# SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

JANUARY 18, 2003 PAGES 33-48 VOL. 163, NO. 3

anticlotting bat spit

wings: lost and found

new take on gene therapy

strangest, farthest planet

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## reindeer south

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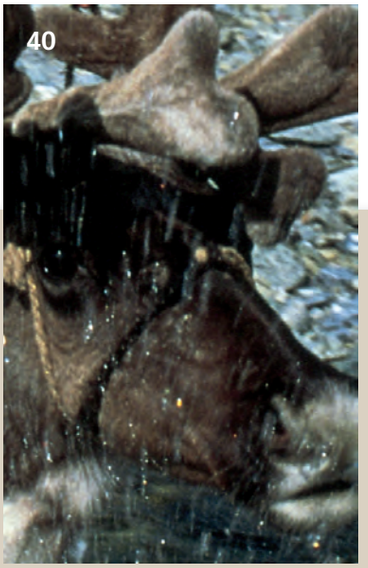


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**Cover** In northern Mongolia, the Tsaatan people still herd reindeer at the southern limit of the tradition. A scientific expedition last summer examined the culture and biology of the area. (David Edwards) Page 40

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**C-minus** Children exposed to cigarette smoke may need more ascorbate, an antioxidant vitamin. See Janet Raloff's Food for Thought.

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# Retaking Flight

## Some insects that didn't use it didn't lose it

A. WHITING

**STICKS THAT FLY** A female *Phasma gigas*, almost a foot long, displays wings that researchers say probably reappeared after ancestors went through an era of winglessness.

**Stick insects may have done what biologists** once thought was impossible: lose something as complicated as a wing in the course of evolution but recover it millions of years later.

That's not supposed to happen with so-called complex traits, at least according to a long-reigning view of evolution, says Michael F. Whiting of Brigham Young University in Provo, Utah. Yet that's the story revealed by a new family tree based on DNA data from 37 species of stick insects, he and his colleagues report in the Jan. 16 *Nature*.

"We were very shocked," says Whiting. He predicts that if biologists start looking closely, they'll find complex traits that have vanished and reappeared in other creatures.

Anthony Zera, who studies insect-wing development at the University of Nebraska in Lincoln, says that if the new stick-insect family tree turns out to be correct, the result has wide implications for evolutionary biology. "It would change the way I would think about complex traits," he says.

Biologists have long theorized that evolution has no rewind button, explains Whiting. When an animal depends for survival on a structure, such as the wing, any mutations that sabotage it get cleaned out of the gene pool quickly. However, if circumstances change so that the animal can get along flightless—and then some genetic quirk stops wing formation—harmful mutations build up unchecked in the rest of the wing-production pathway.

Whiting says that he didn't set out to challenge this dogma. He and his colleagues are working their way through an ambitious project to use DNA data to construct a new comprehensive family tree of all insects. One group focused on stick insects, which often mimic twigs or other parts of plants. This team found that the stick-insect family tree appeared to have sprouted upside down. The 16 species that provide the lower branches, representing the more ancient lineages, had the supposedly new-fangled characteristic of winglessness. Then, at the top of the DNA tree, wings appeared, seeming to have re-evolved at least four times, after up to 50 million years of winglessness.

"It's as if a mammalogist found a whale [a former land creature] walking around on legs," says Whiting.

He proposes that the wings break the old rule because the genetic components of their production pathway may do double duty in other valuable life processes. Thus, these other functions would edit out any harmful mutations.

Whiting and his colleagues have made a big claim, and other scientists are reacting with caution and lots of questions. William Jeffery of the University of Maryland at College Park says that he wants to know more about just how completely the wings had disappeared. He points out that blind cavefish, which he studies, still develop some of the embryonic precursors of eyes. For wings, he says, he's prepared to be impressed if even developmental traces had disappeared. —S. MILIUS

# Getting Attached

## Sugar-protein link joins embryo to Mom

**It's the first bond between a mother and** her child—and arguably, the most vital one.

When a newly created human embryo enters its mother's uterus, it must attach to the wall if it's going to continue developing. The molecules that mediate this initial attachment may be the same ones that white blood cells use to leave the bloodstream and travel to a wound or infection, according to a study in the Jan. 17 *Science*. If confirmed, this discovery could explain some women's infertility and lead to new contraceptives.

