SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

OCTOBER 25, 2003 PAGES 257-272 VOL. 164, NO. 17

flame retardants' health risk

does arsenic foul fowl?

retardation numbers skewed

hiv drug battles brain tumors

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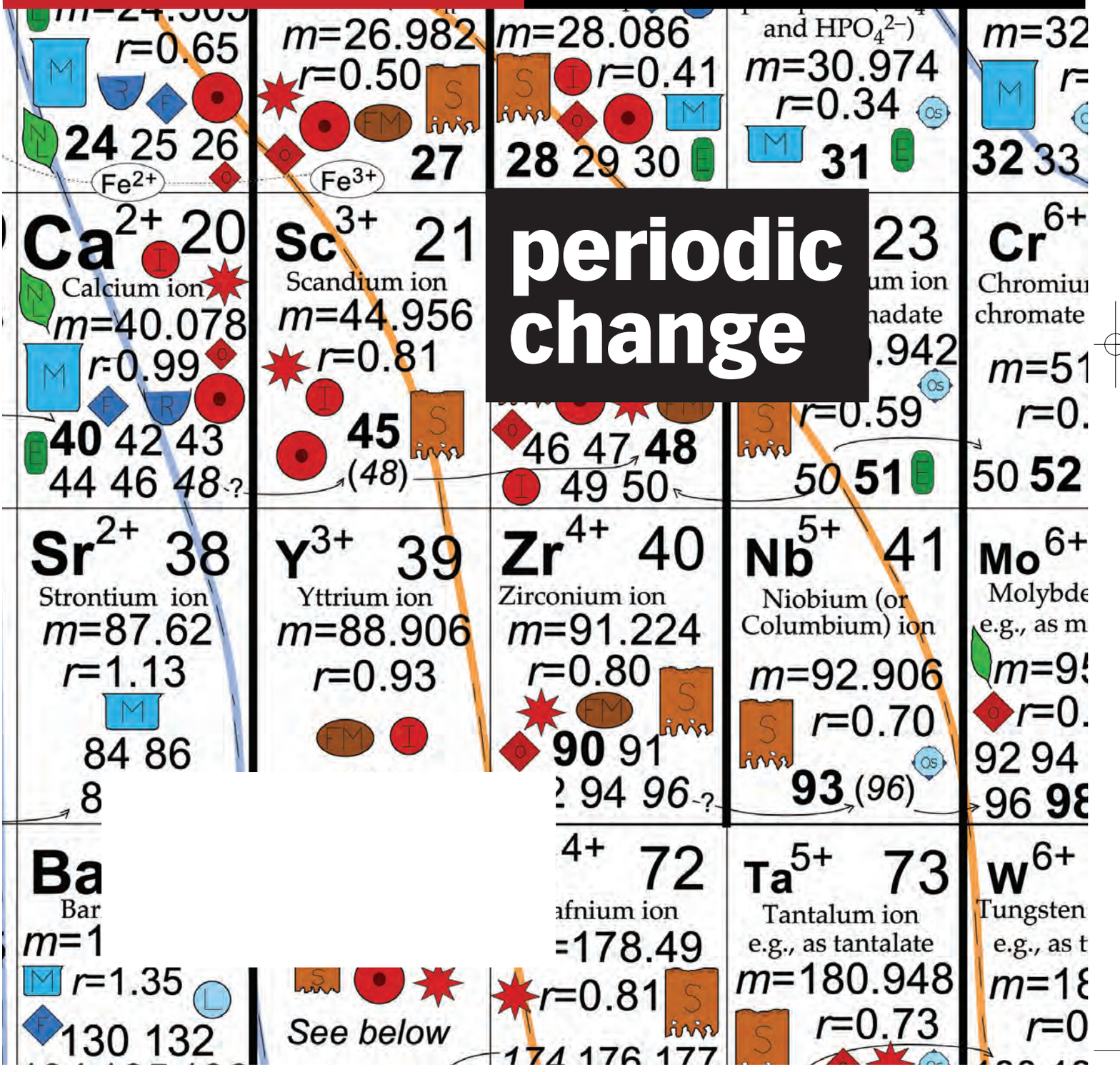

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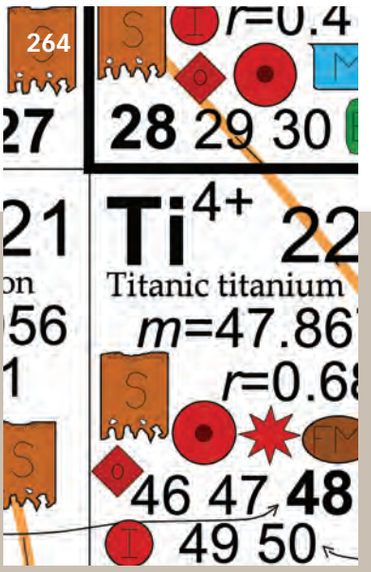

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World Series stats Do series that last seven games occur more frequently than expected? See Ivars Peterson's MathTrek.

Of Note

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Cover An earth scientist has remodeled the periodic table to suit his own research and teaching needs. He's one of many scientists struggling to make this scientific icon more accessible—and more meaningful—to a wide audience. (L.B. Railsback/*Geology*) Page 264

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IQ Yo-Yo

Test changes alter retardation diagnoses

Since average scores on particular IQ tests rise a few points every 3 or 4 years, those tests become obsolete after a couple of decades. In order to reset the average score to 100, harder IQ tests are devised every 15 to 20 years.

Trickier tests have no practical impact on people who score within the normal IQ range of 90 to 110. But so-called renormed IQ tests create a yo-yo effect in the number of mental retardation placements in U.S. schools, a new study finds.

Rates of mental retardation among children appear to bottom out near the end of a particular test's run, followed by a sharp rebound with the introduction of a tougher test, say Tomoe Kanaya, a graduate student at Cornell University, and her colleagues. Scores on the new test then increase over time, pulling many children from just below to just above the score of 70, which stands as the rough cutoff for mental retardation. That trend continues until the next test revision comes along.

As already demonstrated for children with IQ scores in the normal range, kids scoring near 70 lose an average of nearly 6 points when administered a renormed test, Kanaya's team reports in the October *American Psychologist*.

Mild forms of mental retardation often prove difficult to diagnose. Psychologists look not only for an IQ of slightly less than 70 but also for impaired social and practical skills.

"Our findings show the importance of focusing on children's [real-life] functioning when assessing mental retardation," says psychologist Matthew H. Scullin of West Virginia University in Morgantown. For several years after the introduction of a revised IQ test, he adds, "two children in the same classroom with the same cognitive ability could be diagnosed differently, simply because different tests were used for each child."

In their study, the Cornell scientists analyzed IQ data from 8,944 special education assessments conducted by psychologists in nine school districts across the country. Testing was often repeated and ran from 1989 through 1995.

Among the kids who took the old test and then the version revised in 1991, the proportion scoring just below 70 and recommended for special education tripled. The effect was absent in children who took the same test on two occasions.

The impact of the yo-yo effect on IQ scores extends beyond the classroom, Scullin says. People convicted of murder now avoid the death penalty if they're deemed mentally retarded, but they stand a far better chance of scoring below 70 on a recently revised IQ test than on an older test. The same goes for adults trying to qualify for Social Security payments for a mental disability.

"Talk about high-stakes IQ testing," remarks educational psychologist Frank Gresham of the University of California, Riverside.

The new findings are consistent with those from much smaller studies conducted in various school districts over the past 20 years, Gresham says. During that same period, however, diagnoses of mental retardation have decreased, while designations of learning disabilities have soared. In Gresham's view, this trend largely reflects the stigma attached to labeling a child as mentally retarded. —B. BOWER

Chicken Little?

Study cites arsenic in poultry

Most chicken eaten in the United States contains three to four times as much arsenic as do other kinds of meat and poultry. That finding may require researchers to revise upward their estimates of how much of this toxic metal people consume in food, but the revised amount still doesn't exceed what's accepted as safe.

Inorganic arsenic is a carcinogen; organic forms—compounds containing carbon and arsenic—are less toxic and combat animal diseases and accelerate growth. Therefore, organic arsenic is an approved ingredient in roxarsone, a feed additive used in poultry and swine. About 70 percent of chickens grown for meat receive roxarsone. They excrete most of the arsenic but retain some in their tissues, particularly the liver, in both organic and inorganic forms.

To ascertain how much arsenic remains in slaughtered animals, Tamar Lasky and her U.S. Department of Agriculture colleagues in Washington, D.C., analyzed USDA data on arsenic concentrations in the livers of more than 5,000 chickens, 2,700 turkeys, 5,500 pigs, and 7,000 cattle, sheep, and other animals.

The average concentration of arsenic in livers from young chickens—from which most chicken meat is derived—was 0.39 parts per million (ppm). Liver-arsenic concentrations for mature chickens, turkeys, and pigs ranged from 0.10 to 0.16 ppm, and those for all other species contained about 0.10 ppm.

