SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

SEPTEMBER 20, 2003 PAGES 177-192 VOL. 164, NO. 12

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smallest laser

building body asymmetry

spinal clues to alzheimer's?

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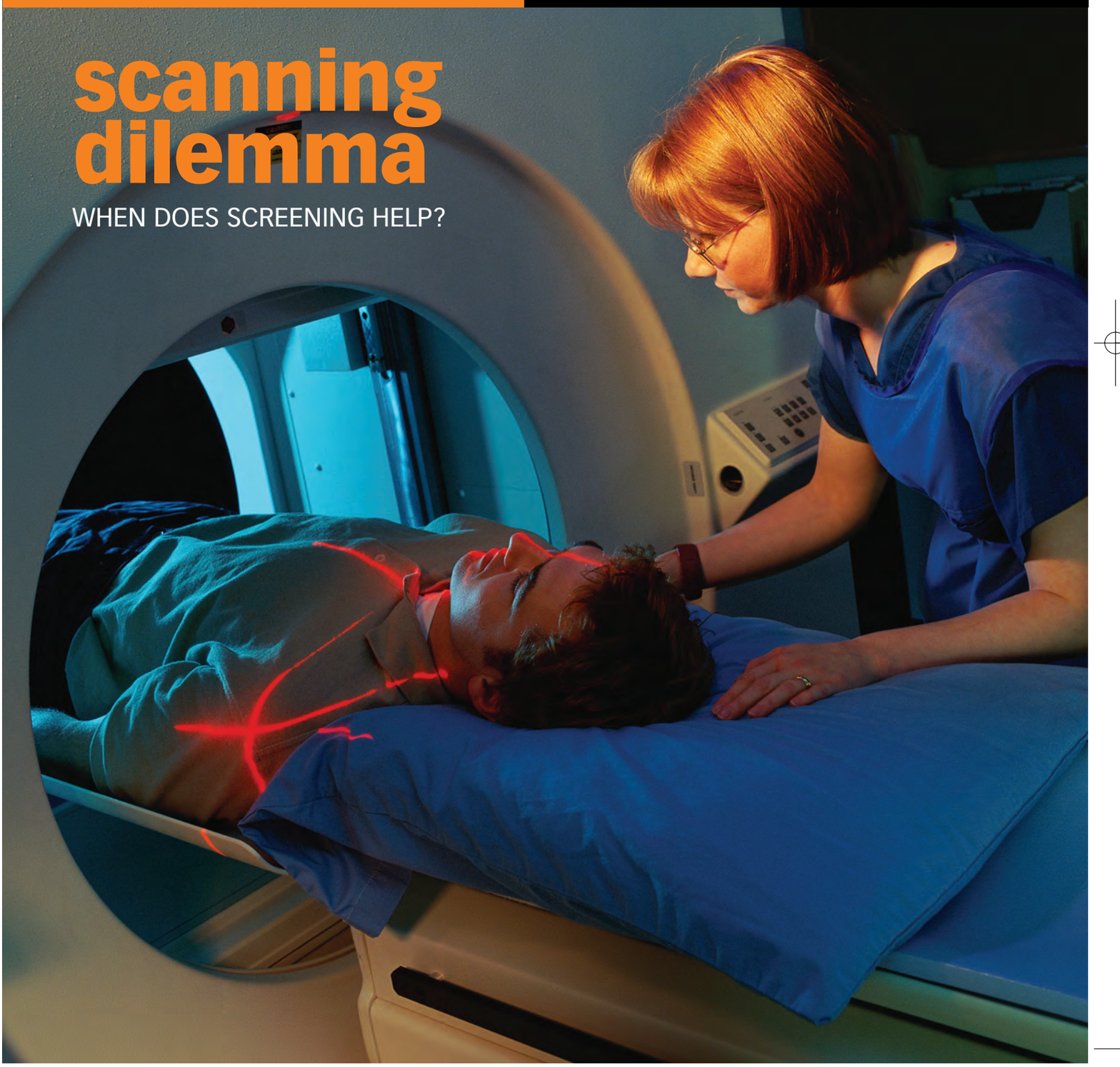
scanning dilemma

WHEN DOES SCREENING HELP?



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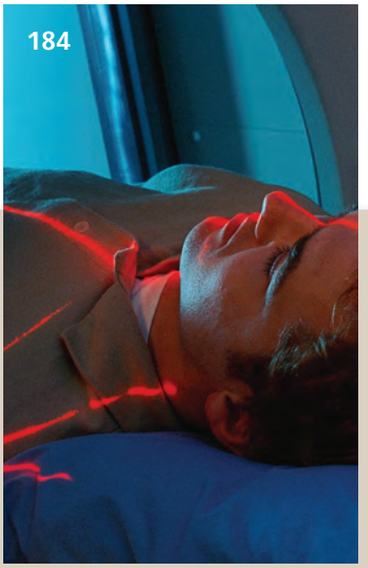

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Of Note

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Cover A new rage in consumer health care is the scanning of the torso for latent disease. Although some special applications appear promising, researchers caution that there are many drawbacks that consumers aren't aware of when they sign up for the procedure. Page 184

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Ratzilla

Extinct rodent was big, really big

Think the rodents you've seen in movies are scary? Scientists who've analyzed the fossilized remains of an extinct South American relative of guinea pigs say that the ancient bruisers were as large as bison.

Researchers first described *Phoberomys pattersoni* in 1980 but until recently had only bone fragments and isolated teeth to study. Despite that limitation, scientists suspected that the animals were huge, says Marcelo R. Sánchez-Villagra, a paleontologist at the University of Tübingen in Germany.

Now, analyses of newly recovered fossils, including a nearly complete skeleton, have enabled Sánchez-Villagra and his colleagues to refine estimates of *Phoberomys*' size. They put it at about 740 kilograms, easily earning the species the title of heavyweight rodent of all time. A disproportion between the front and rear limbs suggests that the creature could rest on its haunches and manipulate food with its front paws like its modern relatives do, says Sánchez-Villagra.

The new fossils, which the researchers describe in the Sept. 19 *Science*, were excavated from 8-million-year-old rocks in northwestern Venezuela. The team also unearthed the remains of crocodiles, fish, and freshwater turtles from the same layer of brown shale, says Sánchez-Villagra. These companion fossils hint that *Phoberomys* led a semiaquatic life and probably grazed on aquatic grasses. Examinations of the sediments suggest that the region was probably a river delta surrounded by brackish wetlands, Sánchez-Villagra notes.

Phoberomys belongs to a group of rodents called caviomorphs. Scientists have evidence that the group evolved in South America about 40 million years ago, a time when that land mass was isolated from other continents. Because South America didn't have any grazing animals such as horses, cows, or antelopes, the caviomorphs seem to have diversified to fill wide-open ecological niches. Living caviomorphs include guinea pigs, chinchillas, and capybaras, which at 50 kg weigh in as the largest living rodents.

C.L. CAIN/SCIENCE

HIDE THE CHEESE **A bison-size rodent, *Phoberomys pattersoni*, grazed on aquatic grasses and roamed the riverbanks of ancient Venezuela about 8 million years ago.**

Being big can be an advantage for plant eaters, says C. William Kilpatrick, a molecular evolutionist at the University of Vermont in Burlington. In general, heftier herbivores have longer digestive tracts and can extract more nutrition from low-quality leaves and grasses than smaller herbivores with shorter guts can.

While South America was isolated from other landmasses for millions of years, a unique fauna developed. The mammalian predators there during that isolation were marsupials, which were less efficient at hunting than were other predators, such as big cats, that had evolved on other continents. Moreover, most of the South American predators were smaller than those on other continents, a characteristic that could have driven herbivores to evolve into large forms less prone to predation.

As often is the case in evolution, the megarodents' golden age came to an end. When a land bridge formed between North America and South America between 5 million and 2 million years ago, the fierce predators that invaded South America wreaked havoc on the plant eaters there, especially those too large to burrow underground. —S. PERKINS

Early Warning?

Spinal fluid may signal Alzheimer's presence

Although it's the most common type of dementia, Alzheimer's disease is notoriously difficult to diagnose. When confronted with a confused and forgetful patient, a doctor must first rule out other brain disorders by putting the patient through a battery of psychological tests, brain scans, and various health assessments. The diagnosis can take months.