Reproduction is a matter of timing. After ovulation, a surge of hormones triggers temporary changes in the uterine wall that enable a human embryo to attach and implant itself. For years, researchers have studied this so-called window of uterine receptivity.

The new insight into the attachment process emerged from studies of embryos already implanted in the uterine wall. Susan J. Fisher of the University of California, San Francisco and her colleagues were examining human placenta, the tissue through which oxygen and nutrients flow from a mother to a developing fetus. The team discovered that the placental cells make L-selectin, a protein usually seen on white blood cells, such as neutrophils.

When these immune cells are called into action, L-selectin and related molecules bind to carbohydrates on the inside surface of a blood vessel. This positions the cells to migrate to injured tissues outside the vessel.

Intrigued by the discovery of placental L-selectin, Fisher wondered whether the protein had an even earlier presence in the embryo. The placenta derives from embryonic cells called trophoblasts, which form a ball around the cells that ultimately develop into the fetus. When Fisher and researchers at a fertility clinic examined unused human embryos donated for research, they found that human trophoblasts make L-selectin. "The cells make as much as a neutrophil," she says.

The investigators then took tissue samples from the uterine walls of women at different stages of their menstrual cycle. The team discovered that during the window of receptivity, the wall's inner surface begins to display several L-selectin–binding carbohydrates. Fisher and her colleagues also showed that an antibody to L-selectin inhibited lab-grown trophoblasts from binding to uterine tissue harvested during the window of receptivity.

Compounds that block L-selectin or its partners could offer a new form of female contraception, says Daniel Carson of the University of Delaware in Newark.

However, Susan J. Kimber of the University of Manchester in England cautions that Fisher's group hasn't directly shown that human embryos use L-selectin for their initial uterine attachment. Moreover, Kimber says, her research team has failed to find L-selectin on human embryos.

But if L-selectin is crucial to implantation, it may explain why some women with sexually transmitted diseases or other genital infections have trouble conceiving. Infections can cause cells to shed L-selectin, which could hinder an embryo from attaching to the uterus, Fisher explains. —J. TRAVIS

# Testosterone's Family Ties

## Hormone-linked problems reflect parent-child bond

**Testosterone has a public reputation as the** hormone that turns men into boisterous louts at best and violent criminals at worst.

New evidence is challenging that. Witness a new study that finds no link between testosterone concentrations and either delinquent behavior or depression in children and teenagers of both sexes—that is, if relations with parents are close.

The behavior and mood problems traditionally blamed on testosterone most often appear in boys and girls with poor parental relations, says sociologist Alan Booth of Pennsylvania State University in State College. In the new study, high-testosterone boys who related well to their mothers engaged in far fewer delinquent acts than low-testosterone boys who got on poorly with their mothers, Booth and his colleagues report in the January *Developmental Psychology*.

"Children's testosterone levels create behavioral predispositions that get modified by the quality of parent-child relationships," Booth theorizes.

As a hormone that shapes masculine physical features, testosterone occurs in small amounts in females and much larger amounts in males. Among men, many studies have associated high testosterone concentrations with aggressive and risk-taking behaviors and low testosterone concentrations with depression. However, some studies have failed to find links between men's testosterone levels and behavior or mood problems. Only a few studies have addressed this issue in women or in children.

The new investigation by Booth's group focused on 400 middle-class families in Pennsylvania. All the parents and 608 children, ages 6 to 18, were interviewed and provided saliva samples for testosterone analysis. The researchers defined a good parent-child relationship as one in which the parent knew about and approved of the child's activities, the parent participated in activities with the child, and the child reported feeling close to the parent.

An intriguing sex difference emerged for youngsters with poor parental relationships. Among these boys of all ages, those with high testosterone concentrations were most prone to delinquency, illicit-drug use, and other risky behaviors. Yet among girls, risky behaviors most often appeared in those between ages 10 and 14 and with low testosterone concentrations.

Moreover, low testosterone concentrations were linked to symptoms of depression in boys of all ages who related poorly to their mothers. The same association emerged for girls only between ages 14 and 18 who had a poor relationship with their fathers.

Reasons for these sex disparities are unclear, Booth says. Larger studies should examine testosterone's link to behavior at various ages, he adds.