The researchers then extrapolated how much toxic arsenic might be consumed in chicken meat. They used past estimates of the ratios of liver arsenic to muscle arsenic, and inorganic to organic arsenic in chickens and then factored in how much chicken U.S. consumers eat.

A typical adult may ingest 3.62 to 5.24 micrograms of inorganic arsenic per day from chicken alone, Lasky—who's now at the National Institutes of Health in Bethesda, Md.—and her colleagues report in an upcoming *Environmental Health Perspectives*. Among the 1 percent of the U.S. population eating the most chicken, each person may ingest between 21.13 and 30.59 micrograms of inorganic arsenic daily, the researchers figure. Even that dose of inor-

A PECK OF ARSENIC Chicken feed contains arsenic in organic compounds, but more toxic, inorganic forms may accumulate in the animals' meat.

ganic arsenic doesn't exceed the World Health Organization's suggested limit for intake of 2 milligrams per kilogram of body weight per day, but it does represent a "sizable portion of the tolerable daily intake," the researchers say. Tainted drinking water is generally considered the greatest source of arsenic in people.

"It didn't alarm me," says Timothy N. Chamblee of Mississippi State University, after seeing the new study. The estimated average exposure "is not an amount that's excessively high," he says.

"Even though it's organic arsenic being fed to these chickens, [they contain] a lot more inorganic arsenic at the end of the day," says John F. Stolz, a microbiologist at Duquesne University in Pittsburgh. That fact is "screaming for research" into how the body processes arsenic, he says.

Apart from any physiological effects on chickens themselves or consumers, feed additives introduce tons of organic arsenic into the environment every year, says Stolz. Some of that arsenic is converted into inorganic forms, which could contaminate water supplies, he notes. —B. HARDER

Timing Is Everything

Implantable polymer chip delivers meds on schedule

Many pills and injections could become history if a group of drug-delivery researchers has its way. The team has fabricated a polymer microchip that stores multiple drug doses and, when implanted in the body, could automatically release the medications at programmed intervals.

The paper-thin, dime-size chip contains a series of tiny reservoirs. Each reservoir can store a single drug dose and is sealed with a membrane made from a second, tailored polymer. By altering the length of this polymer's molecular chains, the researchers can program the membranes to burst and release the reservoir's contents at specific times.

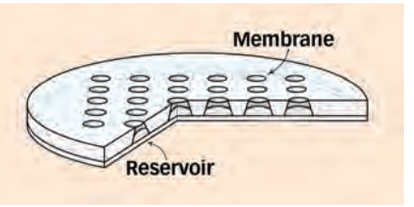
In an upcoming issue of *Nature Materials*, bioengineer Robert Langer of the Massachusetts Institute of Technology (MIT) and his colleagues unveil their new drug-delivery strategy. In one set of experiments, they loaded the sugar dextran, the anticoagulant heparin, or a growth hormone into reservoirs on separate chips. Each reservoir was sealed with a different polymer membrane.

In water, membranes made of molecules of a particular length burst after a specific amount of time. If made with longer molecules, the membranes took longer to burst. The researchers found that they could make chips that released their chemical loads in four pulses over a period of 35 to 60 days.

The MIT group also loaded individual chips with two chemicals—half of the reservoirs contained dextran and half contained heparin. In a final experiment, the researchers showed the device could function for up to 140 days.

"This is a significant contribution to the field of drug delivery," says Nicholas Peppas, a biomedical engineer at the University of Texas at Austin. "This device opens up new methods for treating patients."

Implanted under the skin, the chips could deliver many potent protein-based drugs that are typically delivered via injection



SMART MEDS **A polymer chip holds a series of reservoirs, each sealed with a polymer membrane. In the body, the membranes would dissolve at different rates, releasing their contents at programmed intervals.**

because they readily degrade in the gut if taken orally. The chips could also be useful for delivering hormone therapies, which are most effective when released in pulses, rather than in the continuous fashion of slow-release capsules.

And then there's the issue of patient compliance, says Peppas. "Patients forget to take their pills when they need to." The drug chips could solve that problem, too.

"You could use these chips for multistage vaccines, such as hepatitis B, that require multiple visits to the doctor," says Amy Richards Grayson, one of Langer's coworkers, now at Cornell University. "That could be a really good fit for this technology."

In previous work, Langer and his colleagues devised a silicon microchip for drug delivery. The device, equipped with a tiny battery and microprocessor, consists of reservoirs capped with gold membranes. When a voltage is applied to a membrane, its gold dissolves.

An advantage of the new polymer chip over the more-complex silicon version is that the polymer one doesn't have to be surgically removed, says Grayson. When the chip is empty, the biocompatible materials would slowly degrade, she says.

So far, Langer's team has fabricated chips with 36 reservoirs. However, Langer says, hundreds of reservoirs could easily fit onto a single device. MicroCHIPS of Bedford, Mass., the firm developing the silicon device, also plans to commercialize the polymer version. —A. GOHO

First Viruses, Now Tumors

AIDS drug shows promise against brain cancers

An unlikely partnership between AIDS researchers seeking new antiviral therapies and developmental biologists exploring how the brain forms has produced a promising new drug for the fight against deadly brain tumors. In cell and animal studies, the drug, originally developed as an anti-HIV medication, has slowed the growth of several kinds of brain cancers.

"I hope and would like to think that this will end up being useful in human disease," says Rosalind A. Segal of the Dana-Farber Cancer Institute in Boston, who headed the work.

Several years ago, researchers discovered that for the AIDS virus to infect an immune cell, HIV must grab on to a cell-surface protein called a chemokine receptor. Chemokines are chemicals that guide immune cells around a body, and receptors allow the cells to detect the compounds.

When investigators created mice lacking the chemokine receptor CXCR4, which is one that HIV exploits, the rodents died as embryos, their hearts and blood vessels riddled with defects. The mutant animals also had malformed brains.

"What's become increasingly clear is that there's a deeper ancestral role for chemokines, particularly in patterning the nervous system," says Richard Ransohoff of the Cleveland Clinic.

Research groups led by Ransohoff, Segal, and several other scientists have discovered that CXCR4 and the chemokine that binds to it have multiple roles in a growing brain. The chemokine and its receptor keep brain cells alive and can stimulate their proliferation, for example.

Investigators have also found evidence that the cells of different brain tumors—from the occasionally treatable medulloblastomas to the almost-always-fatal glioblastomas—sport CXCR4 on their surface. The blood vessels that form to nourish a growing brain tumor apparently secrete the receptor's chemokine.

In an upcoming *Proceedings of the National Academy of Sciences*, Segal's group confirms the extensive presence of CXCR4 in various human brain cancers.

ADAPTED FROM NATURE MATERIALS

Moreover, her team reports test tube studies showing that a drug that blocks this receptor slows the growth of medulloblastoma and glioblastoma cells. The researchers also implanted such cells in the brains of mice, permitted tumors to form, and treated the animals with injections of the drug, which is currently called AMD 3100. The drug "significantly decreased the growth of the tumors," says Segal.

AnorMED, a firm based in Langley, British Columbia, has already tested AMD 3100 in people as an AIDS drug and has seen few side effects. The company, along with Segal and her physician colleagues at Dana-Farber, are now discussing whether to try the compound on people with brain tumors that haven't responded to conventional therapies.

"Glioblastoma is a horrible disease with very little in the way of useful treatments. Therefore, the discovery of something that has even a spark of promise, with almost no downside, gives you a great deal of encouragement," says Ransohoff. "It would be crazy not to try it."

Segal notes that other kinds of cancers, such as kidney tumors, also appear to depend on the chemokine receptor CXCR4 and so might also be thwarted by drugs blocking it. —J. TRAVIS

Bad for the Bones

Thwarted hormone leads to skeletal decay

A hormone with one widely recognized task may not be single purposed after all. Thyroid-stimulating hormone (TSH), which is made in the pituitary gland and circulates in the body, pumps up production of thyroid hormone, an important regulator of metabolism. Now, research demonstrates that TSH also affects the constant remodeling of bone: Lab mice that aren't responsive to TSH show signs of the bone-thinning disease osteoporosis.

Mone Zaidi of Mount Sinai School of Medicine in New York and his colleagues created mice missing half or all copies of the TSH receptor, the cell membrane protein to which the hormone must bind to initiate any of its actions. The mice devoid of TSH receptors were small and sickly and died within 10 weeks.

Mice with half the usual number of TSH receptors appeared healthy but had a hidden problem. Although they made normal amounts of thyroid hormone, these mice had frail bones that were rapidly remodeling themselves—simultaneously destroying existing bone while adding new tissue inappropriately. Thyroid hormone deficiencies weren't responsible for the defect, Zaidi says, because even when these mice were given additional thyroid hormone, they still showed bone defects.

"As a physician and as a scientist, I learned that the only function of TSH is to regulate thyroid hormone production," says Zaidi, whose findings appear in the Oct. 17 *Cell*. In this experiment, however, animals with depleted TSH receptors had normal thyroid function but brittle bones. "It really contradicts the textbook picture," he says.