In search of a more precise diagnostic tool, researchers have been looking for signs of the disease in people's spinal fluid. In the September *Archives of Neurology*, a Swiss team reports that spinal-fluid concentrations of forms of two compounds already linked to the disease—tau protein and beta-amyloid peptide—may reveal whether a person has Alzheimer's disease.

The researchers obtained spinal fluid from 51 people whom doctors had judged to have Alzheimer's disease, 30 people with other forms of dementia, 19 people who had brain disorders not associated with dementia, and 31 healthy individuals. The average age of the participants was 67 years.

The Alzheimer's patients had significantly less beta-amyloid peptide and more tau protein in their spinal fluid than people in the other three groups did, says study coauthor Christoph Hock of the University of Zurich. Both findings are consistent with results from previous studies by others.

Hock and his team took an additional step by calculating the ratio of tau protein to beta-amyloid peptide and found that Alzheimer's patients averaged 147 times as much of the protein as the peptide, whereas healthy people averaged only 39 times as much. That ratio was calculated to be 74 for people with non-Alzheimer's dementias and 48 for those with other brain disorders.

Knowing the ratio of tau to beta-amyloid could "help in early and accurate detection of Alzheimer's disease," Hock says. Before the measurement can serve in the clinic, however, additional studies will be required, he says.

Alzheimer's disease is marked by the

death of brain cells, or neurons. Filaments of tau protein accumulate inside these cells, and plaques of beta-amyloid peptide collect outside the cells. When neurons die, one hypothesis holds, they release tau into the spinal fluid, whereas beta-amyloid, being sticky, stays in the brain. In this study, the scientists measured phosphorylated tau, the major component of tau filaments, and beta-amyloid peptide$_{42}$, the chief constituent of beta-amyloid.

There is no cure for Alzheimer's disease, although drugs called acetylcholinesterase inhibitors improve symptoms in some people with mild disease. Researchers are investigating experimental drugs aimed at forestalling the brain damage, says Trey Sunderland of the National Institute of Mental Health in Bethesda, Md.

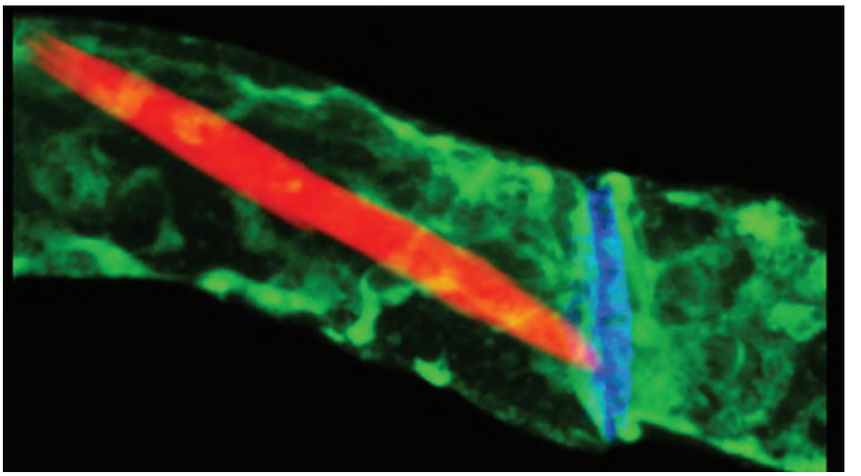
He and his colleagues are examining spinal fluid and blood samples from hundreds of people with a family history of Alzheimer's disease to see whether tau and beta-amyloid measurements will reveal who is developing the disease, perhaps even before signs of the disease are apparent. If Alzheimer's-preventing drugs are ever developed, spinal fluid tests to detect cases early would be especially valuable, he says. —N. SEPPA

Dream Machines from Beans

Legume proteins provide motion

Cells, tiny as they are, are packed with molecular machinery that investigators can exploit for their own purposes. German scientists now report that certain protein complexes in fava beans have characteristics that might make the complexes useful as valves in microfluidic devices.

"It's always difficult to find actuators, or moving parts, that can be controlled neatly and will do what you want them to do on a small scale," says Winfried S. Peters, a biologist at Justus Liebig University in Giessen, Germany. He, Michael Knoblauch, and their colleagues report in the September *Nature Materials* that they've identified just such an actuator. In the beans, the needle-shaped protein complexes are situated in so-called sieve tubes, where they control the plant's flow of sugar-bearing fluid.



CELL STOPPER A forisome (red) at rest in a bean plant's fluid-moving sieve tube. A jolt of calcium would make the forisome expand and seal off the 1-cell-wide tube.

When exposed to calcium, these long, thin structures, dubbed forisomes, shorten by about one-third of their original lengths of 18 to 34 micrometers, the researchers find. At the same time, the complexes fatten to more than twice their original girths. When the researchers remove the calcium, the forisomes revert to their previous shape. The complexes also show mechanical responses to pH changes and electrical stimulation.

Perhaps equally important for practical purposes is that these bean-derived actuators work without adenosine triphosphate (ATP), comments Constantinos Mavroidis of Rutgers University in Piscataway, N.J. ATP is the standard biochemical fuel that cells use to run most of their machinery (*SN: 11/9/02, p. 291*).

"The dependence on ATP means there is a dependence on a special chemical environment" for many actuators from nature, says Mavroidis. Calcium can be used under simpler conditions, he notes.

That simplicity could serve well in systems where forisomes would open or seal off tiny pipelines to control the movement of minute amounts of reagents or would act as microforceps, says Peters. He and his colleagues have already demonstrated that forisomes can control the microscopic spacing between the tips of two glass pipettes.

With further work, forisomes could become the basis of pistons in minimotors, suggests Mavroidis. A thousand times as large as nanoscale components, forisomes would be easier to see and control. "It gives an enormous amount of possibilities for inventions and devices," says Mavroidis.

The German team is currently investigating how forisomes shift shapes and searching for still smaller units of the protein that could work as actuators in even more miniaturized mechanical devices.

"The more we understand how living systems work," says Carlo Montemagno of the University of California, Los Angeles, "the more we're going to find that they are designed and structured in ways that we would like to use to fabricate and engineer nanomachines." —K. RAMSAYER

Estrogen Shock

Mollusk gene rewrites history of sex hormone

Evolutionary biologists have found that the California sea hare, a mollusk that goes by the scientific name of *Aplysia californica*, has a protein similar to proteins in people that respond to estrogen and other steroid hormones. The surprising finding suggests that estrogen was the first such hormone to evolve and that the estrogen-signaling system dates back more than 600 million years. Contrary to past thinking, the estrogen system apparently evolved before the divergence of invertebrates, such as mollusks and insects, and vertebrates, such as fish and mammals. The hormone-binding proteins known as steroid receptors, "had never been found outside the vertebrates," says Joseph Thornton of the University of Oregon in Eugene, who led the work. "Everyone assumed they emerged somewhere deep in the vertebrate lineage."

Estrogen, testosterone, and progesterone are the most familiar of the steroids. All these hormones bind to receptors in cells and thus turn on sets of genes that determine differences between the sexes, regulate reproduction, or guide other aspects of physiology and behavior. People and other vertebrates have genes for six steroid receptors, including two estrogen receptors.

Since estrogen is created from other steroids, scientists once assumed that its receptors arose after the other hormone receptors were in place. Two years ago, however, Thornton and his colleagues found a

KNOBLAUCH AND PETERS

gene for an estrogen receptor in a lamprey, one of the most primitive vertebrates. They proposed that estrogen was the original sex hormone and that one of its receptors was the first to evolve (*SN: 8/11/01, p. 94*).

Thornton, his Oregon colleague Eleanor Need, and David Crews of the University of Texas at Austin have now probed the DNA of *A. californica* for genes similar to those for vertebrate estrogen receptors. One such gene is active in the neural and reproductive tissues of the mollusk, they report in the Sept. 19 *Science*.

Steroid receptors and related receptors are "probably more ancient and widespread than previously believed," says Vincent Laudet of École Normale Supérieure in Lyon, France.

The new report "will cause all of us to rethink our models on the evolution of steroid-hormone signaling," adds Michael Baker of the University of California, San Diego.

Unexpectedly, the receptor encoded by the sea hare's newfound gene isn't responsive to estrogen, Thornton and his colleagues discovered.

