SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

NOVEMBER 24, 2007 PAGES 321-336 VOL. 172, NO. 21

converting skin to stem cells
hiv vaccine hinders immunity
protozoa linked to frog die-offs
are women worse at math?

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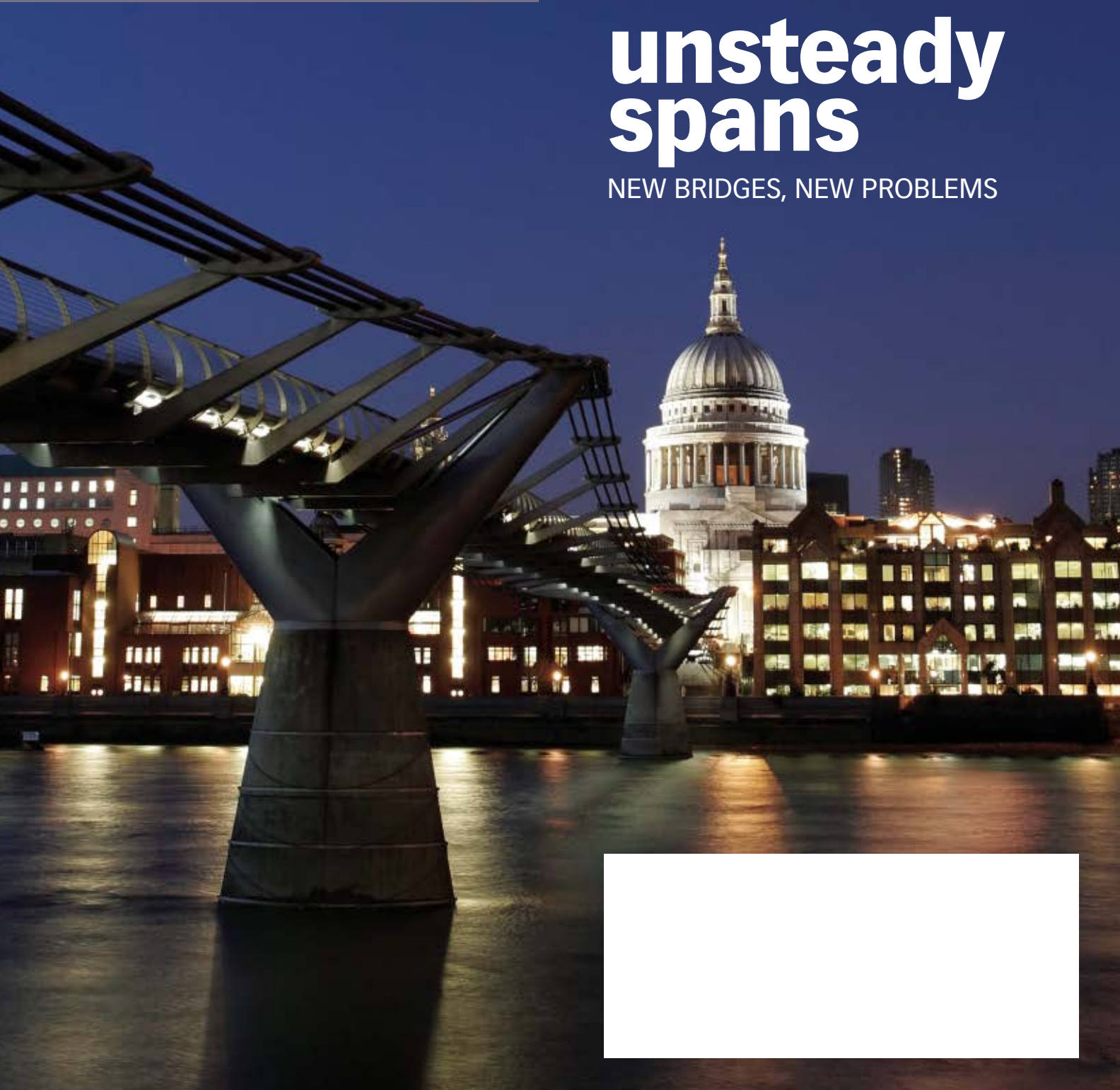
unsteady spans

NEW BRIDGES, NEW PROBLEMS



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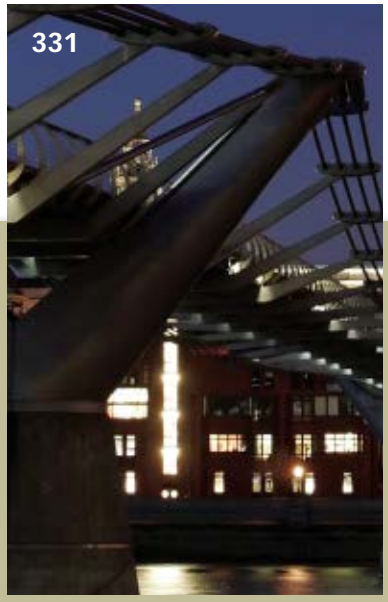

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Cover London's Millennium Bridge swayed alarmingly as soon as the first pedestrians started walking across in 2000, and had to be closed until a fix was devised. Novel bridge designs have surprised engineers with a variety of unexpected behaviors.
(iStockphoto) Page 331

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SCIENCE NEWS
This Week

Hold the Embryos

Genes turn skin into stem cells

In an advance that could solve many of the ethical and technical issues involved in stem cell research, two groups of scientists have independently converted human skin cells directly into stem cells without creating or destroying embryos.

"We are now in a position to be able to generate patient- and disease-specific stem cells without using human eggs or embryos," Shinya Yamanaka, leader of one of the research teams at Kyoto University in Japan, said in an e-mail interview.

Preliminary tests show that the newly created cells can develop into nerve cells, heart cells, or any other kind of cell in the body. Previously, only stem cells taken from early embryos had this kind of flexibility, called pluripotency. Scientists have suggested that such embryonic stem cells could be used for learning about genetic diseases, testing new drugs on cells grown in the lab, or growing healthy cells for therapeutic transplantation.

Producing embryonic stem cells has become controversial, however, because the process destroys the embryo.

"[Our] whole procedure doesn't involve any embryo," says Junying Yu, leader of the other research group, at the University of Wisconsin–Madison. "This approach is certainly going to get rid of this [ethical] problem."

The new technique wouldn't be suitable for medical therapies because it uses viruses to inject genes into the cells' DNA. Such viruses insert the genes at random locations, sometimes causing mutations that can lead to cancer. Several research groups are working on other ways to deliver genes into the cells, and developing safer techniques to do so shouldn't be difficult, observes Jeanne F. Loring, a stem cell researcher at the Scripps Research Institute in La Jolla, Calif.

Both research groups used human skin cells called fibroblasts, chosen because they grow rapidly and are easy to obtain. Yamanaka's group used skin cells taken from a woman's face, and Yu's team used cells from a newborn's foreskin. Acquiring fibroblasts from a patient would require only shallow penetration of the skin.

The research teams each grew samples containing hundreds of thousands of skin cells in a dish, and then used viruses to carry genes into the cells. These genes are active in embryonic stem cells but switched off in skin cells. Each team used a different combination of four genes, but two of the genes—*OCT4* and *SOX2*—were common to both experiments. The genes work by controlling the activity of many others.

After 12 to 25 days, the injected genes had transformed some of the skin cells into cells with all of the key characteristics of embryonic stem cells, the teams report in the Nov. 30 *Cell* and the Nov. 23 *Science*.

"If you didn't know where they came from, you wouldn't be able to tell the difference between these [cells] and true human embryonic stem cells," Yu says.

The experiments each produced between 10 and 35 converted cells, called induced pluripotent stem cells. So a single skin sample can produce several stem cell lines.

"This will be the way people" make stem cells, concludes Loring. —P. BARRY

It Takes a Village

Tweaking neighbors reroutes evolution

When it comes to evolution, no plant stands alone.

For mustard plants, investing heavily in pest defense is a good idea if a different plant species lives next door, says Richard Lankau of the Illinois Natural History Survey in Champaign. If the nearest plant happens to be another mustard, however, then the investment in protection becomes a bloated military budget and the offspring suffer.

Plant communities influence evolutionary forces in very complex ways, a new study finds. Lankau and Sharon Strauss at the University of California, Davis have demonstrated that a plant's surrounding community can boost, shrink, or even reverse evolutionary forces. The relationships are complex enough to make evolutionary outcomes unpredictable, says Lankau.