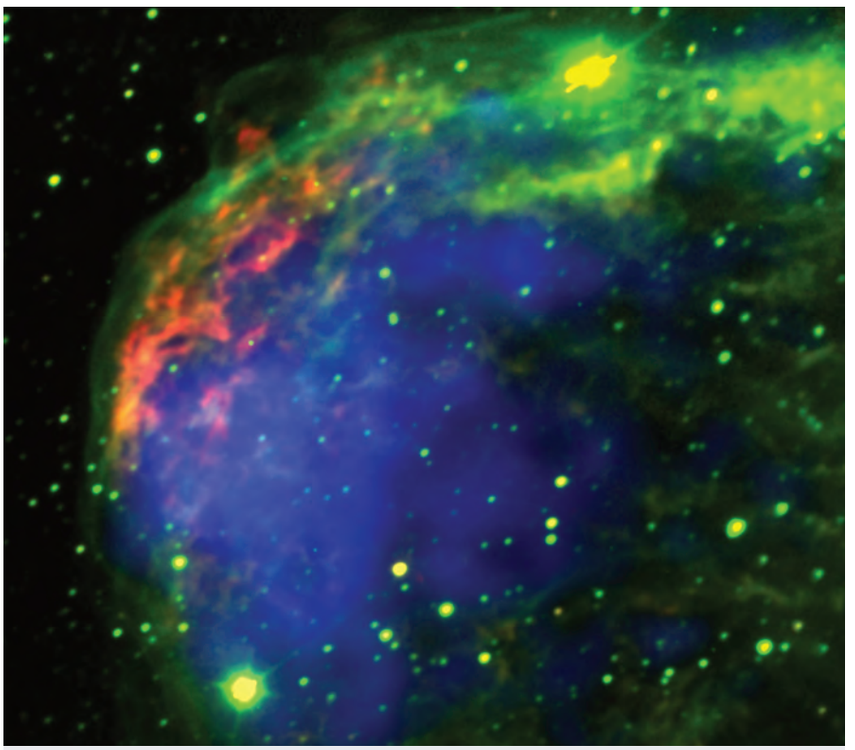
In healthy skeletons, two cell types work in concert to constantly remodel bone. Osteoclasts break down bone structures, while osteoblasts form new bone. Zaidi and his colleagues found that a lack of TSH receptors leads to overactive and unusually long-lived osteoclasts and osteoblasts.

Conversely, when the scientists added TSH to cultures of normal osteoclasts and osteoblasts, their activity diminished. TSH and its receptor appeared to act through separate chemical pathways in each of the two cell types, and the effect was greater in the bone-destroying cells. Altering the amounts of TSH or its receptor can thus disrupt the delicate balance of bone remodeling, says Zaidi.

Physicians had long observed a relationship between an overactive thyroid gland and osteoporosis but generally attributed the bone disease to the increase in thyroid hormone. While there have been studies suggesting that elevated thyroid does affect some aspects of bone physiology, Zaidi's results suggest another explanation: The drop in TSH concentrations that results from excess thyroid hormone could cause the observed bone loss.

Because bone weakening appeared in mice that still had half their TSH receptors intact, "normal variations [of TSH] that you might see in a human population might be contributing to bone mass," says Deborah V. Novack of Washington University School of Medicine in St. Louis.

Both Novack and Zaidi see promise in the TSH molecule and its receptor for designing diagnostic tools and therapies for osteoporosis, a disease that Zaidi calls "perhaps one of the most underdiagnosed



X-RAY: NASA, Y. CHU, R. GRUENDL ET AL./UIUC; OPTICAL: SDSU, MLO, Y. CHU ET AL.

When really big winds collide

Outbursts of a massive star created the gaseous shell known as the Crescent nebula. Rushing toward a supernova death, the star (not shown) had expanded enormously, jettisoning its outer layers at some 32,000 kilometers per hour. Radiation from the exposed inner layers then began ejecting gas at more than 100 times that speed. The collision between the fast and slow winds formed the nebula, a portion of which appears here, and created two shock waves. One wave moved outward to produce the filamentary structure that appears green in visible light, and the other moved inward, producing a bubble of hot, X-ray-emitting gas (blue). Red blotches denote visible-light emission. This composite image was released last week by the Chandra X-ray Observatory Center in Cambridge, Mass. —R. COWEN

and undertreated public health problems."

Treatment based on TSH might not be simple, however, since osteoporosis can remain hidden for decades, says John R. Klein of the University of Texas Health Science Center in Houston. Still, the study "brings a new dimension into the way we think about how bone remodeling occurs," says Klein. "TSH, a molecule that few people would have ever imagined was involved in regulating bone remodeling, is in fact a major player in the process." —K. RAMSAYER

Bob, Bob, Bobbin' Along

Dinosaur buoyancy may explain odd tracks

Some of the heftiest four-legged dinosaurs ever to walk the Earth occasionally left sets of footprints that include only the imprints of their front feet. New laboratory and computer studies may explain what those animals were doing with their hind legs.

The sauropod group of dinosaur species consisted of large herbivores, some weighing up to 100 metric tons. These behemoths spent most of their time on all fours but may have reared up on their hind limbs to defend themselves or browse on high foliage. That posture can't explain the trails of sauropod footprints with no traces of hind feet.

Adding water to the equation, however, may solve the puzzle. Computer analyses of sauropod buoyancy conducted by Donald M. Henderson, a paleontologist at Canada's University of Calgary, suggest that floating sauropods of some species could indeed have made forefoot-only trackways.

Henderson's model divides a sauropod's body into many thin slices and calculates both the downward-acting weight and the upward-acting buoyancy of each slice. The model also accounts for body cavities, such as the lungs, and for appendages, such as the neck, tail, and limbs.

Brachiosaurus and *Camarasaurus*, sauropods that had relatively long front limbs and a balanced weight distribution, floated with their forefeet deeper than their back feet, Henderson found. So, they could have left prints of only their front feet as they moved through shallow water. However, *Diplodocus* and *Apatosaurus*, sauropods that had long tails and carried most of their weight over their rear legs, floated with their hind feet deeper than their front feet. That makes it almost impossible for them to produce forefoot-only trackways while partially floating, says Henderson. He presented results of his analyses last week at the annual meeting of the Society of Vertebrate Paleontology in St. Paul, Minn.

However, there still may have been a way for even those sauropods to have left no-hind-foot tracks, argue Jeffrey A. Wilson and Daniel Fisher of the University of Michigan in Ann Arbor. By placing 1/40-scale models of various sauropods on sensitive balances, the scientists measured the changes in weight borne by each creature's front and rear feet as the models were immersed in slowly rising water. When it reached wading depth for the sauropods, the water partially buoyed the models' tails and bodies. That would have shifted the animals' weights toward their front feet, Wilson says.

At certain water depths, all the sauropod models that Wilson and Fisher analyzed—both those with balanced weight distributions and those that were hip-heavy—exerted footprint pressures with their front feet that were more than twice those exerted by their rear feet. Therefore, says Wilson, it's possible that some sediments would record only the imprints of a wading dinosaur's front feet. He presented these findings at last week's meeting in St. Paul. —S. PERKINS

Super Spinner

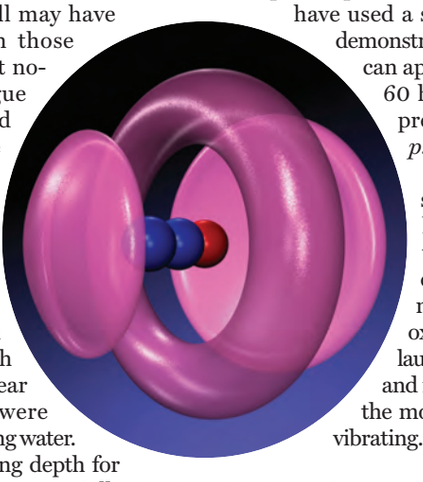
Seven-atom speck acts like superfluid

Superfluids are weird liquids that flow with no friction and can perform fantastic feats, such as spontaneously crawling over the walls of containers. Theorists have proposed that quantum-mechanical interactions among even a few atoms can give rise to such behaviors.

Now, researchers in Canada have evidence for the onset of superfluidity in a droplet containing a mere seven atoms of liquid helium-4. For now, isotopes of helium are the only substances known to exhibit superfluidity, which appears at temperatures just above absolute zero (*SN: 9/23/00, p. 207*).

Wolfgang Jäger and Yunjie Xu of the University of Alberta in Edmonton and A. Robert W. McKellar and Jian Tang of the National Research Council of Canada in Ottawa joined forces to make the discovery. The scientists observed signs of superfluid behavior in successively larger groupings of helium-4 atoms, starting with three atoms and building up to a cool dozen.

In past experiments, other scientists have used a similar approach to demonstrate that superfluidity can appear when as few as 60 helium-4 atoms are present (*SN: 4/25/98, p. 271*).



HELIUM BALLOONS Large ring marks where helium atoms first surround a nitrous oxide molecule. Hints of superfluidity start as additional helium atoms occupy hubcap-shaped end regions.

