SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

AUGUST 25, 2007 PAGES 113-128 VOL. 172, NO. 8

alternative fuel alternatives

shrink gut, extend life

birds bothered by blare

counting photons

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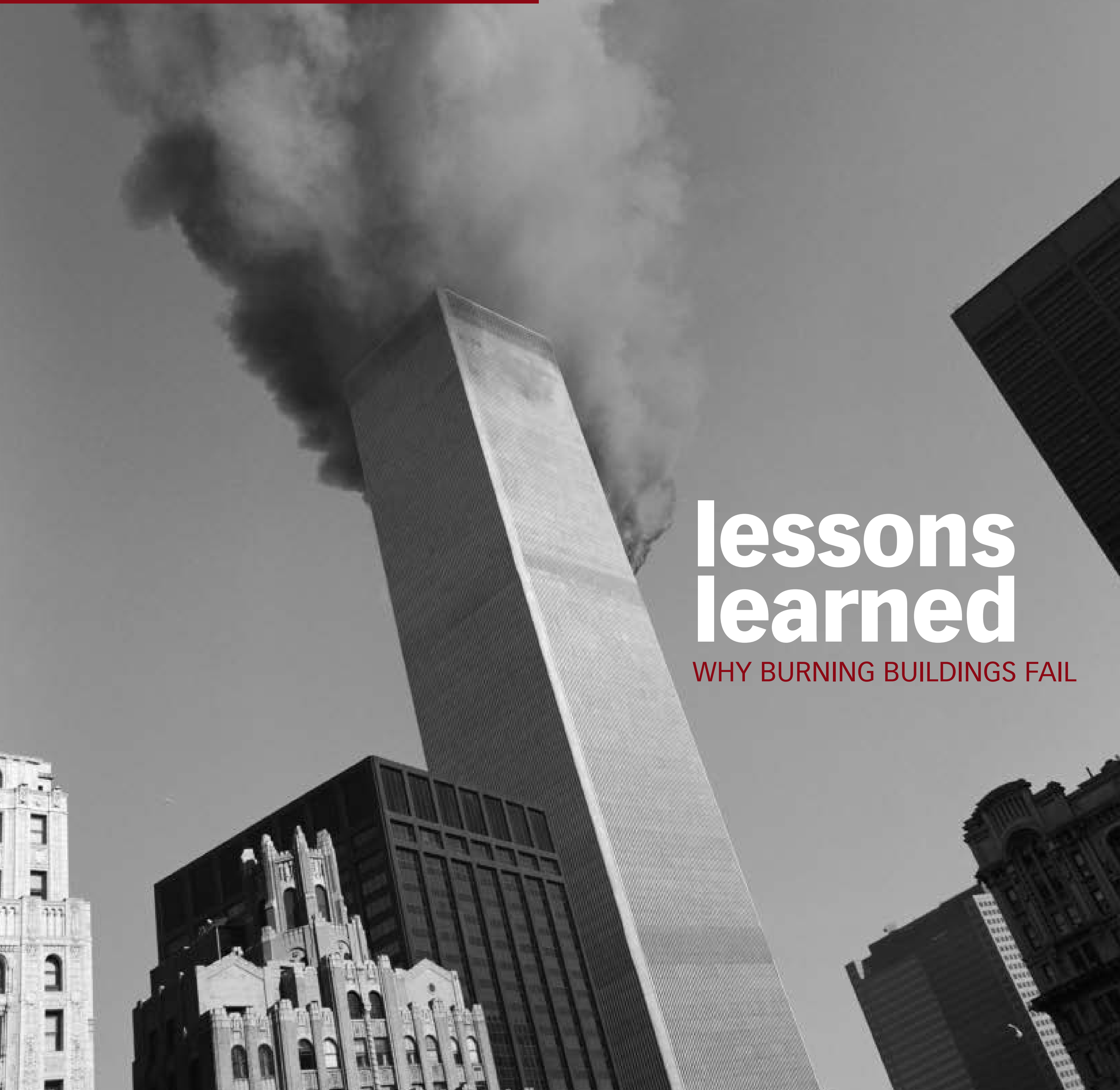

lessons learned

WHY BURNING BUILDINGS FAIL

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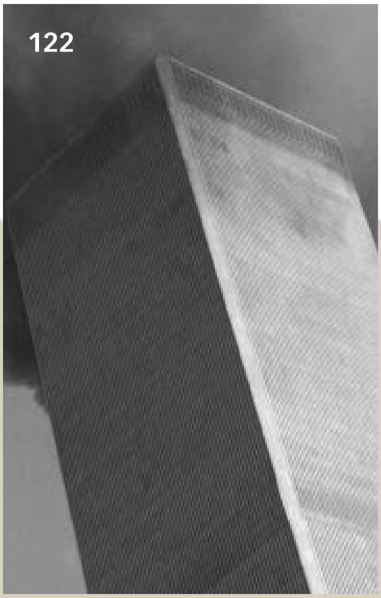
Features



This Week

THIS WEEK ONLINE
http://blog.sciencenews.org/

Food for Thought Called soda or pop, it delivers more caffeine than one might expect—and here are brand-by-brand comparisons.

MathTrek Defending computers against worms that can mutate requires new strategies.

Of Note

Departments

Cover The events of Sept. 11, 2001, drew attention to the devastating structural effects that fire can have on buildings. Since then, engineers have been melding structural-design and fire-protection principles to build safer structures. (Corbis) Page 122

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LETTERS editors@sciencenews.org

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SCIENCE NEWS This Week

If You Can Stomach It

Obesity surgery extends life span

Stomach surgery to curb the appetite offers a radical weight-loss option for extremely obese people. Two studies now show that those who get the surgery live longer than those who don't. The research may put to rest lingering doubts about survival after these operations.

Surgeons have developed three forms of stomach surgery aimed at limiting food intake. After these so-called bariatric surgeries, a person feels full after eating even a small amount of food.

Two of the surgeries work by constricting the stomach with elastic bands or staples. A third, called gastric-bypass surgery, reconfigures the gastrointestinal tract so that food collects at the top of the stomach and is then shunted to the small intestine. This is now by far the most common form of bariatric surgery in the United States, where stapling has largely fallen out of use. Gastric bypass typically produces better results than the other operations.

The surgeries induce weight loss with a much lower relapse rate than dieting. Historically, however, epidemiological studies have linked rapid weight loss and early death. Since sudden weight loss can be unintentional, scientists have suspected that hidden ailments may account for this link.

In 1987, researchers in Sweden enrolled 4,047 severely obese people in a study intended to clarify the matter. Half the volunteers underwent one of the three bariatric surgeries. The others received counseling, behavior modification, or no treatment. The surgical group lost much more weight.

What's more, people getting the surgery were 29 percent less likely than the others to die over the next 11 years, the researchers report in the Aug. 23 *New England Journal of Medicine*.

In the same journal issue, a U.S. team reports a study of 15,950 severely obese people, half of whom had undergone gastric-bypass surgery starting as early as 1984. People who had the surgery had a 40 percent lower death rate during 7 years of comparison than did nonsurgical patients.

The researchers found that the better survival rate stemmed from lower rates of heart disease, cancer, and other serious illnesses in people who had surgery. On the other hand, people in that group were more prone to die from accidents, suicide, or poisoning than were nonsurgical patients, says study coauthor Ted D. Adams, a physiologist at the University of Utah in Salt Lake City.

Bariatric-surgery patients also face an increased risk of death from complications for a short time after their procedures. However, that temporary risk has declined with the advent of laparoscopic surgery, which is done through small openings in the abdomen, says internist Lars Sjöström of Gothenburg University, who coauthored the Swedish study.

Surgeon David R. Flum of the University of Washington in Seattle says that past research had shown that people's blood pressures decline after the procedures and that some type 2 diabetes patients subsequently need less medication. The two new studies show "that if you have surgery and significant weight loss that's sustained, it will translate into improved survival," says Flum.

Endocrinologist George A. Bray of Louisiana State University in Baton Rouge says that the new results might justify expanding the pool of candidates for bariatric surgery. —N. SEPPA

AP PHOTO/DAILY REFLECTOR, RHETT BUTLER

TELETUMMY Physicians and their assistants at Pitt Memorial Hospital in Greenville, N.C., perform a gastric-bypass procedure, shown on a video monitor. Two studies now confirm that such surgery prolongs the lives of severely obese people.