Guided by known vertebrate steroid receptors and the new mollusk receptor, the team then deduced a probable amino acid sequence for the ancestral protein in both vertebrates and invertebrates. The researchers synthesized that protein and found that it responds strongly to estrogen and only weakly to other steroids. Thornton concludes that the original protein was estrogen sensitive and that in certain animals, such as the sea hare, its activity is no longer regulated by the hormone.

Bert O'Malley of Baylor College of Medicine in Houston argues that it's more likely that the ancestral receptor was unresponsive to steroid hormones and only later came under the influence of estrogen in certain animals. Laudet shares that view, noting that he's unconvinced that the amino acid sequence deduced by Thornton is the correct one for the ancestral receptor.

Given the new finding, Thornton calls for more attention to the impact of hormone-like pollutants, so-called endocrine disruptors (*SN: 3/1/97, p. S19*), on animals other than vertebrates. "I think it's very important from an ecological perspective that our policies and our testing programs broaden their scope to include the full range of organisms that could be affected," he says. —J. TRAVIS

Unfair Trade

Monkeys demand equitable exchanges

For the first time, researchers say, they have shown that a species other than *Homo sapiens* has a sense of fairness.

Female brown capuchin monkeys tend to turn uncooperative, and sometimes even throw things, if they see a neighbor receiving a lovely grape in exchange for the same token that gets them only a cucumber, according to Sarah Brosnan of Yerkes National Primate Research Center in Atlanta. The clearest protests come from monkeys that see a neighbor getting that grape for free, she and her Yerkes colleague Frans de Waal report in the Sept. 18 *Nature*.

DE WAAL

MONKEY BUSINESS **Brown capuchin monkeys demand an honest deal.**

De Waal "has been one of the primary researchers promoting the idea that other animals have a sense of fairness," comments primate researcher Susan Perry of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. That view has both advocates and detractors. Perry says, "It is nice to see empirical tests of these concepts."

Brosnan says her inspiration for testing the monkeys sprang from experimental economics analyzing how people react to inequity (*SN: 2/16/02, p. 104*). In 1999, economist Ernst Fehr of the University of Zurich proposed that to understand markets, economists need to recognize that people often forgo immediate gains if they see the system letting someone else benefit more.

To test another species, Brosnan trained brown capuchin monkeys to use rocks as tokens of exchange. She gave a monkey a token and then held out her hand. If the monkey returned the rock, she'd offer food. During 2 years of this basic rocks-for-food economy, monkeys exchanged their tokens for food in a matter of seconds about 95 percent of the time.

Brosnan worked with pairs of female monkeys because in a preliminary trial, females but not males balked at inequities. Her more extensive study tested five females that were familiar with one another but not related. In a series of trading bouts, Brosnan accepted a token from one monkey and handed over a grape as the other monkey watched. However, the second monkey's token was rewarded with a less-tasty cucumber. As the bartering progressed, the second monkey began either to refuse to trade in its token or to reject the cucumber. That monkey on average nixed the deal—sometimes vigorously—in 10 out of a string of 25 opportunities.

When Brosnan gave a grape to the first monkey without requesting a rock in payment, the second monkey opted out of the rock-for-cuke deal in about 20 out of a string of 25 offers.

Such treatment would outrage a person, too, Brosnan contends. The experiment "implies that the human sense of fairness is evolved," rather than solely learned, she says.

Fehr calls the new paper a "very important finding." He agrees that the study "shows that inequity aversion must have very deep evolutionary roots." This aversion underlies human cooperation and affects how markets work, he adds.

Primatologist Joan Silk of the University of California, Los Angeles says that the new work "extends knowledge of cooperation in the primate order." However, she points out that the paper "raises an interesting paradox." Monkeys in lab studies cooperate with partners not related by blood, "yet in nature, we see very little evidence of this capacity," she says. —S. MILIUS

One-Atom Laser

Trapped atom shoots steady light beam

Talk about miniaturization! California researchers have coaxed laser light from a single cesium atom.

"We've pushed [the laser] to its conceptual limit," says Jason McKeever of the California Institute of Technology in Pasadena. He and his colleagues describe the new device in the Sept. 18 *Nature*.

For brief intervals, the itsy emitter produces the steadiest stream of laser light ever, Howard Carmichael of the University of Auckland, New Zealand and Luis A. Orozco of the University of Maryland at College Park remark in a commentary that accompanies the *Nature* article.

Laser emissions with particularly stable intensities and well-spaced photons may prove essential for future computing and communications technologies that exploit the bizarre rules of quantum mechanics (*SN: 12/8/01, p. 364*), Orozco told *Science News*. That's where single-atom lasers might come in. Even a beam lasting only

one-tenth of a second might be sufficient for some quantum applications.

Although primitive today, quantum technologies promise to dramatically outperform conventional methodologies in certain ways. Quantum computers, for instance, might eventually search huge databases thousands of times as fast as current machines do.

McKeever says that he and his colleagues are already modifying their single-atom laser to work as a "photon pistol" that shoots a single photon each time it is triggered—a long-sought capability for quantum technologies. Ordinary lasers are more like billion-barrel machine guns emitting vast numbers of photons.

In a laser, material between two mirrors spontaneously emits photons, some of which bounce back and stimulate the coordinated emission of vast numbers of photons. Some of these leak through one mirror to constitute the laser's beam.

To create the new laser, the Caltech team, led by H. Jeffrey Kimble, mounted a pair of extraordinarily reflective mirrors half a hair's breadth apart in a vacuum chamber. Then the researchers trapped a single cesium atom in the cavity between the mirrors and chilled the atom to a fraction of a degree above absolute zero. They used a laser-based trapping and cooling technique (*SN: 10/25/97, p. 263*).

When excited by laser beams entering from outside the cavity, the atom initially emits photons randomly. Almost instantly, however, the atom begins responding to some of its own photons bouncing back from the mirrors. From then on, the lone atom shoots out photons in the direction that the rebounding photons are moving and in synchronization with them. A weak beam of infrared laser light escapes through the mirrors.

For some years, scientists have been making microlasers that use streams of excited atoms. As each atom zips through the space between paired mirrors, photons already bouncing back from the mirrors stimulate it to emit a photon (*SN: 12/24&31/94, p. 420*). However, that stimulation is haphazard, says Orozco. In contrast, in the new experiment, the atom is at rest, so "it's always there with the right disposition," he adds.

What makes the new laser truly a single-atom device, McKeever says, is that the atom remains confined long enough—roughly a tenth of a second—to emit a beam of photons by itself.

Well, almost. To make the atomic light emitter perform, the Caltech team uses mirrors, optical elements, electronic components, and ordinary full-scale lasers crowded onto a room-size table. —P. WEISS

Molecular Memory

Carbon-nanotube device stores data in molecules

If all goes according to some researchers' plans, organic molecules will replace silicon as the workhorses in electronic devices. Edging toward that goal, chemists at the University of California, Los Angeles have fabricated a memory device in which data are stored in organic molecules connected to a carbon nanotube.

Storing data in such tiny amounts of material could enable chip manufacturers to dramatically boost the storage capacity of memory devices, such as the dynamic random access memory in personal computers and the flash-memory chips in digital cameras. And UCLA team member Hsian-Rong Tseng estimates that 1 gram of these molecules could supply enough memory for all new computers worldwide for several years.

Rather than encode 1s and 0s on the basis of the amount of charge stored in a memory cell, as conventional memory chips do, the UCLA approach encodes data in catenane molecules, each of which has two interlocked rings.

The researchers, led by Fraser Stoddart, sandwich the catenanes between two electrodes. The top electrode is made of metal and the bottom one is a carbon nanotube that resembles rolled-up chicken wire and measures just 1 nanometer in diameter. An applied voltage strips electrons from one ring of each catenane. This causes the electron-depleted ring to rotate 180° relative to the other ring, placing the molecule in the "on" state. An opposite voltage replenishes the lost electrons, causing the ring to rotate back to its original configuration, the "off" state. When the catenane is "on," more electrical current flows across the molecule than when the catenane is "off."