Besides revisiting testosterone's bad reputation, researchers need to probe for beneficial behaviors linked to the hormone, remarks sociologist Allan Mazur of Syracuse (N.Y.) University. "Under the right social conditions, high testosterone levels may help to produce our leaders," Mazur says. "No one has studied this possibility." —B. BOWER

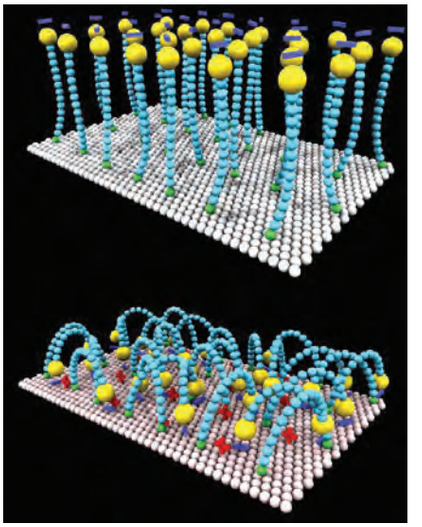
# Quick-Change Surface

## Material repels water on command

**In an advance that could open new routes** to sensors, drug delivery, and many other technologies, researchers have modified a gold surface so that it switches from a water-attracting mode to a water-repelling one on command. With that capability, a flip of a switch could cause drug molecules, proteins, or cells to collect on the surface or to suddenly be released from it.

The turncoat layer, atop a gold-coated wafer, is made of neatly aligned, chainlike molecules that stand up like bristles on a brush. The molecules' tips exposed to the world are negatively charged and attract water, but the molecules' midsections shun water. When scientists apply an electric field to the wafer, the gold attracts the molecules' negative tips and each bristle bends over, exposing its hydrophobic belly.

Since no chemical bond breaking or bond forming occurs, the process is easily reversible, says Joerg Lahann of the Massachusetts Institute of Technology (MIT). He and his colleagues from MIT and the University of California, Santa Barbara and Berkeley describe their surface in the Jan. 17 *Science*.



LAHANN ET AL.

**ALL TOGETHER** **Molecules with water-loving tips (yellow) bend over and expose their water-avoiding parts (blue).**

Making the surface took some computation and a neat chemical trick. When the bristle molecules assemble themselves onto a gold surface, they usually pack together so tightly that they can't bend over. To overcome this problem, Lahann and his coworkers ran simulations that showed that each molecular bristle needs at least 0.65 square nanometer to bow. So, the team found a chemical group that takes up about 0.67 square nanometer of space and linked it to the negatively charged tip of the molecular bristles. Once these mushroom-shaped molecules assembled on the gold, they each occupied about 0.67 square nanometer. When the scientists chemically lopped off the molecules' space-filling heads, each bristle had enough room to bend over.

"This is quite creative work," comments chemical engineer Manoj K. Chaudhury of

Lehigh University in Bethlehem, Pa. For use in many technologies, the technique needs to produce a surface that is even more repellant to water than those in the tests so far, he notes. Then the method would prove useful, for example, in microfluidic devices in which fluid must be reliably directed through exquisitely fine pathways. —J. GORMAN

# Nifty Spittle

## Compound in bat saliva may aid stroke patients

**When a vampire bat bites an animal, its** saliva introduces an anticlotting agent to keep the blood meal flowing. Scientists now report that this compound, which busts up blood clots as well as the leading medication for treating strokes does, avoids one of the drug's major drawbacks.

Researchers injected mice with chemicals that induce brain damage like that brought on by the most common type of human stroke—clots that block vessels and subsequently starve brain tissue. The scientists then injected some mice with the bat-saliva compound, called *Desmodus rotundus* salivary plasminogen activator (DSPA). They injected others with the standard clot-busting drug, tissue plasminogen activator (tPA), which shows the side effect of initiating damage to brain neurons. In the mice, DSPA caused less than 1 percent as much neuron damage as tPA did, the researchers report in the February *Stroke.*

Animal studies have established that tPA leads to the death of neurons, although scientists are still investigating the specific mechanism of the damage.

The new finding suggests that DSPA doesn't sabotage brain cells, says study coauthor Robert L. Medcalf, a biochemist at Monash University in Victoria, Australia.

In two current studies, scientists are assessing DSPA's effectiveness when given to people up to 9 hours after a stroke. Results could be available by the end of this year, says Mariola Söhngen, a physician and managing director of Paion, the company commercializing the drug in Aachen, Germany.

"This could be potentially very exciting, if DSPA is really better then tPA," says Stuart A. Lipton, a neurologist at the Burnham Institute and the University of California, San Diego. He and others are studying compounds that might mitigate tPA's drawbacks.