"This study is amazing," says Anurag Agrawal of Cornell University. "It will make it more difficult to justify studying the evolution of a species in the absence of its real ecological context."

The idea that communities influence evolution isn't new. "Perhaps even Darwin would have argued that it must be so," says Agrawal. However, as researchers begin to consider such influences in their studies, "the logistical, statistical, and conceptual hurdles are substantial," he says.

Lankau and Strauss focused on black mustard plants. Like other members of the mustard family, *Brassica nigra* produces strong-flavored substances that can discourage indiscriminant grazers such as slugs. The black mustard produces most of its defense chemicals in the form of an amino acid called sinigrin. The researchers wanted to see whether the mustard's neighbors would affect the evolutionary benefit of a plant's sinigrin.

LANKAU

MILITARY SPENDER **A black mustard plant contains strong-tasting sinigrin, which discourages slugs. Whether investing in sinigrin is a good idea depends on the plant's neighbors.**

The researchers planted 512 pairs of plants in California's Central Valley. Each pair included a black mustard plant with either high or low sinigrin concentrations. The second plant in each pair was either another black mustard or a different species of plant. By dusting aphids off some of the plants and adding slug-repelling collars to others, the researchers tested various pest assaults on the plant pairs.

At the end of the growing season, Lankau and Strauss sampled the seeds of the mustard plants. If a plant had plenty of nice, fat seeds for abundant offspring, it meant that natural selection favored that plant's sinigrin strategy.

Examining the influences of the various other species on a plant's seed quality produced a pattern that was "all over the place," says Lankau. Effects of the neighbors, slugs, and aphids interacted in very complex ways, the authors write in an upcoming *American Naturalist*.

For example, a slug that bites into a plant

with too much sinigrin will leave and chew on the plant's neighbor. Aphids aren't much bothered by sinigrin, so when choosing between two plants in the mustard family, they attack the larger one. Aphids therefore eliminate the benefit of slug protection, making sinigrin production potentially wasteful. —S. MILIUS

Snappy Transition

Venus flytrap inspires new materials

Inspired by the quick-shut action of the Venus flytrap, researchers have designed a material patterned with microscale hills that can rapidly flip to form valleys. Such materials could serve as fast-release adhesives, sensors in food packaging that detect spoilage, and quick-change lenses.

To capture its prey, the Venus flytrap takes advantage of a snap instability that resembles half a tennis ball flipping inside out. Uneven stresses in the outer and inner cells of the plant's leaf make it move quickly without muscles (*SN: 1/29/05, p. 69*).

To build snapping surfaces, Alfred Crosby and Douglas Holmes of the University of Massachusetts, Amherst, molded a silicone polymer into a flexible layer, 1.5 millimeters thick, with circular indentations. They stretched this layer, and then bonded another layer of the same polymer over it, creating an array of enclosed pockets. When the double-layered material contracts, the second layer wrinkles to form a pattern of convex microlenses a few hundred micrometers across or less—roughly the diameter of a human hair.

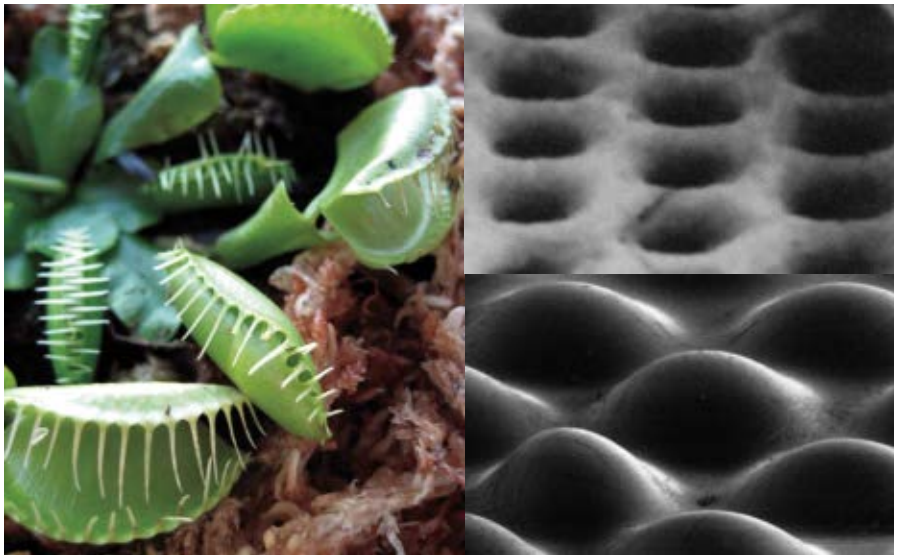
External cues can change the surface geometry within tens of milliseconds, the researchers showed. Mechanical pressure can flip the lenses from convex to concave reversibly or permanently. Chemicals can also trigger the snap instability. When the researchers treated silicon in the polymer's surface with oxygen, the resulting chemical reaction stressed the surface, causing the pockets to flip from convex to concave. Adding fluids that swelled the polymer popped concave surfaces back into convex ones.

Similar surfaces could also respond to heat, light, or electricity, Crosby says, but the primary innovation is that there's a fast mechanical response without added energy. The key feature of a snap instability, he says, is that "there are very, very large changes in shape and geometry with a very, very small amount of pressure. So it's extremely sensitive." The researchers report their findings in the November *Advanced Materials*.

"Learning from nature can actually teach us how to come up with something more functional," says Hongrui Jiang of the University of Wisconsin–Madison.

Incorporated into food packaging, such surfaces could work as sensors that could reveal a hidden warning in response to chemical spoilage or temperatures above a set threshold, Crosby says. In addition, small biodegradable chips with these pockets could transport drugs in the bloodstream, snapping open when they reached their targets.

The researchers expect to make surfaces larger than the square centimeter or so they've created so far. And they're already working to make their enclosed quick-change pockets smaller, from 100 nanometers to 500 nm across. Varying the pockets' size and spacing will allow scientists to control the physics of the response, tune the sensitivity of the sensors, and minimize inappropriate responses. —S. WEBB



HOLMES AND CROSBY

FLIP-FLOP In the same way that leaves of Venus flytraps (left) can quickly snap shut, depressions in the surface of a new material (top) can flip into bumps (bottom).

Einstein Unruffled

Relativity passes stringent new tests

By tracking the moon's location to within 1 centimeter, astronomers have put general relativity, Albert Einstein's theory of gravity, to a stringent new test. The theory stood up. In a separate experiment, physicists reconfirmed Einstein's older predictions on the stretching of time.

While both general relativity and quantum theory so far fit experimental data very well, their incompatibility makes physicists believe that at small scales either one of them or both must be wrong. Scientists constantly work to improve the sensitivity of their experiments to violations that might point to a new "theory of everything."

Astronomers at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., have now performed a new analysis of 35 years' worth of data on the moon's distance from Earth, including data they recently collected themselves with centimeter precision. The data tracked the time it took for a laser beam to reach a mirror on the lunar surface—left behind by the Apollo 11 astronauts—and bounce back to Earth. The results, described in an upcoming *Physical Review Letters*, confirmed one of general relativity's cornerstones: The laws of gravity are the same in all frames of reference.

The results place some strict requirements on any conceivable theory of everything, says team member James Battat.

Last year theorists Alan Kostelecký and Quentin Bailey of Indiana University in Bloomington, calculated the implications for gravity of a broader theory developed by Kostelecký. Called the standard-model extension, it represents the most general form that a theory of everything must have to fit the best known data. It involves more than 200 parameters—like so many knobs physicists can turn to change the equations underlying general relativity and quantum theory.

For example, some of the knobs would change Einstein's equations, Kostelecký says. "You don't have $E = mc^2$ anymore," he says as an example. "You have $E = mc^2$ plus a little bit"—a large number of tiny, hypo-

thetical correction terms. The Harvard-Smithsonian results found no deviation from relativity for six of those knobs, with precisions ranging from one part in a million to 1 part in 100 billion.