Infectious Obesity

Adenovirus fattens stem cells

Twenty-five years ago, researchers discovered that certain viruses can cause obesity in some animals. A decade ago, they extended the finding to people. Now, a team reports that one such virus works by transforming adult stem cells into fat-storing cells. The finding supports the notion that some cases of obesity may be infectious.

Magdalena Pasarica of Louisiana State University in Baton Rouge, who led the new work, stresses that obesity has many causes, including genetic factors, overeating, and a sedentary lifestyle. In some people, however, adenovirus-36 may be the culprit, she says. Adenoviruses cause colds, but adenovirus-36, apparently, does more.

In a 2005 study of 502 obese and normal-weight people, researchers reported that 30 percent of the obese group showed signs of previous adenovirus-36 infection, while only 11 percent of the lean group did.

In earlier laboratory tests, the virus made chickens, rodents, and monkeys fat, says Richard Atkinson, now president of Obetech in Richmond, Va., who led some of that work.

But how the virus might be raising obesity risk remained a mystery. To solve it, Pasarica and her colleagues collected adult stem cells from fat removed from patients during liposuction. These cells sometimes grow into adipocytes, or fat-storing cells, but can also transform into bone and cartilage.

Pasarica's team grew the stem cells in lab dishes and infected half the dishes with adenovirus-36. Most infected cells quickly transformed into adipocytes, but most of the others did not. "The difference was really big," Pasarica says. "Of the uninfected cells, just a few became fat cells. Whereas, with [the infected cells], the majority of them became fat cells." When grown on standard culture media, the adipocytes rapidly accumulated fats.

Pasarica then infected some stem cells with the virus and exposed them to a formula that usually transforms stem cells into bone. The infected cells became fat instead. "That's how we showed the virus is inducing this change at the stem cell level," says Pasarica. She presented the research this week at the American Chemical Society meeting in Boston.

Atkinson, whose company sells a test that shows whether a person has been exposed to adenovirus-36, says that the new work "closes the loops" on the earlier data. "It's the closest you can come to proving this virus makes people fat without actually infecting people," he says.

Atkinson cautions that the revelation that obesity is infectious "doesn't mean you should avoid your fat friend," because the active infectious phase lasts only a few weeks. During this time, though, the virus apparently induces long-term changes in how stem cells develop, which slowly enlarge the unlucky viral victim.

In hope of finding early treatments, Pasarica and her colleagues are now trying to track down exactly how the virus performs its cellular-fattening trick. —B. VASTAG

High Volume, Low Fidelity

Birds are less faithful as sounds blare

EH, WHAT? A female zebra finch (left) normally prefers her established mate (middle) to another male (right)—except in noisy places.

Female zebra finches, normally devoted to their mates, are more likely to flirt with male strangers when background noise goes up, say researchers.

A test with finches in a lab found that white noise with the loudness of heavy traffic virtually wipes out female loyalty to established mates, says John P. Swaddle of the College of William and Mary in Williamsburg, Va. Yet those same females strongly prefer their mates when tested in a hushed room.

"This is a new way of thinking about the consequences of noise pollution," says Swaddle.

Previous research had raised concerns that noise pollution can stress animals, and some studies found that birds change their songs' frequencies (*SN: 7/19/03, p. 37*) or timing, as if trying to make themselves heard above the urban cacophony. Direct evidence that human-generated noise can change important things like the number of young fledged "is still lacking," cautions Hans Slabbekoorn of Leiden University in the Netherlands. He says that he's planning research into that question.

Swaddle says that he was investigating another finch habit when he noticed female zebra finches losing interest in video images of their mates. He wondered whether the anomaly had something to do with the white noise coming from the video monitor.

To test noise effects, he and William and Mary undergraduate Laura Page worked with 20 pairs of zebra finches that had each spent at least 4 months as a couple. Researchers put each female in a private cage and offered her two males that she could flirt with through the bars. One was her mate, and the other was a stranger.

The researchers observed each combination of birds during test sessions with different background noises. For the quietest test, the researchers let the building's air conditioner hum. It provided about 45 decibels of sound at the birdcage. For the loudest, they played a white noise CD that blared 90 dB of sound at the birds. Bursts of city noises or the racket in lab aviaries can exceed that level, says Swaddle, as can certain natural sounds, such as cicada choruses, in the birds' home range.

The lab noise didn't seem to upset the established pairs greatly, since they courted with enthusiasm, Swaddle says. When up against loud noises, however, a female was as likely to prefer a stranger as her mate, he and Page report online and in an upcoming *Animal Behaviour*.

Swaddle says he needs to do more testing to figure out why this happens. He notes that males perform more of their stylized courtship hops when around unfamiliar females than around their mates. If noise jams vocal communication, the extra display might win attention, Swaddle speculates.

Regardless of why they happen, increasing extrapair matings could alter a population's evolutionary trajectory, he says.

Extrapair encounters intensify the pressures of sexual selection, which favors enhancement of sexy traits. That enhancement can sap resources normally devoted to other activities.

"Many of the effects [of noisy environments] may initially seem subtle," says Richard Fuller of the University of Sheffield in England. Still, they "could have profound genetic and evolutionary consequences." —S. MILIUS

Groomed for Trouble

Mice yield obsessive-compulsive insights

Neuroscientist Guoping Feng and his colleagues had a simple plan. They would breed mice lacking a particular gene in order to probe the brain effects of the protein produced by that gene. To the scientists' surprise, they found that these gene-deprived animals provide a rudimentary rodent model of obsessive-compulsive disorder (OCD), a poorly understood psychiatric ailment that affects nearly 1 in 50 people.

The team, primarily from Duke University Medical Center in Durham, N.C., reports that mice missing this gene appear to be fine for their first 4 to 6 months. Then they begin to groom themselves excessively, which results in hair loss and skin injuries. They also display heightened anxiety. Compared with genetically intact mice, the gene-deprived animals are slower to enter and quicker to exit risky settings, such as open spaces.

The targeted gene makes a protein known as SAPAP3, which fosters brain-cell communication via the chemical messenger glutamate, especially in the striatum, a structure near the top of the brain stem. The striatum coordinates physical actions and guides the planning and control of behavior.

Further study of the gene for SAPAP3 and related genes in mice and people may

SWADDLE

lead to new drug treatments for OCD, Feng's team reports in the Aug. 23 *Nature*.

"We obviously cannot talk to mice to find out what they are thinking, but these mutant mice clearly did things that looked like OCD," Feng says.

The disease is characterized by unwanted intrusive thoughts that generate intense worry and result in repetitive behaviors aimed at quelling anxiety. Sufferers may wash their hands for hours every day for fear of becoming contaminated by germs or repeatedly check that doors are locked.

Prior studies of OCD have implicated disturbed communication among three areas of the brain: the thalamus, which relays sensory signals; the frontal cortex, which controls thoughts and behavior; and the striatum. Causes of this communication breakdown were unclear.

Video surveillance confirmed that mice without the gene for SAPAP3 slept fitfully and caused their own skin injuries by excessively grooming themselves. Administration of fluoxetine (Prozac) to the mutant mice for 6 days generally decreased excessive grooming, aided sleep, and eased signs of anxiety.

Doctors often prescribe Prozac and related medications for OCD. These drugs target the neurotransmitter serotonin and alleviate symptoms in about half of OCD patients, suggesting to Feng that various neurotransmitters contribute to the disorder.

Feng's analyses of neural tissue from mutant mice indicate that the lack of SAPAP3 suppresses activity in the striatum usually triggered by glutamate, and that this cutback stunts connections between the striatum and the cortex.

When the scientists injected the striata of 7-day-old mutant mice with a substance containing the gene for SAPAP3, the animals didn't develop grooming abnormalities or anxiety.

Feng's team provides an urgently needed model of OCD, remarks neuroscientist Ann M. Graybiel of the Massachusetts Institute of Technology. It remains unclear why deleting the gene for SAPAP3 produced only excessive grooming and anxiety, because brain circuits that include the striatum underlie a broad range of behaviors, Graybiel says. —B. BOWER

Separation Anxiety

Cosmic collision may shed light on dark matter

M. WEISS/CXC, NASA

Some 3 billion years ago, two massive clusters of galaxies collided head on. The debris from this ancient cosmic train wreck, astronomers say, might pose a new puzzle about the invisible material believed to account for most of the mass in the universe.

ILLUMINATION NEEDED **Illustration of the galaxy cluster Abell 520, in which dark matter (blue), hot gas (red), and galaxies (yellow and orange) might have gone their separate ways.**

A variety of evidence indicates that this material, known as dark matter, is about eight times as abundant as ordinary matter and that it resides in vast, invisible halos around star-filled galaxies. Dark matter keeps galaxies and galaxy clusters intact, theorists say.

