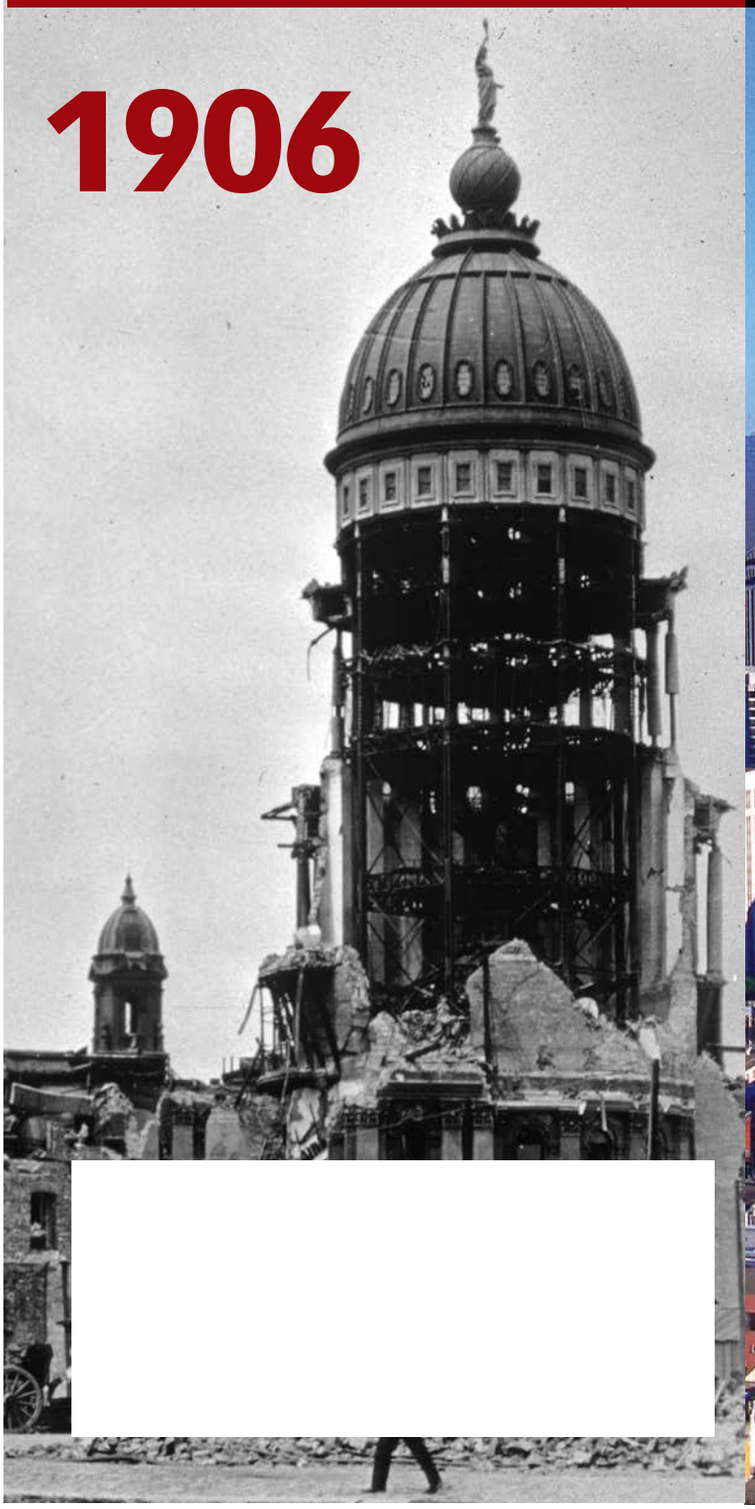
shiny, icy planet

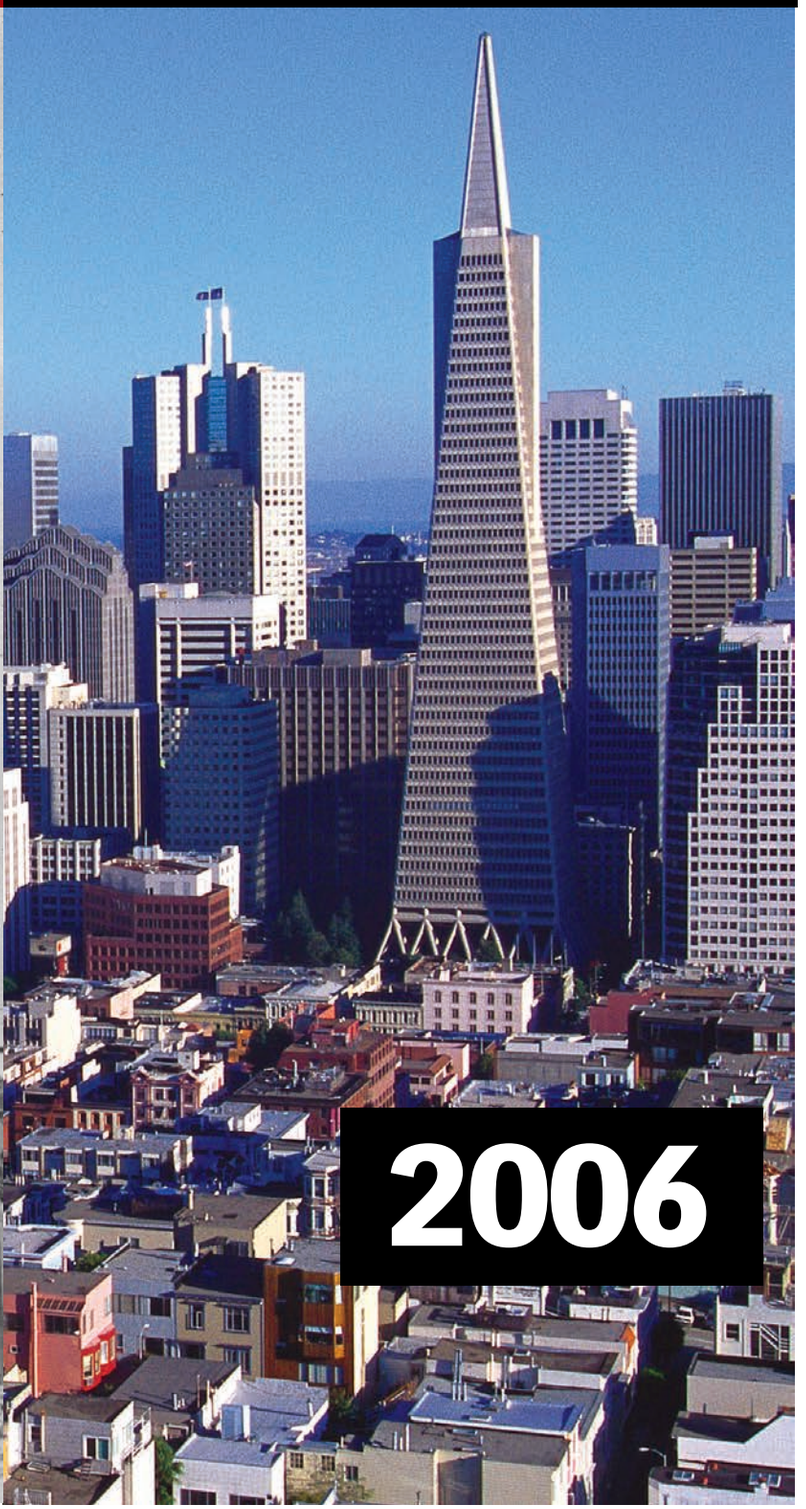
human evolution's single line

hibernation hormone

mixed news on estrogen

www.sciencenews.org





THE WEEKLY NEWSMAGAZINE OF SCIENCE

SCIENCE NEWS

APRIL 15, 2006 VOL. 169, NO. 15

Features

This Week

Of Note

Meetings

Departments

Cover A century ago, a magnitude 7.9 earthquake rocked San Francisco and triggered fires that devastated much of the city. Today, scientists are analyzing the Bay Area's many faults to estimate the region's seismic risk. (SFMUSEUM.ORG; Corbis) Page 234

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

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. Change of address: Two to four weeks' notice is required—old and new addresses, including zip codes, must be provided.

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.

Branchless Evolution

Fossils point to single hominid root

Scientists working in Ethiopia's Middle Awash valley have uncovered fossils of a 4.1-million-year-old human ancestor that bolster the controversial proposition that early members of our evolutionary family evolved one at a time on a single lineage rather than branching out into numerous species.

ANCESTRAL BITE **Investigators see an evolutionary link between newly found teeth of 4.1-million-year-old *Au. anamensis*, left, and previously discovered teeth of 3.3-million-year-old *Au. afarensis*, right.**

A team led by anthropologist Tim D. White of the University of California, Berkeley unearthed 31 fossils of *Australopithecus anamensis*, the earliest known species of this ancient hominid genus. The finds, from at least eight individuals, consist primarily of teeth and jaws, but include foot and hand bones and much of an upper right-leg bone.

Anatomical similarities indicate that *Au. anamensis* evolved directly from an earlier hominid, *Ardipithecus ramidus* (*SN: 1/22/05, p. 51*), between 4.4 million and 4.1 million years ago, the researchers assert in the April 13 *Nature*. By 3.6 million years ago, they add, *Au. anamensis* had evolved into *Australopithecus afarensis*, the species that includes the partial skeleton known as Lucy.