The Canadian researchers created the helium groupings so that each one was clustered around a molecule of nitrous oxide, better known as laughing gas. Microwave and infrared radiation set the molecule spinning and vibrating.

The first six helium atoms to accumulate are essentially dragged along with the rotating molecule at about 10 billion revolutions per second, Jäger says.

Helium atom number 7, however, altered the picture dramatically. The additional atom not only didn't join the merry-go-round, but its presence also somehow lessened the connections between the other six helium atoms and the nitrous oxide. Slippage started appearing between the spinning molecule and the surrounding helium—a first hint of frictionless flow—and continued with additional helium-4 atoms.

Jäger, McKellar, and their colleagues report their results in the Oct. 17 *Physical Review Letters*.

These new findings may be the first direct observation of superfluidity setting in as helium-4 atoms pile up to form a droplet, Jäger says. The observations also illuminate the physical nature of liquid-helium droplets engulfing molecules, he adds.

Some theorists regard these minuscule droplets as a mixture of two fluids—a normal fluid and a superfluid. Others argue that the droplets constitute a single superfluid of uneven density.

The new data "provide a far more interesting and demanding test of [superfluidity] theory than any previous experiment," says Kevin K. Lehmann of Princeton University, a proponent of the single-superfluid point of view.

Theorist K. Birgitta Whaley of the University of California, Berkeley points out that the new data actually fit nicely with previous theoretical studies based on the two-fluid model. —P. WEISS

JÄGER

THE NATURE OF THINGS

Attempts to change the periodic table raise eyebrows

BY ALEXANDRA GOHO

One day, during the spring semester of 1999, L. Bruce Railsback turned against one of science's most visible icons: the periodic table of chemical elements. He was using a conventional periodic table mounted on the wall to illustrate a geochemistry lecture about the behavior of minerals in natural waters. That's when he realized how confusing the table's organization was, at least for his purposes. "I looked like a contortionist trying to point to different elements in different places," says Railsback. "That's what pushed me over the edge."

To most people, the periodic table is the epitome of science at its most orderly. The table's tidy rows and columns slot all of the 110 or so elements into fixed groups. However, to Railsback, an earth scientist at the University of Georgia in Athens, the table represents complete chaos.

"I thought, 'There ought to be a way to group the elements that would make sense to someone interested in natural and geological processes,'" says Railsback. Back in his office, he set to work designing a new periodic table that would be more scientifically, and therefore more ergonomically, suited to an earth scientist.

Earth scientists encounter elements mainly in their ionic forms, where they carry a positive or a negative charge. So, Railsback organized his table around ions rather than the neutral atoms featured in the conventional periodic table.

"It's a very nice tool, kind of like an expert system for viewing the periodic table in the context of a variety of applications," says Laura Crossey, a geologist at the University of New Mexico in Albuquerque.

Railsback's table is also emblematic of an ongoing quest among scientists to find the perfect format for the periodic table.

LABOR OF LOVE It took Railsback more than 4 years to produce a new chart—a project that culminated in the publication of "An earth scientist's periodic table of the elements and their ions" in the September *Geology*.

In this new version, Railsback changed the way the elements are grouped, although within those groups, he more or less maintained the order in which the atoms appear in the conventional table, that is, according to the number of protons in the atom's nucleus. Blocks of elements make up six separate groups that are connected by colored lines. All the positively charged ions, or cations, are together on the right side of the collage, and all the negatively charged ions, or anions, are on the left. Uncharged elements constitute their own cluster, situated to the left of the table's center. Two copies of the column with the noble gases, such as helium and neon, bracket the table like bookends.

Many elements appear in the table more than once. Sulfur, for instance, appears four times—S, S^{2+}, S^{4+}, and S^{6+}. "It reflects the different ways sulfur can behave in nature," says Railsback, adding that sulfur is found in dissolved forms in the ocean as well as in various solid mineral forms.

In his chart, a colored shape within the box for each element indicates where in the environment a particular ion is concentrated—in Earth's mantle and crust, soils, seawater and rivers, the atmosphere, or living organisms.

Elaborate contour lines add another dimension to the table. Much as markings delineate a topographic map, a series of lines meander around groups of ions. These lines demark similar ionic potential, which is a measure of how tightly an ion's charge is packed. The larger the potential, the more the ion will attract particles of opposite charge or repel particles of similar charge.

"That's going to have a lot to do with how that ion behaves in solution," says Railsback. A positively charged ion with a high ionic potential will react more readily with the negatively charged ends of water molecules than will a cation with a smaller ionic potential.

Because ions with similar ionic potentials tend to concentrate in the same sorts of environments, the contour lines link groups of elements with same colored symbols. The overall effect: Speckles of different colors cluster in swaths across the table. A swath of blue represents ions in seawater, and a band of brown represents ions in soils.

> "There ought to be a way to group the elements that would make sense to geologists."
>
> — BRUCE RAILSBACK
> UNIVERSITY OF GEORGIA

"It's a fabulous piece of work," says Richard Wanty, a research chemist at the United States Geological Survey in Denver. Wanty was particularly pleased to see his favorite element, vanadium, appear three times —in the ionic forms V^{3+}, V^{4+}, and V^{5+}. "In the normal periodic table, you get one shot at vanadium and that's it," he laments.

From the behavior of gold in mineral deposits to the uptake of potassium ions by plants, "there's something for everybody in this periodic chart," says Wanty.

For example, a scientist specializing in dating ancient rocks might want to investigate potential problems in using the decay rates of radioactive uranium to determine the age of materials (*SN: 9/6/03, p. 147*). Railsback's chart shows that the uranium ion, with a charge of +6, falls among materials with very high ionic potentials and therefore high solubilities in water. There's plenty of water in geologic settings, such as limestone caves, so uranium will leach away.

Says Railsback: "If we start losing material, then our data is no longer correct."

The new ionic organization of elements could also be useful for materials scientists, Crossey suggests. In recent years, researchers have made great strides in fabricating a wide range of biomaterials that interact with ions. Examples include materials made from proteins and synthetic polymers that can remove mercury ions from water, and polymers that release drugs in the body when concentrations of calcium or magnesium ions are high enough (*SN: 3/8/03, p. 150*).

Now that the table is publicly available, Railsback hopes that researchers and educators will take note. Wanty, for one, is an early convert. "If I were to teach a geochemistry class, I would start here," he says.

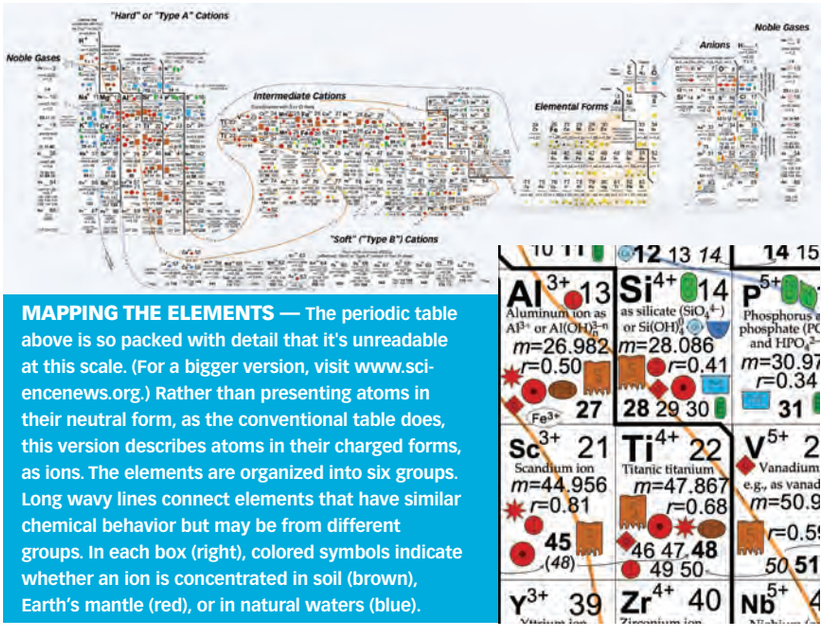
TABLE MANNERS Railsback isn't the only one inclined to modify the conventional periodic table into a more specialized and revealing reference suited to his specialty.

In fact, there is a long tradition of modifying the chart among geologists, metallurgists, and even biologists, says Eric Scerri at the University of California, Los Angeles. "People in different disciplines will want different things out of the periodic table," says Scerri, who specializes in the historical and philosophical aspects of the periodic system of elements. Keeping the order of the elements fixed, the table can be molded in any number of ways. "It's infinitely flexible. . . . That is one of the strengths of the periodic table," he says.

From spirals and trees to three-dimensional pyramids, numerous alternative tables have been proposed.

While many of these tables bring the conventional table to life, some are downright wacky, says William Jensen, a chemistry historian at the University of Cincinnati. Last year, he notes by way of an example, a high school teacher drove across the country to show Jensen his own version of the table. "He had a 1957 Cadillac, and on it was painted the periodic table," says Jensen.