The leading model for dark matter suggests that it interacts only through gravity and can't be pushed around by the strong, the weak, or electromagnetic forces. That picture gained support last year from observations of a collection of galaxies called the Bullet cluster, which had been distorted by a collision with another cluster. Astronomers inferred that the location of dark matter coincided with the cluster's visible horde of galaxies, while the hot, X-ray–emitting gas associated with the cluster lay to one side (*SN: 8/26/06, p. 131*).

That distribution of dark matter makes sense because colliding gas clouds interact both by gravity and the electromagnetic force and can slow each other down, while dark matter and galaxies would breeze along unimpeded and remain together.

That's why new X-ray and visible-light observations of the cluster Abell 520 stunned Andisheh Mahdavi of the University of Victoria in British Columbia and his colleagues. The cluster, about 2.5 billion light-years from Earth, had also suffered a major collision.

In the Oct. 20 *Astrophysical Journal*, the team reports that Abell 520 contains concentrations of dark matter and galaxies that are separate from each other.

"The Bullet cluster was a spectacular result, because it beautifully confirmed our assumptions about how dark matter, gas, and galaxies behave, [but] Abell 520 does the complete opposite," comments Julianne Dalcanton of the University of Washington in Seattle.

One explanation for the new results is that dark matter is composed of particles that interact through forces other than gravity. However, such particles would cause a variety of other effects that have never been seen, such as making galaxy clusters spherical, notes Katherine Freese of the University of Michigan in Ann Arbor. Without further evidence, theorists seem loath to reject the standard take on dark matter.

The standard view could prevail if galaxies had been ejected from the core of Abell 520. That might have occurred if the cluster had suffered more than one collision, Mahdavi says.

It's also possible that Mahdavi's team, along with two other groups also using ground-based telescopes, didn't have data precise enough to correctly map the dark matter in Abell 520. To map dark matter, researchers measure the distortion of images of background galaxies whose light passes through the cluster on its way to Earth. That's a tricky business, because galaxies are naturally elongated, notes Douglas Clowe of Ohio University in Athens, who used the sharper eye of the Hubble Space Telescope to examine the Bullet cluster.

In their own ground-based study, Clowe and his collaborators don't find a significant separation between dark matter and galaxies in Abell 520, Clowe told *Science News*. That's in accord with the results of another team, which reported its results earlier this year online (*http://xxx.lanl.gov/abs/astro-ph/0702649*).

Upcoming observations of Abell 520 with Hubble should indicate whether dark matter theory really has to be reassessed or if researchers are merely arguing about noisy data, says Clowe. —R. COWEN

Crueltyfree

Counting photons without killing them

Disclaimer: No particles were harmed in the making of this experiment. Physicists have found a way to count photons as they zip along, without destroying them. The researchers say that the technique will enable scientists to probe quantum effects that so far have been the subject only of speculation.

In physics labs, detecting light has long been synonymous with absorbing photons.

Typically, the photons cease to exist and the light's energy transforms into an electrical signal. Physicists can count single photons—but they haven't been able to count them and keep them.

"Up to now, when you measure light, it's a destructive process," says Serge Haroche of the École Normale Supérieure of Paris. Now, Haroche and his colleagues have shown how to count photons nondestructively while they bounce back and forth between two mirrors.

Haroche's team began by introducing small numbers of photons into the space between two niobium-coated screens. Kept at less than 1 kelvin, the niobium became superconducting, which made the screens into virtually perfect mirrors. The photons could bounce back and forth up to a billion times, lingering inside their hall of mirrors for more than a tenth of a second.

The team then shot rubidium atoms one by one across the photons' path. The atoms were in a highly excited state in which their electrons were especially sensitive to the photons' electric fields. The electrons responded with a shift in the timing of their orbits, essentially acting as the hands of microscopic clocks. The amount of shift was proportional to the number of photons between the two mirrors.

Quantum uncertainty dictates that the number of photons could not be well defined at the start of the experiment. Measuring the influence of the photons on a single rubidium atom yielded only incomplete information about the number of photons. But after the researchers had shot about 100 atoms through the chamber—gaining information and reducing uncertainty at each step—the number of photons converged to a definite value. Subsequent measurements confirmed that count. So far, the team has managed to count up to seven photons, Haroche says.

While the photons didn't die, their lives would never be the same. In any experiment, measuring one physical quantity with increasing precision leads to increased fuzziness in a related quantity. In this case, obtaining a precise count of the photons came at the expense of losing knowledge about the relative timing, or phase, of the photons' wavelike fluctuations. The findings appear in the Aug. 23 *Nature*.

David Hume of the National Institute of Standards and Technology in Boulder, Colo., says that the results are "an elegant demonstration of the measurement process in quantum mechanics."

The experiment highlights a little-known aspect of quantum physics: When quantities go from a fuzzy state to one with a precise value, the transition can take place in small increments. In that way, measurements can extract partial information (*SN: 5/12/07, p. 292*). Haroche says that his team's setup could be a means for testing new quantum phenomena in which photons occupy multiple states simultaneously. "Quantum physics textbooks are illustrated by thought experiments," Haroche says. "Now we are doing those experiments." —D. CASTELVECCHI

O River Deltas, Where Art Thou?

Coastal sinking stalls sediment accumulation

Gradual subsidence of terrain along the western coast of Siberia since the end of the last ice age has thwarted the formation of river deltas there, a new study suggests.

When large rivers reach the sea, they slow and drop much of their sediment. As the material accumulates on the seabed, it diverts the river along other paths where it then deposits more sediment, and a classic river delta forms. Many of today's deltas began growing about 8,500 years ago, when global sea level stabilized after the last ice age ended, says Glenn A. Milne, a geophysicist at the University of Durham in England.

But large river deltas are conspicuously absent from the Arctic coast of western Siberia, says Milne. For instance, the Ob and Yenisei Rivers each carry as much water as the Mississippi does, but they meet the sea in shallow estuaries that are hundreds of kilometers long.

In contrast, the Lena River of eastern Siberia, also about the size of the Mississippi, sports a 32,000-square-kilometer delta—the largest in the Arctic, says Milne. Over the past few millennia, the eastern portion of the Lena's delta has grown seaward by as much as 200 km.

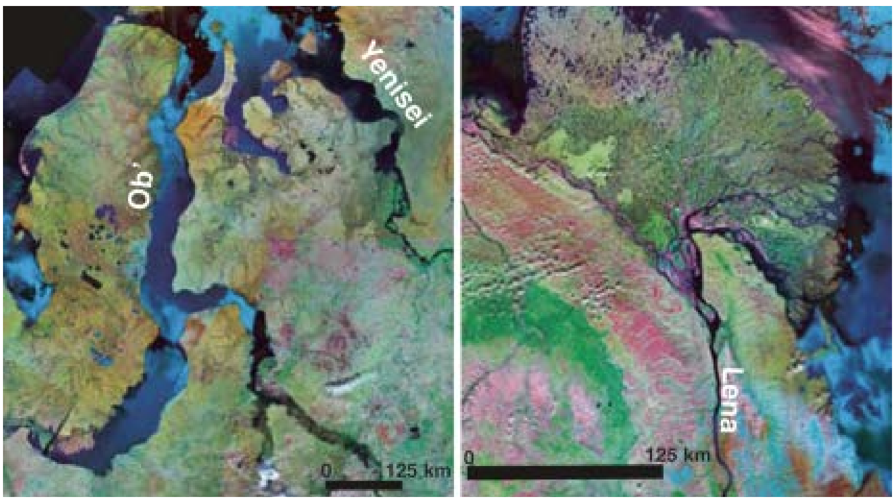
The Ob, Yenisei, and Lena each carry roughly the same amount of sediment, says Milne. Also, there are no climate differences between eastern and western Siberia that can account for the absence or presence of deltas, he adds. In the August *Geology*, he and his colleagues propose a new explanation for why the rivers of western Siberia lack large deltas.

During the last ice age, a broad, kilometers-thick ice sheet smothered northern Europe. The weight of that ice depressed the terrain, squeezing outward some of the underlying mantle. That in turn caused the landscape in icefree regions thousands of kilometers away to bulge upward, Milne explains. When the ice sheet melted, the ring of bulging terrain that had surrounded it—a ring that passed through the western coast of Siberia—began to subside.