"There may have been times when one early hominid species evolved into another one without branching off into multiple species," White says. His view contrasts with that of researchers who suspect that hominids branched into many species over the past 6 million to 7 million years (*SN: 5/3/03, p. 275*).

To prove that *Au. anamensis* branched from an earlier, as-yet-unknown population would require evidence that the *Australopithecus* species lived at the same time as *Ar. ramidus*, the Berkeley scientist notes. No such evidence exists.

The new finds come from two Middle Awash sites, Aramis and Asa Issie. The fossil discoveries occurred between November 1994 and December 2005. The finds extend the known range of *Au. anamensis* by about 600 miles to the northeast of two Kenyan sites where another team reported finding remains of the species in 1995.

White's team dated the Middle Awash material by measuring both the rate of decay of argon isotopes in volcanic ash just below fossil-bearing deposits and the magnetic properties of the sediment.

Early hominids in eastern Africa apparently lived in forested areas, the researchers say. Both Asa Issie and Aramis, also the home of *Ar. ramidus*, contain abundant fossils of monkeys, antelopes, and other woodland dwellers.

Since *Ar. ramidus* and *Au. anamensis* lived in the same place and negotiated comparable habitats, it's plausible that the earlier hominid evolved directly into the later one, remarks anthropologist Alan C. Walker of Pennsylvania State University in University Park, a member of the team that found *Au. anamensis* fossils in Kenya.

From 4.2 million to 1.2 million years ago, *Australopithecus* evolved increasingly larger jaws and teeth from one species to the next with minimal or no evolutionary branching, Walker proposes.

Anatomical comparisons of earlier *Au. anamensis* and *Au. afarensis* finds, conducted by anthropologist Donald C. Johanson of Arizona State University in Tempe and his colleagues, also indicate that the older species evolved directly into Lucy's kind. Their study will appear in the *Journal of Human Evolution*.

"We need more-detailed knowledge about [*Ar.*] *ramidus* to test the veracity of the proposed ancestor-descendant relationship between it and [*Au.*] *anamensis*," Johanson says. —B. BOWER

Microbe Hunt

Novel bacterium infects immune-deficient people

A newfound bacterium can cause illness in people, its discoverers have concluded. However, it may infect only people with a rare, inherited form of immune deficiency.

All three patients known to carry the microbe had a preexisting immune deficiency, chronic granulomatous disease (CGD).

In people with CGD, the bacterium may account for a significant number of infections, says Anthony S. Fauci, director of the National Institute of Allergy and Infectious Diseases (NIAID) in Bethesda, Md. The finding, he says, "clearly will have very important implications for CGD patients."

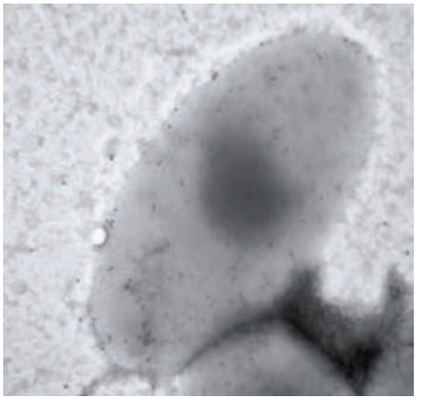
In the approximately 1,000 people in the United States who have CGD, immune cells called phagocytes have trouble digesting certain pathogens. People with CGD develop frequent, persistent infections, some of which are caused by known bacteria and fungi that normally succumb to phagocytes.

Other illnesses among people with CGD result from unidentified infections. "The discovery of a brand-new pathogen [puts] a little bit of a dent in that black box," says Fauci.

The novel microbe's discoverers, several of whom work at NIAID, have dubbed it *Granulobacter bethesdensis*. They first identified it in 2003 in swollen lymph nodes removed from a 39-year-old man. He had unexplained fever and chills and had lost 4.5 kilograms of body weight during the previous 3 months.

To prove that the newfound bacterium could cause illness, David E. Greenberg of NIAID and his colleagues put the microbe into lab mice.

Animals that had been bred to have CGD-



BUG SHOT **Scientists identified this microbe in 2003 in a man with impaired immunity.**

like defects developed abnormalities in their lymph nodes similar to those seen in the patient. Mice with normal immune systems had at most mild symptoms, the researchers report in the April *PLoS Pathogens*.

Tests of blood from some people with healthy immune systems indicate past exposure to *G. bethesdensis*, but there's no evidence that they got sick, Greenberg says.

The opportunistic bacterium might have lived in the original patient for several years before he became ill, says medical microbiologist David A. Relman of the VA Palo Alto (Calif.) Health Care System. "The evidence that this organism caused this patient's disease is suggestive but not conclusive," he says.

The patient was still infected with *G. bethesdensis* as of late last year. The bacterium has since been found in two other people ill with CGD.

Where *G. bethesdensis* usually lives is a mystery. Genetic tests show that its closest relatives include benign soil and plant bacteria, some of which are used to manufacture vinegar. —B. HARDER

Estrogen Safety

Studies raise cancer, blood clot questions

Three studies this week brought mixed news about the risks of estrogen-only hormone replacement therapy to ameliorate menopausal symptoms.

Data from a massive study called the Women's Health Initiative (WHI) show that estrogen therapy taken for 7 years doesn't increase a woman's risk of breast cancer. However, a separate study of black women finds a greater risk of breast cancer in women who took the hormone for 10 or more years than in women who had no hormone therapy.

What's more, another analysis of the WHI data reveals that women taking estrogen were more likely to develop blood clots than were women getting dummy pills.

Researchers launched the WHI in part to study the long-term effects of hormone replacement. However, the estrogen-only study was stopped in 2004 after researchers noted an increased incidence of stroke among women taking the hormone. That boost in stroke risk, combined with the new results, suggests that estrogen's declining reputation isn't likely to rebound any time soon, says J. David Curb, a geriatrician at the University of Hawaii in Honolulu, who coauthored the blood clot study.

"The best answer we have is that estrogens are probably not beneficial for postmenopausal women," says Curb.

The WHI cancer study enrolled postmenopausal women who had had hysterectomies. Roughly half of the 10,739 women participating took estrogen, and the other half took a placebo. The new analysis finds no significant difference in the rates of breast cancer in the two groups after 7 years, scientists report in the April 12 *Journal of the American Medical Association*.

In the other cancer study, epidemiologist Lynn Rosenberg of Boston University and her colleagues analyzed estrogen use and breast cancer risk among 23,000 black women. Women who had taken estrogen for 10 or more years had a 41 percent greater rate of breast cancer than did women who had never taken the hormone, the researchers report in the April 10 *Archives of Internal Medicine*. The difference in the results of the two studies may arise from the shorter average follow-up of WHI, Rosenberg says.

"There's a huge amount of evidence that estrogen is related to the risk of breast cancer in women," Rosenberg says.

However, the hormones used in prescriptions aren't identical to human estrogen, so although the natural hormone can promote breast cancer, it's difficult to know whether the drug does, says Marcia L. Stefanick, a Stanford University physiologist who coauthored the WHI breast cancer study.

In the other WHI analysis, 0.30 percent of women receiving estrogen, but only 0.22 percent of those getting a placebo, developed blood clots large enough to block a vein, Curb and his colleagues report in the *Archives* issue.

Doctors should prescribe estrogen only for women "with menopausal symptoms that are intolerable," Stefanick says. —N. SEPPA

Into Hot Water

Lab test shows that worms seek heat

Worms from deep-sea vents actually prefer water at temperatures near the upper limits of what animals are known to survive. An experiment, featuring a heated aquarium pressurized to 246 atmospheres, marks the first time researchers have directly tested vent worms' temperature preferences.

Paralvinella sulfincola is one of the few worms that set up house in the hot zones of hydrothermal vents called chimneys. These deep-sea features spew hot fluids that come from within Earth. The team collected specimens of *P. sulfincola* from 1,800 meters deep in the northeastern Pacific.

In an aquarium, some of the vent dwellers moved to a spot with 50°C (122°F) water and stayed there for 7 hours, says Peter R. Girguis of Harvard University. A vent worm even survived a blast of 55°C water for 15 minutes, he and Raymond W. Lee of Washington State University in Pullman report in the April 14 *Science*.

SOME LIKE IT HOT **The red, feathery gills mark the heads of heat-loving worms *Paralvinella sulfincola* on vents at depths of 2,200 meters off the coast of Washington State.**

I. MCDONALD AND S. KIM JUNIPER

Those are unusually high temperatures, even for a vent creature, says Girguis. For example, *Rimicaris exoculata* shrimp collected around vents all died in the lab at temperatures above 43°C.

In their natural habitats, the worms look like tipped-over palm trees. The burgundy, frondlike gills stick out of a tube that the worm secretes around the rest of its body.

Girguis and Lee used the robotic arms of submersible vehicles to collect the worms, brought the creatures to the surface, and immediately put them in an aquarium pressurized to mimic the conditions of the species' native depths. The now-tubeless worms could travel across their new home.

To test temperature preferences, the researchers heated the box so that temperatures ranged from 20°C at one end to 61°C at the other. They then monitored where the worms settled.

Earlier tests of worms' temperature tolerances were performed undersea. Craig Cary of the University of Delaware in Lewes hovered in a submersible and inserted probes inside the tubes of a different Pacific-vent worm, *Alvinella pompejana*. He recorded temperatures rapidly fluctuating between 40° and 90°C. That worm's heat tolerance comes from its protective fleece of bacteria. Cary speculates.