For stroke victims, tPA "is a two-edged sword," Lipton says. Doctors don't typically give the drug to someone more than 3 hours after a stroke because risks of damage, whether from neurotoxicity or bleeding in the brain, outweigh the benefits. Söhngen notes that in people, it's difficult to identify damage caused specifically by neurotoxicity.

M. LIPMAN/CANADIAN MUSEUM OF NATURE

**GOOD GUY? The saliva of the common vampire bat, *Desmodus rotundus*, contains a compound that might yield a new drug for dissolving blood clots in stroke victims.**

The 3-hour window limits tPA's usefulness because a stroke's immediate symptoms can be subtle, and many people don't get to a hospital within that period. Among people who do, roughly 6 percent of those receiving tPA suffer some brain bleeding, says neurologist John R. Marler of the National Institute of Neurological Disorders and Stroke in Rockville, Md. —N. SEPPA

# Northern Vents

## Arctic shows surprising hydrothermal activity

**A recent survey along a midocean ridge** beneath the Arctic icepack unveiled an unexpected abundance of hydrothermal activity. Besides casting doubt on current theories about where such vent systems can arise, the wayward vents could harbor ecosystems that are dramatically different from those found in other oceans.

Midocean ridges are seams where material wells up from Earth's interior to form new seafloor, explains Hedy Edmonds, a marine geochemist at the University of Texas' Marine Science Institute in Port Aransas. In 2001, she and other scientists used icebreakers to plow their way across the Arctic Ocean to make measurements along a 1,100-kilometer segment of the 1,800-km-long Gakkel Ridge. That little-explored midocean ridge, which is spreading slower than other known seams, runs within 350 km of the North Pole and lies at frigid depths between 4,500 and 5,000 meters.

Edmonds and her colleagues dredged the ocean floor for rocks at more than 150 sites along the ridge. As the dredge dropped to the seafloor, instruments attached to its cable measured the temperature and optical properties of the seawater. That's when evidence for vents started pouring in. At 119 sites, researchers found thick layers of water with high concentrations of suspended particles. At 58 of those spots, those light-scattering layers were warmer than those above and below. Water from some sites contained manganese, often a component of the mineral-rich water discharged from vents. The data suggest there are 9 to 12 vent systems along the surveyed segment.

Until recently, most scientists thought the amount of hydrothermal activity along a particular portion of a midocean ridge depended on the rate of seafloor spreading there, says Edmonds. Her team's survey, described in the Jan. 16 *Nature*, found double to triple the number of vent systems that current models predict.

The newfound vents may soon catch biologists' attention. Hydrothermal vents often host thriving ecosystems that are nourished by the warm, mineral-rich fluids. The biological communities that surround the Gakkel Ridge's vents may be significantly different from those that populate hydrothermal systems elsewhere, says Cindy L. Van Dover, a biological oceanographer at the College of William and Mary in Williamsburg, Va. Deep parts of the Arctic Ocean contain

many unique aquatic species, she notes.

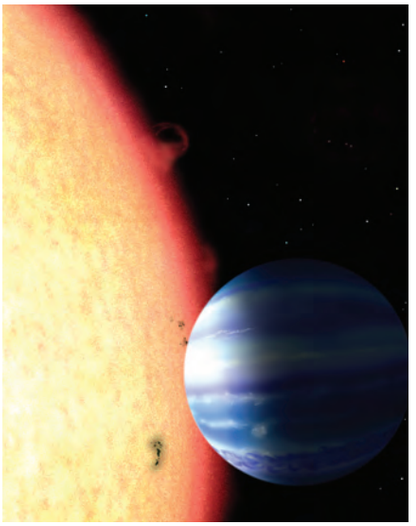
"I'd say that Arctic hydrothermal vents are the premier sites for finding new species," says Van Dover. —S. PERKINS

## Distant and Strange

### Orb isn't just another extrasolar planet

**With the discovery since 1995 of more than** 100 planets beyond the solar system, finding yet another one might seem more of a yawn than hot news. But the latest detection of an extrasolar planet smashes several records: At 5,000 light-years from Earth, the newfound body lies 30 times farther away than any other detected planet and is the first one found outside our own spiral arm of the Milky Way. The planet lies closer to its parent star than any other known orb does and endures the highest temperature. It's so hot that iron droplets may rain down on its gaseous surface.