The team's computer simulations suggest that eastern Siberia stopped subsiding about 3,000 years ago, allowing river deltas to accumulate there. In western Siberia, however, the terrain is still sinking about 1 millimeter each year, faster than the river sediment can accumulate to form a delta.

"This is a very elegant study," says Torbjörn Törnqvist, a geologist at Tulane University in New Orleans. "A lot of people don't really think about these issues very much."

The findings are a dramatic demonstration that subtle, ongoing changes in terrain resulting from the end of the ice age thousands of years ago can produce a dramatic effect today, says Jerry X. Mitrovica, a geophysicist at the University of Toronto. A similar effect may explain why many rivers in eastern North America haven't formed deltas, he adds. —S. PERKINS



NASA/LANDSAT

SINKING FEELING **Continuing subsidence in western Siberia has prevented rivers there from forming deltas (left), unlike those in eastern Siberia (right), where the landscape is stable.**

CELLULOSE DREAMS

The search for new means and materials for making ethanol

BY CORINNA WU

Alternative energy is hitting the headlines. Last year, former Vice President Al Gore scored a surprise hit with his climate-change documentary *An Inconvenient Truth*. Currently, drivers are steeling themselves against gasoline prices that could shoot well past $3 per gallon. The war in Iraq continues to draw attention to the United States' dependence on imported oil and has prompted calls for a shift toward domestic sources of fuel.

More and more, policy makers are touting a homegrown solution—literally—to the nation's energy and global warming problems: ethanol made from plants. Mixing ethanol into gasoline reduces overall greenhouse-gas emissions from vehicles because plants recycle carbon: The fuel that they yield produces carbon dioxide, just as fossil fuels do, but the plants consume carbon as they grow. And because ethanol molecules contain oxygen, their presence makes gasoline burn more completely, reducing carbon monoxide and other harmful tailpipe emissions.

WASTE NOT — Cornstalks, gathered and baled here in a Nebraska field after harvest, can serve as a high-cellulose feedstock for making ethanol.

W. WILHELM/USDA

Ethanol figures significantly in the Bush Administration's promotion of biofuel. Currently, the United States produces about 6 billion gallons of ethanol annually, mostly from corn. The President's Twenty in Ten initiative sets a goal to reduce gasoline usage by 20 percent in 10 years—in part by increasing the production of renewable fuels to 35 billion gallons per year by 2017.

But to reach that goal, corn alone won't do. Researchers are looking to trees, grasses, and waste organic matter as possible raw materials for ethanol production. The basic idea is to extract the cellulose locked up in plants' cell walls, break it down into its component sugars, and ferment those sugars into ethanol.

In February, the Department of Energy (DOE) announced that it would spend up to $385 million over the next 4 years to work with commercial partners on six ethanol pilot plants. Then in June, DOE granted $375 million to fund three new Bioenergy Research Centers to develop technology for cellulosic ethanol and other biofuels.

"I equate what we're doing to society saying, 'We're going to the moon,' or 'We're going to sequence the human genome,'" says Tim Donohue, a bacteriologist at the University of Wisconsin–Madison. "To me, this is a critically grand scientific mission that we're just setting off on today."

BILLION-TON VISION People figured out long ago how to make alcohol from grains, and now a similar process is used to turn corn into ethanol for fuel. First, corn kernels are ground into a coarse flour and combined with water and the enzymes alpha-amylase and glucoamylase, which convert starch into sugar.

After this mash is cooked and sterilized—to destroy the two amylase enzymes—yeast is added to ferment the sugars into ethanol. The final step, distillation, separates the ethanol from water, solids, and other chemical products of fermentation.

Corn sugar is almost entirely glucose, which yeast readily ferments into ethanol, Donohue says. But because corn is a foodstuff for people and animals, diverting large amounts of it into ethanol production could push up prices and even cause shortages. That's why plants that aren't currently used in other ways are attractive alternatives to corn.

In 2005, the Oak Ridge National Laboratory in Tennessee issued a report for the Departments of Energy and Agriculture estimating that the United States could produce 1.3 billion tons of plant matter that, if turned into ethanol, could fill more than 30 percent of the nation's petroleum needs. Agricultural waste forms a large part of that estimate.

But in order to reach that ambitious billion-ton goal without impinging on food supplies, high-cellulose crops, such as poplar, switchgrass, and wheatgrass, must also be grown specifically for ethanol production. All three plants are relatively undomesticated, so there's plenty of opportunity for breeding them to improve their value as cellulose sources, says Brian Davison of the Oak Ridge lab.

The nagging problem with these plants and others is that the cellulose in their cell walls is hard to get out, a problem that researchers call "recalcitrance of biomass."

"Nature developed plants so they're not easily degraded," says Martin Keller, also at Oak Ridge. The rigid cell wall has a complex structure built from three polymers: cellulose, hemicellulose, and lignin. Cellulose consists of long chains of glucose molecules (simple sugars with six carbon atoms) organized into tiny fibers. These fibers form a scaffold that supports hemicellulose, a polymer composed mostly of xylose (simple sugars with five carbon atoms). Lignin is a compound of various polymers that gives the plant strength and rigidity, but how it links with cellulose and hemicellulose is not well understood.

Current ethanol-making strategies require a number of difficult steps to dismantle a cell wall. Treatment with heat, pressure, or acids first removes hemicellulose and lignin from the long cellulose fibers. The cellulose and hemicellulose are then separately processed into ethanol, though doing so is challenging. The cellulose fibers don't dissolve well in water, making it difficult for the amylase enzymes to access the cellulose and break it down into glucose. Microbes are used to break hemicellulose into its component sugars and ferment them, but they produce a lot of by-products and not much ethanol.

Finding a way to process cellulose and hemicellulose together would make the process simpler and cheaper. Researchers are also looking to genetically modify plants to produce softer types of lignin or cellulose, making their cell walls easier to break down. The poplar tree's genome was sequenced last year, for example, so researchers could begin identifying genes important for cell wall synthesis.

MISSION: BIOFUELS Efficient and environmentally sound production of cellulosic ethanol is foremost in the minds of researchers involved with DOE's three newly funded Bioenergy Research Centers. "The centers provide a mechanism and a platform for coordinated activities between people in the plant sciences, the processing of plant materials, and the microbiology and chemistry of converting plant sugars into a variety of different types of fuels," says Donohue, principal investigator for one of the three consortia, the Great Lakes Bioenergy Research Center, based in Wisconsin. "And they provide a way to think about how we develop these new practices in an economically viable and environmentally sustainable manner."

Scientists at the second Bioenergy Research Center, headquartered at Oak Ridge National Laboratory, are focusing on poplar and switchgrass. Keller, director of the center, highlights the need to find new enzymes to break down the cell walls of these plants. The two amylase enzymes work well for extracting glucose from corn, but for other feedstocks, he says, "I predict we'll need to develop a whole suite of enzymes."

FROM GRASS TO GAS — Switchgrass, a wide-ranging perennial, is harvested from a University of Tennessee test plot for studies of its value for biofuel production.

OAK RIDGE NATIONAL LAB/DOE

As to where such enzymes might be found, ethanol researchers like to point out that when a tree falls in the forest, it doesn't stay around forever—it rots. The microbes growing on that tree must contain enzymes that can chew through the cellulose in wood. Identifying the microbes, however, might require development of new laboratory techniques. For example, if the microbes grow on wood particles but aren't soluble in water, they can't simply be grown in a water-based nutrient solution, as most cultured cells can, Keller says.

Researchers at the Great Lakes center are bioprospecting for useful enzymes in bacteria, fungi, and other microbes. In addition, they hope to engineer yeast and bacteria that can ferment xylose as well as glucose and that can tolerate high ethanol concentrations. Microbes could also be engineered to make other products such as hydrogen, biodiesel, and chemical precursors for various industrial processes.

Keller sees promise in getting a single organism to do all the degradation and fermentation without the need for extra enzymes—an approach called consolidated bioprocessing. Lee Lynd, a biochemical engineer at Dartmouth College in Hanover, N.H., won the 2007 Lemelson–Massachusetts Institute of Technology Award for Sustainability for his work on engineering *Clostridium thermocellum* bacteria to break down biomass and ferment the resulting sugars into ethanol. The bacterium naturally degrades cellulose and survives the high temperatures typical of industrial fermentation.

At the third center, the Joint Bioenergy Institute in Berkeley, Calif., chief executive officer Jay Keasling has a different point of view on alternatives to gasoline and diesel fuel. He says he's not fond of ethanol because of its low energy density—the modest amount of energy that 1 kilogram of the fuel yields.