Bruce Shillito of Pierre and Marie Curie University in Paris says that he'd like to test *A. pompejana*'s temperature preferences in a setup similar to the one that Girguis and Lee used. However, Shillito says that when he brought samples of *A. pompejana* up from the depths, they arrived in "very rotten shape."

Thomas Dahlgren of Göteborg University in Sweden, who studies deep-sea worms on dead whales, applauds the new efforts as "very important." He says, "The deep sea is like a continent not yet discovered." —S. MILIUS

Limited Storage

Lack of nutrients will constrain carbon uptake

Plants take carbon dioxide out of Earth's atmosphere and use its carbon to promote their growth. However, if human activities continue to increase atmospheric concentrations of the planet-warming gas, vegetation won't sequester large amounts of carbon dioxide in the long term, two new analyses suggest. That's because plants will quickly run out of other nutrients.

In the short term, plants store carbon in their tissues. Eventually, some of that carbon makes its way into the soil through the roots or via fallen leaves and stems. Those phenomena had raised the possibility that plants would decrease the buildup of carbon dioxide in the atmosphere.

Lab and field experiments had shown that plants grow more quickly in the presence of higher-than-normal concentrations of carbon dioxide in the air, says Peter B. Reich, an ecologist at the University of Minnesota in St. Paul. Unfortunately, results of a long-term experiment by Reich and his colleagues show that the trend doesn't last.

In their 6-year study, the researchers measured carbon storage in nearly 300 patches of Minnesota grassland cultivated under various conditions. Some plots were exposed to an atmosphere with 50 percent more carbon dioxide than the current concentration, some received extra nitrogen via fertilizer, some received both treatments, and others received neither. The plots contained between 1 and 16 species of grasses, herbs, wildflowers, and legumes.

As expected, for the first 4 years of the experiment, plants exposed to higher-than-normal concentrations of carbon dioxide grew faster and became larger than those that didn't get extra carbon, says Reich. However, unless they were also receiving nitrogen supplements, growth of such plants slowed substantially in the fifth and sixth years of the experiment. Reich and his colleagues report their findings in the April 13 *Nature*.

Another group of researchers also finds that plants getting extra carbon dioxide run out of other nutrients. That team, led by ecologist Johan Six of the University of California, Davis, reports in an upcoming *Proceedings of the National Academy of Sciences* an analysis of earlier experiments by several research groups.

In the presence of nitrogen-producing legumes and higher-than-normal concentrations of atmospheric carbon dioxide, soil continues building up carbon only when other nutrients, such as phosphorus, potassium, and molybdenum, are added. In other ecosystems, high concentrations of atmospheric carbon dioxide increase soil carbon only when researchers add nitrogen, the Davis group concludes.

If nutrient limitations cause plant growth to slow, as the new studies suggest, carbon dioxide may build up in Earth's atmosphere faster than scientists previously expected, says Reich. —S. PERKINS

Sleeper Finding

Hormone key to hibernation?

A recently discovered hormone may play a major role in triggering and maintaining hibernation. The finding could shed light on this annual period of slumber, which largely remains a mystery even after decades of research.

Each year, species ranging from amphibians to rodents settle in for a long winter's nap, which helps them conserve energy and other resources during harsh weather. Their body temperatures plummet to near freezing, and metabolisms slow.

Researchers are eager to understand hibernation because it seems to protect slumbering animals from a variety of ills, including hypothermia, strokes, muscle atrophy, infections, and cancer—a defense that might someday be emulated in people.

But because hibernating animals' metabolisms drop so dramatically, it's difficult to detect what molecules might control the phenomenon, notes biologist Noriaki Kondo of Kanagawa Academy of Science and Technology in Tokyo.

Several years ago, Kondo and his colleagues identified a hormone that's abundant in Siberian chipmunks' blood during summer but fades away during the winter. Suspecting that the hormone's seasonal fluxes might be related to hibernation, the researchers decided to give it a closer look. The hormone is made of four proteins and is called hibernation-protein complex (HPc).

First, to make sure that HPc doesn't fluctuate simply because of body temperature or light, the researchers kept a group of chipmunks in cold and darkness year-round. Other chipmunks were kept warm throughout the year, with regular 24-hour cycles of daylight and darkness. Regardless of these conditions, HPc continued to fluctuate on a seasonal schedule.

Next, Kondo's team examined whether HPc makes its way to the brain, the presumed control site for hibernation. Though blood concentrations of the hormone were highest during the summer, the researchers couldn't find HPc in the fluid bathing the chipmunks' brains during that season. However, concentrations of the hormone rose in the brain fluid as hibernation began and remained steady during hibernation.

KONDO

SWEET DREAMS **A hormone complex discovered by Japanese researchers may be orchestrating seasonal slumber for this hibernating chipmunk.**

When the scientists injected hibernating chipmunks' brains with antibodies that blocked the hormone's action, some of the animals cut short their hibernations. This result suggests that HPc keeps hibernation going, the researchers report in the April 7 *Cell*.

The study is "a nice first step" toward understanding hibernation's molecular mechanism, says Sandy Martin of the University of Colorado School of Medicine in Aurora. However, she warns, "more work needs to be done before anyone writes this into the textbooks." Martin notes that no study has found HPc in other hibernating animals. She adds that even in Siberian chipmunks, it's unclear what HPc might do in the body to trigger and maintain hibernation. —C. BROWNLEE

Dynamic Duo

Two catalysts build valuable carbon chains

By combining the power of two well-known reactions, chemists have devised a way to alter the length of carbon chains.

The process might someday convert less-valuable carbon chains into a transportation fuel, the researchers say.

As oil supplies shrink, chemical processes that turn coal or biomass such as corn into liquid hydrocarbons will become more important, says chemist Maurice Brookhart of the University of North Carolina at Chapel Hill. Of particular interest are linear alkanes, chains in which single bonds connect carbon atoms and hydrogen atoms fill out the molecules. Diesel engines, for example, run most efficiently on alkanes with 9 to 20 carbons per molecule.

The reaction that converts coal and biomass to alkanes, however, produces carbon chains of many lengths. Included in the mix are alkanes with four to seven carbons, lengths that can't be used as fuel, says Brookhart.

Brookhart, Alan S. Goldman of Rutgers University in Piscataway, N.J., and their research teams used two catalysts to promote reactions that together reclaimed the short alkanes. The first reaction removes two hydrogen atoms from an alkane, creating a double bond between two of the molecule's carbons. The second reaction induces two molecules to exchange chain portions from either side of the double-bonded carbons. Then, the first reaction's catalyst returns the hydrogen atoms, eliminating the double bond.

The reactions convert a starting short alkane into products with two lengths. For example, two 6-carbon-long alkanes—hexanes—would become a 10-carbon alkane—decane—and a 2-carbon alkane—ethane. "Then, you are in great shape: You've got the diesel fuel, and you've got the ethane," a gas that can be used as heating fuel, says Goldman. The team describes its work in the April 14 *Science*.

"It's a spectacularly clever use of those two reactions," says John F. Hartwig of Yale University.

But the process is far from ready for industrial applications, Brookhart notes. For example, the number of reactions that each catalyst molecule can perform before becoming unstable must increase from about 1,000 to several million.

The reactions' selectivity isn't optimal either, Brookhart says. The catalysts also convert alkanes of desired lengths into other lengths. "What we would really like is, from hexane, to get only ethane and decane," says Brookhart. However, he notes that with the current procedure, chemists could put the unwanted alkanes "back in the pot" to cycle through the reactions again.

The group is now testing other catalysts for its system. —A. CUNNINGHAM

Brilliant!

Tenth planet turns out to be a shiner

Xena, unofficially called the 10th planet, is the second-most-shiny known object in the solar system, new observations show. Scientists are scrambling to explain where Xena got its sparkle. Some suggest that it might have enough heat to belch methane, despite being in the coldest region of the solar system.

The new notion of Xena arises from Hubble Space Telescope images that were released this week. The images reveal that Xena, the most distant known object in our solar system, isn't quite the big shot that scientists had thought it was.

The chilly outpost's diameter—2,384 kilometers—makes it about 5 percent larger than Pluto, Mike Brown of the California Institute of Technology in Pasadena and his colleagues announced April 11. That's still large enough for Xena to retain its unofficial status as a planet, Brown says, but considerably smaller than ground-based observations had indicated (*SN: 8/6/05, p. 83*).

Researchers have difficulty determining the size of remote denizens of the solar system because a large object that reflects a small amount of sunlight looks the same as a small object reflecting a lot of light.

But for Xena, the sharp Hubble pictures erase that ambiguity.