The Internet, with its hundreds of Web sites dedicated to the periodic table, has added a hypertextual dimension. Through links and interactive features, users can retrieve a wealth of data on the chemical and physical properties of different elements, including animated visuals of an element's orbiting electrons and a brief history of each element's discovery.



MAPPING THE ELEMENTS — The periodic table above is so packed with detail that it's unreadable at this scale. (For a bigger version, visit www.sciencenews.org.) Rather than presenting atoms in their neutral form, as the conventional table does, this version describes atoms in their charged forms, as ions. The elements are organized into six groups. Long wavy lines connect elements that have similar chemical behavior but may be from different groups. In each box (right), colored symbols indicate whether an ion is concentrated in soil (brown), Earth's mantle (red), or in natural waters (blue).

The table was devised in 1869 by the Russian chemist Dimitri Ivanovich Mendeleev. His tack was to order the elements on the basis of their atomic weights—that is, the number of protons and neutrons in an atom's nucleus. Moreover, he arranged the elements in columns on the basis of the number of chemical bonds an atom can form.

Early in the 20th century, one of these fundamental rules for the table changed slightly. Elements have since been ordered according to their atomic numbers, or number of protons.

The last major change to the table was in the 1940s, when Nobel Laureate Glenn Seaborg at the University of California, Berkeley created a separate group for the lanthanides and actinides—the rare earth and radioactive elements.

Before Seaborg's revision, these elements were mixed in with the transition metals in the middle of the chart. While bombarding uranium with neutrons in the lab, Seaborg discovered that the actinides shared their chemistry primarily with the lanthanides. Therefore, he concluded, the two types of elements warrant their own block.

"That resulted in a very fundamental change in the whole structure of the periodic table," says Jensen.

All subsequent changes to the conventional table have revolved primarily around esthetic issues, says Jensen. The questions tend to be, "Do we want the table in the shape of a cone or a fan?" he says. "But all these things are really devoid of any real scientific content. They are not really telling us anything new or insightful about the nature of the elements."

STIRRING THE BEAST Most scientists agree that the order of atoms in the table will never change, unless, of course, a major revolution turns upside down everything known today about matter. Even so, many researchers contend that the current organization of the table is far from perfect.

"Should the form of the table be the conventional form, which is rather ugly and asymmetrical, or could it be more symmetrical?" asks Scerri. This is only partly a matter of aesthetics.

Scerri and other chemists have begun scrutinizing the placement of helium at the top of the right-hand column in the conventional table. That's the column housing the noble gases, so-called because of their penchant for not engaging with other elements. What makes helium odd among the noble gases is that instead of having six electrons in its outer shell, it has only two electrons. This suggests, says Scerri, that helium belongs on the far left of the chart with the alkaline earth metals, which also have two electrons in their outer shells.

"Chemists are a bit horrified by the idea of putting helium in with a bunch of metals," says Scerri. But he argues that placing helium with the alkaline earth metals results in a more regularly shaped structure that can take two forms. One form, referred to as a pyramid, is a stack of blocks with increasing length from top to bottom. The other resembles a set of stairs descending to the left. Helium sits next to hydrogen at the top of the stairs. This left-step table places atoms in different rows on the basis of the size and shape of an atom's electron orbitals.

Other scientists have proposed this particular structure before, Scerri notes, but the idea has been gaining momentum in recent years. "Now, something might actually happen," says Scerri.

Getting the entire world to adopt the same, new periodic table will be a challenge, especially because the table will need to garner approval from the International Union of Pure and Applied Chemistry. Traditionally, chemists have not taken well to attempts to change the table. "I call this 'the tyranny of the chemist,'" says Scerri.

In the meantime, researchers like Railsback are less concerned with the wholesale adoption of a new table than molding the table to suit their needs. As more scientists pursue that end, the periodic table will continue to evolve into a diversity of forms, each one filling a niche. ■

RAILSBACK/GEOLOGY

NEW PCBS?

Throughout life, our bodies accumulate flame retardants, and scientists are starting to worry

BY JANET RALOFF

Polybrominated diphenyl ether (PBDE) is hardly a household phrase. Yet it probably should be. Household products ranging from kids' pajamas to computers release these brominated flame retardants. The chemicals have been turning up in house and yard dust, as well as in specimens collected from sewage sludge, streams, and even people's bodies. For 3 decades, manufacturers have been putting these chemicals into a wide variety of products to reduce the risk that these goods will catch fire.

And indeed, PBDEs have performed reliably, saving an estimated 300 or more lives each year in the United States alone. However, emerging data on the extent to which the chemicals pollute the environment have kindled concern that these useful compounds may have subtle toxic effects, despite having passed standard safety tests.

Most U.S. chemists trace their initial concern about these compounds to a report by Swedish scientists at an international chemistry conference in Stockholm 4 years ago. The researchers stunned the audience with data showing that PBDEs were present in samples of women's breast milk stored over the past quarter century and that the more recent the sample, the higher the concentration of the chemicals (*SN: 10/13/01, p. 238*).

Ronald A. Hites of Indiana University in Indianapolis, who attended that conference, remembers feeling immediate concern because of the close structural similarity between PBDEs and polychlorinated biphenyls (PCBs)—insulating oils that were banned in 1979 owing to their toxicity.

As soon as he got home from the meeting, Hites began surveying published studies that recorded PBDE concentrations in people. Data were available only for industrial countries. At an Environmental Protection Agency conference in Chicago this past August, he reported his findings: PBDE concentrations are 10 to 20 times as high in North Americans as they are in Europeans. And the Europeans' concentrations are about double those of people living in Japan. Moreover, Hites says, his calculations show that since the 1970s, these body concentrations have been "exponentially increasing, with a doubling time of 4 to 5 years."

So what? That's a question scientists and policy makers have been puzzling over. Animal data reported this summer support concerns that these useful compounds might, over the long term, prove toxic to people.

A record 80 papers on brominated flame retardants were presented in August at an international meeting in Boston called Dioxin 2003. Although presentations linked all five major classes of brominated flame retardants with some animal toxicity, the majority of studies focused on the three PBDE classes—related chemicals with different commercial applications and toxicity profiles. Especially troubling were reports indicating that relatively low-dose exposures to PBDEs in the womb or shortly after birth could irreparably damage an animal's reproductive and nervous systems. Earlier test-tube studies had indicated that the compounds could alter concentrations of thyroid hormones—agents that play a pivotal role in growth and development.

Blood concentrations of PBDEs eliciting some of these effects in animals are close to those now being measured in North Americans, observes Linda S. Birnbaum, EPA's director of experimental toxicology in Research Triangle Park, N.C. The animal studies are still preliminary and fall well short of proving that PBDEs pose a major threat to people, Birnbaum says. However, if people prove as vulnerable, the concentrations showing up in North Americans leave "no margin of safety," she told *Science News*.

BAMBI FACTOR To many toxicologists at the Boston meeting, most troubling were data indicating that human exposures to PBDEs begin in the womb. Hites had instructed delivery-room nurses to extract 10 milliliters of umbilical cord blood from each of 20 Indiana newborns. Each baby's mother also donated blood.

Concentrations of PBDEs in each mother and her baby were virtually identical. However, the values between mother-baby pairs varied widely. In the July *Environmental Health Perspectives*, the Indiana scientists report that although the average was around 40 parts per billion (ppb) of PBDEs in blood, some moms and babies showed concentrations up to 450 ppb.

STATS

PBDE flame retardants save some

300

U.S. lives annually

For breastfed infants, mothers' milk continues the PBDE exposure. At the Boston dioxin meeting, Arnold Schecter of the University of Texas Health Sciences Center in Dallas previewed his team's data on PBDEs in breast milk recently donated by 47 women to Texas milk banks.

All PBDEs have a double-ring structure onto which bromine atoms attach at any of 10 positions. Of 209 different PBDEs, called congeners, Schecter and his colleagues focused on the 13 that occur most commonly in commercial products.

The Texas study is the first to detect the 10-bromine form of PBDE—a congener known as BDE-209—in human milk. BDE-209 is the primary ingredient of a commercial flame-retardant product known as the deca mix because the 10-bromine congener predominates. This congener, among the hardest to measure, has been studied only recently. Indeed, many toxicologists doubted its large molecules could enter the body in measurable amounts.

The milk of seven women had concentrations up to 8 ppb. That's disturbing, notes Birnbaum, a coauthor of the Texas study. Soon-to-be-published animal research, briefly described at the Boston meeting, indicates that deca may damage nerve cells during brain development, which in humans occurs not only in the womb, but also for up to 2 years after birth.

The milk's total mix of PBDEs—from 6.2 to 419 ppb, with an average of 73.9 ppb—proved similar to the totals that Hites' group had measured in blood. The Texas study is scheduled to appear in the November *Environmental Health Perspectives*.

An even newer, nationwide study by the Environmental Working Group, an advocacy organization based in Washington, D.C., searched samples of human breast milk from 20 first-time mothers for some 30 PBDE congeners. Every one turned up in at least one milk sample. Eighty percent contained BDE-209, though none at concentrations as high as recorded by Schecter's group.