He says that his focus is on generating "biogasoline" from plant matter. His group is attempting to engineer microbes to turn cellulose into hydrocarbons that can go directly into a gas tank without the need for mixing in petroleum.

ETHANOL, ENVIRONMENT The success of cellulosic ethanol as a fuel depends on whether experimental processing methods can be scaled up in an economically sound way. Because it's risky to try these technologies on a large scale, DOE is sharing the cost with industry, according to Davison. The six biorefineries funded in February represent a "great survey of the technology available now," he says, adding that he's "confident that more than half of these biorefineries will work." The pilot plants are being built by six companies across the United States. Some will focus on feedstocks grown specifically for energy, such as switchgrass, while others will use agricultural waste.

Still, many questions remain about the long-term practicality and environmental value of large-scale ethanol production. "Can it be produced efficiently and economically?" Davison wonders. "Can we produce enough plant matter to make a substantial impact? Then, can we do it sustainably?" He's confident about answers to the first and second questions, he says, but not so confident about the third.

A sustainable crop, he says, can ideally be grown on the same land for 100 years with no inputs—that is, no fertilizer or irrigation. By contrast, even collecting existing waste biomass for ethanol may not be as environmentally benign as it seems. Farmers often plow cornstalks back into their fields to keep the soil fertile, so "if we immediately start taking cornstalks off the field, we need to worry about how the soil is going to be affected by the loss of carbon or other nutrients," says Donohue.

Then there's a much bigger question: Is ethanol worth pursuing at all? The answer depends on how it's produced, says Daniel Kammen, director of the Renewable and Appropriate Energy Laboratory at the University of California, Berkeley. Large-scale farming of feedstocks would involve heavy machinery that burns energy and produces greenhouse gases. Transporting those feedstocks to a refinery and converting them into ethanol would also require energy.

Kammen and his colleagues have developed a model—published in the Jan. 27, 2006 *Science* and modified since—that takes these factors into account. They find that ethanol from corn requires 95 percent less petroleum to produce than gasoline does but cuts greenhouse-gas emissions by only about 18 percent.

Cellulosic ethanol, by contrast, cuts greenhouse-gas emissions by more than 90 percent. That's mainly because producers of corn ethanol burn fossil fuels to heat fermentation tanks, while producers of cellulosic ethanol burn the lignin from their feedstocks.

Contrary to one charge made by some critics, however, the researchers concluded that it doesn't take more energy to make ethanol than can then be obtained by burning it.

Despite the excitement currently devoted to ethanol, it's likely to be only a short-term answer to the country's growing fuel needs, Keller says. "Within the next 5 years, ethanol is where we can make a difference. But will it be the final answer? I don't know." ■

FIRE INSIDE

Structural design with fire safety in mind

BY CAROLYN BARRY

Assistant chief firefighter Allen Hay was off duty the day terrorists flew hijacked airplanes into the World Trade Center buildings. By the time he reached the scene, both the North Tower and South Tower had collapsed, killing at least 2,550 people and spewing thousands of tons of debris onto the streets of New York.

Hay was given the task of attending another burning building surrounded by debris from the twin towers, Building 7 of the complex, which was still standing. "I don't want any more buildings collapsing," he recalls his supervisor telling him.

He arrived to find six floors ablaze, almost no water supply, and no radios to communicate with his firefighters. "We decided to give up on the building," he says.

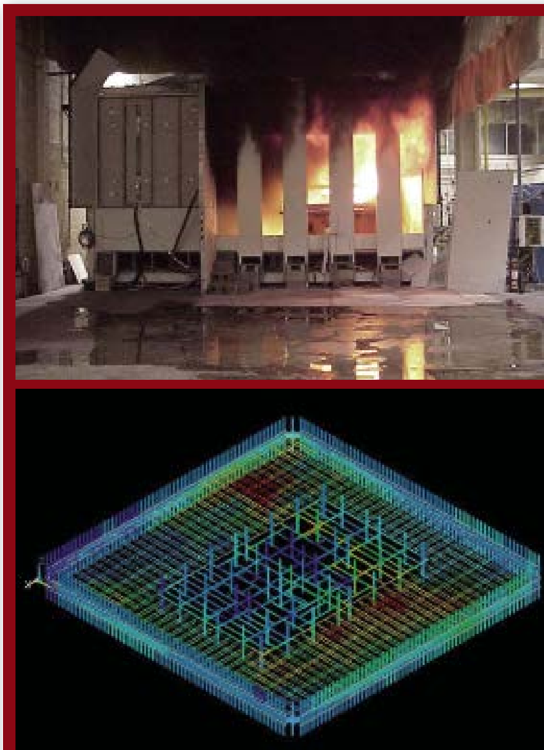
Although a part of Building 7 bulged dangerously, Hay and others expected fire to simply burn away whatever was flammable and leave the 47-story shell standing. But at 5:20 that afternoon, 7 World Trade Center became the third structure to crumble that day and the first to do so without being hit by a plane.

"We just expected it to burn out—we didn't expect it to fall down," says Hay, who is now chief safety officer of the New York City Fire Department. "It's the only building I know in New York City to ever collapse [strictly] from fire."

The events of 9/11 highlighted the danger that fire poses for the stability of structures and the need to design buildings that maintain integrity when they're ablaze. "Fire was one of the primary factors that led to the collapse of the World Trade Center," says Venkatesh Kodur, a civil and environmental engineer based in East Lansing, Mich., who consulted on the investigation into the failure of the towers and Building 7.

It's the fire that ignites after damage from some other cause—such as an earthquake, a tornado, or even a vehicle impact—that often makes a structure unstable by burning through walls, crumbling concrete, and melting steel. According to the Quincy, Massachusetts–based National Fire Protection Association, 2005 saw 511,000 building fires in the United States that killed 3,105 civilians and resulted in $9.2 billion dollars of damage.

"Fire causes as much if not more loss of lives than any other hazard in this country," says Doug Foutch, program director for structural systems and hazard mitigation of structures at the National Science Foundation in Arlington, Va. Foutch sees a need to increase funding of research into how fires affect structural integrity. "I consider it one of the top priorities in my area," he says.



RECONSTRUCTION — Scientists at the National Institute of Standards and Technology burned a model section of a World Trade Center floor (top) to test the results against the predictions of a computer simulation. At bottom, a computer-generated image shows heat distribution in simulated steel beams of the North Tower.

BUILDING AND FIRE RESEARCH LAB./NIST

The devastation to structures caused by natural hazards, such as earthquakes and severe storms, spurred engineers in the early 20th century to design buildings that could withstand seismic shaking or fierce winds. But the structural effects of fire, often a secondary hazard triggered by other damage, have not been given the same engineering attention, Kodur says. "We've made significant progress in earthquakes in the last 20 years, but now is the time to tackle fire as well," he says. "It's an everyday event that can become a severe threat."

THE THREAT Heat generated by combustion causes myriad changes to the properties of building materials, says structural engineer Amit Varma of Purdue University in West Lafayette, Ind. When heated, materials lose their stiffness and strength, which means that they fail at a lower load than they could normally bear, says Varma.

Concrete can disintegrate in extreme heat, as water trapped in its porous structure boils. Pressure from the water vapor cracks the concrete and breaks it into pieces, a phenomenon that engineers call spalling. And heat can weaken a structure's steel framework by making metal components expand, soften, and sag. Deformation of one part of the framework can increase stress on neighboring parts, to the point that the entire structure can fail.

"Buildings are designed to be very reliable and safe," Varma says. "We have a lot of confidence of the reliability of the structures and components from experiments." But those experiments, he notes, are largely performed at room temperature, so they don't reliably test how buildings behave in fires. "What has changed since 9/11, 2001" he says, "is that people are now looking toward structural engineers for more answers: Is a [burning] building going to be able to deform and carry the load?"

That kind of knowledge would enable architects to design buildings that could better withstand severe fires and might give firefighters better warning of when a building is about to collapse. "We're behind the eight ball just walking in the door," firefighter Hay says. "Often, we're arriving on the scene as the building is collapsing, so it's basically a time game. That's a danger—we don't know how long we've got." That danger was tragically realized June 19, when nine firefighters died after the roof of a burning furniture factory in Charleston, S.C., caved in on them.

THE TESTING In the late 19th century, concerns over fire safety grew with the height of the buildings that were starting to clutter city horizons. Chimney-shaped skyscrapers could go up in flames quickly and trap occupants inside a structure that might then fall down around them. The American Society for Testing and Materials (ASTM), formed in 1898, developed the first standard tests for the structural integrity of building materials should they be in an intense fire.