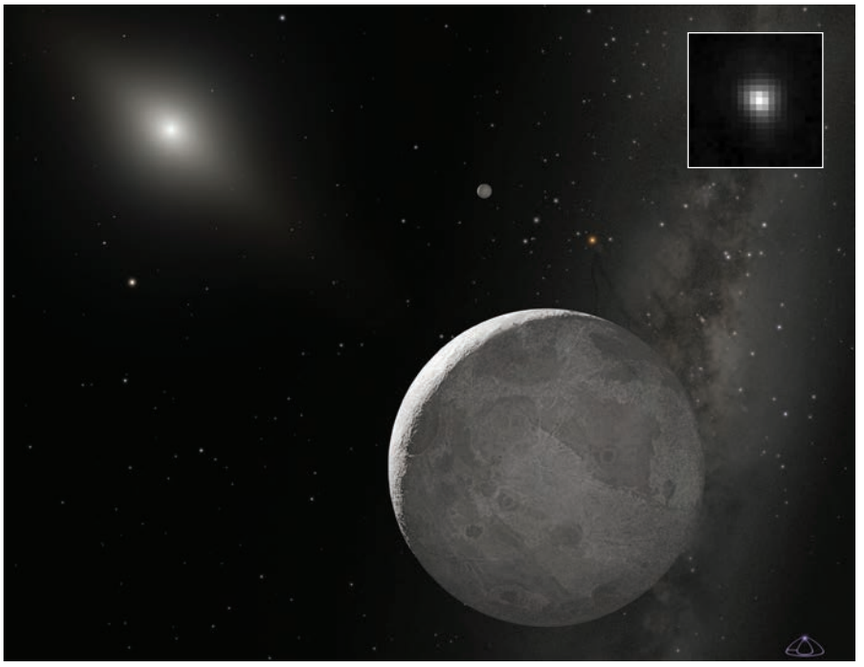
The relatively small size shown in those images indicates that the body reflects 86 percent of sunlight. Brown says he was "thoroughly shocked" by that finding. Researchers had assumed that Xena's surface was similar to that of Pluto, which reflects 60 percent of sunlight. Saturn's moon Enceladus, recently shown to be shooting out a geyser of water vapor (*SN: 1/7/06, p. 13*), is the only solar system object known to have a higher reflectivity, notes Brown.

Scientists have proposed two scenarios to explain Xena's high reflectivity. In one, a jet of methane leaks continuously from Xena. The methane jet freezes as it emerges, continually blanketing the surface with fresh snow.

What's the heat source that could drive such activity? "Beats me," says planetary scientist Rick Binzel of the Massachusetts Institute of Technology. He notes that gravitational tugs from a neighboring moon sometimes generate heat within a body, but Xena's moon is too small to do that.

Another source of heat, sunlight, would penetrate only a few tens of meters below Xena's surface and would probably have long ago depleted the reserves of methane there.

In the other model, the planet has a methane-rich atmosphere created during the portion of its 560-year-long orbit when it's nearest the sun. As Xena speeds away, the atmosphere freezes on the surface as a bright frost. However, Brown says, it's not clear that such frost would be bright enough to account for the shininess of Xena's surface. —R. COWEN



A. SCHALLER, NASA, ESA; (INSET) BROWN, NASA, ESA

XENA FILES **The distant sun shines on Xena, often called the 10th planet, in this illustration. Inset: The Hubble Space Telescope image that revealed Xena's size for the first time.**

THEY'RE ALL PART FUNGUS

Grass blades, coffee or cacao leaves ... probably all plants

BY SUSAN MILIUS

"You've mistaken a fungus for a pine tree" can be a ticklish thing for one botanist to say to another. Yet, in the 1990s, one respected university researcher made that very accusation to another. Stories such as this have spiced botanist gossip for years, but in this case, the two scientists resolved their differences and published a paper telling the whole story.

In the mid-1990s, Aaron Liston of Oregon State University in Corvallis was studying the evolutionary history of pine trees and managed to sequence a long stretch of DNA from pine needles. "It was still a big deal in those days," he says. He searched databases for genetic sequences from similar pine trees and found some that didn't match his results at all.

After more work, he became confident that his lab had the real pine-DNA sequence. He contacted Anita Klein of the University of New Hampshire in Durham, whose graduate students had contributed the other sequences to the database and used them in a journal paper.

"I broke the news to her slowly," he says. In a series of e-mails over about 2 weeks, he persuaded her that what her students had described as pine and fir genetic material wasn't actually from a plant. Nor was it from surface contamination or DNA wafting around the lab. It came from fungi living inside the needles.

In figuring this out, Liston says, he had the advantage of his colleague Jeffrey Stone, who was "one of the few people who knew and cared about fungal endophytes." These fungi grow intermingled with cells inside plants but don't cause any apparent disease. Thus, from the outside, a leaf may look like solid plant tissue, but deep inside, spaghettilike strands of fungal cells twist among the plant cells. The fungi are ensconced far more intimately than are the microbes that thrive on the vast plains of human skin or in the wet caverns of animal guts.

Klein says that she now realizes that her lab's primers for the procedure preferentially amplified fungal, rather than plant, DNA. The fungi probably coevolved with their plant hosts, she says, so fungal DNA taken from seven-or-so spruce and pine species showed plausible relationships when regarded as a plant family tree. "I can look back on it now and chuckle," she says. "But I was devastated then."

PHOTODISC

WHAT LIES WITHIN — Plant species of forests, deserts, and farms all seem to have fungi living deep within their tissues. Most of these hidden houseguests don't cause disease but can still have big effects on their hosts.

Plant-entrenched fungi have been challenging to study, but modern molecular technology is finally revealing their world. Now, they're turning up all over, and their influence can be big, even though they are not.

FUNGUS AMONG THEM Fungi can put the greediest human land developers to shame when it comes to turning open real estate into homes. Given just a few lucky breaks, some fungi exploit the vast acreage of leaf surfaces. Other fungal species target plant roots and show up routinely on some 85 percent of plant species. These mycorrhizal fungi can boost the root system's efficiency.

Fungal endophytes slip into plant leaves and stems to set up housekeeping between, or even inside, plant cells. Some fungal endophytes, such as those in tall fescue or other grasses, also infiltrate the seeds that their host plants are forming, thereby stowing away for the ride to the next generation.

More commonly, endophyte spores waft through the air in search of a new home.

The spores are impressive at breaking and entering, says Elizabeth Arnold of the University of Arizona in Tucson. They usually don't take the easy way in, through a leaf's breathing holes. Instead, a spore typically lands on a leaf, germinates, and drills a strand of tissue right through the plant's fortified coatings.

A colony founded by one of these intruders typically grabs only a few cubic millimeters of internal leaf space, favoring locations near the plant's internal plumbing. The fungus lives off carbon and other nutrients from leaky pipes. Under a microscope, strands of the fungal lurker can be seen curving through the brickwork of plant cellular tissue. The fungus grows, often extremely slowly, by sprouting off more strands of cells.

For many of these fungi, scientists don't know how the life cycle wraps up, says Arnold. Somewhere, somehow, most of the species must make spores. Yet the fungal lurkers have only rarely been caught sporulating in living plant tissue.

One solution to the mystery might be that the endophytes, other than those in some grasses, wait until the plant dies to make their spores, says Arnold. A big benefit of invading living tissue might be preparation for fast postmortem access. "Maybe they're like little vultures," she says.

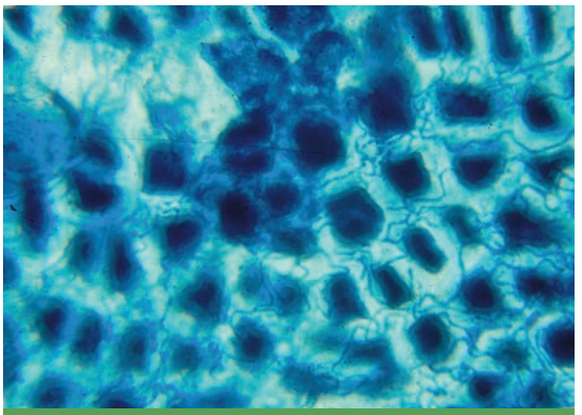
Whatever drives the plant-endophyte fungus relationship, it's showing up all over. Every one of the several hundred plant species

tested so far has yielded lurking fungi, says Arnold. They've turned up in the little dryas wildflower of the tundra and in leaves of tropical trees. In 2005, an international research team even collected an abundance of endophytes from the innards of cacti.

A single plant species can have a large assortment of the lurkers. Arnold says that she was first jolted into an appreciation of the variety of fungi inside plants when she worked as a research assistant in Panama. To learn how the age of leaves influences their disease resistance, she placed strips of tropical-tree leaves on a standard lab-fungus food. The dishes turned into fantastical fungus gardens with spots of white fuzz, dark slime, and colored fur. One of her prize specimens grew out in a cluster of little rounded arcs "like a green rose," she says.

A sample of 83 healthy leaves from just two species of tropical tree yielded more than 400 kinds of fungus living inside, Arnold and her colleagues reported in 2000. They called the fungi not diverse but "hyperdiverse."

Endophyte variety seems to far outstrip that of the plants they inhabit. In the tropics, there may be dozens of fungal endophyte species per plant. Researchers have estimated that Earth's endophyte species outnumber its plant species by a factor of four. More than a million kinds of endophytes might be lurking around us.



HITCHHIKERS GUILE — Twisting strands of a *Neotyphodium* fungus (colored dark blue in image) have grown among the boxy cells within this grass-seed tissue. Some fungi ride along in seeds to new homes, but many depend on air currents to transport them to welcoming plants.

BEWARE OF GRASS In the 1970s, biologists discovered that invisible endophytes can have visible effects. The first discoveries of endophyte power came from grasses on farms. One story begins in the 1930s, when University of Kentucky agronomists got seeds from a farmer with a hillside of remarkable grass.

The grass flourished, but sometimes the cattle grazing on it did not. Farmers reported that when the cattle ate primarily the fescue called Kentucky 31, they went lame more often than usual, and their tails sometimes sloughed off. While investigating the livestock troubles, researchers eventually realized that a fungus in the genus *Neotyphodium* secreted compounds that constricted blood flow in cattle extremities.

Another species introduced for grazing, perennial ryegrass, turned out to carry these fungi too. A Southwestern native species called sleepygrass hosted a fungus of the same genus. That plant earned its name from wooziness that struck animals grazing on it.