Separately, in an upcoming *Nature Physics*, physicists confirm Einstein's prediction that an object moving at a high speed appears to have its own flow of time slowed down. At the Max Planck Institute in Heidelberg, Germany, the researchers shot a beam of lithium ions at up to 6 percent of the speed of light and hit them with two laser beams. The laser frequency was tuned to excite some of the ions' electrons. To do so, the physicists had to make a small correction in the laser tuning, since the speeding ions' dilated sense of time affected their reaction to the frequency of the lasers' waves.

The precise measurement of this correction nailed down another knob with a threefold improvement in sensitivity over the team's own 2003 results, says team member Gerald Gwinner, now at the University of Manitoba in Winnipeg. —D. CASTELVECCHI

A toothy smile

This dinosaur didn't have to worry about dentures. The *Nigersaurus taqueti* boasted 500 teeth, arranged in 50 rows across its jaw. When a tooth fell out, the teeth that had been lined up behind it would shift forward. Roaming modern-day Niger 80 million years ago, *Nigersaurus* didn't use its long, snaky neck to munch on treetops, says Paul C. Sereno of the University of Chicago, a discoverer of the skeleton. Instead, it grazed on ground vegetation. Sereno and his colleagues analyzed the dinosaur's skull and found that *Nigersaurus* inner ears pointed down. The ears of tree-foraging creatures, such as giraffes, point up. The find is reported online in the November *PLoS ONE*. Sereno says paleontologists had never before considered that any long-necked herbivores, called sauropods, ate from the ground. "It took an extreme dinosaur to open our eyes to this cowlike behavior," he says. —S. WILLIAMS

Wrong Way

HIV vaccine hinders immunity in mice

Two months after investigators halted a once-promising HIV vaccine trial, a horde of mice is delivering more bad news. The viral packaging used in another HIV vaccine has hurt, not helped, the animals' immune systems.

The finding prompted study leader Hildegund C.J. Ertl of the Wistar Institute in Philadelphia to call for a pause in human tests of the vaccine that delivers snippets of HIV to people via a genetically altered adeno-associated virus (AAV). This viral package is designed to train the immune system to recognize and attack HIV. But vaccines employing AAV "may potentially cause harm," Ertl says. "Without additional preclinical studies, they should not be used in humans."

In a clinical trial in Africa, 91 volunteers have received the AAV vaccine, which was developed by the International AIDS Vaccine Initiative (IAVI). The organization says that even before the new mouse study, it had decided not to conduct further human trials of the vaccine because of "relatively modest immune responses" in the volunteers.

In Ertl's study, mice receiving the AAV vaccine showed signs of immune system impairment. Ideally, vaccines induce a population of immune T cells that "remember" what a particular infectious organism looks like. The next time the T cells encounter the same organism, the cells activate, proliferate, and attack the infection.

But T cells in Ertl's mice appeared exhausted. They generated few important immune-activating chemicals called cytokines. More important, these cells failed to proliferate when exposed to the snippet of HIV they were supposed to recognize. Ertl concludes that the vaccine's AAV overstimulated and depleted the animals' T cells. She reports in the December *Journal of Clinical Investigation*.

Anthony Fauci, director of the National Institute of Allergy and Infectious Diseases (NIAID) in Bethesda, Md., agrees that the study shows T cell exhaustion. He cautions, however, that the results might not apply to people.

Pat Fast, IAVI's medical-affairs director, says Ertl's mouse findings "may well be an effect of a very high dose" of the vaccine. She adds that the study's relevance to human trials remains "unclear" and that a new, unpublished monkey study of the vaccine found no evidence of T cell exhaustion.

In September, NIAID and Merck & Co. of Whitehouse Station, N.J., stopped a large clinical trial of an HIV vaccine that used a different genetically modified virus. An early analysis found that the vaccine may have inadvertently increased susceptibility to HIV infection. This vaccine used an adenovirus—not an adeno-associated virus—to deliver pieces of HIV to the volunteers.

Fauci says he's worried that the similarity in the viruses' names will lead people to conclude that T cell exhaustion caused the anomalous mouse results in the halted Merck trial. "There is a major difference between adeno-associated virus vectors and adenovirus vectors," he says. Investigators are now trying to sort out why the adenovirus vaccine didn't work, says Fauci.

Of some 30 HIV vaccines that have been developed, none has yet proved effective in preventing infection or slowing HIV transmission. —B. VASTAG

Tadpole Slayer

Mystery epidemic imperils frogs

From Alaska to Florida, a novel and yet-unnamed protozoan is knocking off tadpoles. Species vulnerable to "the beast" belong to the genus *Rana*, which includes

SICK TADPOLE The organs of this river frog tadpole are riddled with tiny killer protozoa (inset).

D. STEVENSON/UNIV. GEORGIA; (INSET) K. KEEL

leopard frogs, green frogs, and bullfrogs, says ecologist John C. Maerz.

His team at the University of Georgia in Athens stumbled across mass die-offs of southern leopard frog tadpoles in nearby ponds last year. Dissection showed the animals' innards peppered with spherical, one-celled parasites. Genetic testing confirmed these are loosely related to *Perkinsus*, a disease-causing organism that affects marine shellfish.

Maerz' group now offers the first published photos of the pathogen and descriptions of its effects in the current issue of *EcoHealth*. Infected tadpoles become lethargic and developmentally stunted, the Georgia scientists report. Although the mystery parasite infects all organs, it clusters in the liver, sometimes tripling that organ's size and giving the false impression that an animal is fat and robust. So many protozoa swamped and killed tissue in the liver of one sick tadpole, Maerz recalls, that throughout most of the organ "we could find no identifiable liver cells."

He notes that his team did not discover the pathogen. It was first found by veterinary pathologist D. Earl Green of the National Wildlife Health Center in Madison, Wisc., part of the U.S. Geological Survey.

Since 1999, Green has quietly been recording a steady and growing incidence of the novel infection in frogs sent to his lab. All came from east of the Mississippi except for two outliers: frogs from Alaska's Kenai Peninsula, several years ago, and one sample that he ran across 3 weeks ago from the West Coast.

Fueled by warm weather, "this infection kills steadily and slowly over the course of summer," Green says. Although it targets tadpoles, there's a chance that adults could also carry it and serve as amphibian Typhoid Marys.

When Green can steal a moment, he intends to publish his experiences with the pathogen—and name it. But that may require yet a bit more information on the shape of its mitochondria, explains Sanford H. Feldman of the University of Virginia in Charlottesville, a collaborator on Green's studies. Feldman says his work indicates that "this wicked-looking organism is very primitive" and appears to "phylogenetically sit at the spot where animals and fungi diverged."

It's one of only three infectious agents capable of causing large die-offs of amphibians—almost all of which are in decline the world over. To date, the new protozoan has been reported only in the United States, Green says, where it has emerged as the "principal threat" that could lead to extinction of the Mississippi gopher frog. This amphibian's sole wild population breeds in only one infected pond, where for at least 4 years virtually all tadpoles have died. —J. RALOFF

Biohazard

Smoking before or after pregnancy may harm daughters' fertility

Exposing female mice to chemicals found in cigarette smoke before pregnancy or during the period in which they nurse their young impairs the reproductive capacity of their female offspring, a new study finds.

Many women stop smoking when they discover they are pregnant, aware that this habit endangers the baby. The new data suggest that may not be enough to protect their daughters' long-term reproductive health.

In mammals, females develop their lifetime supply of eggs—housed in the ovaries—while still in the womb or shortly thereafter. At menarche, women gradually begin to lose this dowry through monthly ovulation until their eggs run out at menopause.

However, data had suggested other factors, including cigarettes, can cut into egg reserves. For instance, women who smoke tend to reach menopause sooner than nonsmokers.

To test whether this risk is passed along to offspring, scientists injected female mice with two chemicals found in cigarette smoke, benzo(a)pyrene and 7,12-dimethylbenz(a)anthracene. Mice got one injection weekly for 3 weeks in doses that mimicked amounts ingested by a woman who smoked at least a pack of cigarettes a day. The scientists accounted for weight differences.

Shortly afterward, the mice became pregnant and delivered normal-size pups. Ovaries in the female pups were not normal, however. Examined shortly before the pups reached puberty, these ovaries had one-third fewer eggs than pups born to unexposed mothers, the researchers report in the December *Journal of Clinical Investigation*.

Another group of female adult mice exposed to the cigarette-smoke chemicals only after pregnancy, while suckling newborn pups, had female young with a similar dearth of eggs. Finally, female pups whose mothers were exposed to the chemicals before pregnancy and during lactation were missing two-thirds of the normal egg supply, notes study coauthor Andrea Jurisicova, a molecular biologist at the University of Toronto.