The biggest surprise, says study author Sonya Lunder in the Environmental Working Group's Oakland, Calif., office, was the high-end exposures, the top 5 to 10 percent of samples. In most PBDE surveys, these samples have proved surprisingly high. "In Sweden, those much-higher levels may be 30 ppb," she notes. "In ours, they were above 500 ppb—with one above 1,000 ppb."

Highlighting these flame-retardant exposures to the youngest, most vulnerable segment of society constitutes "the ultimate Bambi factor," Hites notes. Lunder and others express hope that the new findings will make investigation of fetal and neonatal PBDE toxicity a high priority.

NEWFOUND RISKS At the Boston dioxin meeting, several researchers linked PBDEs to reproductive and brain problems. For example, Chris Talsness of Berlin's Free University reported on reproductive-system impairments in rats after exposures in the womb to BDE-99, a 5-bromine PBDE.

Her team injected the chemical into the stomachs of females on the sixth day of their pregnancies, when fetal organs begin developing. The rats received either 60 or 300 micrograms per kilogram of body weight. The latter, Birnbaum points out, is about 10 times the highest values for PBDEs reported in U.S. residents' blood or fat.

Although treated rat moms experienced a slightly higher miscarriage rate than did females that had received an equivalent amount of peanut oil, the big effects showed up once pups reached adulthood. Ovaries of daughters from both groups of BDE-treated moms sported cell abnormalities not seen in unexposed rats.

Some sons of treated animals exhibited low spleen weights, "a flag that the immune system may be affected," Talsness says. Compared with sons of untreated rats, exposed males also had testes weighing less and producing fewer sperm.

In a follow-up study, the researchers mated unexposed rats with offspring of treated moms. Abnormalities in the offspring of those crosses suggested that the BDE-99 had caused genetic changes, Talsness says. For example, daughters that had been exposed to the chemical as fetuses bore pups with unusual birth defects, such as missing vertebrae and skull bones. Sons exposed as fetuses showed decreased fertility. These problems turned up far less often in matings of unexposed pairs.

Per Eriksson of Uppsala University in Sweden and his coworkers also worked with BDE-99 in their recent studies. Two years ago, the scientists reported that this chemical, as well as the 4-bromine congener BDE-47 and various PCBs, could impair learning and memory in rodents if given at a critical period in brain development. In a newer study, Eriksson's group gave BDE-99 orally to mice 10 days after birth, a period when baby rats are at about the same stage of development as a human fetus is during the third trimester of pregnancy. The researchers used a dose of either 0.8 or 8 milligrams per kilogram of an animal's body weight. When the pups reached adulthood, the researchers ran the animals through water-maze tests to evaluate their mental skills. Although animals in the lower-dose group performed much as untreated mice did, those getting the higher dose showed memory problems.

The scientists also observed how well each mouse familiarized itself to a new cage. An untreated or low-dose mouse would typically start out agitated, rapidly explore a novel cage, and then slow down within an hour. However, mice getting the higher PBDE dose became increasingly hyperactive through the hour. Tested again 2 months later, these animals became even more hyperactive during the cage-familiarization test.

> If PBDEs are as toxic to people as they are to animals, amounts in North Americans leave 'no margin of safety.'
>
> – LINDA BIRNBAUM

More disturbing, in Eriksson's view, was the outcome of a test in which mice got the low dose of BDE-99 and a similar subtoxic dose of a PCB. Early exposure to PCBs can cause lasting IQ deficits in children (*SN: 6/16/01, p. 374*). In the new tests, animals performed even more poorly on learning and memory tests than had mice exposed to a dose of the PCB 10 times that given in this experiment. Says the toxicologist, "I was surprised the [flame retardant] had such a strong and pronounced interaction with the PCB." Indeed, he notes, the pollutants' combined impact appeared "more than additive."

In a study due out soon in *Toxicological Sciences*, Eriksson's group shows that exposure to BDE-209 during that same early period of brain development elicits similar lasting neurobehavioral effects in mice.

Marcia L. Hardy, a toxicologist with Albemarle Corp., in Baton Rouge, La., which makes the deca-PBDE product, notes that she has been trying to see those BDE-209 data since 2001. Several months ago, her group obtained a draft version, but she notes that the report "still leaves a lot of questions unanswered." However, even if Eriksson's data hold up, the exposure a mother mouse needed to deliver PBDE concentrations in milk that are equivalent to what the pups received is "astronomically huge," she says. "I don't see how there could be any exposure like that."

WHAT TO DO? Almost 2 years ago, 126 nations, including the United States, endorsed a new international treaty to control the production and use of so-called persistent organic pollutants

Brominated Flame Retardants

The top 5 of about 35 commercial products

TYPE	GLOBAL / U.S. USE (METRIC TONS)	APPLICATIONS
Tetrabromobisphenol-A	119,000 / 18,000	Computer circuit boards, plastic housing for office equipment
Deca-BDE mix	56,100 / 24,500	Plastic housing and small parts in office equipment, rubber cables, paints, plastic electrical parts, fabric backings and coatings
Hexabromocyclododecane	16,700 / 2,800	Plastics, polystyrene foams and resins, cable and textile coatings, rigid-construction foams and blocks
Penta-BDE mix	7,500 / 7,100	Polyurethane foam, imitation wood, carpet padding, packaging, sound-insulating panels, cushioning, rubber cables, paints, plastic electrical parts, fabric backings and coatings
Octa-BDE mix	3,790 / 1,500	Plastic housing and small parts in office equipment

DATA FROM BROMINE SCIENCE AND ENVIRONMENTAL FORUM

(POPs). The goal was to limit the release of agents that were toxic, long-lived, and able to travel long distances (*SN: 6/2/01, p. 343*). PCBs, dioxins, and DDT are among the first POPs slated to be banned worldwide under the treaty. Indeed, owing to their established toxicity, most of the initially listed chemicals had already been banned in the United States and other developed countries.

PBDEs and some other brominated flame retardants now in production also deserve such a global phaseout, argues Åke Bergman of Stockholm University. After all, he notes, most PBDEs are quite long-lived (*see p. 269*) and long-distance travelers. As several research teams reported at the Dioxin 2003 meeting, PBDEs show up not only near where they were made or used but also in remote Arctic lakes. Many toxicologists have begun referring to PBDEs as "the next PCBs."

Bergman points out that when it comes to PBDEs' toxicity and persistence, "we know more about these than we knew about PCBs at the time they were banned in the 1970s."

The European Union will ban two of the three most popular PBDE formulations starting next year. These are the penta and octa mixes, containing primarily 5- and 8-bromine congeners, respectively. In September, California became the only U.S. jurisdiction to move against PBDEs. It passed a law to ban penta and octa mixes, but not until 2008. Elsewhere, production and use of these compounds remain unregulated, and no government has targeted the deca mix for controls.

Bergman expects the toxicity data emerging on the 10-bromine BDE-209 to change that. "I would be surprised if the deca [mix] isn't going to also be banned [in Europe] quite soon." However, a ban on the deca mix won't come easily, he concedes, "because there is tremendous pressure from industry to keep it."

Indeed, Hardy told *Science News*, data on the deca mix—which now accounts for some 80 percent of PBDEs used globally—indicate its toxicity is so low that "this is the flame retardant we should be using."

In the meantime, argues Leif Magnuson of EPA's pollution-control program in San Francisco, manufacturers should try weaning themselves from brominated flame retardants. Already, he notes, the electronics companies NEC, Toshiba, Sony, and Fujitsu have announced a phaseout of the PBDEs from their products.

IKEA, the Swedish furniture maker, has eliminated brominated flame retardants from its product line. One U.S. maker of mattress foam, Hickory Springs in North Carolina, tried to switch to a non-brominated flame retardant this year, but in summer, the new production processes turned the foam yellow. Mattress makers balked at accepting anything but snow-white foam.

> NEC, Toshiba, Sony, and Fujitsu are voluntarily phasing out brominated fire retardants from their electronics
>
> – LEIF MAGNUSON

Moreover, there are problems looming for the two major brominated flame retardants, ones unlikely to serve as replacements for any banned PBDEs. At the EPA and Dioxin 2003 meetings last August, toxicologists reported that tetrabromobisphenol–A impairs the liver and the immune, nervous, and endocrine systems, and hexabromocyclododecane is detrimental to the nervous system and also toxic to fish and other aquatic animals.

Manufacturers of flame retardants are already working on a host of potential alternatives. Though Lunder and others call for extensive safety reviews of whatever new flame retardants those companies come up with, Bergman argues that nothing should stall action against PBDEs.

Counters Hardy: "The real risk is fire." PBDEs have proved valuable at reducing fire risk, but she says that in discussions of any possible risks, "we're not really hearing much about their benefits."