The *Neotyphodium* fungi exude toxins related to the hallucinogenic drug LSD. The fungal taints also bring ill effects to minigrazers, such as insects and nematodes, scientists discovered.

These effects vexed farmers but fascinated ecologists. By the 1960s and 1970s, those hidden fungi, once dismissed as curiosities, seemed to be sophisticated, mutualistic partners of grasses. A plant sheltered and fed them, and, in turn, they defended it against grazers. Ecologists also reported other effects, such as resistance to drought.

Recent years have seen challenges to the idea of plant-endophyte mutualism. Stan Faeth of Arizona State University in Tempe, for example, reports that one of tall fescue's native relatives, *Festuca arizonica*, doesn't grow as well when it houses one of the supposedly protective fungal partners. He's found that the endophyte is usually a parasite rather than a pal.

Even for some of the textbook mutualism cases, such as sleepygrass, Faeth and his colleagues are raising questions, which he notes are controversial. "The hallmark of native endophytes and grasses is remarkable variability," he says. The agronomic grasses are poor models and fail to capture the wide range of endophyte interactions in nature."

In a recent example of his lab's work, the researchers sampled 17 grass patches at distances up to about 600 kilometers from a patch of highly toxic grass in Cloudcroft, N.M. How widespread the endophyte was—and its effects—varied considerably, the researchers report in an upcoming *Journal of Chemical Ecology*. They found that some patches of grass in Colorado were thoroughly infected with the toxic grasses' fungal species but had no antigrazing toxins. So, Faeth asks, is the supposed mutualist earning its keep?

Kari Saikkonen of MTT Agrifood Research in Turku, Finland, suggests that by looking only at the grass and the fungus, researchers have oversimplified the interactions. To better represent the complications of the real world, he and his colleagues set up a four-way laboratory interaction to see whether other players could alter a grass-fungus interaction.

In the lab, the researchers let a plant in the snapdragon family, the greater yellow-rattle, attack a fungus-bearing meadow rye grass. Yellow-rattle sneaks suckers over to the roots of other plants and steals sap.

When yellow-rattles parasitized grass that carried an antigrazing fungus, the researchers found that the parasite took up the fungal defensive toxins along with other goodies from the plant. In the presence of both yellow-rattle and aphids, the ryegrass with the toxic fungus didn't do as well as ryegrass without the fungus did. In this setup, fungus looked like a burden to the ryegrass, the researchers reported in the Dec. 2005 *Ecology Letters*.

If a fungus can tweak predators of neighboring plants, can its effects ripple up a food chain? When researchers at the University of Zurich herded cereal aphids onto fungus-bearing ryegrass, the ladybird beetles that fed on the aphids failed to thrive and didn't reproduce well. Jochen Krauss and his colleagues describe that experiment in an upcoming *Proceedings of the Royal Society B*.

BEYOND GRASS Scientists have in recent years turned to the fungi in plants other than grasses. In 2003, Arnold and her colleagues presented the first strong evidence of fungal-pest fighting by natural endophytes in a nongrass plant, wild cacao (*SN: 12/13/03, p. 374*).

The myriad fungi in tree leaves might create a defense system, suggests Edward Allen Herre of the Smithsonian Tropical Research Institute in Balboa, Panama. The abundance of fungi with their differing powers of interaction similarly increase the odds that for any no-good intruder, there's already an antagonist on hand.

Herre is working to manipulate such fungi to fight diseases of cacao. He says that he's getting promising preliminary results from a field test applying extra endophytic fungi.

The approach is attracting interest. The American Phytopathological Society annual meeting devoted a session to the concept last August in Austin, Texas, and the U.S. Department of Agriculture is funding research. Fernando Vega of the USDA's Beltsville facility has found some endophytes that deter insects in lab tests of coffee leaves.

Making the world safer for chocolate and coffee, among other crops, is a big job for organisms that nobody sees. That's not a problem, according to endophyte enthusiasts. As Krauss says, "It's the little things that rule the world." ■

FAETH

REGION AT RISK

A look at San Francisco's seismic past and future

BY SID PERKINS

At 5:12 a.m. on April 18, 1906, the residents of San Francisco awoke with a start as a massive temblor ripped along the San Andreas fault. The shifting earth turned liquid, and buildings shook from their foundations. Subterranean gas pipes fractured and fueled fires that in the following 3 days would consume more than 10 square kilometers of the city. The blazes couldn't be extinguished because the city's water pipes had been fractured too.

The quake and subsequent fires destroyed about 28,000 buildings, causing an estimated property loss of $524 million. At the time, the estimated death toll from the event was about 300, but subsequent interviews with survivors suggested that the actual number of fatalities might have been 10 times as high.

Using data gathered during and soon after the temblor, scientists estimated the quake's magnitude at about 7.9. Since then, the Bay Area hasn't experienced a seismic shock that large. The biggest was magnitude 6.9 in 1989 in the mountains south of San Francisco. Today, the area's residents wonder about when and where the next "Big One" will occur.

The century long lull in major quakes will probably end sometime in the next 30 years, according to seismologists' latest estimates.

A repeat of the 1906 quake would be as devastating to the Bay Area as Hurricane Katrina was to New Orleans. Insurers estimate that the costs of rebuilding would range between double and triple the amount of the annual California state budget. In an attempt to forestall some of that damage, billions are now being spent to seismically upgrade the region's bridges, pipelines, and other infrastructure. However, relatively little of that money is being spent to strengthen homes and apartment buildings—a trend that will ensure demographic upheaval when the inevitable quake occurs.

New analyses of seismic data gathered during the 1906 quake, as well as field observations made soon thereafter, suggest that the San Andreas fault ruptured much more quickly than scientists had previously estimated. Analyses of ground motions indicate that as bad as the destruction was that day, it could have been much worse.

WATCHING HISTORY — After the San Francisco quake of 1906, residents could only stand by as fires, often fueled by broken gas lines, devastated the city. Fractured water mains hampered firefighters, so flames spread unabated for 3 days after the quake.

SFMUSEUM.ORG

WHAT HAPPENED? In early 1906, San Francisco was the largest and richest city in the western United States. About 400,000 people, a quarter of all residents west of the Rockies, lived there. Banks in the city held deposits exceeding $1 billion, more than all other western banks combined.

Then came the quake.

Slippage along the San Andreas fault, the boundary between the North American and the Pacific tectonic plates, began offshore just west of San Francisco Bay. From that epicenter, the rupture spread along the fault to the southeast and the northwest, says Mary Lou Zoback, a geophysicist with the U.S. Geological Survey (USGS) in Menlo Park, Calif. Slippage occurred along almost 500 kilometers of the fault, the longest known rupture of any fault in the lower 48 states. In San Francisco, the ground shook for 45 seconds to a minute.

The temblor was one of the first to be studied scientifically, Zoback notes. Data gathered by researchers nearly a century ago are still yielding new insights. At the fall meeting of the American Geophysical Union in San Francisco last December, Zoback gave a new perspective on the quake and its aftermath.

Seismology was a fledgling science in 1906. There were only 96 seismometers operating worldwide at the time, five of them in and around San Francisco. However, ground motions generated by the rupturing fault were so large that measurements made by the local instruments were literally off the chart—and therefore useless. For scientists then and now, some of the most useful data about the quake were recorded by distant instruments in Japan, Puerto Rico, and Europe, says Gregory C. Beroza, a seismologist at Stanford University.

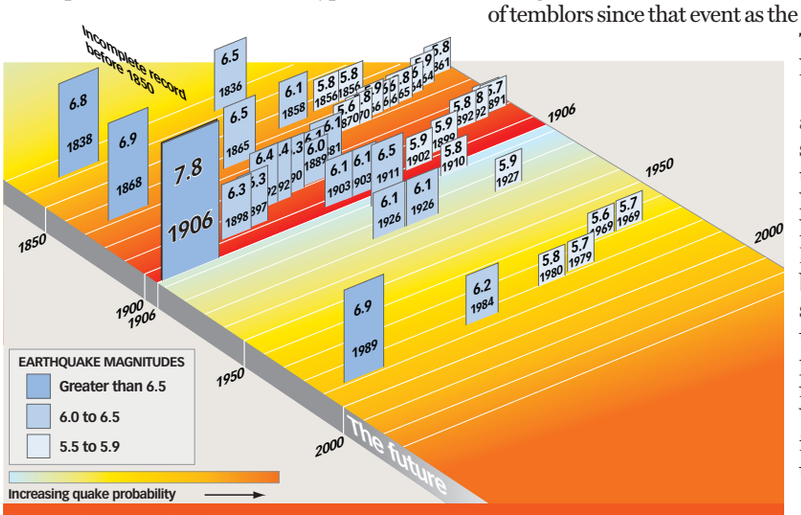
Different types of analyses produce different estimates for the quake's magnitude and the length of fault rupture, says Beroza. Analyses conducted soon after the quake—ones that considered the size and duration of the ground motions recorded by remote seismometers—suggested that the quake measured a magnitude 7.7 and that slippage occurred along only 350 km of the fault. That distance estimate matched the length of disturbed earth that field geologists observed at the time—the San Andreas fault was ruptured from just northwest of San Juan Bautista, Calif., to Point Arena, where the San Andreas fault enters the ocean northwest of San Francisco.