The most obvious explanation for the losses, Jurisicova says, "is that the [smoke] compounds are hanging around in the mom" and getting released during pregnancy or lactation. The chemicals may accumulate in fat, and then leach out slowly. "It's very likely that the compounds affect the primordial germ cell population being formed," she hypothesizes.

Smoking before pregnancy or during lactation poses a biohazard to the offspring's health, Jurisicova and her colleagues conclude.

Further experiments showed that resveratrol, a chemical derived from the skin of grapes, prevents egg loss. Female mice born to mothers given resveratrol had normal egg reserves, even when their mothers had also been exposed to the smoke chemicals. Research has suggested resveratrol offers a host of health benefits (*SN: 11/4/06, p. 293*). These now might include the ability to rescue germ cells from chemicals that would switch on a self-destruct mechanism, Jurisicova says.

"This is very interesting work indicating that maternal cigarette smoking may have transgenerational effects," says Jodi A. Flaws, an epidemiologist at the University of Illinois at Urbana-Champaign. "Future studies should examine whether there are similar effects ... in humans." —N. SEPPA

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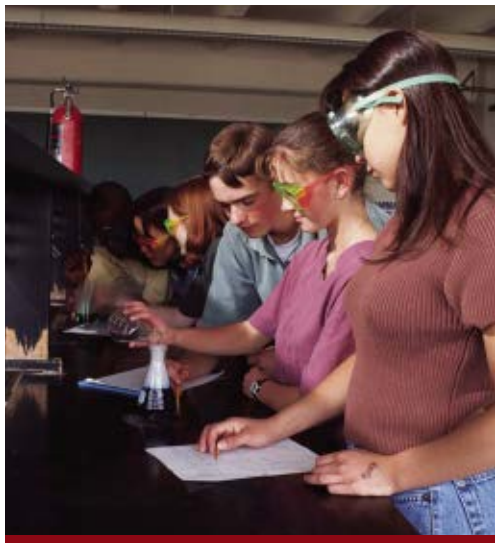
SHOWDOWN AT SEX GAP

Women's intrinsic math and science aptitude divides scientists

BY BRUCE BOWER

Here's a good way to inflame the tempers of all those within earshot. Do as former Harvard University President Lawrence Summers did in 2005 and suggest that the relatively low number of high-achieving women in mathematics and science partly reflects a lack of an inherent aptitude for such pursuits. Summers lost his job in the campuswide tumult that followed his remarks. But in the ambiguous world of research on sex differences and their influence on math and science abilities, Summers' saga prompted new attempts to clarify what scientists know and how their data apply to education and test taking.



GIRLS, INTERRUPTED — Researchers disagree about why more boys than girls take up math and science careers.

At an Oct. 1 meeting at the American Enterprise Institute (AEI) in Washington, D.C., scientists tried to hash out why females lag behind males in math and science achievement. Participants focused considerable attention on a recent extensive review that found a place for sex-related biological disparities in explaining such achievement differences as well as on an earlier report that dismissed biology as a factor.

The latter report was issued in 2006 by the 18-member Committee on Maximizing the Potential of Women in Academic Science and Engineering, convened by the National Academy of Sciences (NAS). "It is not lack of talent," the committee concluded, "but unintentional biases and outmoded institutional structures that are hindering the access and advancement of women" in technical fields.

Controversy greeted the NAS report, notes psychologist Susan M. Barnett of the University of Cambridge, England. Some researchers suggested that committee members held their own biases against acknowledging any sex-related biological differences in math and science aptitude.

Enter a consensus statement, published in the August *Psychological Science in the Public Interest*, written by six researchers with varying takes on the reasons for sex differences. They conclude that "early experience, biological factors, educational policy, and cultural context affect the number of women and men who pursue advanced study in science and math" and that "these effects add and interact in complex ways."

Psychologist Diane F. Halpern of Claremont (Calif.) McKenna College directed work on the consensus statement. She also spoke about sex differences to the NAS committee during its deliberations.

"Can we increase the number of women who enter careers in science and math? Yes," Halpern asserts. "Is there evidence of a sex-related biological component to success in science and math? Yes."

WHAT DIFFERENCE? At the AEI sessions, two psychologists challenged the assumption that biology in any way undermines women's math and science proficiency.

Psychologist Rosalind C. Barnett of Brandeis University in Waltham, Mass., noted that several research reviews—including analyses conducted by Janet S. Hyde of the University of Wisconsin–Madison, a contributor to the consensus statement—find no or minimal sex differences in math and science aptitude.

Although more males than females earn extremely high scores on standardized math tests, such scores predict surprisingly little about who will succeed in math and science careers, Barnett says. Among college-educated men with math, science, or engineering jobs, less than one-third scored 650 or better out of 800 on the math portion of the SAT.

Men's monopoly on high-level math and science achievements derives largely from unfair social and institutional advantages, the Brandeis psychologist says. For the past several hundred years, social forces have limited women's access to education and employment in the sciences, Barnett argues. Now, women receive the same education as men do but struggle against academic undercurrents of bias, she says. One study, cited in the NAS report, evaluated peer-reviewers' ratings of applications for postdoctoral fellowships in Sweden. Researchers found that a woman had to be twice as productive as a man in publishing research and in other areas of scientific achievement in order to be judged equally competent.

Productivity aside, boys and girls possess the same three mental systems at the core of mathematical and scientific reasoning, according to Harvard University psychologist Elizabeth Spelke, a member of the NAS committee.

"Evidence to date does not favor the hypothesis of a male advantage in intrinsic aptitude for math and science," Spelke says.

From infancy on, in her view, all typically developing children rely on one mental system that represents and reasons about objects, another that represents and reasons about numbers, and a third that does the same for geometric relations.

For instance, preschool-age boys and girls are equally adept at tracking items moving among distracting objects on a computer

PHOTODISC

screen. Moreover, infants of both sexes recognize approximate quantities of items.

Spelke and her coworkers have also tested 6- to 10-year-olds in the United States and in a remote Amazonian population for the ability to recognize relationships among simple visual forms and basic geometric concepts, such as distance and angle.

Overall, boys and girls performed comparably well on more than 40 geometric problems, Spelke says. Boys displayed superiority only on a mental-rotation problem, which requires a skill often incorrectly portrayed as the ultimate indicator of spatial ability, she argues.

BIO-LOGIC Neuroscientist Richard J. Haier of the University of California, Irvine got plenty of flak 20 years ago when he talked about possible intelligence-related brain differences between men and women. Now he gets a friendlier reception from people who attend his public lectures, even if such work still makes many academics uneasy.

"The NAS committee prematurely dismissed biological research on sex differences," Haier says. "The new consensus statement waffles a bit on the biological research as well."

Men and women display comparable general-intelligence levels, on a measure derived from IQ scores. Yet the brain may foster intelligence differently in the two sexes, Haier suggests.

In the April *Behavioral and Brain Sciences*, he and Rex E. Jung of the University of New Mexico in Albuquerque reviewed 37 brain scan investigations of intelligence published to date. They concluded that parts of the parietal and frontal cortex, in concert with a few other neural regions, form a network that orchestrates individual differences in intelligence and reasoning.

Studies suggest that this network critically supports men's intellect, including mathematical reasoning, Haier says. The same brain network modestly contributes to how well women do on various achievement tests.

Two large investigations conducted by separate teams indicate that girls call on a more distributed network of neural areas during reasoning tasks than boys do.

> "Evidence to date does not favor the hypothesis of a male advantage in intrinsic aptitude for math and science."
>
> — ELIZABETH SPELKE, HARVARD UNIVERSITY

The new consensus statement suggests that male brains often rely on enhanced communication within each hemisphere, as indicated by measurements of large numbers of neural connections on each side of the brain in men. In contrast, female brains may specialize in communication across hemispheres, the consensus statement proposes, with extra assistance from language-related areas.

Neural clues coincide with what researchers know about the development of math and science expertise among mathematically talented youth. Researchers have tracked the accomplishments of more than 5,000 individuals from junior high school to middle age. As 12- to 13-year-olds, about 500 scored 700 or more on the SAT math test or 630 or more on the SAT verbal test, placing them within the top 1 percent of test takers.