"For heaven's sake," Bergman counters, "didn't we learn anything from the issues of DDT and PCBs? It's really time to act." ■

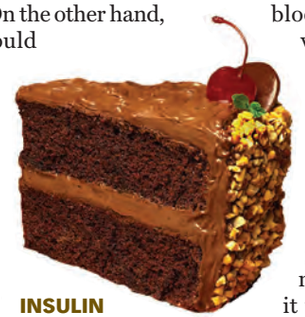
OF NOTE

NUTRITION

Cocoa puffs up insulin in blood

Eating foods flavored with cocoa powder, as opposed to other flavorings, stimulates greater production of the sugar-processing hormone insulin, Australian scientists report. An excess of insulin, which helps cells extract glucose from the bloodstream, could depress blood sugar concentrations and stimulate appetite. On the other hand, the new observation could reflect a rapid, healthy response to food intake.

Jennie Brand-Miller of the University of Sydney and her colleagues fed snacks of breakfast cereal, cake, candy, ice cream, milk, and pudding to 11 lean young adults. One version of each food item contained cocoa powder, and the other had an alternative flavoring, such as vanilla or strawberry. The team measured concentrations of insulin and glucose in blood samples drawn from the volunteers just before and within 2 hours after each snack.



INSULIN HEAVEN? Cocoa-flavored foods pack extra punch.

Chocolate-flavored foods increased insulin concentrations by 28 percent more, on average, than did the same snack with a different flavor, the researchers report in the October *Journal of Nutrition*. For each snack, both versions caused similar spikes in blood-glucose concentrations, indicating that sugar or starch content was not responsible for the foods' different influences on insulin production. —B.H.

ENVIRONMENT

Flame retardants take a vacation

Getting blood drawn may not be everyone's idea of a vacation. Yet that's just what some Swedish workers volunteered for. Researchers wanted to measure how bloodborne concentrations of polybrominated diphenyl ethers (PBDEs)—ubiquitous and potentially toxic flame retardants—changed during month-long respites from work. Other workers were tested in the workplace.

PBDEs escape from plastics, fabrics, and other materials (*SN: 10/31/01, p. 238*). Potential health consequences are now being investigated (*see p. 266*). Kristina Jakobsson of Lund (Sweden) University Hospital and her coworkers focused on 11 PBDEs that show up frequently in human blood. The researchers reasoned that any drop in concentration during vacation was likely to have resulted from the absence of workplace exposures. Unchanged concentrations might reflect food and other nonoccupational sources. The researchers reported their results on 123 workers in late August at the Dioxin 2003 meeting in Boston.

All 11 PBDEs showed drops in blood concentration during the workers' holidays. Blood concentrations of PBDEs fell faster as the size of the molecules increased. Values dropped 50 percent every 14 days for the largest PBDE, the 10-bromine BDE-209, Jakobsson reports. In contrast, her group calculated from the month long data collection that it would take nearly 2 years of vacation for concentrations of occupationally acquired 6-bromine BDE-153 to fall by half.

As expected, rubber workers who handle a powdered flame-retardant mix containing primarily the 10-bromine BDE-209 had concentrations of that chemical some 10 times as high as those in hospital cleaners or slaughterhouse workers. Jakobsson says she was "astonished," however, that BDE-209 concentration in workers manufacturing rubber-coated electrical cable was 25 percent higher than that among the rubber workers. "Was it exposure to some fine rubber dust coming from wires as they were handled?" she wonders. —J.R.

BIOMEDICINE

Balance benefits from noisy insoles

If Granny has trouble keeping her equilibrium, it may be because her feet have become less sensitive to pressure changes. Boston scientists have found that they can diminish swaying in elderly people by sending subliminal, erratic vibrations to the bottoms of the seniors' feet. This subtle postural therapy relies on a principle known as stochastic resonance, whereby noise improves signal recognition in a system such as the nerves (*SN: 11/23/96, p. 330*).

Pressure changes on the bottom of feet normally signal that the standing body is beginning to sway—movement that can lead to falls in the elderly. To reduce swaying, James J. Collins of Boston University and his colleagues developed gel-based insoles embedded with battery-powered mechanical vibrators, called tactors. Then, they asked volunteers to stand shoeless on these cushions with their eyes closed for a series of 30-second tests—20 trials for people in their 20s and 10 trials for those in their mid-70s. During half of each person's trials, the tactors vibrated at intensities too low to be consciously felt.

Participants swayed less when tactors delivered their subtle, erratic drumming to nerves, the researchers report in the Oct. 4 *Lancet*. The decrease was 5 to 20 percent depending on how motion was measured. The oldest volunteers benefited most. Indeed, Collins told *Science News*, "we were effectively able to take 75-year-old individuals and, by introducing noise, improve their balance to the level of 20-year-olds." —J.R.

ENVIRONMENT

Gulf War vets face elevated ALS risk

Two studies suggest that veterans of the 1991 Gulf War are at elevated risk of developing amyotrophic lateral sclerosis (ALS). Also known as Lou Gehrig's disease, the fatal neurodegenerative condition rarely strikes before age 50.

Researchers led by Ronnie D. Horner of the National Institute of Neurological Disorders and Stroke in Bethesda, Md., computed the difference in ALS risk between military personnel who were and weren't deployed to the Persian Gulf region during the war. They found 40 ALS cases among nearly 700,000 deployed personnel and 67 cases among almost 1.8 million other personnel. In the Sept. 23 *Neurology*, the researchers report that soldiers deployed to the gulf were 1.92 times more likely to develop ALS in the decade following the conflict than if they had not been deployed.

In a second study in the same journal, Robert W. Haley of the University of Texas Southwestern Medical Center in Dallas tracked down 17 veterans who were diagnosed with ALS by 1998 and before they had turned 45. Given the frequency of ALS among all U.S. residents under 45 and the number of war vets under that age during the Gulf War, he calculated that about 4 cases of ALS should have occurred among

OF NOTE

war vets between 1991 and 1994 and about 6 cases between 1995 and 1998. Those periods actually yielded 4 and 13 cases, respectively, suggesting that Gulf War service didn't significantly contribute to ALS in the immediate postwar period but may have done so in more recent years. —B.H.

TECHNOLOGY

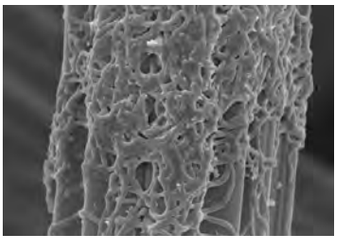
Sweet-toothed microbe tapped for power

A whip-tailed bacterium wrenches electrons from sugars so effectively that researchers have harnessed the organism to make an extraordinarily efficient fuel cell.

As many fuel cells do, this tabletop device includes two membrane-separated chambers, each one containing an electrode immersed in an aqueous solution. To one chamber, Swades K. Chaudhuri and Derek R. Lovley of the University of Massachusetts–Amherst added the bacterium *Rhodoferax ferrireducens*. The microbes pump more than 80 percent of the glucose's removable electrons from the chamber's liquid into an electric circuit, the scientists report in the October *Nature Biotechnology*.

That process is slow, however, so the new fuel cell generates just enough electricity to run a pocket calculator.

Microbial fuel cells have previously achieved sugar-to-electricity conversion efficiencies of up to 50 percent. However, those performances were attained only by adding so-called mediator compounds that shuttle electrons between the electrode and the microorganisms. Many of those shuttle compounds, which are not needed with *R. ferrireducens*, are poisonous.



STICKY SWEET Clinging to a graphite electrode roughly 15 micrometers in diameter, clumps of sugar-munching bacteria shunt electrons from a sweet solution directly into an electric circuit.

LOVLEY AND CHAUDHURI

Collaborating with other scientists, Lovley only recently discovered *R. ferrireducens* and other bacteria that can hand off electrons directly to electrodes (*SN: 7/13/02, p. 2*). Among those microbes, *R. ferrireducens* is the first with a sweet tooth, enabling it to exploit the sugars even in potential fuels including grass clippings and crops such as corn, says Lovley. —P.W.

BIOMEDICINE

Treatment helps newborns avoid HIV

Many pregnant women in developing countries don't find out they're infected with HIV, the AIDS virus, until they show up at a clinic to give birth. Despite the risk of exposure during birth, many babies born to such women are nevertheless free of the virus.

A study in Kenya in 2000 showed that 16 percent of such babies still end up acquiring HIV through their mothers' breast milk. Now, a study from Malawi suggests that this transmission rate can be reduced significantly by giving at-risk infants oral doses of two anti-HIV drugs shortly after birth.

Scientists randomly assigned babies of HIV-positive women to get nevirapine or nevirapine plus zidovudine (AZT). Of 444 HIV-negative newborns exposed to the virus through breastfeeding, 8 percent were found to be infected at 8 weeks of age if they had gotten both drugs. Of 421 HIV-negative babies getting only nevirapine, 12 percent were infected at that age, the researchers report in the Oct. 11 *Lancet*.

Although switching to formula might seem like a feasible solution, the widespread lack of clean water in some countries makes that dangerous. In Africa, infants who aren't breastfed face strikingly higher odds of dying than those who are, says study coauthor Taha E. Taha of the Johns Hopkins Medical Institutions in Baltimore. —N.S.