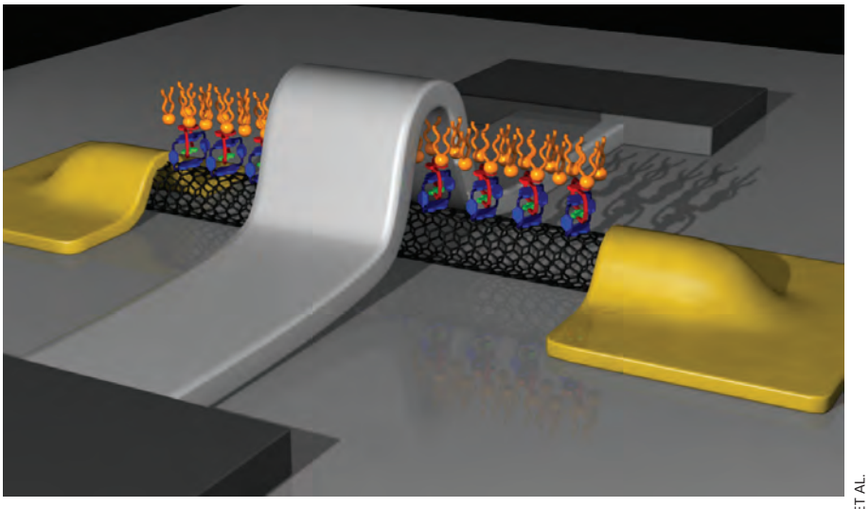
Labs around the world are striving to find ways of using individual molecules for storing bits of data. To succeed in this quest, researchers also need to integrate such molecules with ultrathin electrodes, only a few nanometers thick, for writing and reading data to and from the molecules.

That's not an easy task and it's expensive, but James Tour of Rice University in Houston, says that carbon nanotubes could simplify the process and make it less expensive. Carbon nanotubes are about as wide as a catenane molecule. With electrodes this thin, says Tour, researchers could squeeze billions of catenane-based molecular switches onto a single chip.

An added advantage, Stoddart notes, is that carbon nanotubes are much more chemically compatible with organic switching molecules, such as catenanes, than more conventional metallic electrodes are.

"It's a very nice marriage of two materials," says Stoddart, who described his device on Sept. 10 at the American Chemical Society meeting in New York.

"This is truly novel," says Tour. The next big hurdle, he predicts, is to make memory devices in which both the bottom and top electrodes are carbon nanotubes. "Right now, the [UCLA group] has half of that structure . . . a big step in the right direction," says Tour. —A. GOHO



INFO JUNCTION **Sandwiched between a metal electrode (silver) and a perpendicular carbon nanotube (black roll), catenane molecules (blue and red) change configuration when a voltage is applied. Other molecules (orange) protect catenanes from the top electrode.**

STODDART ET AL.

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TO YOUR HEALTH?

Controversy surrounds whole-body scans—a costly screen for silent threats

BY JANET RALOFF

You've probably heard a radio ad or driven past a billboard hawking the service. The pitch usually goes something like this: "Sure, you look and feel healthy. But each year, countless people succumb to the silent killers: cancer and heart disease. That's where computed axial tomography scanning can make a difference. A 90-second CT exam at our screening center could reveal lurking disease—before it's too late for your doctor to do something about it. CT screening: It might just save your life."

Such ads are selling one of today's most sophisticated medical technologies. CT scanning looks deep inside the body with low-dose X rays and has been used for decades to pinpoint the problems behind patients' symptoms. As a screening tool, it looks for lumps, bumps, and other irregularities that may signal developing disease.

Radiologists refer to the newly popular CT screening as "whole-body scanning," but the tests typically target just the torso. Some centers will scan the head, though at an additional charge. Most people have the screening done without medical consultation and then take the results to a doctor.

CT-screening centers routinely post testimonials on their Internet sites from customers saved from potentially life-threatening conditions for which they had no symptoms.

That's just one side of the issue.

Critics of this growing medical enterprise are many, including the U.S. Food and Drug Administration, the American College of Radiology, the Health Physics Society, the Conference of Radiation Control Program Directors, and the American Association of Physicists in Medicine. These groups all conclude that CT scanning of apparently healthy individuals isn't ready for prime time.

First, CT scans often turn up suspicious anomalies that may not reflect disease. The extra tests that subsequently result, such as more X rays and tissue biopsies, can not only cost a bundle but also impose their own risks.

Second, a clean scan isn't the same thing as a clean bill of health, since some diseases, including colon cancer, don't ordinarily show up on routine whole-body scans.

Third, when a screening scan finds an abnormality, doctors may feel obligated to treat it, even if doing so isn't likely to increase the person's life expectancy or comfort, notes radiologist Leonard Berlin of Rush North Shore Medical Center in Skokie, Ill. For example, he explains, many small tumors are noninvasive. Because they don't spread, people typically "die with, not of" them, he says.

Finally, scans are expensive. Typically $300 to $1,000, they aren't covered by insurance.

Over the past 5 years, whole-body scanning has become a growth industry, notes Judy Illes of the Stanford (University) Center for Biomedical Ethics. Her group reports in the August *Radiology* that most centers offering the scans are freestanding, for-profit screening centers not associated with hospitals. They're popping up in shopping malls, along interstates, and even in mobile vans, but only in communities whose residents are wealthy and well educated.

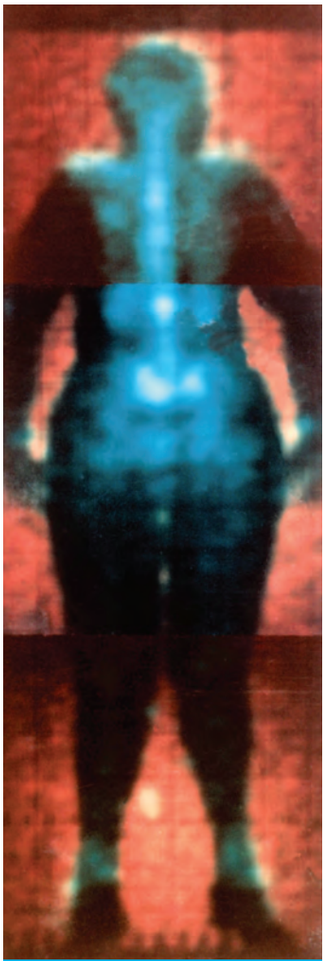
"They thrive on what I call the 'worried well,'" Berlin observes.

"This whole thrust toward whole-body scanning is clearly profit driven on the part of the providers," says William J. Casarella, who heads the radiology department at the Emory University School of Medicine in Atlanta. The for-profit scanning centers charge full price for their services and require payment up front. In contrast, Casarella's university center "winds up with only about 40 percent [of the billed amount] from insurance companies."

Despite all the criticism of whole-body scanning centers, screening with CT undoubtedly has saved some lives. A few preliminary studies have suggested that CT screening might prove a boon for scouting out particular diseases in at-risk patients. The best known is the Early Cancer Action Project, which in 1999 showed that CT screening of long-time smokers found four times as many lung cancers as conventional chest X rays did.

A National Cancer Institute study plans to give lung scans to 50,000 current and former smokers to evaluate whether such screening can detect cancer in time to save lives. Lung scans are an element of whole-body screening exams.

Most radiologists would prefer to have had the results of such trials before whole-body scanning ads began flooding the airways. "But scanning centers are out there now, so we have to do more than just wring our hands," says Illes. She



BODY LANGUAGE — Unlike most so-called whole-body screening, which focuses on just the torso, this CT scan ran from head to foot. Healthy consumers are paying for CT screening at for-profit centers to scout for heart disease and cancers.

argues that "we have to put in place a set of operating guidelines today for these centers," requiring that, at a minimum, they better inform consumers of what they should and shouldn't expect of the costly tests.

TAKE HEART Physicians have been prescribing CT scans, formerly known as CAT scans, since the mid-1970s. "Many order whole-body [scans], not calling them that," observes radiologist Michael Brant-Zawadzki of Hoag Memorial Hospital in Newport Beach, Calif. Last year alone, he notes, U.S. hospitals and other centers performed some 35 million CT scans.

More and more of those scans are for screening rather than just homing in on the source of symptoms, says Brant-Zawadzki. What's relatively new is who's ordering up many of the full-torso scans: symptomfree consumers, usually without consulting their doctors. Fueling this trend, he says, are baby boomers' preoccupation with wellness, relatively high standard of living, comfort with new technology, and dissatisfaction with insurance that limits access to some doctors and procedures.

Furthermore, Brant-Zawadzki maintains, some physicians approve of the screening as "an ounce of prevention," although whole-body scanning hasn't been endorsed by much research.