More boys than girls received the highest math scores, although this gap has narrowed over the past decade to about four boys for every girl.

A larger proportion of mathematically talented males than females entered math and science careers, according to psychologist and study director Camilla P. Benbow of Vanderbilt University in Nashville. However, mathematically talented girls displayed a broader range of verbal strengths than boys did and often achieved advanced degrees in areas that required all of their skills, such as law, medicine, and the social sciences.

PHOTODISC

MEASURED SUCCESS — Several lines of evidence suggest that sex-related biological factors contribute to math and science talent.

"Men choose more object-oriented jobs and women choose more people-oriented jobs, but so what?" remarks psychologist David Geary of the University of Missouri–Columbia. "Men and women report no differences in life satisfaction."

Neuroscientist Simon Baron-Cohen of the University of Cambridge in England suspects that sex differences involved in intelligence and social interest emerge early in life, possibly as a result of fetal exposure to varying levels of the sex hormone testosterone.

In several studies conducted since 2002, his team has found that high testosterone concentrations—identified in amniotic fluid during pregnancy—predict a youngster's tendency to avoid eye contact and to display a limited vocabulary at age 18 months as well as to show oral-communication difficulties at age 4.

These children typically show special interest in analyzing rule-based systems, involving computers, cars, and mathematics, for example. By age 8, they find it difficult to take another person's perspective and to react appropriately in social situations.

Boys display elevated testosterone concentrations more often than girls do, although some girls show this pattern as well, Baron-Cohen says. He theorizes that autism develops in extreme cases of fetal-testosterone overload and often fosters mathematical talent, despite its other drawbacks.

Certain patterns of sex differences indicate that evolution sculpted male and female intellectual capacities along different lines, asserts Geary. For instance, in a 2005 study, school-age boys scored better on tests of spatial rotation and map reading than girls did, but only if the boys lived in middle- or upper-income families. Low-income children exhibited no such sex differences.

In other words, Geary says, males showed a special sensitivity to poverty that eliminated their superiority on spatial tasks.

This fits with the hypothesis that, by taking charge of long-distance journeys, big-game hunting, and warfare during the Stone Age, males evolved an affinity for spatial tasks. Early deprivation affects the brain in ways that undermine males' evolved spatial aptitude, Geary proposes.

Still, the consensus statement, to which Geary contributed, notes that scientists sharply disagree about whether evolutionary forces lie behind the sex gap.

STEREOTYPE-CAST In 1995, psychologists Claude Steele of Stanford University and Joshua Aronson of New York University administered an achievement test to college students. One set of students was told that the test measured intelligence, whereas another group was told that the test was simply a research tool. Each group contained both black and white students.

Whites performed much better than blacks when taking a purported intelligence test, but the racial groups scored comparably well when they regarded the same test more neutrally. Steele and Aronson attributed this result to what they called stereotype threat, a sense of discomfort and distraction arising from subtle reminders of a group's negative reputation in a situation. For example, anxiety about having read that blacks do poorly on IQ tests might have interfered with black students' performance on the "intelligence test."

Numerous laboratory studies have implicated stereotype threat as a drain on the intellectual abilities and test proficiency of women as well as blacks. At the AEI meeting, Aronson described a study in which female college students performed especially

"Men choose more object-oriented jobs and women choose more people-oriented jobs, but so what?"

— DAVID GEARY, UNIVERSITY OF MISSOURI

poorly compared to male students on a spatial rotation test after having been asked to indicate their sex. However, much of the sex-related disparity disappeared when male and female test-takers were first reminded that they all attended an elite college.

"Cultural ideas about group differences can exacerbate or lessen those differences," Aronson says. "Intervention can boost performance and nurture intelligence so that biology need not mean destiny."

However, stereotype-threat research draws fire for saying little about real-world, high-stakes testing situations. "The claims routinely made on behalf of stereotype threat are vastly exaggerated," says neurologist and law professor Amy Wax of the University of Pennsylvania in Philadelphia. She uses social science research to examine public-policy issues.

Stereotype-threat studies often begin by statistically adjusting for the unequal prior test scores of men and women or of blacks and whites. Performance is then contrasted between groups either exposed to or protected from stereotype threat. Psychologist Paul R. Sackett of the University of Minnesota in Minneapolis and his coworkers argue that this approach indicates only that, absent stereotype threat, men and women, or blacks and whites, would display the same achievement gaps as they did before the experiment.

Moreover, stereotype-threat studies have not examined male and female samples that reflect the sex gap in math performance observed in the general population. As a result, it's impossible to estimate whether stereotype threat accounts for 90 percent of that gap, 5 percent of it, or some other proportion, Wax says.

Psychologist Lawrence J. Stricker of the Education Testing Service in Princeton, N.J., doubts that stereotype threat sways scores on actual achievement tests. In a 2004 study, Stricker and a colleague collected information on race and sex either before or after 1,652 high school students took an advanced-placement test in calculus. The researchers did the same for 1,341 incoming community college students taking a battery of placement tests.

Stereotype threat, in the form of being reminded of one's race and sex before the test, did not lower women's calculus or math scores. Neither did it lower black students' overall scores on the two tests.

However, a reanalysis of Stricker's data using a looser statistical standard of success found that stereotype threat indeed lowered women's calculus scores. Psychologists Kelly Danaher and Christian S. Crandall, both of the University of Kansas in Lawrence, estimate that 5.9 percent more women and 4.7 percent fewer men would receive passing scores if they indicated their sex after taking the test rather than before.

This "simple, small, and inexpensive change" would boost the number of U.S. women receiving advanced-placement calculus credit by more than 4,700 annually, Crandall says.

Stricker calls that conclusion "sensational but unwarranted." Crandall's projection is unreliable because the original advanced-placement sample was not chosen to represent the sex gap among all test takers, he says.

However this dispute shakes out, the rampant sexism that math- and science-oriented women struggled against in past decades shows signs of decay. As one young woman who recently earned an undergraduate degree in biochemistry and pharmacology put it at the AEI meeting, "Most of my professors didn't look up from their podium long enough to realize that I was a woman, much less care. When I would fail an exam, I wouldn't say, 'Gosh, I wish my brain was more predisposed to science.' It was 'I really should have studied a hell of a lot harder than I did.'" ■

BAD VIBRATIONS

The ancient craft of bridge design still holds surprises

BY MASON INMAN

In the middle of rush hour on Aug. 1, at 6:04 p.m., traffic zoomed across the westbound span of the I-35 Mississippi River bridge in Minneapolis. By 6:05, the 40-year-old structure had buckled and broken, dumping most of the bridge into the river and killing 13 people. Though it came as a shock, this was in retrospect an accident waiting to happen, experts say. The Minneapolis bridge had been poorly maintained, with cracks in its iron arches that had been patched up over the years. And the bridge's design lacked redundancy.

"This is a classic example of how ... a single failure can lead to a collapse," says Spiro Pollalis, a bridge designer who teaches at Harvard University. "At the time [the bridge was built], it was considered an acceptable risk," he adds. "Now we try to be more careful."

Whether because of obsolete design or disrepair, thousands more U.S. bridges are similarly at risk, according to the American Society of Civil Engineers' 2005 "Report Card for America's Infrastructure." Yet the majority of bridges built in the 1950s and 1960s are still holding up, even though they typically carry much more traffic than they were designed to handle.

With increasingly sophisticated computer tools and wind tunnel tests, and more-detailed understanding of steel, concrete, and other materials, engineers have a better grasp than ever of how bridges work. But some recently built bridges have surprised their designers by showing disturbing and unexpected vibrations.

Every new bridge that's different from those that have been built before—with a longer span, say, or a novel design—represents a leap into the unknown. "Until you build structures, they really are like scientific hypotheses," says Henry Petroski, a civil engineer and historian at Duke University in Durham, N.C. "If it's never been done before, no matter how many theoretical supports you have, the proof is only in building it."

TWIST AND POUT — The original Tacoma Narrows bridge fluttered in the wind until it snapped.

CORBIS

LESSONS LEARNED The most famous bridge collapse in history—caught on film and burned into engineers' memories—was the 1940 failure of the Tacoma Narrows suspension bridge, south of Seattle. Nicknamed "Galloping Gertie" because of the way its roadway wriggled in the wind, the bridge failed spectacularly after being open just 4 months. High winds induced the bridge's extraordinarily slender deck—the horizontal span that carried the roadway—to twist back and forth, wrenching the structure past its breaking point. "That was obviously an inferior design," says Khaled Mahmoud, president of Bridge Technology Consulting in New York City. "It did not provide enough stiffness for the bridge."