Most significantly, the finding marks the first time that astronomers have discovered a planet by observing the body periodically pass in front of the star it orbits, blocking a little of the starlight seen from Earth. This technique, known as the transit method, could expand the search for planets to 100 million distant stars and will be key to searching for Earthlike worlds, says Dimitar D. Sasselov of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass.



**PLANET SHADOW** Illustration of a planet passing in front of its parent star.

D. AGUILAR/CFA

All the extrasolar planets discovered until now have been detected indirectly through their gravitational tug, which induces a wobble in their parent star. Astronomers subsequently observed one of these planets by the transit method (*SN: 11/20/99, p. 324*). In the new study, reported last week at a meeting of the American Astronomical Society in Seattle, Sasselov and his collaborators did the reverse—they used the transit method to find an extrasolar planet and then confirmed the finding by measuring the parent star's wobble.

The difference is important because the wobble method is so time intensive that it can only search for relatively massive planets around some 40,000 stars within 150 light-years of our solar system. In contrast, the transit technique can hunt planets among a much larger, more distant population of stars. The transit method also yields both the radius and the mass of a planet, while the wobble technique provides just the lower limit of the mass.

The data obtained by Sasselov's team are "a bit noisy," comments Adam S. Burrows of the University of Arizona in Tucson. But he adds that "if this approach proves out, it will open the way to a new means [for planet hunters] to survey the nearest large chunk of the galaxy."

Sasselov's group bases its findings on data from the Optical Gravitational Lensing Experiment (OGLE), in which ground-based telescopes search for planets and other objects by monitoring thousands of stars for telltale changes in brightness. The newly detected planet blocks about 1 percent of its star's light. Spectra taken with the Keck 1 telescope on Hawaii's Mauna Kea confirm that the body, now dubbed OGLE-TR-56b, tugs on its star with a strength indicative of a planet rather than a more massive body. The object has 90 percent of Jupiter's mass and 1.3 times its radius. The planet whips around its star once every 29 hours.

In 2006, NASA plans to launch Kepler, a mission that will use the transit method to search for planets as small as Earth. —R. COWEN

## Blood-Clot Surprise

### Finding might explain a danger of Viagra

**For a fraction of 1 percent of the men who** take sildenafil, the impotence-fighting pill known as Viagra, sex comes with nasty side effects: heart attack and sometimes death. However, scientists have never linked the deaths directly to the drug, leaving open the possibility that the physical stress of amorous activity could be the problem.

Now, researchers studying the blood component called platelets have stumbled upon evidence that might implicate the drug instead of the sex.

Platelets are tiny cell-like disks that collect and form blood clots at the site of an injury. Overactive platelets can clog blood vessels, causing heart attack or stroke. Sildenafil increases blood concentrations of a compound that both increases blood flow to the penis and stimulates production of an enzyme called cGMP-dependent protein kinase, or PKG. Researchers have long known that PKG keeps platelets from sticking together. In fact, scientists initially developed sildenafil to treat heart disease.

Researchers at the University of Illinois College of Medicine in Chicago now report that PKG plays a dual role, first spurring platelet aggregation and then, only minutes later, limiting clot size. The initial clot promotion, reported in the Jan. 10 *Cell*, suggests that a PKG booster such as sildenafil could send some men with already damaged heart vessels into cardiac arrest.

"We know of hundreds of [sildenafil-related] cardiac deaths, but they have never been causally linked to the drug's effects," says Xiaoping Du, a molecular biologist at the medical school. "Our results provide a possible mechanism" for such a link, says Du.

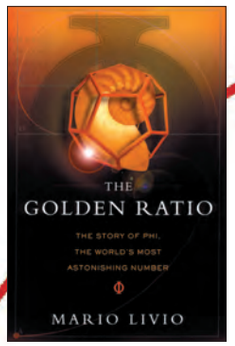
He and his colleagues first tested PKG's effects in hamster cells that had been engineered to produce human blood proteins. PKG enhanced the action of the protein that hooks platelets together during clot formation. Also, wounded tails of mice lacking PKG bled four times as long as those of normal mice did.

The researchers next treated human platelets with compounds to quell or stimulate the enzyme. Platelet binding changed with PKG concentrations. Also, sildenafil made platelets clingier only when natural blood-clotting stimulants were present. After several minutes of exposure to PKG, however, platelets became less sticky.