MEETINGS

Annual October Astronomy Meeting
College Park, Md.,
October 13 – 14

ASTRONOMY

Extrasolar planet gets heavier

Among the more than 100 extrasolar planets discovered since 1995, nearly all have been detected by measuring the tiny wobble they induce in the motion of their parent stars. But a few have been found by recording the tiny dip in starlight that occurs each time the putative planet passes in front of the star it orbits. This so-called transit method, which requires a rare alignment among the star, the planet, and Earth, yields both the radius and mass of a planet. The wobble technique can reveal only a lower limit for the mass.

The astronomers who last January reported finding the first planet using the transit method (*SN: 1/18/03, p. 38*) have now refined their estimate of the planet's mass. Rather than weighing nearly as much Jupiter, the newfound planet, designated OGLE-TR-56b, is about 1.5 times as heavy as Jupiter, reports Guillermo Torres of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass.

The newly calculated mass comes from a combination of the transit data, as well as new readings of the parent star's spectra, which indicate a star's wobble. The planet appears to have a radius 1.23 times that of Jupiter. OGLE-TR-56b lies so close to its parent star that its surface must be hot enough to melt iron.

The revised mass puts the planet more in line with models of how such a sizzling planet could evolve, says Peter Bodenheimer of the University of California, Santa Cruz.

His team's model, described in the July 20 *Astrophysical Journal*, assumes that OGLE-TR-56b was initially twice as large as Jupiter but that over 4 billion years, it contracted, despite being blasted by inflationary heat and radiation. —R.C.

EXTRASOLAR ORB

Vanishing planet

Earlier this year, a team based at the Institute for Astronomy and Astrophysics in Tübingen, Germany, suggested that the star OGLE-TR-3, which appears to undergo periodic dimming, has a closely orbiting planet (*SN: 5/10/03, p. 301*).

But Guillermo Torres of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., says analysis of his team's spectra of the star, as well as a reanalysis of data from the German team, indicate there is no planet. Instead, the dimming is probably due to a pair of mutually eclipsing stars that happen to lie along the line of sight of OGLE-TR-3, he says. —R.C.

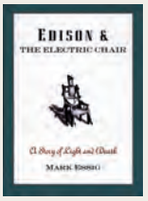
Books

A selection of new and notable books of scientific interest

EDISON AND THE ELECTRIC CHAIR: A Story of Light and Death

MARK ESSIG

Thomas Edison is celebrated for inventing the phonograph and the lightbulb, not to mention electrifying major North American cities. Essig explores one of Edison's lesser-known inventions—the electric chair—and how Edison's intentions may have been less noble than trying to find a more humane way to put people to death. Although Edison was a staunch opponent of capital punishment, he put a lot of effort into perfecting the electric chair and convincing politicians of its advantages over the noose, the guillotine, or lethal drugs. At the time, George Westinghouse was selling residents of Manhattan alternating current electricity as a cheaper alternative to Edison's direct current power. In response, Edison tried to prove that his system was safer than Westinghouse's and pointed out that the electric chair worked only with alternating current. Thus, Edison intimated that DC was safer than AC for home use. Essig makes this morbid tale a compelling one. ***Walker, 2003, 358 p., b&w photos/illus., hardcover, $26.00.***



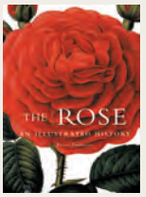
FRUIT: An Illustrated History

PETER BLACKBURNE-MAZE

THE ROSE: An Illustrated History

PETER HARKNESS

These stunning, oversize books tell the history of fruit and roses by defining the origins of many varieties, detailing how they have been dispersed around the world, and describing the cultural significance of each variety. Chapters in both books profile individual varieties in an inviting, conversational style. Color illustrations from the archives of the Royal Horticultural Society are featured on every two-page spread. *Fruit* is divided into four major groups—pome (apple and medlar), stone (plum and apricot), berry (currant and blueberry), and exotic (avocado and lychee). Among the interesting facts conveyed is that pomegranate juice stain is almost impossible to remove and that the fig isn't a fruit, but an inside-out flower. *Roses* charts the 5,000-year-old history of the flower from its wild origins in China to today, when there are more than 20,000 hybrids. This tome follows the rose's travels to Iraq, where 4,000-year-old Sumerian tablets refer to the flower. Eventually, Harkness gets to France, where roses were marketed for cosmetic and medical purposes. Looking to the future, he proposes that roses will be bred without thorns, repellent to aphids, and more fragrant than ever. Both books were originally published in the United Kingdom. ***Firefly, 2003, 335 p. /336 p., color illustrations, hardcover, $60.00 each.***



FIREFLY ENCYCLOPEDIA OF BIRDS

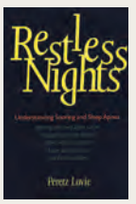
CHRISTOPHER PERRINS, ED.

This massive volume is global in its scope, featuring 9,850 species of birds that live in locales as extreme as the icy arctic tundra and teeming tropical rain forests. Organized by family, each entry presents facts about birds' physical features, distribution, evolutionary history, classification, breeding, diet and feeding behavior, social dynamics, conservation, and relationships with people. Some passages are written by experts on a specific group and feature details of the authors' research, in addition to comprehensive accounts of the social and breeding behaviors of the animals and conservation efforts on their behalf. Stunning color photographs and illustrations of the birds aid in identifying species. Some photographs are oversize and extremely detailed—in one, the flickering tongue of a cuckoo in song is clearly visible. Maps show species' locations, and photos illustrate behaviors such as mating and nest building. This is one of the most visually stimulating and informative books ever compiled on avian life. ***Firefly, 2003, 656 p., color photos/illus., hardcover, $59.95.***

RESTLESS NIGHTS: Understanding Snoring and Sleep Apnea

PERETZ LAVIE

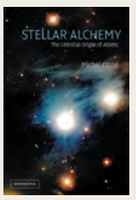
Sleep researchers believe that 1 man in 10 has sleep apnea. In the most extreme cases, sufferers may go 90 seconds without a breath and suffer sleep deprivation regularly. Yet sleep apnea wasn't considered a problem until recently. Lavie, a sleep specialist and professor at Technion-Israel Institute of Technology, traces the history of this disorder. He explains the mechanics of breathing and the role of oxygen in the body. Then, he dissects sleep apnea by detailing the symptoms (including snoring) and treatments. He also outlines risk factors for the problem and its links to cardiovascular disease. Many case studies, including those of children with breathing disorders in sleep, enliven the text and illustrate the magnitude of the problem. Originally published in Israel in 2002. ***Yale U Pr, 2003, 274 p., b&w illus., hardcover, $27.50.***



STELLAR ALCHEMY: The Celestial Origin of Atoms

MICHEL CASSÉ

Why do stars shine? It's a child's question—one that has intrigued us since the beginning of time. Cassé provides a rather adult answer in this introduction to nuclear astrophysics. He explains how modern astronomy has traced chemical elements to their origins in the universe. As it turns out, the transformation of base metals into gold, something once dreamed of by alchemists, is a process commonly occurring in the cores of massive stars. These types of revelations help explain the relationships among all things, from primordial light to particles, atoms, stars, and human beings. ***CUP, 2003, 242 p., b&w illus., hardcover, $30.00.***



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

And dot your T's

In the article about infinity ("Infinite Wisdom," *SN: 8/30/03, p. 139*), the "stereoscopic" images of tiny squares on page 140 are too far apart to view in the conventional way. However, if the viewer holds the magazine at arm's length and looks cross-eyed at the pair, the diagonal across the square becomes visible.

ROBIN FROST, SANTA BARBARA, CALIF.

A shaky start?

"Long Ride West: Many western sediments came from Appalachians" (*SN: 8/30/03, p. 131*) suggests that the most likely transportation system of the sandstone across the continent would have been a river system. Could it have been due to tectonic movement instead?

EDWARD B. FAN, UPPER MARLBORO, MD.

Both Utah and the Appalachians are on the North American plate, so there's no tectonic boundary between them. Sediments from the East could have been deposited and then remobilized at innumerable locations on their way to Utah. —S. PERKINS

Familiar ring

The idea of compensating tidal forces using a ring of compact matter ("Black Hole Life Preserver: Don't get sucked in without one," *SN: 8/30/03, p. 132*) isn't quite "something no one has shown before." A concept based on the same principles was analyzed 20 years ago by physicist Robert L. Forward, who published the details in a paper in *Physical Review* and his science-fiction novel *Dragon's Egg*. Forward discussed using such tidal compensation to allow humans to explore the environment near a neutron star.

GEOFFREY A. LANDIS,
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The article should have identified the size of the black hole in question. For a large-enough black hole, a person falling through the event horizon would feel just a gentle stretch-compression force. The real fun would begin as singularity were approached at the center.

DAVID MARCUS, POTOMAC, MD.

Correction *"Scrutinized chemicals linger in atmosphere"* (SN: 10/11/03, p. 238) *misidentified the journal in which Scott Mabury and his colleagues described the atmospheric lifetime of fluorotelomer alcohols. The report was in the Sept. 1* Environmental Science & Technology.