The disaster impressed on engineers the need to understand bridges' aerodynamics—that is, the way they respond to wind-generated forces. Today, engineers typically conduct wind tunnel tests of full-scale sections of a bridge's decks and sometimes also of a scale model of the entire bridge, occasionally set in a mock-up of the surrounding landscape. Computer modeling can complement such empirical tests, and allow engineers to factor in the inevitable imperfections in steel beams and other parts, says David Goodyear of the San Francisco engineering firm T.Y. Lin International.

Such methods have not only made traditional bridge designs safer but have allowed architects and engineers to try innovative designs that may be more cost-effective but are also more difficult to analyze.

These trends are behind the increasing popularity of so-called cable-stayed bridges, which typically sport towers of solid concrete that anchor high-tension cables running in straight lines down to the deck, either splayed like the ribs of a handheld fan or parallel to each other like harp strings. Usually the cables run from both sides of the tower down to the roadway in a symmetrical pattern, so the forces pulling on the tower from each side are in balance.

But that general form allows a wide variety of designs. Some cable-stayed bridges have separate spires on either side of the roadway; others have a single tower in the center of the bridge, with cables running to both sides of the roadway. Some have a triangular arch over the roadway. And some even have a leaning tower that balances the tension in the cables with its own weight. Compared with suspension bridges, cable-stayed bridges give engineers much more "freedom of expression," Petroski says.

They're also typically cheaper. A suspension bridge needs large anchors sunk into the ground at both ends to support the tension of the cables. In a cable-stayed bridge, by contrast, tension is balanced where the cables meet at the central tower, and no external anchoring is needed. Such bridges must have taller, thicker towers and stiffer decks than suspension bridges do, but can use thinner, shorter cables.

A recent innovation could make cable-stayed bridges even more attractive. Figg Engineering Group in Tallahassee, Fla., has pioneered a "cradle" in which cables are routed through a curved tube set inside the central tower rather than being anchored to the tower. This seemingly subtle change has big repercussions. It makes the bridge simpler and allows individual strands of a multistrand cable to be pulled out and inspected while the bridge is in use.

With this system "you can test new kinds of cables in the context of a new bridge, and if they fail, you can replace them," says Petroski. On the Penobscot Narrows Bridge, between Bangor and Brewer, Maine, one of two bridges in the United States that use the cradle system, engineers have installed test strands of carbon-fiber composite in a few of the cables.

CHARISMATIC CABLES — Eye-catching cable-stayed bridges, like Boston's Zakim-Bunker Hill Bridge, are becoming city showpieces.

SHIMMIES AND SHAKES

Although the calamity that befell the Tacoma Narrows bridge has not been repeated, some cable-stayed bridges have suffered wind-induced trouble of a novel kind. In the mid-1980s, reports came in that moderate winds of about 20 to 50 kilometers per hour could set these bridges' cables fluttering. The phenomenon usually happened only during light or moderate rain—something that puzzled engineers for years.

These vibrations can make cables sway by more than a meter at their midpoints—not enough to bring a bridge crashing down, most experts say, but potentially enough to shorten a bridge's life span through wear and tear on the cables and their anchors.

In the early 1990s, a combination of lab tests and field measurements suggested that moderate winds can cause rain to trickle in rivulets down the cables, which typically have a smooth plastic coating. The resulting change in the cable's profile can affect the way it reacts to wind, creating an aerodynamic instability that sets the cable vibrating at some resonant frequency, somewhat like a guitar string. "While the cause is known, it still remains impossible to predict the cable-excitation process from first principles," says Anton Petersen of COWI, an engineering firm in Kongens Lyngby, Denmark, that consults on many of the world's biggest bridges. "The physical mechanism responsible ... is still an active area of research," he says.

A team led by Emmanuel de Langre at the École Polytechnique in Paris recently developed the first mathematical model to predict how the rivulets will run on a cable vibrating in the wind. Their model, described in the October *Journal of Wind Engineering and Industrial Aerodynamics* supports earlier ideas that wind pressure, along with friction between the water and the cable, causes the rivulets to form.

Engineers have been installing retrofits to deal with vibrating cables. "We don't have any cases where the problems were not corrected," Harvard's Pollalis says.

One solution has been to add cables that run between the main stay cables. Tying the cables together creates a more complex aerodynamic response and removes the simple resonance that can lead to vibration.

More popular now are dampers, like shock absorbers, that attach to the stay cables near where they connect to the deck. China's Dongting Lake Bridge, a midsize cable-stayed bridge in northeast Hunan Province, was the first to employ a new kind of sophisticated damper incorporating a magnetorheological fluid. When the cables start to vibrate, it triggers the damper to turn on a magnetic field. This causes the fluid—which has iron nanoparticles suspended in it—to stiffen, putting resistance on the cable. Tests show that it works better than earlier dampers, according to a study by Jan-ming Ko and his colleagues at the Hong Kong Polytechnic University in the April 2006 *Journal of Intelligent Material Systems and Structures*. Other researchers are working on subtler ways of fixing these vibrations, using bumps, wires, or flanges that wrap in a helix around the cables to break up the flow of water.

Another kind of vibration, familiar but still capable of causing surprises, can afflict pedestrian bridges. Engineers know to design bridges so that they don't have a natural vibration frequency close to 2 Hertz, because that's the frequency that an average person's footsteps hit the ground. Soldiers have long been ordered to break step when crossing a bridge so as not to set it oscillating. Failure to take that precaution seems to have contributed to the collapse of at least two suspension bridges. One in Manchester, England, collapsed in 1831 with 60 soldiers on it, and in 1850 the Dordogne Bridge in France fell, killing more than 220.

A variant of this old problem resurfaced when London's Millennium Bridge opened to fanfare in 2000. Hundreds of people surged across, but within minutes, many of them were hugging the handrails as the bridge slithered back and forth like a snake. After only a couple of days, officials shut the bridge.

The bridge's engineers at the London-based firm Arup studied the bridge, checked the literature, and found that the same thing had happened before on at least a few other pedestrian bridges. However, as they said in a report about the Millennium Bridge, "these cases have not been widely published and as a result the phenomenon has not become known to practicing bridge engineers."

Even after Arup retrofitted the bridge with dampers that prevented the swaying, the reason for it was obscure. Researchers surmised that the instability might begin because of people's tendency to push sideways a little with each step as they walk. In the Nov. 3, 2005 *Nature*, a team led by applied mathematician Steven Strogatz of Cornell University showed how feedback between pedestrians and the bridge could turn this effect into wholesale swaying. A few people falling into step by chance could make the bridge sway a little. Then other people would tend to fall into step because synchronizing one's pace with the bridge is more comfortable than fighting the sway—except that this positive feedback would only make the bridge sway more.

These problems with swaying footbridges and vibrating cables are more of a nuisance than a real danger, most experts say. But it's hard to know what would happen if they weren't dealt with. "Swaying could have led to failure of Millennium Bridge," Petroski says.

GOING FURTHER

Despite computer modeling and wind tunnel tests, vibrations in new bridges caused by pedestrians, wind, and rain came as a surprise to engineers. "There's always a question whether scale models really reflect the full bridge," Petroski says. The models are typically built of wood, fishing line, and other materials totally different from steel and concrete, but they are tuned to have stiffness and elasticity similar to what's predicted for the real bridge, says Guy Ferguson of RWDI, a wind-engineering firm in Guelph, Ontario.

Whether computers can supplant empirical models remains debat-

GETTYIMAGES

able. With improvements in computational fluid dynamics to describe wind flows, "maybe in 10 years, [computer simulations] may take over from wind tunnel tests," Goodyear says. But others disagree. "We're still a long way away from that," Ferguson says. "There's so much going on in a wind tunnel—to model it accurately [on a computer] is next to impossible."

Even as computer simulations improve, more surprises could spring up as engineers push bridges to longer spans, and try out simpler, cheaper, or more daring designs. One idea that's been floating around for a few decades is for a buoyant tunnel that sits just under the surface of the water. A team of Italian and Chinese engineers is aiming to build such a tunnel to span the 3-km Jintang Strait on the coast of Zhejiang Province, China. The engineers call it an Archimedes bridge, after the ancient Greek mathematician who first understood the principle of buoyancy.