Though Brant-Zawadzki is "not a big proponent of whole-body scanning," he says he does perform some CT screening at patients' requests. Why? At least for people at elevated risk of heart disease (*SN: 9/13/03, p. 174*) and lung cancer, CT scans can find hidden disease.

"For 180,000 people a year, the first sign of coronary artery disease is death," he says. CT screening highlights calcification of coronary arteries, providing direct evidence of disease. Since one in three men has such artery disease by age 40, "why not allow men over 40 direct access to this screening test?" Brant-Zawadzki asks.

"I had my coronaries tested," he told *Science News*, "and now I'm on [a cholesterol-lowering drug] and aspirin because I had calcification."

George T. Kondos, director of clinical cardiology at the University of Illinois at Chicago College of Medicine also supports CT heart scans for apparently healthy people.

His team used CT scans to determine the calcification of coronary arteries in 8,855 initially asymptomatic adults. Then they divided the volunteers into four groups according to their calcification scores. Over the next 3.5 years, men in the highest-calcification group were 2.3 times as likely to die of heart problems or have a heart attack, and 10 times as likely to need bypass surgery or an unclogging of arteries, as were men in the three lower-calcification groups. Women with the highest calcification were 3.8 times as likely to need surgery to clear or shunt blood around a coronary artery as were those with the lowest calcification, the researchers reported in the May 27 *Circulation*.

Kondos says, however, that CT screening isn't warranted in people clearly at either low or high risk of heart disease. Low-risk people, such as nonobese nonsmokers without a worrisome family history, don't need the test. High-risk people should take preventive measures without this costly procedure. CT's value will come in discriminating the nature of disease in people at intermediate risk, which Kondos says include all men over 45 and those women over 50 with at least one additional risk factor, such as high cholesterol.

Cardiologist Matthew Budoff of Harbor-UCLA Medical Center in Torrance, Calif., says that CT screening for heart disease "can be easily justified in most people over a certain age." He calls such testing "the most medically valid" aspect of whole-body CT screening.

A FLUKE? In contrast to heart tissue, most abdominal organs reveal little detail in CT scans unless a radiologist injects a person with an iodine-based contrast dye before the scan. That's not done in most whole-body scans of symptomfree people, Berlin notes, because it increases costs and some people prove allergic to the dye.

Yet University of Miami urologist Raymond J. Leveillee says that he and his colleagues have caught several kidney tumors in patients who had received whole-body scans without contrast dye.

BILLBOARD SIREN — For-profit screening centers increasingly advertise to consumers directly via billboards, mailings, and radio commercials.

Last year, for example, a physician referred a patient to Leveillee's department for removal of a kidney after a suspicious spot showed up on a whole-body scan at a for-profit center. Shortly thereafter, a second kidney-cancer case was flagged the same way. "By the time the third and fourth arrived," Leveillee recalls, "we thought, 'This is weird.' We were seeing a lot of big tumors in people with zero symptoms." Indeed, at least one person had gone in for scanning only because he had received the screening as a birthday present.

Leveillee and his colleagues then reviewed the cases of some 30 kidney cancer patients they'd seen over the previous 6 months and found that for seven of them, the first hint of trouble came when doctors noticed a suspicious spot on a whole-body CT scan. The Miami physicians reported their findings at the May meeting in Chicago of the American Urological Association.

"A year ago, I probably would have said [whole-body CT screening] was a waste of money," Leveillee says. But here, "in at least a half-dozen cases, it has probably saved people's lives." Indeed, he says, "when I get to be 45 or 50, I'll probably jump on the table for my own [scan]."

SIZABLE COSTS Despite the success stories, most anomalies that whole-body scanning turns up aren't clear signs of disease. Casarella knows firsthand how nontrivial the resolution of such a finding can be.

A few years ago, a dye-enhanced CT scan targeted at his own colon picked up nodules in the background. The procedure found lesions on a lung and two abdominal organs, suggesting a cancer that was spreading. These spots, Casarella notes, are exactly the type that shows up in whole-body CT screening.

The nodules turned out to be scars from an old infection. But Casarella's doctors didn't find that out until they did a biopsy. It required surgery in which they needed to collapse his lung. He then faced a substantial hospital stay. Total cost: roughly $40,000, paid for by Casarella's insurance.

This highlights one public health implication of the nation's growing infatuation with whole-body scanning, says Kim Howard, a Longview, Texas–based radiologist who reviewed CT screening as an advisor to his state's bureau of radiation control.

J.A. MILLER

Some people argue that since consumers pay for whole-body scanning out of their own pockets, they're the only ones who stand to lose anything financially, says Howard. "In fact," he says, "it becomes a public cost the minute a nodule shows up." Then, public or private health insurance steps in to cover any additional procedures needed to resolve or treat the abnormality.

Such costs could bankrupt the U.S. health-care system, he says, pointing to a Mayo Clinic study in the March *Radiology*. Stephen J. Swensen and his colleagues performed annual CT scans of the lungs in 1,500 current or former smokers. Each was at least 50 years old and showed no symptom of cancer. After 2 years, the screening turned up 41 true cancers—and another 2,800 questionable nodules. Some 70 percent of all the volunteers in the study had at least one questionable nodule.

On the basis of subsequent biopsies and surgery on some people in the study, follow-up scans, and data from earlier work, Swensen's group concluded that nearly 99 percent of the questionable nodules that they detected were benign. Extrapolating this rate to the nation's 90 million current and former smokers suggests they harbor some 150 million similarly benign nodules that would masquerade, on scans, as cancer.

"That is the 'fly in the ointment' that concerns all of us involved in screening," Swensen observed in an October 2002 commentary in the *American Journal of Roentgenology*. "One important feature of a useful screening test is a low false-positive rate," he noted. "CT apparently will not meet this criterion."

Swensen's team picked up new nodules in the study volunteers in each subsequent year's scans. That, Howard notes, brings up the question of how frequently any screening would need to be repeated to prove useful. Most cancers tend to appear sporadically after age 50. So, he argues, "if you don't do periodic screening, you're going to miss the vast majority of cancers." However, he says, frequent CT screening risks exposing healthy people to potentially carcinogenic amounts of radiation.

In general, a whole-body CT scan exposes the body to a radiation dose that's about 30 times that of a standard chest X ray—by itself, not a big deal, most radiologists say. However, once a suspected cancer shows up, doctors will usually request repeat, higher-dose CT scans—in some cases, up to five focused scans over the next 2 years—notes radiologist Philip C. Goodman of Duke University in Durham, N.C. At the Radiological Society of North America meeting last year, he reported the cumulative radiation dose from such a follow-up is "going to be hundreds of times that of a chest X ray."

> "This whole thrust toward whole-body scanning is clearly profit-driven on the part of the providers."
>
> —WILLIAM J. CASARELLA

Risks and cost of follow-up procedures are among the complications of whole-body CT scanning that many people won't recognize when they sign up for it, says Berlin.

"That's why we need guidelines for these centers," Illes contends. She'd like to see doctors, bioethicists, and others evaluate current information on CT screening and then make recommendations for a code of conduct. That code, she says, might insist that whole-body scanners disclose in their advertising which organs these scans don't image well. Berlin would like them to also provide typical false-negative and false-positive rates, the costliness and potential dangers of follow-up testing, and how frequently people need to be scanned to catch diseases as they develop.

Indeed, Casarella says, "I don't have any problem with patients referring themselves for CT screening. We just need to be careful that we tell them what the benefits and risks are."

No one, he adds, should have to pay for "a false sense of security or false sense of anxiety." ■

THE BODY ELECTRIC

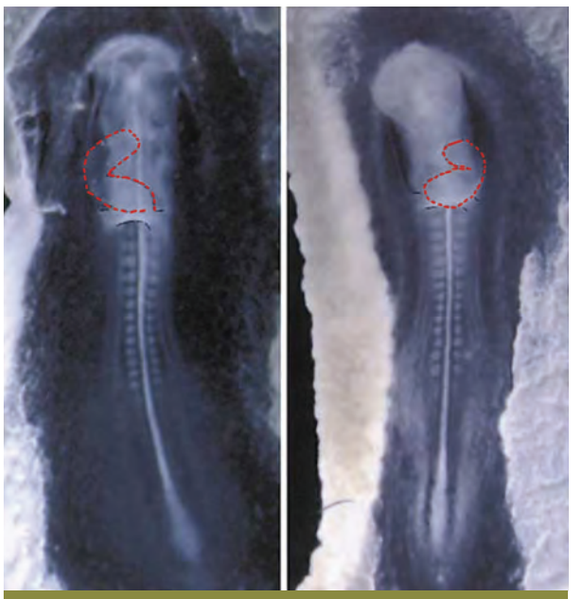
A natural voltage within a growing embryo may teach it left from right

BY JOHN TRAVIS

As anyone who has ever recited the Pledge of Allegiance will attest, having your heart in the right place means having it on your left side. Despite the outward symmetry of the human body, left-right differences abound beneath everyone's skin. The majority of the heart's bulk usually sits on the body's left side, although the organ's aorta loops to the right. The right lung has three lobes, while the left has two. The liver and gallbladder fill up the right side of the abdomen, whereas the spleen and stomach dominate the left.