"The data are quite convincing that [PKG] can both activate and inhibit platelet function," says molecular cardiologist Edward F. Plow of the Cleveland Clinic Foundation in Ohio, and they "should raise caution about using [sildenafil]."

Hematologist José A. López at Baylor College of Medicine in Houston warns against overextending the laboratory results. For most people, he says, the drug appears to be "pretty safe—safer than lots of other things people take."

If the drug substantially increased heart attack risk, adds Geoffrey Cook, spokesman for Viagra-maker Pfizer in New York City, clinical trials of the drug would have revealed it because many sildenafil users have cardiovascular disease. —K. MORGAN




*Broadway, 2002, 294 pages*
*6 ¼" x 9 ½", hardcover, $24.95*

Throughout history, thinkers from mathematicians to theologians have pondered the mysterious relationship between numbers and the nature of reality. In this fascinating book, Mario Livio tells the tale of a number at the heart of that mystery, *phi* or 1.6180339887. Euclid defined this curious number, widely known as the Golden Ratio, more than 2,000 years ago because of its crucial role in the construction of the pentagram, to which magical properties had been attributed. Since then it has shown a propensity to appear in the most astonishing variety of places—from mollusk shells, sunflower florets, and crystals to galaxies containing billions of stars. Psychological studies have investigated whether the Golden Ratio is the most aesthetically pleasing proportion to the eye, and it has been asserted that the creators of the pyramids and the Parthenon employed it. It is believed to be featured in works of art from Leonardo da Vinci's *Mona Lisa* to Salvador Dali's *The Sacrament of the Last Supper*, and poets and composers have used it in their works. It has even been suggested that it is connected to the behavior of the stock market.

*The Golden Ratio* is a captivating journey through art and architecture, botany and biology, and physics and mathematics. It tells the human story of numerous *phi*-fixated individuals, including: the followers of Pythagoras, who believed that this proportion revealed the hand of God; astronomer Johannes Kepler, who saw *phi* as one of the greatest treasures of geometry; such medieval thinkers as mathematician Leonardo Fibonacci of Pisa; and such masters of the modern world as Claude Debussy, Le Corbusier, Bela Bartok, and physicist Roger Penrose. Wherever his quest for the meaning of *phi* takes him, Mario Livio reveals the world as a place where order, beauty, and eternal mystery will always coexist.

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NEWTON ON THE TEE

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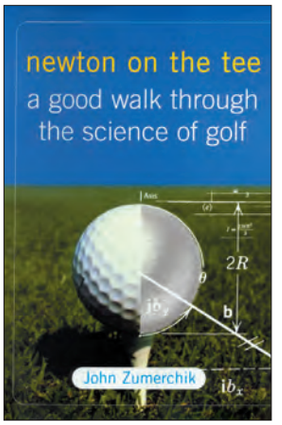


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# SOUTHERN REINDEER FOLK

## As far from Santa as the old herders go

BY SUSAN MILIUS

Paula DePriest was thrilled when she finally got the chance to see the species that she studies as they were being chewed up by the grazer for which they're named. She didn't even mind having to go halfway around the world and travel via uncomfortable means to a valley in northern Mongolia. A biologist at the Smithsonian Institution in Washington, D.C., DePriest studies lichens, especially the reindeer lichens. When she heard that anthropologist William Fitzhugh, also of the Smithsonian, was leading scientists of various disciplines on an expedition to a region of northern Mongolia that for decades has been off-limits to Western scientists, she rushed to him and said, "I'm going with you."

Until the early 1990s, this place had been behind the Soviet-era Iron Curtain. Now that it wasn't, she wanted to finally see for herself reindeer eating reindeer lichens. She and the others who would be going on the expedition, however, took as their primary goal to discover what in that distant region might make appealing topics of scientific study.

**HOME ON THE RANGE —** In northern Mongolia, movable dwellings enable the Tsaatan people to move their reindeer herd with the seasons.

SMITHSONIAN

One of the main research draws of the area is the people who call themselves the Tsaatan, a Mongolian word that translates roughly as people who have reindeer. The Tsaatan tend reindeer in a style much different—and possibly much older—than that practiced in Northern Europe. Before the Mongolian government pushed them northward in the 1980s, these herders, known as the Dukha to Westerners, were the southernmost traditional reindeer herders in the world.