The Archimedes bridge would stay in place through buoyancy, counteracted by cables tethering it to the floor of whatever body of water it crosses. Such a bridge would be much cheaper than a suspension bridge, and might be the only way to cross spans longer than a few kilometers, argues Federico Mazzolani of the University of Naples in Italy. "In principle, we can cross a span of 20–30 km without any difficulties."

ISTOCKPHOTO

LEANING TOWER OF SEVILLE — Architect Santiago Calatrava went out on a limb with the unusual Alamillo Bridge in Spain.

"But nobody wants to be the first one to build it," he adds. For now, Mazzolani and his colleagues are aiming to build a much smaller prototype, a pedestrian bridge in a lake in China, just 100 m long and a couple of meters underwater. "We will use it as a full-scale laboratory," Mazzolani says, to try out the manufacturing and see how the tunnel reacts to vibrations. But he has his sights on distant shores. "After the prototype is built, it will be a revolution in bridge design."

For modest-size bridges, engineers are confident they understand the mechanics well enough to take more liberty with the designs, blurring the line between architecture and engineering, Pollalis argues. "You can take this in two directions," he says. "You can make things cheaper and more efficient, or you can make them more appealing. But people aren't so interested in having things cheaper." The growing popularity of cable-stayed bridges, Petroski argues, is in part because communities want distinctive, signature bridges.

As the recent collapse of the bridge in Minneapolis showed, it's not just the design of a bridge that gives it a long life but also how it's maintained. But the two may be tightly intertwined. "My old adviser ... used to say, if you want a bridge to last, make it beautiful, because people will want to preserve it," Goodyear says. "If it's ugly, people will want to tear it down." ■

OF NOTE

TECHNOLOGY

A smaller magnetometer

A sensor the size of a rice grain can detect magnetic fields as small as those produced by brain waves, researchers report.

John Kitching of the National Institute of Standards and Technology in Boulder, Colo., and his colleagues filled a millimeter-wide silicon cylinder, sealed by glass at both ends, with a gas of about 100 billion rubidium atoms. Under normal conditions, shining a laser through the container causes the spins of the atoms to line up.

The presence of a magnetic field, however, tips the atoms out of alignment. The disoriented atoms absorb some of the light from the laser beam, so by measuring how much light passes through the cylinder, the scientists can infer how misaligned the rubidium atoms are. The misalignment provides a measure of the strength of the magnetic field, the researchers report in the November *Nature Photonics*.

Kitching says these tiny sensors could be used noninvasively to measure brain waves or fetal-heart waves.

The detectors "are small, can run on low power, and could be very low cost," he says. "That's what gives them such great possibility for applications." —S.C.W.

BIOLOGY

Eastern farms have native-bee insurance

Watermelon fans can stop biting their nails, at least around the Delaware Valley region. Even if the beleaguered honeybees disappear, native bees should be able to buzz in and take care of most of the crop by themselves, says a new study.

It's a compelling example of biodiversity as insurance, says Rachael Winfree of Princeton University.

U.S. farmers who need pollinators for their crops use European honeybees (*Apis mellifera*). Those bees have had their troubles lately, with parasitic mites and colony-collapse disorder, among other ills (*SN: 7/28/07, p. 56*). But the United States has hundreds of species of native bees that drop in on farms.

Within the past 5 years, two studies have analyzed the role of native bees as pollinators on watermelon farms. The studies found that the natives assisted but that their numbers were rarely large enough to pollinate entire crops, reports Claire Kremen of the University of California, Berkeley and her colleagues. Where wild lands were scarce within a bee's flight from the field, native bees were scarce too.

Kremen's studies took place in and near the intensely managed agricultural lands of California's Central Valley. In the new

study, Winfree, Kremen, and their colleagues turned to the Delaware Valley of New Jersey and eastern Pennsylvania, where more scraps of natural vegetation survive amid the farmland.

The researchers tallied bees visiting watermelon plants on 23 farms. Computer simulations based on those observations predict that native bees alone could handle the job at 21 of the farms, the researchers report in the November *Ecology Letters*. —S.M.

ASTRONOMY

One star, five planets

With the discovery of a fifth planet circling the nearby star 55 Cancri, astronomers have found the richest—and heaviest—planetary system beyond the sun's.

The sunlike star 55 Cancri lies just 41 light-years from Earth. Exoplanet hunters found the fifth planet by recording the tiny wobble it induces in the motion of its parent star—the same way researchers found the four other orbs. Three of those earlier finds, ranging in mass from that of Neptune to that of Jupiter, have orbits smaller than about one-tenth Earth's distance from the sun. The fourth is about four times as massive as Jupiter and circles 55 Cancri at about Jupiter's distance from the sun.

PLANETARY MENAGERIE
Artist's depiction of four of the five planets known to orbit the nearby star 55 Cancri. The recently discovered fifth planet looms largest. The star's three innermost planets are seen in the background.

Theorists predicted that the large gap between the inner and outer planets could accommodate an additional planet in a stable, circular orbit, provided it was not too large. The newfound planet fills the bill, residing at a distance of about three-quarters Earth's separation from the sun and weighing at least 45 times as much as Earth, Debra Fischer of San Francisco State University and her colleagues announced at a Nov. 6 NASA briefing.

That orbit places the planet in the star's habitable zone—the region where water can be liquid. The new planet is presumably a giant ball of gas, but if it has moons, "like all the giant planets in our solar system, then the moons could provide a rocky surface for liquid water to pool," says Fischer.

The planetary entourage of 55 Cancri "exhibits the 'fullness' of our solar system," notes Fischer. "It is hard to find a place in the inner part of that planetary system where another planet could be hiding." If other planetary systems are similarly full, she adds, "we'd know exactly where to look for the currently invisible Earths: the empty, unperturbed habitable zones of nearby stars." —R.C.

MATHEMATICS

Net advantage

Some complex networks are resilient. Cut out one of the hubs in the Internet's backbone, for example, and information will find alternate routes through other hubs. In some cases, however, cutting connections can make a network so inefficient as to be unusable, researchers have now shown.

Eduardo López of the Los Alamos (N.M.) National Laboratory and his collaborators looked at a variety of abstract networks and randomly cut links between nodes. Even when up to 60 percent of the links had been severed, the networks usually stayed connected—meaning that for any two nodes, a path still existed between them. But as links were cut, the average distances between nodes got longer.

For disruptions in certain kinds of networks, such as those modeling interconnected roads or the spread of a disease epidemic, a threshold is quickly reached beyond which getting from one node to another becomes impractical, the team writes in the Nov. 2 *Physical Review Letters*.

For disease epidemics, therefore, measures such as quarantines or travel restrictions can slow contagion enough that the epidemic would peter out. In the case of the Internet, data should still be able to reach its destination unless all the principal hubs are cut off, López says. "The Internet will continue to be resilient unless the failures occur in a very targeted way." —D.C.

NANOTECHNOLOGY

Crystal clear

Wires just a few nanometers thick are among the technologies that could lead to improvements in memory chips and high-resolution displays. The challenge, however, has been to assemble nanowires in regular patterns in order to build large numbers of devices such as transistors or diodes on a single chip. Babak Nikoobakht of the National Institute of Standards and Technology in Gaithersburg, Md., has now managed to grow nanowires exactly where they're needed.

Nikoobakht first placed an orderly array of gold nanodroplets on a sapphire crystal surface. He then exposed the droplets to a hot gas of zinc oxide. The droplets acted as catalysts, each one spawning the growth of a zinc oxide crystal just 10 or 15 nm across.

The sapphire's molecular structure made all the zinc oxide crystals grow on its surface in the same direction, which pushed the gold droplets along. With each nanodroplet acting "like a printer" on the sapphire's surface, says Nikoobakht, the resulting zinc oxide trails formed a regular array of nanowires. Nikoobakht was able to fine-tune his process to make the nanowires grow to lengths of a few hundreds of nm to 50 microns.

By adding layers of different materials, Nikoobakht was able to use the nanowires as building blocks for transistors and diodes, he reports in the Oct. 30 *Chemistry of Materials*. He says that the technique might be useful for imprinting high-density memory chips. Because zinc oxide is transparent but can also emit light, the nanowires could also work as components of transparent semiconducting displays, he says. —D.C.