Despite that concordance, the magnitude estimated by those methods didn't match the magnitude calculated from precise sur-

veys of the region after the quake. Those field data hinted that the quake measured a magnitude 7.9 and that rupture occurred along 500 km of the fault—from San Juan Bautista all the way to Cape Mendocino, where the San Andreas fault comes back on shore, farther northwest of Point Arena. Although field teams had noticed disturbed earth at Cape Mendocino after the 1906 quake, scientists at the time couldn't agree whether that disturbance resulted from the rupture of the fault or an unrelated landslide.

Now, Beroza and his colleagues have developed a model for the quake that removes the discrepancies. The problem with previous seismic analyses is that the researchers assumed that the fault ruptured at a speed of about 2.7 km per second (km/s), a rate typical of small quakes. But Beroza's team considered data gathered during some recent large quakes, including a magnitude 7.4 temblor in Izmit, Turkey, in 1999; a magnitude–8.1 quake that rocked Tibet in 2001; and a magnitude–7.9 quake in Alaska in 2002. Those data suggest that faults can rupture at speeds exceeding 3.5 km/s, says Beroza.

That velocity is so great that the seismic waves form an intense pressure pulse that's analogous to a sonic boom in the air. Such pressure pulses can do a lot more damage than the seismic waves that travel at lower speeds can.



TOMBSTONE ROW — The frequency of Bay Area quakes larger than magnitude 5.5 dropped precipitously after the 1906 temblor (large bar at left of diagram). Scientists forecast a 62 percent likelihood of a magnitude 6.7-or-greater quake by 2032.

USGS

When Beroza and his team reanalyzed the seismic data and assumed the San Andreas fault ruptured at high speed, the magnitude of the quake and the rupture length of the fault matched the estimates obtained by analyzing the field-survey data. The researchers presented their findings last December at the American Geophysical Union meeting.

When the San Andreas fault let loose in 1906, the rupture started offshore near San Francisco and, for the most part, spread away from the city, says Beroza. Therefore, most of the seismic energy radiated away from the city, not toward it, and the subterranean pressure pulses didn't strike San Francisco as forcefully as they would have if the waves had been crashing toward the city from a distant earthquake. The devastation "could have been much worse," says Beroza. The 1906 quake was one of the least damaging earthquakes of that size that could have struck the region, he notes.

WHAT'S THE FREQUENCY? At least seven faults running through the Bay Area can accumulate enough seismic stress to generate quakes of magnitude 6.7 or higher. For such a seismically active region, earthquakes have been rare, at least in recent history. Temblors larger than the 1906 San Francisco quake are even rarer. In the past 3 centuries, there have been no such quakes in the Bay Area and only 30 or so anywhere on Earth.

Seismic instruments haven't been around long enough to provide researchers with a good idea of how often damaging quakes strike a particular region over the ages. In a sense, though, the Bay Area has had an earthquake-reporting network since the United States was founded.

People in charge of the region's Spanish missions—the first of which was founded in San Francisco in 1776—diligently kept records of all significant events within their jurisdictions, including natural phenomena such as droughts and earthquakes. Their observations show that the region's seismic history can be divided into two periods, with the 1906 earthquake as the dividing line.

In the years before the 1906 quake, earthquakes occurred frequently throughout the region, says Zoback. Between 1858 and 1906, for instance, 13 quakes with an estimated magnitude of 6.0 or larger were generated by slippage along the area's faults, a rate of one quake every 4 years. In the past century, only five quakes of that magnitude have occurred. Scientists speculate that the 1906 quake released a large amount of the seismic stress that had accumulated along the San Andreas fault, and they refer to the dearth of temblors since that event as the quake's "seismic shadow." The question is "How long is that shadow?"

To come up with an answer, scientists have scrutinized mission documents, but they've also looked for clues in the local geological record. For example, they've carbon-dated samples of sediments that were disturbed by quakes that predate those known from mission records. With these sources of information, scientists at the USGS have reconstructed the region's seismic history since 1600.

A series of large temblors occurred throughout the Bay Area between 1680 and 1776, a cluster that ruptured nearly all of the region's faults, says Zoback. The San Andreas fault let loose four times in the past 4 centuries—the massive quake of 1906 as well as smaller events in the mid-1600s, the mid-1700s, and in 1838. Big quakes have ruptured the Hayward fault, which runs through the eastern portions of the Bay Area, three times—in the early 1600s, the early 1700s, and in 1868.

The patterns found in these seismic data suggest that the probability of a magnitude 6.7-or-greater earthquake striking the Bay Area before 2032 is at least 62 percent, says Zoback.

It's uncertain whether the next big quake in the region will mark the end of the 1906 quake's seismic shadow. Indeed, that pall might have already lifted. The magnitude 6.9 quake of October 1989, which was centered in the Loma Prieta Mountains, might have been the first in a new series of seismic salvos to strike the region. Although that quake released just 3 percent as much energy as the 1906 San Francisco quake did, it killed 62 people and caused more than $5.6 billion in damage.

WHAT'S THE DAMAGE? What would happen if a quake the size of the 1906 temblor happened today? Analyses suggest that the devastation would be widespread and even more costly than it was a century ago.

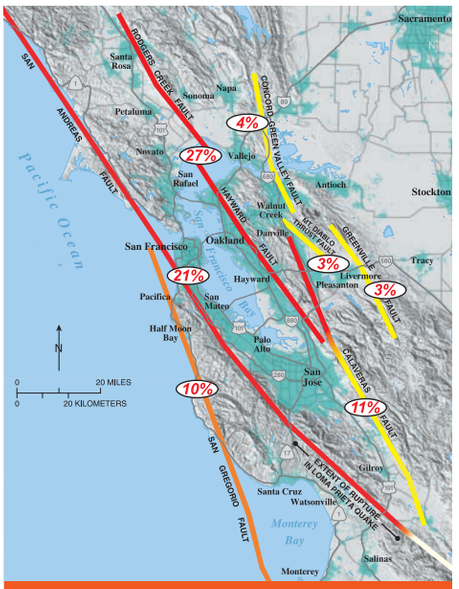
Building codes in San Francisco, as well as those in many other earthquake-prone regions, have evolved over the past century to require stronger construction and better seismic performance. The most recent such updates to San Francisco building codes were enacted in the 1970s, says Zoback. However, more than 84 percent of the residential structures in the city were built before that time.

A 2001 neighborhood-by-neighborhood study, conducted for the city of San Francisco, showed extensive vulnerability in the city's privately owned buildings, says Zoback. About 70 percent of the dam-

age in the city would be to homes, apartments, and other residential structures.

Neighborhoods in the western and southern areas of the city would bear the brunt of destruction, in large part because of the soft soils there. Citywide, about 45,000 buildings would be destroyed by the quake and subsequent fires, and more than 160,000 families would be left homeless, according to the city's study.

A major quake would probably cause significant shifts in the city's demographics, says Zoback. About 65 percent of the people who live in San Francisco are renters, and 71 percent of those residents live in rent-controlled apartments or buildings. Because in many cases those renters are paying much less than market rates for their apartments, owners might actually have an economic disincentive to perform seismic upgrades. If a building is destroyed by a quake and then rebuilt, its apartments would no longer be subject to rent control, and many of the current residents wouldn't be able to afford to live there.



ALL CRACKED UP — At least seven faults capable of generating a magnitude 6.7 earthquake underlie the Bay Area. Faults are labeled with their estimated probability of rupture by 2032.

USGS

WHAT'S THE OUTLOOK? Although the damages in San Francisco from a large quake would be devastating, scientists suggest that municipalities along the eastern shores of San Francisco Bay are at even greater risk than San Francisco itself.

To better survive such a temblor, the public and private sectors have spent, or will soon spend, about $30 billion to seismically upgrade Bay Area buildings and infrastructure, says David P. Schwartz, a research geologist at the USGS in Menlo Park. He noted at the December 2005 American Geophysical Union meeting that the largest portion of this pie, about one-third, is dedicated to transportation. The state department of transportation has already spent about $3.5 billion to retrofit or replace the region's overpasses and toll bridges.

Public utilities have spent about $6.5 billion to upgrade the pipelines that bring water to San Francisco, a lifeline that tragically failed in 1906. Also, Pacific Gas & Electric, the main utility provider in northern California, has spent $2.4 billion since 1985 to replace or enhance gas pipelines and power lines with ones that are more resistant to quakes.

Because no one knows when the inevitable Big One will occur, it's tough to tell whether the race to ameliorate its effects is going well. In many respects, however, efforts are lagging. For example, state legislators in 1994 gave hospitals 2 decades to upgrade their facilities to ensure they could remain open after a large earthquake. Data compiled by the USGS indicate that, so far, only $900,000 of the $5.7 billion needed to meet that target has been spent.

Because of the dearth of big earthquakes in the Bay Area since 1906, "people have a distorted view of the real earthquake hazard," says Stanford's Beroza. Sooner or later, one of the seven faults in and around San Francisco will let loose, he notes. It's not a question of if, but of when. ■

OF NOTE

ARCHAEOLOGY

Early farmers took time to tame wheat

Domesticated varieties of wheat emerged gradually in the prehistoric Near East over a roughly 3,000-year span, a new investigation suggests.

Ken-ichi Tanno of the Research Institute for Humanity and Nature in Kyoto, Japan, and George Willcox of the National Center for Scientific Research in Berrias, France, examined 804 wheat-ear remnants recovered at four ancient villages in southeastern Turkey and northern Syria.

Wild and domesticated ears of wheat shatter at maturity in distinctive ways, so microscopic study can distinguish the two forms.