In rare cases, about 1 in 8,500 people, a person's internal organs are completely flipped across the left-right axis—for example, the spleen is on the left, not the right. Known as situs inversus, this condition doesn't usually have ill effects. It's only when just some of the organs are reversed that there's a potential for serious problems.

About 5 years ago, developmental biologists stumbled upon a potential explanation for the origin of a body's normal left-right asymmetry. While studying mice, they found that an embryonic region called the node has hairlike cilia that twirl in a clockwise direction. The researchers also reported that this action creates a leftward current within the fluid bathing the node. Soon after the cilia appear during embryonic development, certain genes turn on in either the left or right sides of the mouse embryo.



CHANGE OF HEART — Hearts (outlined areas) are on opposite sides in this comparison of a normal frog embryo (left) and one treated with the drug lansoprazole (right).

LEVIN ET AL./CELL

These findings led the scientists to speculate that the ciliary action leads to cell-secreted chemical signals becoming concentrated on one side of the embryo and switching on genes there (*SN: 8/21/99, p. 124*).

Although virtually all scientists agree that this explanation for left-right asymmetry is elegant, some refuse to accept it. "It's a very appealing model, but I don't think it's consistent with the facts," says Michael Levin of the Forsyth Institute in Boston.

On the basis of his work with frog and chick embryos over the past few years, Levin in an upcoming *Bioessays* makes a case against the cilia model and puts forth his own theory for how vertebrate embryos establish their two sides. The break in symmetry happens long before the cilia appear on nodal cells, asserts Levin. He argues that an asymmetric distribution of ions arises as early as the first few cell divisions of a vertebrate embryo. The uneven distribution of these charged atoms creates an electric field that pulls other ions and charged molecules to one side of the embryo or the other. This, Levin theorizes, ultimately triggers various genes to become active on only the right or left side of the embryo.

ONE-SIDED DEBATE For developmental biologists studying left-right asymmetry, the fundamental problem rests in the fact that the vertebrate embryo starts out as a seemingly uniform ball of cells. Through a variety of cues that scientists are still teasing out—gravity, the site of sperm entry to the egg, and the activity of maternal proteins stored in the egg—vertebrate embryos seem to establish top and bottom, as well as front and back, almost immediately after fertilization. Yet scientists used to think that the left-right distinction doesn't arise until much later in the growth of an embryo, when organs start to take shape.

Over the past decade, biologists have documented several genes that have a left- or right-sided nature to their activity in the growing embryo. Perhaps the best-known one is *nodal*, named for the embryonic node. In all species examined so far, which include mouse, frog, and chick, *nodal* turns on initially in what will become the left side of an embryo. This gene appears to set off a cascade of asymmetric gene activity at about the time when the heart, intestines, and other internal organs begin to form.

Cilia entered the asymmetry story when researchers found that mutant mice without cilia in the node or with paralyzed cilia develop situs inversus or at least have some organs out of place. Biologists have even shown that artificially reversing the direction of the fluid flowing across the embryo's node disrupts proper positioning of a mouse's internal organs. The cilia must be pushing leftward signals that turn on *nodal* or other genes, many biologists assumed.

Yet no one has identified these signaling molecules, notes Levin. He and other investigators also question whether a cilia-driven current can consistently define left and right, given the intricate dynamics of fluid movement.

The most significant challenge to the hypothesis that cilia position organs, however, comes from the embryos of other vertebrates, such as frogs and chicks. In these animals, researchers have found

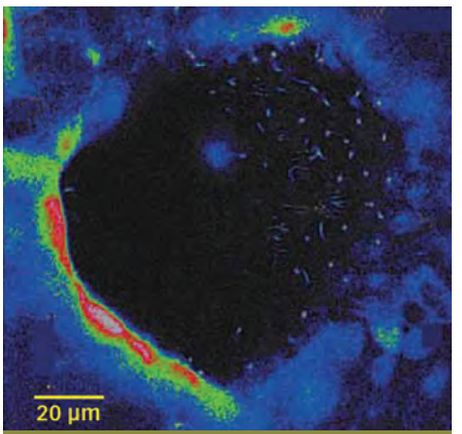
genes and proteins with an asymmetric distribution of activity long before cilia appear in the embryonic node. For example, in the Dec. 27, 2002 *Cell*, Joseph Yost of the University of Utah in Salt Lake City and his colleagues reported that an enzyme that alters a protein called syndecan-2 is active only on the right side of an early frog embryo.

"The cilia are there in the frog, but they [appear] later than these left-right asymmetries," says Yost.

MIND THE GAP While working in the laboratory of Cliff Tabin at Harvard Medical School in Boston in the mid-1990s, Levin also documented one-sided gene activity in the chick before the cilia appear. When he teamed up with Mark Mercola, then also at Harvard Medical School, Levin began to get the first hints of an alternative means by which the embryo might define left and right. The two researchers discovered that cell-to-cell portals known as gap junctions are required for proper left-right patterning.

Adjoining cells use gap junctions to exchange small molecules directly. Levin compares gap junctions to the hatches that link compartments in a submarine.

In experiments on early frog and chick embryos, he and Mercola disrupted gap junctions, either by applying drugs that block the portals or by mutating genes encoding the proteins that make up the junctions. These manipulations perturbed the cascade of asymmetric gene activity and caused the embryos to position some of or all their internal organs on the wrong sides.



RIGHT DECISION — In this mouse embryo, a surge of calcium (red and green) occurs in cells on the left side of a region called the node. This is one of the earliest signs of left-right asymmetry in the mouse.

But what's flowing through the gap junctions that's so important to left-right organ placement? And how do the portals create embryonic asymmetry, given that molecules can usually flow through them in both directions? Aware of the tendency for cells to transfer ions via gap junctions, Levin, Mercola, and their colleagues exposed early frog embryos to the hundreds of compounds known to affect ion movement into and out of cells. The scientists then examined the treated embryos for left-right organ abnormalities.

Levin recalls that most other scientists thought this strategy was "insane" because they assumed that ion flow is so important to general development that the experimental embryos would simply die. Yet many embryos did survive, including some that had problems such as a heart looping the wrong way or a gallbladder on the left side.

Levin's team discovered that the few drugs with such effects target select proteins that regulate the flow of potassium and hydrogen ions into and out of cells. Consider the drug lansoprazole, which prevents a cell-membrane protein called H^+/K^+-ATPase from swapping potassium ions outside a cell for hydrogen ions inside. More than half of the frog embryos treated with lansoprazole early in their growth develop left-right patterning defects, Levin, Mercola, and their colleagues reported in the Oct. 4, 2002 *Cell*.

Following up on that clue, the researchers examined the distribution of the H^+/K^+-ATPase within the early frog embryo. Vertebrate embryos don't immediately turn on their own genes but initially depend on the egg's residual proteins, amino acids, and messenger RNA (mRNA), the instructions that a cell uses to make a protein. The scientists found that the fertilized frog egg starts with a symmetric distribution of mRNA for H^+/K^+-ATPase. But within the first or second cell division, this mRNA concentrates on the future right side of the embryo. This is the earliest left-right asymmetry that biologists have seen, and it occurs more than a day before cilia appear in the frog embryo.

"One of the big arguments in the field is, 'When does the embryo know left from right?' The frog embryo knows its left and right at the four-cell stage," concludes Levin.

Levin, Mercola, and their colleagues also found that chick embryos early on, before they have cilia, develop a voltage between what will become their left and right sides. This electric asymmetry appears to arise because the cells on one side of the embryo use ion channels and pumps to drive positively charged ions, such as potassium, out of the embryo. Ultimately, the cells on that side have a more negative charge than do those on the other side.