These standards "continue to govern practice even today," says Shyam Sunder, director of the Building and Fire Research Laboratory at the National Institute of Standards and Technology (NIST) in Gaithersburg, Md.

REMAINS OF THE DAY — Steel-beam remnants from the World Trade Center, contorted by fire on 9/11, lie in a yard at the NIST laboratories in Gaithersburg, Md. NIST scientists studied these beams in their investigation of the building's collapse.

NIST doesn't set the standards, but the government lab tests materials and makes recommendations to the ASTM and to local governments for their building codes. In a typical integrity test, a segment of a concrete column, a steel beam, or a wall is exposed to flames of controlled intensity rising to a critical temperature. If the segment retains its strength for at least 60 minutes, it's given a 1-hour rating. Most load-bearing components of buildings have ratings of 2 to 3 hours. The main structural elements of the World Trade Center towers had 2-hour ratings, and Building 7 had 4-hour components.

Typically, fire-protection engineers ensure that the design and materials proposed for buildings measure up to the fire-resistance standards of local building codes. Those codes are often based on information from fire tests dating back to the early 1900s. When a new material is tested, however, the information is added to a database that engineers can access.

If a proposed design is unusual or incorporates novel materials, a company must submit samples of the relevant components for new testing. Given that testing a segment of a wall, for example, can cost $15,000 to $20,000, such a test is usually conducted only once.

Chicago-based fire-engineering consultant Nestor Iwankiw points out that many such tests don't fully probe the failure of materials. That's because a test of a beam or a pillar will usually be stopped once it reaches the 2- or 3-hour safety rating required under a given code.

For the most part, the standard fire tests represent good safety benchmarks, says Iwankiw, but "in unusual circumstances, like 9/11, all bets are off." The extensive damage that the planes caused to the buildings' frameworks and their fire-resistance coatings was "just never anticipated or designed for." Engineers usually don't even plan for multiple-story fires when designing buildings, he says.

The biggest limitation of current testing methods is that they don't mimic conditions in real fires. Even the largest furnace at NIST can test samples no longer than about 5 meters, a fraction of the length of many structural components. And, testing single elements gives little guidance in understanding how a combination of components behaves, let alone how a whole building performs, in a fire.

"The rating tests don't give you much additional information on materials' properties," Iwankiw says. Those tests don't provide any information about how an assembly of connected components would fail. "We're picking assemblies out of a catalog for a standard fire and we really don't know how safe or unsafe [they] will be."

When a beam starts to deform, for example, adjoining columns or other components may take up extra loads, so the failure of the beam won't necessarily bring down the building. On the other hand, unanticipated stresses placed on adjoining components could tip them into failing. A building, therefore, might be more or less stable in a fire than the safety rating of its component parts would indicate.

In the late 1990s, researchers at a testing facility in Cardington, England, burned an eight-story building purposely constructed to test how an entire building would behave. They found that even without expensive fireproofing insulation on non-weight-bearing steel beams the building frame didn't fail because the structure as a whole redistributed the extra stresses.

Further blurring the overall assessment of a building's fire integrity is the behavior of the connections—bolts, welds, and mortar—that hold a structure together. The joints between different materials have been subject to "very little engineering" for fire safety, Iwankiw says. "We really don't know how the system or the construction will perform in a real fire."

In June, Kodur and his colleagues unveiled one of the biggest fire-testing furnaces in the United States. Located at Michigan State University in East Lansing, the furnace is specially designed for studying combinations of steel and concrete in conditions that occur in real fires. An important part of that research will focus on the effects of cooling on building materials and their contact points as a fire dies out—a factor known to be important but not accounted for in standard fire-integrity tests. Firefighters know well that even after a building has burned out, it can still suddenly collapse. Seven firefighters died in Gretzenbach, Switzerland, in 2004 when the roof of a smoldering parking garage fell in on them.

REALITY CHECK To complement better physical testing of materials, researchers have begun to develop computer simulations of how structures would perform in fires. "You'd essentially like to be able to burn the building down ahead of time on the computer," says William Grosshandler, chief of fire research at NIST and a lead investigator of the World Trade Center collapse.

To figure out why the twin towers and Building 7 fell, Grosshandler and his team had to develop programs that simulated, in three dimensions, damage from the planes' impacts and the ensuing fire. In a fire, Grosshandler says, "even something as benign as concrete has extremely complex chemical reactions going on." His team's computer analyses required four separate programs that ran a total of 2 months, day and night, to model the buildings' fates from the moment the first plane hit.

The NIST team used one program to simulate how the planes' impacts damaged fireproof-coatings on beams and pillars in the buildings, and also to account for the fuel and combustible materials that came from the aircraft.

The second program modeled the progression of the fire after it ignited. The software predicts the movement of fire and smoke through a structure and calculates the resulting heat distribution.

C. BARRY

The third program modeled the effect of heat on the strength and durability of the buildings' components. The detailed calculations, for example, worked out the deformation of steel beams that received more heat on one side than the other.

The fourth and most complicated stage of modeling tracked how deformation of the buildings' structural components threw new stresses onto adjoining components, ultimately causing failure. The program calculated, minute by minute, the changing position of each building's structural elements until that building almost reached the point of collapse.

The modeling was quite an achievement, says Jean-Marc Franssen, research director of the National Fund for Scientific Research in Liège, Belgium. "Until about 10 years ago we modeled all buildings as 2-D skeletons," he says.

The NIST simulation, like all models of building failures to date, couldn't follow the 9/11 collapses through to the end. No computer is yet powerful enough to follow the chaotic sequence of events that ensues when components break apart and a building falls, but this is where research is headed.

Franssen and his colleagues have recently made a breakthrough in modeling the collapse of a structure. They developed an algorithm that figures out the velocity and acceleration of individual building components.

That allows the program to calculate what engineers call the dynamic forces involved in a fast-changing scenario, which makes the analysis one step closer to replicating a real collapse, Franssen says. Without the added algorithm, a program must stop at the first sign of failure, but that point may not reliably indicate a building's imminent collapse because of the structure's ability, or inability, to redistribute stresses. "We don't know much about the failure mode," he says.

To fully understand the collapse of buildings, researchers are also attempting to model the behavior of connections between components in a fire as well as the process of spalling and the cooling of materials after the fire is out.

FIRE IN THE HOLE — Scientists lower a piece of a steel beam into the furnace chamber of one of the largest fire-testing facilities in the United States. It opened at Michigan State University in East Lansing in June.

MICHIGAN STATE UNIV.

A WELL-LIT FUTURE "Structural engineers spend millions of dollars thinking about wind and earthquakes, but not at all about fire," says Susan Lamont, a structural engineer who studied the fire damage to the intentionally ignited eight-story building in Cardington. Fire experts and structural engineers are now joining forces to make fire-resistance design as important and routine as earthquake-damage protection and wind proofing of buildings. That trend has begun to take hold in Europe, she says, and "gradually, the U.S. is starting to do this."

The future of design for structural integrity in fires should be based on risk analysis, Lamont says. Any innovative structure or novel skyscraper design, she adds, should be analyzed by the modeling software to predict how a fire might affect its stability. "It's about designing a building for the forces and fire, rather than applying fireproofing and hoping that's adequate," she says. ■

OF NOTE

ANIMAL SCIENCE

Tail singers

The sound effects of Anna's hummingbirds, widespread along the West Coast, have been misunderstood, according to a new test.

Some of the males' most dramatic noises aren't vocalizations, as has been thought. Instead, the birds make noises by whipping their tails through the air.

HUMMER A male Anna's hummingbird can make sounds with its tail.

Males, with iridescent, rose-colored throats and heads, perform aerial dives when courting a female or confronting another male. For a display, a male flies high in the air and then drops nearly straight down. When he's plummeted to the level of his intended audience, he pulls out of the dive while sounding an explosive squeak.

In the late 1970s, ornithologists decided that those notes came from the birds' vocal organs. Chris Clark and Teresa Feo of the University of California, Berkeley have challenged that idea by removing some birds' outer tail feathers. A clipped male still dives, but he no longer makes the sound as he bottoms out. Clark also tested the tail feathers in a wind tunnel and was able to make noises like the birds'. The researchers reported their findings at the July 21–25 meeting of the Animal Behavior Society in Burlington, Vt.