EPIDEMIOLOGY

9/11 reflux

A series of studies has found that workers who were near Ground Zero shortly after the 9/11 attacks in New York City suffer respiratory problems at rates much higher than the general public. Up to 20 percent of those workers also experience symptoms of gastroesophageal reflux disease (GERD), also called acid reflux.

Since October 2001, the New York City Fire Department and a consortium of academic medical centers have screened nearly 40,000 first responders, construction workers, and others who spent time at or near the World Trade Center site after the attacks.

The most recent data show that 5 to 10 percent of those screened suffer significant GERD and that about 20 percent show at least some symptoms of the disorder, says Paul Landsbergis of the Mount Sinai School of Medicine in New York City. He presented the data at a Nov. 5 meeting of the American Public Health Association in Washington, D.C.

Landsbergis says that many workers with GERD probably swallowed some of the highly alkaline dust that wafted in the air for weeks. With a pH of 10 or 11, the dust—primarily pulverized concrete—could easily damage the esophagus, he says. —B.V.

JPL/NASA

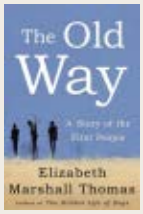
Books

A selection of new and notable books of scientific interest

THE OLD WAY: A Story of the First People

ELIZABETH MARSHALL THOMAS

During the 1950s, anthropologist Elizabeth Marshall Thomas lived among the San, also known as Bushmen, in a remote part of southern Africa's Kalahari Desert. Drawing on her field experiences, Thomas argues that the San were among the last modern people to live according to the Old Way—a system of prudent, simple practices and beliefs that sustained untold generations of hunter-gatherers. Thomas describes the San approach to finding water holes, hunting game, and foraging for roots and berries. She explains marriage customs aimed at expanding family social ties. She also writes of the many gods in the San belief system and the tradition of trance dancing. Thomas portrays the Old Way as a template that still has plenty to teach us. Yet Bushmen no longer live in the Old Way, and their traditions are nearly lost. Thomas offers suggestions as to how to revive some of those practices. ***Farrar, Straus and Giroux, 2006, 368 p., b&w illus., hardcover, $27.00.***



THE VOYAGE OF THE BEETLE

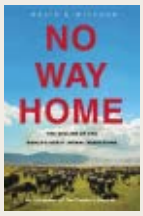
ANNE H. WEAVER

Darwin scholars may reel at anthropologist Weaver's revelation that a large part of the theory of evolution derived from hints provided by a friendly rose chafer beetle. The younger readers (fourth grade and up) that this generously illustrated book targets may prove more open-minded. Weaver lets Rosie the beetle tell the story. Darwin is still a student when he takes Rosie home. She accompanies him on the *H.M S. Beagle* as he ponders what he calls the mystery of mysteries: Why are there so many species on Earth, each fitted to its environment? He and Rosie discuss the wonders they see, illustrating how observations of insects, sea slugs, and such led to the idea of natural selection. Rosie feeds Darwin clues in gentle bits, predicting that readers will understand evolution before he does. ***Univ. New Mexico, 2007, 80 p., b&w and color illus., hardcover, $16.95.***

NO WAY HOME: The Decline of the World's Great Animal Migrations

DAVID S. WILCOVE

Salamander fanciers may thrill to the sight of a spotted species in Maine on the move to breeding ponds, making perilous treks of up to 150 yards. Migration is far easier on spectators than on the Arctic terns' trip to their nesting sites—a journey that takes them from the Antarctic Ocean to the Bering Sea. There's a migration for nature fans of just about any taste: Tens of thousands of species make back-and-forth seasonal movements. Ecologist Wilcove, a professor at Princeton University, celebrates these journeys with vignettes of species and the scientists who study them. Organized into migrations by air, land, or water, the survey reveals human threats to these natural marvels. Habitat destruction, overexploitation, and climate change are taking their toll, as are roads and other human creations. Wilcove concludes with ruminations on the challenges of protecting migrants, such as the difficulties of coaxing jurisdictions to cooperate when animals migrate on a tern's scale instead of a salamander's. ***Island Press, 2007, 240 p., b&w illus., hardcover, $24.95.***



AUTO MANIA: Cars, Consumers, and the Environment

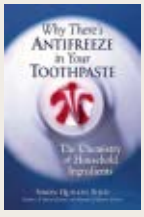
TOM McCARTHY

As crude oil approaches $100 per barrel, wallet pain, more than any fears of global warming, may eventually lead Americans to reconsider their thirst for ever-heavier and ever-faster cars and trucks. Since Henry Ford's invention of the mass-produced car, consumers have chosen what to drive based less on the environmental consequences—which include not just tailpipe emissions but the full product cycle, from mining to disposal—than on the allure of the car as a status symbol, McCarthy argues. He tells the story of a nation's affair with four wheels and of how the car's role as cultural icon has influenced its evolution. When considering the car's impact on the environment, it is simplistic to blame it all on Detroit's "big three" or the inadequacy of government regulations. One case in point, McCarthy writes, is the astonishing rise of the SUV, which took even car manufacturers by surprise. ***Yale Univ., 2007, 368 p., b&w illus. and photos, hardcover, $32.50.***

WHY THERE'S ANTIFREEZE IN YOUR TOOTHPASTE: The Chemistry of Household Ingredients

SIMON QUELLEN FIELD

Ever scan the ingredients listed on a product label and wonder what those chemicals are and what they do? While reading his shampoo bottle one morning, chemist Simon Quellen Field discovered a seemingly inappropriate ingredient: salt. Turns out that this common substance isn't just a table seasoning: It's a shampoo thickener too. In this in-depth reference, Field explains the purposes of some of the thousands of chemicals in products we use every day. Each entry provides the chemical formula of the ingredient and a drawing of its molecular structure. Capsaicin, the chemical that makes chili peppers hot, also dilates blood vessels and relieves pain from arthritis, muscle aches, and sprains. Xanthan gum, a slimy gel produced by a particular species of bacteria, thickens many sauces, prevents ice crystals from forming in ice cream, and provides the "mouth feel" of fat without the calories. Learn about the surprising, and sometimes alarming, chemicals used in household products. You'll be amazed at what's in hairspray! ***Chicago Review Press, 2007, 240 p., paperback, $16.95.***



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LETTERS

Blame where it's due

Although multinational agreements on global warming try to spread the burden among all nations, data from the MILAGRO project in Mexico City ("What Goes Up," *SN: 9/8/07, p. 152*) suggest that the major responsibility for excess production of greenhouse gases and other pollutants lies with the megacities, which constitute a rather small number of culprits and ones that not all nations possess. Perhaps global, and indeed national, initiatives to control air pollution should focus on compelling these megacities to curb their waste.

JAMES M. BRYANT, RIVERSIDE, CALIF.

Less would mean more

The news is filled with observations of our species' role in global warming and in the depletion of fisheries, arable land, fresh water, and fossil fuels ("Invasive, Indeed," *SN: 10/13/07, p. 235*). Yet I seldom hear the size of the human population cited as a driving force behind these problems. The easiest path to reducing our environmental footprint would be to slow our population's growth rate—after all, it takes a foot to make a footprint. Has our evolutionary drive to multiply also endowed us with a blind spot when it comes to recognizing the peril of our numbers?

PATRICIA LEITNER, OAKLAND, CALIF.

Ultimately, Malthus was right: No technology can save us from unfettered population growth on a planet with finite resources.

LEANDRA VICCI, SILK HOPE, N.C.

Health shake

Mild vibration encourages precursor cells to turn into muscle and bone ("Good Buzz: Tiny vibrations may limit fat-cell formation," *SN: 10/27/07, p. 260*). This seems like something NASA could use to keep astronauts fit.

RICH DESILETS, SANTA ROSA, CALIF.

Not so nice

"Platinumfree fuel cell" (*SN: 10/20/07, p. 253*) describes hydrazine hydrate as a benign and cost-effective alternative fuel to hydrogen. But hydrazine hydrate is a fuming liquid that is toxic, very corrosive, and can decompose explosively. In a reaction with hydrogen peroxide, it powered the German V-2 rockets in World War II.

CARL F. GUERCI JR., SEVERNA PARK, MD.

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