Levin suggests that the natural electric field established by the asymmetric ion flux pulls charged signaling molecules through gap junctions in a directed manner, concentrating the signals on one side of the embryo or the other. Those signals, in turn, could set off the left- and right-sided cascades of gene activity that guide the growth and positioning of organs.

The electric field could operate on ions such as hydrogen or calcium. Mice genetically engineered to lack polycystin-2, a protein that controls the release of calcium ions within cells, show disturbed left-right patterning, notes Levin.

Another possible signal is serotonin, a chemical best known as a transmitter of nerve signals. At this summer's Society for Developmental Biology meeting in Boston, Levin's colleague Takahiro Fukomoto reported that frog and chick embryos treated with drugs affecting serotonin's activity show disrupted left-right asymmetry. Since it's a relatively small, charged molecule, serotonin is an "ideal candidate" for one of the left-right patterning signals that flow through gap junctions, says Levin.

ELECTRIFYING APPEAL Levin acknowledges that his theory doesn't explain how normal left-right asymmetry gets started: Something has to first distribute H^+/K^+-ATPase and other ion pumps and channels unevenly. The experiments on frog embryos indicate that this biased allocation begins almost immediately after fertilization, so the left-right axis is probably established at about the same time as are the front-back and top-bottom axes.

"We still don't know step one of [left-right] asymmetry," says Levin. "We now have it trapped in an hour-and-a-half slot."

Levin's theory has won the support of some developmental biologists, especially those skeptical of the role of cilia. "I love it," says Lewis Wolpert of University College London. "I can't say whether it's right or wrong, but I find it terribly interesting."

Wolpert also appreciates that Levin's work has brought renewed attention to natural electric fields within organisms.

This concept has been around for decades, according to Kenneth R. Robinson of Purdue University in West Lafayette, Ind., who collaborated with Levin and Mercola on the recent studies. In the August *Bioessays*, he and a colleague review the growing evidence that endogenous electric fields have roles in embryonic patterning, wound repair, tissue regeneration, and plant biology.

Robinson chides other molecular biologists for ignoring endogenous electric fields in favor of genes and biochemistry. "They basically just don't know what an electrical field is. When you talk about these issues, a lot people just don't get it because they're not intellectually prepared," he says.

While calling Levin's work innovative, Tabin still supports a cilia-based mechanism for left-right determination. In the Jan. 1

Continued on page 190

J. MCGRATH ET AL./CELL

OF NOTE

BEHAVIOR

Widows show third-year rebound

A widow typically struggles with grief immediately after her husband dies. By 3 years after the loss, however, these women have largely overcome grief-related problems, such as depression, social isolation, bodily pains, and poor eating habits, according to a large U.S. study of 50- to 79-year-olds.

The findings underscore the resilience of older women faced with sea changes in their lives, say Sara Wilcox of the University of South Carolina in Columbia and her coworkers. The data also highlight a need for social and mental-health programs for women within the first year of their husbands' deaths, the researchers say in the September *Health Psychology*.

Using surveys and medical data, Wilcox's group first focused on the responses of 72,247 women who had been widowed in the past year, widowed for more than 1 year, or married. The researchers then examined 3-year follow-up data for 55,724 of those women.

Compared with married women, widows reported worse physical and emotional health and less-healthful daily habits, including irregular exercise and failing to eat fruits and vegetables. Such problems were most prominent in recent widows.

Three years later, the women who had been recently widowed at the start of the study reported marked improvements in mental health and social activity, with smaller gains in physical health. The death of a spouse may have relieved many of these women from the strain of constant caregiving or allowed them to seek support from friends or mental-health workers, the researchers theorize. During the 3 years of the study, longer-term widows showed slight mental and physical advances. —B.B.

PHYSICS

Particle decays hint at new matter

Unexpected observations at a Japanese particle accelerator may signal the presence of previously unknown subatomic matter.

The conjecture, from the so-called Belle team at the High Energy Accelerator Research Organization (KEK) in Tsukuba, was inspired by the team's measurements of a specific type of decay of fundamental particles called bottom, or b, quarks and their antimatter counterparts, anti-b quarks.

Such measurements may ultimately help explain why there is so little antimatter in the universe, although matter and antimatter were presumably created equally in the Big Bang. The measurements could also point to alternatives to the prevailing theory of particle physics, known as the standard model.

Theorists have calculated just how different the decay rates of b and anti-b quarks should be. The predicted value for the newly measured disparity, which is a type of so-called charge-parity (CP) violation, is 0.73 ± 0.06.

The preliminary value the Belle team reported at a conference last month at Fermi National Accelerator Laboratory in Batavia, Ill. is -0.96 ± 0.50. However, another team, dubbed Babar, at the Stanford (Calif.) Linear Accelerator Center (SLAC) finds a value of 0.45 ± 0.43—nearly what the standard model predicts.

"If [the Belle value] were the only measurement, we would be thinking it is pretty good evidence that there is something . . . beyond the standard model," comments SLAC's Helen R. Quinn. For instance, there could be yet-undiscovered heavy particles that interact differently with quarks than with antiquarks, she says.

However, because the two teams' CP violation values don't agree, she and other physicists are waiting for both groups to collect additional data.

In previous studies of a different type of b-quark decay, both teams reported values for CP violation in agreement with the standard model (*SN: 3/3/01, p. 143*). —P.W.

ZOOLOGY

Risk of egg diseases may rush incubation

Bird eggs can catch infections through their shells, and new tests in the wild suggest that this risk may be one of the pressures driving avian parents to start incubating eggs with a timing that puzzles biologists.

Birds lay an egg a day at most. Many bird species let early eggs in a brood sit

OF NOTE

unincubated for several days but begin incubation before the last eggs are laid. Since the eggs need the same number of incubation days, the eggs end up hatching at different times. This leads to siblings of different sizes, the bigger of which sometimes kill the smaller ones.

The debate over possible benefits for this staggered hatching has overlooked the risk of egg diseases, according to Mark I. Cook of the University of California, Berkeley. Studies of farm fowl have shown that a warm parent on top of an egg keeps moisture away and discourages microbial growth. So the longer a parent waits to start incubating, the greater may be the chance of eggs becoming infected.

To survey infection risks in the wild, the researchers set out 164 chicken eggs in two Puerto Rican forests for 1 to 7 days. Although conditions differed, in both places, bacterial and fungal invasions were significant after 5 days.

To test the impact of infections, the researchers again set out eggs in the forests but cleaned half of them with alcohol twice daily to reduce infections. After 5 days, the researchers collected the eggs and incubated them. Only in the cooler and more humid forest, three times as many cleaned eggs hatched as did uncleaned ones, the researchers report in an upcoming *Proceedings of the Royal Society of London B*.

The results suggest that beginning incubation of a brood before all the eggs are in the nest could boost survival among a brood. —S.M.

TECHNOLOGY

Channeling light in the deep sea

A genus of sea sponges grows its own light-conducting fibers that are remarkably similar to commercial-grade optical fibers—and in some ways better. A team of U.S. and Israeli researchers that recently studied several *Euplectella* species says the primitive creatures' fibers might serve as a model for improved telecommunications fiber optics.

In the Aug. 21 *Nature*, Joanna Aizenberg of Lucent Technologies' Bell Labs in Murray Hill, N.J., and her colleagues report that the sponges' fibers, called spicules, have glass cores infused with sodium ions that enhance the fibers' optical properties.

Made at high temperatures, commercial fibers can't exploit such impurities because those additives tend to clump as the glass cools. Moreover, these heated-then-cooled fibers develop undesirable internal stresses. On both counts, Aizenberg says, human-made fibers might benefit if manufacturers could assemble them bit by bit at low temperatures, as the sponges do.

LIGHT HOUSE **A deep-sea *Euplectella* sponge grows light-transmitting glass fibers (arrow) that are in some ways superior to commercial optical fibers.**

V. SUNDAR ET AL./NATURE

Other sponges previously found to sprout light-conducting spicules (*SN: 8/4/01, p. 77*) inhabit shallower water than does *Euplectella* and may harvest sunlight with their fibers. At the inky depths of 500 to 1,000 meters, says Aizenberg, *Euplectella*'s fibers are more likely to transmit photons from bioluminescent organisms to help the sponges find their meals. —P.W.