No signs of domesticated wheat appeared at the oldest Near Eastern site, which was initially inhabited about 10,200 years ago, Tanno and Willcox report in the March 31 *Science*. A 9,250-year-old village yielded a small amount of the cultivated cereal. Progressively larger amounts of domesticated wheat turned up at two younger sites, one dating to 7,500 years ago and the other to 6,500 years ago.

The researchers suspect that as wheat domestication slowly expanded, some Near Eastern farmers nevertheless continued to tend and harvest wild wheat. —B.B.

WILLCOX/CNRS; JPL/NASA

CULTIVATED FINDS Microscopic analysis of wheat grains such as these from a 6,500-year-old Syrian site revealed clues to plant domestication in prehistoric times.

ZOOLOGY

Hummingbirds can clock flower refills

Hummingbirds can keep track of when a particular flower has replenished its nectar and is worth visiting again, say researchers working in the Canadian Rockies.

That knack may require that hummingbirds have parts of what's called episodic memory, says T. Andrew Hurly of the University of Lethbridge in Alberta. When people recall episodes from their lives, they're remembering what happened and where and when. Clocking nectar refills means hummingbirds remember at least "when" and "where," Hurly and his colleagues say in the March 7 *Current Biology*.

For decades, people touted episodic memory as a uniquely human ability. However, there's some evidence that other animals have similar mental capabilities, says Hurly. For example, a different research group found that scrub jays can remember where and when they hid perishable food (*SN: 9/19/98, p. 181*).

Hummingbirds also seemed as if they'd benefit from such skill, says Hurly. They burn energy fast but can't store much fat and therefore need to eat often. The hearts of the rufous hummingbirds he studies beat 1,000 times a minute. The birds weigh only 3 grams.

To test the hummingbirds' memory, the researchers visited the birds' natural mountain territories. The team set out arrays of artificial flowers made from syringe tips surrounded by cardboard discs.

The researchers refilled half the syringes 10 minutes after a male drank the sugar solution, and the other half after 20 minutes. Even when keeping track of eight fake flowers, hummingbirds tended to visit the refilled flowers at appropriate intervals—about 10 minutes for quickly refilled flowers and 20 minutes for the slower refills. —S.M.

PLANETARY SCIENCE

Making Mercury

A theory about the early solar system suggests that Mercury arose when a giant asteroid struck a large planet 4.5 billion years ago, leaving behind what would become the solar system's innermost planet. New computer simulations indicate that some of the debris from the collision would have found its way to Earth and Venus. The simulations also account for Mercury's abundance of heavy elements.

Jonti Horner of the University of Bern in Switzerland and his colleagues found that the proposed asteroid collision would have ejected into space the lower-density, outer layers of the giant planet. Using simulations, the team then tracked the fate of the debris over several million years.

The findings reveal that the pressure exerted by sunlight would have scattered most of the ejected material before it had a chance to fall back to the planet. That would explain Mercury's high density, Horner says.

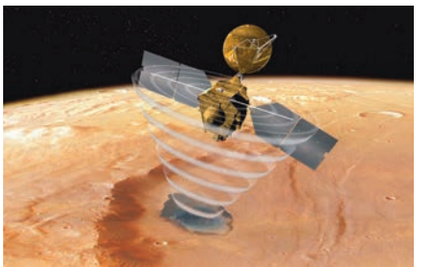
The simulation indicates that a small fraction—16 quadrillion tons—of the debris from Mercury, struck its neighbors Venus and Earth and bored into their interiors, he says.

Horner presented the findings at the Royal Astronomical Society's National Astronomy Meeting on April 5 in Leicester, England. —R.C.

PLANETARY SCIENCE

Another visitor to Mars

The newest emissary from Earth arrived at the Red Planet on March 10. The NASA craft, known as the Mars Reconnaissance Orbiter, joins three other satellites exploring the planet: two from NASA and one from the European Space Agency. Meanwhile, the twin rovers Spirit and Opportunity, more than 2 years after they landed, continue their treks along the Red Planet's surface.



RED PLANET EXPLORER The Mars Reconnaissance Orbiter depicted with its radar sensor deployed.

Using instruments ranging from radar sensors to gamma-ray detectors, Orbiter will explore the Martian atmosphere and surface and search for underground deposits of water. The craft's highest-resolution camera will discern features as small as a card table. Orbiter will also scope out sites suitable for future landing missions and act as a communications relay for other craft, radioing data to Earth at 10 times the rate of any previous Mars craft.

The new arrival is currently in a highly elongated orbit. Over the next 6 months, engineers will command Orbiter to dip into the Martian atmosphere some 500 times to slow the craft and ease it into the smaller, circular orbit required for the main mission, which will begin in November. —R.C.

NUTRITION

Breakfast trends

Breakfast contributes significantly—and positively—to the quality of U.S. diets, a new survey finds. On average, it offers just 17 percent of the day's calories but provides a quarter of the day's recommended intake of dairy foods, 28 percent of the day's recommended intake of fruit, 20 percent of recommended grains, and up to 30 percent of the recommended intake of most vitamins and minerals—independent of any dietary supplements taken in the morning.

However, the analysis shows, on any given day, one in five people forgoes this meal. About one-third of teens, 20-somethings, and blacks skip breakfast.

Ready-to-eat cereals, breads, and rolls top the breakfast list, with more than one in four people eating at least a serving of one of these on any given day. Milk was consumed by at least 40 percent of people surveyed. Coffee, the next-most-popular beverage, was downed by 44 percent of adults. Roughly 5 percent of U.S. residents, regardless of age, appear to get their morning pick-me-up another way—via soft drinks.

Kevin J. Kuczynski and his colleagues at the U.S. Department of Agriculture's Beltsville (Md.) Human Nutrition Research Center scoured through a day's worth of dietary data collected from more than 9,000 individuals in the What We Eat in America survey 4 or 5 years ago. Participants were selected to represent the U.S. population in terms of age, gender, race, and other demographic features. —J.R.

TOXICOLOGY

Do flame retardants make people fat?

Studies in recent years have found growing concentrations of certain brominated chemicals in the blood of people worldwide. Manufacturers use these substances widely as flame retardants in plastics and foams. Although the chemicals have caused neurological and developmental impairments in test animals, nobody had probed the flame retardants' effects on animals' body fat, which is where the chemicals accumulate. Now, scientists report that in rodents, the flame retardants provoke fat cell changes that appear to boost the risk of obesity and type 2 diabetes.

Andrea C. Arel of the University of New Hampshire in Durham and her colleagues worked with a mix of polybrominated diphenyl ethers (PBDEs) that was dominated by five-bromine—or penta—molecules. The group fed the mix to some just-weaned male rats in daily doses of 14 milligrams per kilogram of body weight. Other rats got a normal diet with none of the PBDE mixture. The researchers analyzed fat cells from half of the animals in each group after 2 weeks and from the other half after another 2 weeks.

Differences between bromine-treated and untreated animals emerged only at 4 weeks. The dosed animals' fat cells were mobilizing lipids 25 percent faster than were cells in the other rats. Increased fat circulation in the body is characteristic of obesity, notes team leader Gale Carey.

Fat cells from animals treated with PBDEs for 4 weeks also exhibited roughly 65 percent less glucose oxidation, a measure of blood sugar's ability to enter cells. Carey describes this change as a "crude measure of insulin resistance," which typically precedes development of type 2 diabetes.

When the researchers put the PBDE mixture in incubated colonies of fat cells from other mice, no similar changes occurred. "You need the whole animal to see the effects," Carey concludes. —J.R.

BIOCHEMISTRY

Alcohol spurs cancer growth

At least in mice, downing the human equivalent of two to four alcoholic drinks per day dramatically spurs the growth of an existing cancer.

Epidemiologic studies have shown that people who regularly drink alcohol face an increased risk of certain cancers, notably breast malignancies. Last year, researchers at the University of Mississippi Medical Center in Jackson showed that alcohol spurred the development of new blood vessels to feed bone cancer cells implanted in chick embryos (*SN: 1/15/05, p. 37*).

The same team, led by Wei Tan, has now stimulated cancer growth by giving alcohol to animals. The researchers implanted melanoma tumors in 6-week-old mice and then administered 1 percent alcohol as drinking water to some of the rodents. The animals drank as much as they wanted for 8 hours a day. Their resulting doses of alcohol remained well below those administered in other rodent-cancer studies, says Tan.

At the end of a month, tumors in animals drinking the spiked water were twice as large as those in mice getting plain drinking water, Tan reported. Microscopic investigation showed that the tumors in alcohol-drinking animals had also experienced far greater blood vessel growth, or angiogenesis, than did tumors in alcohol-free mice. Moreover, receptors for a protein that promotes angiogenesis were 40 percent more numerous in tumors from the alcohol-drinking rodents.

Tan's colleague Jian-Wei Gu says, "We're not against drinking." However, he says, for people with genetic signs of vulnerability to any kind of cancer, "our message is simple: 'No drinking.'" —J.R.

PHYSIOLOGY

Foodfree growth

Animals endure famine—some more successfully than others—by cannibalizing their own tissues. Rattlesnakes, among the champions, can survive more than 2 years between meals.

To understand how, evolutionary physiologist Marshall McCue of the University of Arkansas in Fayetteville starved 2-year-old rattlers for more than 5 months and measured changes in their bodies. To his surprise, he found that although the snakes continued to move about and even to grow, "they undergo an almost hibernation-like drop in metabolic rate." In this state, the snakes consumed just 20 percent as much oxygen as when they were well fed, says McCue.