Ornithologists have documented a wide variety of noises made by bird wings, from cricketlike rubbing sounds to aerial whistles. A tail-feather sound effect, though, is quite rare, says Clark. —S.M.

BIOLOGY

The origins of immunity?

When the going gets tough, social amoebas get together. Most of the time, these unusual amoebas live in the soil as single-celled organisms, but when food runs short, tens of thousands of them band together to form a sluglike multicellular cluster, which then slithers away in search of a more bountiful patch of dirt.

New research shows that, within this slug, specialized cells rove around vacuuming up invading bacteria and toxins, thus forming a kind of rudimentary immune system. The discovery could provide a molecular link between the bacteria-eating behavior of single-celled amoebas and similar behavior by cells of animals' immune systems.

Adam Kuspa of the Baylor College of Medicine in Houston and his colleagues showed that, to identify foreign bacteria, the slug's roving cells require a protein called toll/interleukin-1 receptor A (TirA). When the team disabled this protein in the amoebas, the specialized cells lost their ability to hunt down bacteria, the researchers report in the Aug. 3 *Science*. In addition, when the impaired slug was teased apart, its individual cells could no longer identify and eat soil bacteria, which are the amoebas' natural food.

Because TirA is closely related to bacteria-identification proteins that are active in animals' immune systems, Kuspa says that the work may indicate an ancient evolutionary connection between microbes and immune system cells. "People wondered whether it might be the same conserved molecular mechanism, and here we see it's a related protein in both cases," he says. —P.B.

CLIMATE

It's not nice to fool Mother Nature

Attempts to manipulate climate to counteract current trends of global warming could cause more problems than they solve, a study of weather data suggests.

Major volcanic eruptions spew large amounts of tiny particles, or aerosols, high into the atmosphere, where they scatter light back to space and significantly cool Earth for months to years (*SN: 2/18/06, p. 110*). Some researchers have proposed deliberately lofting tons of tiny particles into the stratosphere to achieve the same effect. That's probably not a good idea, says Kevin E. Trenberth, a climatologist at the National Center for Atmospheric Research in Boulder, Colo.

Trenberth's team studied data gathered by weather stations and river gauges worldwide from 1950 to 2004. For the 16 months following the 1991 eruption of Mount Pinatubo in the Philippines—an event that temporarily cooled Earth as much as 0.3°C—daily precipitation over landmasses worldwide dropped, on average, about 0.07 millimeter. Although that sounds small, no other large-scale weather phenomenon during that period triggered an extended decrease in daily precipitation that exceeded 0.04 mm.

Because the current global warming trend results from an increase in the atmospheric concentration of carbon dioxide, not an increase in solar radiation, simply providing Earth some shade doesn't address the problem, the researchers say in the Aug. 14 *Geophysical Research Letters*. Besides causing extended droughts, lofting artificial aerosols could significantly affect weather patterns and ocean currents, the team cautions. —S.P.

ENVIRONMENT

Cat disease associated with flame retardants

Since 1979, a mysterious epidemic has been afflicting house cats. Feline hyperthyroidism, usually characterized by weight loss, hyperactivity, and eventual heart disease, is now the leading hormonal disorder in cats. A pilot study tentatively links it to certain flame retardants that began showing up in the environment in 1979 and are now ubiquitous.

The chemicals, called polybrominated diphenyl ethers (PBDEs), show up in water, fish, house dust, human foods, and people (*SN: 10/25/03, p. 266*).

Veterinarian Janice A. Dye of the Environmental Protection Agency in Research Triangle Park, N.C., realized that indoor cats—already known to be at high risk of hyperthyroidism—consume a lot of dust when they groom themselves. Data have suggested that sick cats are also more likely than healthy felines to have eaten canned cat food, especially fish varieties.

Dye's team tested blood samples from 23 cats, including 11 with hyperthyroidism. Although all carried PBDEs, the animals with the thyroid disease had higher average concentrations. Sick cats and well cats also had different mixes of PBDEs, the researchers report in an upcoming *Environmental Science & Technology*.

Tests of 20 types of dry and wet cat foods showed that all contained PBDEs, although canned, fish-flavored food had the highest amounts and could deliver 12 times as much of the chemicals as dry foods typically did. The canned, fish-flavored foods also had con-

ISTOCKPHOTO

centrations of PBDEs that were up to 100 times as high as those in the human diet.

"It sure as heck looks like there's something going on," says coauthor Linda S. Birnbaum of EPA. "Our data beg for additional studies." —J.R.

MICROBIOLOGY

Lithium might help bone healing

Lithium maintains production of a bone-repair protein, suggesting that the element might help people with fractures that are mending slowly or not at all.

Scientists had known that the protein beta-catenin is instrumental in orchestrating bone growth in childhood. But it was less clear whether beta-catenin played such a role in bone repair.

Meanwhile, other research had shown that lithium increases the amount of beta-catenin in the body by preventing its degradation.

Researchers at the Hospital for Sick Children in Toronto decided to test lithium's possible effect on healing rates in mice with broken leg bones. It helped the healing process when given a few days after a break, but not when given earlier, the scientists report in the July *PLoS Medicine*.

This curious delay coincides with the time that it takes mesenchymal cells to arrive at a fracture site. These cells differentiate into bone-building cells called osteoblasts. "If mesenchymal cells get there and beta-catenin levels aren't just right, they won't differentiate properly" into osteoblasts, says study coauthor Benjamin A. Alman, an orthopedic surgeon at the hospital. Timing a lithium-induced rise in beta catenin with the arrival of these cells may optimize healing, he says. —N.S.

ARCHAEOLOGY

Map yields new view of ancient city

An international team of scientists has assembled a map of the world's largest preindustrial city, the sprawling settlement of Angkor in what's now Cambodia. The new map shows that Angkor's ruins cover more than 1,000 square kilometers, including areas outside boundaries that have been established to protect the archaeological site.

It's now evident that an elaborate canal system once supplied water throughout Angkor, say Damian Evans of the University of Sydney in Australia and his colleagues. Although the city prospered for 6 centuries and reached a peak population of nearly 1 million residents, its reliance on canals for water led to its collapse in the 1500s, the researchers contend.

Overpopulation and massive clearing of forests for rice fields contributed to erosion that filled the canals with sediment. Attempts to revamp the canals proved unworkable, Evans' team asserts in an upcoming *Proceedings of the National Academy of Sciences*.

ANGKOR MANAGEMENT **Residential areas and artificial ponds dot the landscape at Angkor, which also included a canal system, according to a new map of the medieval Cambodian city.**

Angkor has been studied for more than 100 years. It's best known for Angkor Wat, a massive 12th-century temple.

Evans and his coworkers constructed the new map by combining information from maps drawn about 20 years ago, recent ground surveys, aerial photography, and ground-sensing radar deployed on the space shuttle in 2000. The effort identified at least 74 formerly undetected temples, each surrounded by a moat, and more than 1,000 artificial ponds that were used for water storage. —B.B.

BIOMEDICINE

Vaccine targets ovarian-cancer cells

By using a vaccine patterned after a protein fragment found on some malignant cells, scientists have been able to direct an immune response against ovarian cancer.

The protein fragment, called NY-ESO-1, appears on the surface of tumor cells in about 40 percent of ovarian cancer cases, and also in some other cancers.

In the new study, scientists at the Roswell Park Cancer Institute in Buffalo, N.Y., selected 18 patients who had ovarian cancers that were positive for NY-ESO-1. In most of the volunteers, the cancer had spread beyond the ovaries. All the women had undergone chemotherapy, and their cancers were under control at the time they entered the study, says study coauthor Kunle Odunsi, a gynecologic oncologist at Roswell.

The women received shots containing the NY-ESO-1 vaccine every 3 weeks for a period of 4 to 11 months between 2003 and 2005. After treatment, the women experienced no recurrence of ovarian cancer for an average of 19 months, Odunsi and his colleagues report in the July 31 *Proceedings of the National Academy of Sciences*.

Following vaccination, most of the women's immune systems made cells primed to attack anything sporting NY-ESO-1. A few of the patients also developed antibodies against the protein fragment.

Blood samples obtained up to 18 months after the treatments showed that the immune response was durable. "If the cancer begins to grow, the immune system is still ready to attack," Odunsi says. However, some patients relapsed when they formed tumors that didn't display NY-ESO-1.

Odunsi's team reports that 15 of the 18 patients are still alive and that seven remain free of ovarian cancer. —N.S.

PHYSICS

Frizzed molecular carpets

Researchers have taken the first snapshots of heat bursts moving along hydrocarbon molecules.