Continued from page 188

Genes and Development, he and Kyle J. Vogan of Harvard Medical School tried to reconcile some of the field's conflicting data by proposing that the node contains two kinds of cilia: A twirling set establishes a leftward flow of fluid, and immobile cilia respond to this flow by releasing intracellular calcium and activating genes such as *nodal*.

In the July 11 *Cell*, a research group led by Martina Brueckner of Yale University School of Medicine confirms the presence of these two types of cilia in the mouse node and reports a surge of calcium into cells on the left side of the node at the same time that the twirling cilia establish a leftward flow of fluid.

Gap junctions could propagate such a calcium surge through other parts of the embryo, notes Mercola. Despite working with Levin, he still thinks that cilia may represent the first step in left-right determination in many vertebrates.

"Maybe chicks and frogs initiate asymmetry with a different mechanism," he says. "I'd caution against the idea that there's one way to bootstrap left-right asymmetry and argue instead that the jury is still out. It might indeed turn out that nature has employed multiple means in different species to initiate left-right asymmetry."

Yost points out that part of the field's disagreement arises because scientists working on different animals have focused on different stages of embryonic development. He predicts that investigators will find left- or right-sided gene activity in mouse embryos before cilia appear.

Yet Levin's results don't necessarily eliminate a role for cilia, Yost stresses. The cilia could lock in any left-right decision that the vertebrate embryo has made earlier or spread its effects beyond the node, he points out.

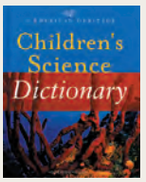
"I think the two models are not mutually exclusive at this point," Yost says. "My sense right now is that asymmetry will be set up in the same way in all vertebrates. We just don't know how that happens at this point." ■

Books

A selection of new and notable books of scientific interest

CHILDREN'S SCIENCE DICTIONARY

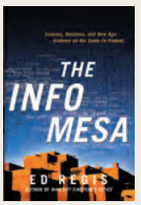
STEVEN R. KLEINEDLER, ED.



This vividly illustrated dictionary presents scientific concepts in a straightforward manner. More than 2,600 entries cover all areas of science. Snapshot biographies of famous scientists capture the essence of individual contributions. Boxes titled "Did You Know?" appear randomly throughout the volume. These notes encourage children's curiosity about such things as how hot lightning is and why a chameleon changes color. Recommended for ages 9 to 12. ***HM, 2003, 280 p., color photos/illus., hardcover, $17.95.***

THE INFO MESA: Science, Business, and New Age Alchemy on the Santa Fe Plateau

ED REGIS



While scientists and venture capitalists in California's Silicon Valley have seen their riches rise and fall in the past few years, a group of maverick scientists residing in Santa Fe, N.M., has sustained success. Regis profiles three dozen of the world's premiere complexity theorists, biophysicists, neurophysiologists, geneticists, and computer scientists from Santa Fe. Among them is Stu Kaufmann, who runs a company that uses complexity theory to help major corporations solve otherwise-intractable problems, such as efficiently moving cargo via airline routes. Dave Weininger invented a new nomenclature for chemicals used in labs around the world. Anthony Nicholls is developing a computer program for depicting proteins in a way that could revolutionize medicine. Regis paints compelling portraits of these sometimes-eccentric personalities and explains how their diverse pursuits affect us all. ***Norton, 2003, 268 p., hardcover, $25.95.***

MAPPING THE SKY: The Essential Guide to Astronomy

LËILA HADDAD AND ALAIN CIROU

This guide is both a visually engaging and a clearly written introduction to reading the night sky with the naked eye, a telescope, or binoculars. A broad historical account of how the universe has been understood, explored, and charted by Greek philosophers, Renaissance sky mappers, Galileo, and Isaac Newton illustrates how observation and theory collaborate. The second half of the book details how to pick the right telescope and how to use it, then unlocks one-by-one the mysteries of the night sky from our solar system to the nebulae of deep space. A star chart is included, as are details of how to photograph one's observations. Originally published in France in 2001. ***Chronicle Bks, 2003, 236 p., color photos/illus., flexibind, $24.95.***

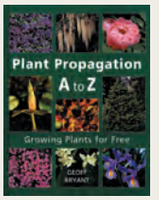
THE MIRACULOUS FEVER-TREE: Malaria and the Quest for a Cure That Changed the World

FIAMMETTA ROCCO

Growing up in Africa, Rocco was touched directly by malaria. She had it; her father suffers regular bouts; and her grandfather died from it. Because of this, the story of quinine resonates deeply for her and makes this a compelling book. For hundreds of years, malaria was a scourge that plagued Europe, Africa, and North and Central America. The cure, however, came from the foothills of the high Andes, in the bark of the cinchona trees. Quinine was first brought to Europe in 1631. But the disease had centuries of destruction yet to wield. Thousands of British troops succumbed to it while fighting Napoléon in 1809. The building of the Panama Canal came to a halt in 1889 when malaria and yellow fever struck. Rocco relates the story of how the seed of a New World plant eventually conquered a mainly Old World disease, as well as how the process changed Western medicine and civilization. ***HarpC, 2003, 348 p., b&w plates, hardcover, $24.95.***

PLANT PROPAGATION A to Z: Growing Plants for Free

GEOFF BRYANT



If you've ever considered growing plants from cuttings or wondered about the ideal conditions for germinating seeds, then this book is for you. Bryant clearly outlines all aspects of plant propagation, from selecting the right tools to identifying which plants reproduce by seed, division, and cutting. The first half of the book provides lessons in general propagation methods, including advanced techniques involved in grafting, budding, and layering. Bryant also troubleshoots potential problems involving pests and disease. The second half of the volume describes propagation methods for more than 500 garden plants that are listed in a dictionary organized by Latin name, followed by common name. Color photographs accompany each entry. ***Firefly, 2003, 224 p., color photos, hardcover, $35.00.***

QUANTUM: A Guide for the Perplexed

JIM AL-KHALILI

This highly visual tour is an enlightening journey through the basics of subatomic physics and its practical consequences. An introductory chapter charts the short history of quantum mechanics through the work of Max Planck and Albert Einstein. Subsequent chapters introduce the weird and amazing concepts that underpin this field, from Schrödinger's cat and Heisenberg's uncertainty principle to superposition and entanglement. Without taking a stand in favor of or against any particular interpretation of the field, Al-Khalili surveys the most prevalent views on how the building blocks of matter behave. Originally published in the United Kingdom in 2003. ***Weidenfeld and Nicolson, 2003, 280 p., color photos/illus., hardcover, $24.95.***

HOW TO ORDER To order these books, please contact your favorite bookstore. *Science News* regrets that at this time it can't provide books by mail.

LETTERS

Popping off

I suspect that none of the researchers whose work was described in "Where's Poppa? Absent dads linked to early sex by daughters" (*SN: 7/19/03, p. 35*) was ever a teenage girl with an absent (or distant) father. I think the simplest explanation is that the girls are looking for male affection and protection, which they can't get any other way. Most of these girls just want to feel loved and valued as women.

ANITA LEES, EAST LANSING, MICH.

The authors of the study seem to miss an obvious reason for later sexual activity among teenage girls whose fathers are still in the house: The fathers are protecting their daughters from predatory sexual advances by young men.

ROBERT BAUMAN JR., AMARILLO COLLEGE, AMARILLO, TEXAS

It seems to me, as a father of a daughter born some decades ago, that researcher Bruce J. Ellis is missing what are to me the most likely implications of his study: that daughters with fathers present are fulfilling, in their suberotic loving relationship with the father, components of desire that encourages delay in sexual relationships. I recall studies showing that close relationships with fathers facilitate sexual relationships of later life, and another reporting that menarche is delayed in girls with the genetic father present. It seems to me that there probably are behavioral and physiological mechanisms, to some degree genetically (and thus evolutionarily) based, that encourage early reproduction in the emergency case of no present father and delayed reproduction in the relative stability of the home with the father present.

WILL RITTENHOUSE, ST. LOUIS, MO.

Ellis generally agrees with this evolutionary theory, although the data to back it up are controversial. —B. BOWER

Correction *The oral diabetes drug Glucophage (metformin) works by increasing cells' insulin sensitivity, not by inducing the pancreas "to make more insulin," as stated in "Blood Sugar Fix"* (SN: 8/16/03, p. 104).

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