After initially putting Western diamondbacks (*Crotalus atrox*) on a regular feeding regimen of one mouse every 2 weeks for 6 months, McCue suddenly gave them only water. He reports that the animals relied largely on stored fats to survive.

But the rattlers' bodies didn't treat all fats equally. The snakes preferentially burned medium-chain fatty acids, while conserving longer fatty acids. The snakes also appeared to derive some energy by desaturating—or removing hydrogen atoms from—their stored long-chain fatty acids. Rarely, McCue found, did the snakes break down muscle protein for energy as some other malnourished animals do.

Throughout the prolonged fast, the snakes slimmed down. "However, in the wild, we regularly see snakes much skinnier than these," McCue says. Most amazing: Despite going months without food, the snakes' bodies, excluding their rattles, actually lengthened by 2 to 3 centimeters. "This is significant," McCue notes, because it reflects growth comparable "to what might be experienced with normal feeding." —J.R.

Books

A selection of new and notable books of scientific interest

WHAT WE BELIEVE BUT CANNOT PROVE: Today's Leading Thinkers on Science in the Age of Certainty

JOHN BROCKMAN, ED.

Science is the incremental process of making hypotheses and then testing and retesting them until they're disproved or adequately accepted to be the foundation of further hypotheses. However, a lot of what is deemed certain about the universe and our place in it has its origin in leaps of faith, sudden intuitive connections, and even prophetic dreams, writes Brockman, who is president of a science-advocacy organization called the Edge Foundation. Guesswork and scientific revelation often go hand in hand, according to the editor. This book asks more than 100 leading scientists, "What do you believe but cannot prove?" Answers come from such luminaries as physicist and Nobel laureate Leon Lederman, evolutionary biologist and author Jared Diamond, physics professor Freeman Dyson, and psychologist Steven Pinker. The thought-provoking responses to Brockman's question offer a tantalizing glimpse into the future of human inquiry. ***Harper-Collins, 2006, 252 p., paperback, $13.95.***

THE ELECTRIC LIFE OF MICHAEL FARADAY

ALAN HIRSHFELD

Michael Faraday began his adult life as an impoverished bookbinder, but with innate curiosity. Hirshfeld describes Faraday's early career toiling ceaselessly in makeshift laboratories and his apprenticeship to Humphry Davy at England's Royal Institution. By his 40th birthday in 1831, Faraday had become famous as a result of his work in chemistry, electricity, and magnetism. He had published more than 60 scientific papers. By the end of that year, he discovered the phenomenon known as induction, the genesis of a current within a circuit under the influence of a magnetic field. The insight led to his inventions of the electric generator and electric motor, foundations of countless modern technologies. Faraday also speculated insightfully on the nature of light and space. Throughout the book, Hirshfeld uses Faraday's own words, from his extensive journal entries and letters, to flesh out the portrait of a successful yet humble 19th-century scientist. ***Walker & Co., 2006, 258 p., hardcover, $24.00.***

THE SCIENCE OF WINE: From Vine to Glass

JAMIE GOODE

Wine inspires passion and devotion. Many oenophiles say that the beverage captures the soul of the land on which its grapes were grown. Goode, a wine columnist and former scientific editor, seeks not to dissuade people from such romanticism but to add to it by acknowledging the important role that science and technology can play in influencing how wine tastes. The book that he has produced outlines the biology of *Vitis vinifera*, the species of grape responsible for all wine, and describes the numerous grape varieties that have developed through evolution and human intervention. He addresses the concept of *terroir*—the tastes and aromas imparted to a wine by its vines' location—how climate and soil chemistry shape wine, the implications of global warming on viticulture, the use of genetically modified vines, the role of chemicals such as sulfur dioxide in winemaking, and the importance of barrels. Finally, Goode examines the wine drinker: the role of smell in the perception of wine's flavor, allergies and aversions to wine, and some of the drink's health benefits. ***Univ. Cal. Press, 2006, 216 p., b&w photos, hardcover, $34.95.***

BEFORE THE DAWN: Recovering the Lost History of Our Ancestors

NICHOLAS WADE

Much is known about the physical evolution of humans from their divergence from chimps 5 million years ago to the emergence of modern people 50,000 years ago. But scientists still have scant clues about how men and women lived during much of that time. Wade, a science writer for the New York Times, reports that genes provide clues to the development of such human traits as language use, communal living, and cognitive functioning. Homo sapiens shifted from foraging to tending crops and animals. Signs of the transformation lie in genes acquired at that time for digesting cow's milk and tolerating cold weather. Genetics also explains, in part, bonding between a man and a woman, the emergence of racial differences, and the human propensity for warfare, writes Wade. In a book certain to be controversial, the author has synthesized much of the science that attempts to explain how modern people became human. ***Penguin, 2006, 320 p., hardcover, $24.95.***

SOMETHING OUT OF NOTHING: Marie Curie and Radium

CARLA KILLOUGH MCCLAFFERTY

Through her remarkable achievements in the male-dominated field of the physical sciences, Marie Curie opened the door for a legion of other women. As a codiscoverer of radium, she was awarded a Nobel prize in 1903, the first woman to receive the honor. In this easy-to-read biography, young readers are given a glimpse into Curie's life and work. She grew up poor in Russia-controlled Poland, where she developed a fierce sense of national pride and identity. McClafferty explains how Curie transformed herself from a teacher and governess into one of the most important scientists of her time. The author details Curie's education in France and her marriage to Pierre Curie, who received the Nobel prize with her. The Curies began researching radioactive elements after Henri Becquerel discovered, by chance, radioactive uranium. Though their discovery of glowing radium, with all its commercial potential, could have made them rich, the Curies eschewed patents and made their methods available to anyone who might need them. For readers age 10-12. ***Farrar, Straus, and Giroux, 2006, 144 p., b&w photos, hardcover, $18.00.***

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.

LETTERS

Light shift

Regarding "Blasts from the Past: Astronomers begin to go the distance with gamma-ray bursts" (*SN: 2/11/06, p. 88*), why is it that visible light is shifted to lower frequencies but gamma rays aren't? Shouldn't they have become X rays after all that distance?

STEPHEN WOOD, ORLANDO, FLA.

All wavelengths are redshifted. That means that high-energy gamma rays beyond a detector's energy range would get shifted into the detectable range by cosmic expansion, while slower-energy gamma rays would get shifted to below the detector's range. —R. COWEN

Sizzle or fizzle?

There are several problems with the popular-press interpretation of the study described in "Low-Fat Diet Falls Short: It's not enough to stop cancers, heart disease" (*SN: 2/11/06, p. 85*). The study saw a reduction to only 29 percent of calories from fat, which is still far above the 20 percent-or-less advocated by dietary and cardiovascular experts. Also, no one in the field of heart disease prevention would advocate solely reducing fat intake. For instance, salt intake needs to be reduced, exercise needs to be added, stress should be avoided, and diets should include more fruits and vegetables and less red meat and simple carbohydrates.

GLENN M. GUNGEL, FORRESTON, ILL.

Science takes another big hit from the results of the new low-fat study. What is troubling is the number of people whose behavior was affected by an earlier study's faulty conclusions. Nonscientists are becoming increasingly cynical about scientific research. The fields of nutrition, medicine, and environmental studies appear to be particularly vulnerable to this problem. We scientists need to spend a little more time and some intelligent design in policing ourselves to ensure that our credibility is preserved.

JAMES SEESER, ST. LOUIS, MO.

Corrections *"Ancient Andean Maize Makers: Finds push back farming, trade in highland Peru" (*SN: 3/4/06, p. 132*) miscalculated when the Inca civilization arose, which was nearly 1,000 years ago. "That's One Weird Tooth" (*SN: 3/25/06, p. 186*) should have attributed the pictures on the cover and pages 186 and 188 to Glenn Williams. Also, the picture on page 186 was flipped, making the narwhal's tusk appear to be its right tooth.*

SO MANY GREAT TOPICS, ONE GREAT SCIENCE WEEKLY

EARTH SCIENCE • ANTHROPOLOGY •
COSMOLOGY • SEISMOLOGY •
ENVIRONMENT • PLANETARY SCIENCE •
BIOMEDICINE • BEHAVIOR • ARCHAEOLOGY •
PHYSICS • ASTRONOMY • BIOTECHNOLOGY •
OCEANOGRAPHY • GENETICS • TECHNOLOGY •
NANOTECHNOLOGY • ZOOLOGY •
INFECTIOUS DISEASES • CHEMISTRY •
MATERIALS SCIENCE • PALEONTOLOGY •
SCIENCE AND SOCIETY • ASTROPHYSICS •
BIOLOGY • FOOD AND NUTRITION •
PHARMACOLOGY • CELL BIOLOGY •
AGRICULTURE • MICROBIOLOGY •
ENDOCRINOLOGY • NEUROSCIENCE •
IMMUNOLOGY • PSYCHOLOGY •
MATHEMATICS • EPIDEMIOLOGY •

Science News is designed for people on the go. In about an hour's reading time, ***Science News*** provides a reliable account of the week's news.

SPECIAL SAVINGS!

A 1-year subscription to *Science News* is $54.50. Each additional subscription that you order is only $49. **You may include your own renewal or new subscriptions at this money-saving rate.**

SEND GIFT ORDERS NOW!

For fastest service, call
1-800-552-4412
or visit our web site at
www.sciencenews.org