A team led by Dana Dlott at the University of Illinois at Urbana-Champaign, anchored ends of the carbon-chain molecules to a gold surface, creating an atomic-scale carpet. A laser pulse then heated the gold base to around 800 kelvins in less than a trillionth of a second. Meanwhile, the team measured how the top of the carpet scattered light from a second laser. When heat reached the molecules' upper ends, making them jiggle, the scattered signal changed.

By repeating the experiment on hydrocarbons of different lengths, the researchers showed that the bursts traveled along single molecules at a constant speed of about 1 kilometer per second. That's much faster than heat diffuses in a macroscopic object. The findings appear in the Aug. 10 *Science*.

Understanding how molecules conduct heat will be crucial for "molecular electronics," Dlott says. Researchers in that field seek circuits in which single electrons carry information down molecule-thin wires.

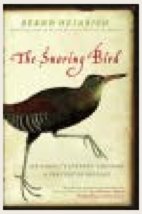
Arun Majumdar of the University of California, Berkeley says that this is "certainly an excellent piece of work." Other experiments have suggested that heat's speed is constant along a molecule and even faster than Dlott's group measured. "I wonder what is going on," Majumdar says. —D.C.

PNAS

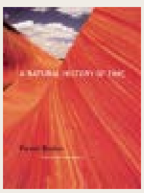
Books

A selection of new and notable books of scientific interest

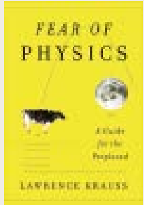
THE SNORING BIRD: My Family's Journey through a Century of Biology
BERND HEINRICH
This personal narrative chronicles the experiences of the author's father, Gerd Heinrich, a naturalist who specialized in wasps, and the author's own development into a premier experimental biologist and naturalist. For the elder Heinrich, solving questions of speciation and animal behavior was a lifelong pursuit. As a youth, he collected animal specimens. Later, he made bird-collecting expeditions to Persia and Burma. Bernd Heinrich recounts the effects of World War II on his family and the emergence of his interest in nature after the war's end. The family eventually moved from Germany to Maine. Drawing on correspondence between him and his father, the author chronicles his childhood explorations of nature in America and his father's continued worldwide scientific expeditions. ***HarperCollins, 2007, 461 p., b&w photos, hardcover, $29.95.***



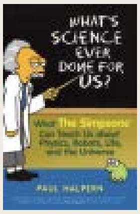
A NATURAL HISTORY OF TIME
PASCAL RICHET
Geochemists and astrophysicists have determined that the universe is billions of years old. However, until the past century, attempts to prove the age of the universe were based on religion as well as on science. Richet profiles the notion of time throughout history, focusing on the history of Earth and life on it. The ancient Greeks believed that time was infinite. Christian scholars struggled to reconcile their belief that the age of the universe could be expressed in millennia with emerging scientific evidence that the universe was indeed billions of years old. Harmonizing scientific evidence with religious belief sometimes required a stretch of the imagination; for example, fossils were once explained as relics from the biblical great flood. And though scholars as early as the 10th century recognized the effects of erosion and sedimentation, no one made the connection between these processes and the passage of geological time. Using radiometric-dating methods, scientists of the early 20th century finally established a time line for the universe. ***Univ. Chicago, 2007, 470 p., b&w illus., hardcover, $29.00.***



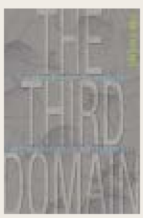
FEAR OF PHYSICS: A Guide for the Perplexed
LAWRENCE M. KRAUSS
In this revised edition of what has become a classic in introductory physics classes, Krauss attempts to dispel the mystery surrounding physics. A physicist himself, he demonstrates that the science is based on a set of core principles that make it easier to understand the world. Unlike scientists such as psychologists and engineers, the author posits, physicists look at the world in the simplest-possible terms. A physicist's motto might well be, Krauss writes, "Before doing anything else, abstract out all the irrelevant details!" He explains why mathematics is a key to understanding physical phenomena. He emphasizes that advances in physics are often based on centuries-old ideas, noting that Isaac Newton benefited from observations made by Tycho Brahe, Johannes Kepler, and even by Galileo. Krauss touches on the notion of physics as a means to understanding how the universe is structured. He also describes scientists' ongoing search for a unified theory. ***Basic, 2007, 257 p., b&w illus., paperback, $15.95.***



WHAT'S SCIENCE EVER DONE FOR US? What The Simpsons Can Teach Us about Physics, Robots, Life, and the Universe
PAUL HALPERN
The Simpsons, the longest-running animated television series, is a surprising trove of scientific knowledge. In a guide that should appeal to science buffs and *Simpsons* fanatics alike, Halpern takes a tongue-in-cheek look at some of the hidden scientific lessons in the series. For example, one episode has Homer Simpson, an employee at a nuclear-power plant, marketing a plutonium-treated tomato. Halpern looks at how radiation and genetic modification might affect real-life crops as well as the fictional Springfield's ever-present three-eyed fish. Halpern uses an episode in which Lisa Simpson inadvertently produces a town full of miniature life forms from one of her baby teeth to ponder the emergence of life on Earth. With *Simpsons* episodes as references, Halpern explains principles such as chaos theory, gravitational theory, and artificial intelligence. He ends with a science checklist for the newly released *Simpsons* movie and a list of scientifically relevant episodes from the television series. ***Wiley, 2007, 262 p., paperback, $14.95.***



THE THIRD DOMAIN: The Untold Story of Archaea and the Future of Biotechnology
TIM FRIEND
Until 1977, the known classes of life included eukaryotes and bacteria. When microbiologist Carl Woese announced the discovery of a third class, most academics scoffed. Yet today, barely 30 years later, archaea are known to be at least as abundant as bacteria. They are among the oldest life forms on Earth. These hardy organisms are capable of surviving within the harshest conditions, from volcanic mud to deep-ocean sediments. Friend, a science writer for USA Today, examines the implications of Woese's discovery on microbiology, genetics, and studies of the origin of life. In a book that is based in part on lab visits, treks to hot springs, and interviews with members of undersea-expedition teams, Friend chronicles scientists' efforts to decode archaea's genetics and to unlock the secrets of its amazing survival skills. ***Joseph Henry Press, 2007, 296 p., b&w plates, hardcover, $27.95.***



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LETTERS

Where did the chicken cross?

"Chicken of the Sea: Poultry may have reached Americas via Polynesia," (*SN: 6/9/07, p. 356*) states, "The most likely sea route ran north of Hawaii and down America's Pacific coast." The Polynesians were master mariners, so anything is possible, but continuing east from Tonga to South America is an extension of the main voyaging area, whereas Hawaii is well off this beaten path.
TOM MALLARD, PHOENIX, ARIZ.

A guy thing

"Brain Gain: Constant sprouting of neurons attracts scientists, drugmakers" (*SN: 6/16/07, p. 376*) states, "Exercise, estrogen, [and more examples] all rev up production of new brain cells." I am compelled to ask: If estrogen leads to neurogenesis, does the "male" hormone testosterone also?
JAIME HUNTER, MESQUITE, TEXAS

There's good evidence that testosterone increases neurogenesis in songbirds but little evidence that it does the same in mammals. —B. VASTAG

First line of defense

In "Moths mimic 'Don't eat me' sounds" (*SN: 6/23/07, p. 397*), the study is reported as the "first confirmed acoustic example of classic defensive mimicry." Not so. In 1986, Matthew P. Rowe and colleagues published in *Ethology* an elegant study demonstrating that the burrowing owl's hiss is acoustic defensive mimicry of the rattlesnake's rattle.
WILLIAM K. HAYES,
LOMA LINDA UNIVERSITY, LOMA LINDA, CALIF.

Death defining

In "Jurassic CSI: Fossils indicate central nervous system damage" (*SN: 6/23/07, p. 390*), the unusual head positions seem to indicate that these creatures died from a kind of nerve damage. One of the possibilities is oxygen deprivation. Doesn't this suggest that most of these creatures probably died from suffocation after a sudden mud slide or other deluge?
RON MCMURTRY, MODESTO, CALIF.

Suffocation from a mud slide, deluge, or volcanic eruption is a strong possibility. But not all fossils in this pose are found in those geological settings. —C. BARRY

Correction *"Not-So-Elementary Bee Mystery"* (SN: 7/28/07, p. 56) *failed to give the first name of entomologist Maryann Frazier of Pennsylvania State University in University Park.*