When Fitzhugh led the first Western scientific expedition to the region in 2001, Mongolian scientists joined the U.S. team. Together, they scouted out possible research projects, among them studies of ancient cultures and examinations of the future of the region and its herds in the face of global warming. The expedition members immediately planned a second joint exploratory trip to the valley and other remote sites in Mongolia in 2002.

**NEW CONTACT** The first push for an expedition to Mongolia's Darkhat Valley came from retired diplomat Ed Nef, who runs the InLingua language schools in the Washington, D.C., area. In the 1990s, he visited a sister language school in Mongolia, and while touring the newly opened country, he became interested in the Tsaatan reindeer herders.

He learned that despite some 70 years of Communist rule, the 30 or so families have preserved many of their traditional ways. They live in movable, teepeelike homes and rely on shamans for medical and spiritual guidance. Their territory lies in a part of northern Mongolia dotted with what anthropologists call deer stones. These slender monuments are carved with designs of flying deer and creatures that have deer bodies and antlers but ducklike bills.

When Nef returned to Washington, he urged the Smithsonian to take advantage of the new opportunity for Westerners to observe a traditional culture.

The 2002 expedition began in June, a time of the year when herders have moved their reindeer to grazing grounds to fatten them up for the coming winter. The researchers flew as far as they could into Mongolia, to the town of Mörön, where they climbed into one old Russian van and three rugged jeeplike vehicles. Outside the towns, roads first turned into graveled tracks, and then vanished altogether. "We were just a string of jeeps screaming across the steppe," DePriest says.

"We asked our driver, 'How do you know where we're going?'" she recalls. "He just sniffed and said, 'Because I've been here before.'"

After DePriest, Fitzhugh, and the other scientists had bounced along for 2 days, Tsaatan guides met the caravan with horses for the trip's last, day-and-a-half climb. Finally, the group approached reindeer and reindeer lichen country. "You come up over this pass, and there's this big bowl that has lots of grass and streams running across the bottom. And then you see on the surrounding hillsides, the yellow-green that are lichens at about 100 percent plant cover," DePriest recalls.

As they arrived, DePriest's guide, Sanjin, spotted his daughter and granddaughter riding to meet them. It took DePriest a minute to realize that they weren't riding on horses but on reindeer.

**REINDEER COUNTRY** The origin of reindeer domestication remains unknown, but one scenario places it in northern Mongolia. Reindeer and caribou belong to the same widespread, high-latitude species, *Rangifer tarandus*. During its domestication, the reindeer has diverged somewhat from its wild caribou counterparts in both appearance and behavior. Reindeer tend to be shorter and plumper. They also live with people more readily than caribou do.

Reindeer and caribou stand out among deer species. Females, as well as the males, grow antlers. Also, they're the only deer species with fully furred noses. What's more, when they walk, their joints click like a person's knuckles cracking. "You read about that, but you never quite believe it until you hear it," says DePriest.

More apropos of DePriest's interests, however, is a feeding trait that partly explains why these animal survive so well in frigid places: Reindeer voluntarily graze on the carpet of lichens—symbiotic combinations of algae and fungi—that takes over where not even wiry grasses and sedges can survive.

Knowledge of other herding practices gives little insight into reindeer tending. "We have this idea of herding based on cattle, with cowboys galloping around and dogs yapping," DePriest says. "Reindeer are completely different."

For one thing, specially selected youngsters are raised much like pets. These animals grow up to form a useful core of people-friendly animals in the herd. Indeed, Tsaatan children and small adults ride reindeer everywhere, much the way U.S. suburban kids grab their bikes. "Sanjin's 3-year-old granddaughter was getting to ride a reindeer on her own," says DePriest.

Always in search of salt and other minerals, the animals "come up to you and nuzzle your hands," she says. A person urinating in the open also attracts salt-craving reindeer. The herders seemed to treat this as just another aspect of tending their animals, but "the American gentlemen found it quite disconcerting," says DePriest.

After a day of grazing, the reindeer come back to the Tsaatan camps in the evening. The women dole out rock salt to the animals before the herders tether the reindeer, which then settle onto the ground to sleep. "What's funny about them is how they flop their heads almost completely back on their sides," says DePriest. The dogs settle down, too, guarding the reindeer from wolves and bears.

The Tsaatan don't eat their animals, except as a last resort. "It's like eating your horse," says DePriest.

**DEER STONE —** Carved designs of animals scroll over monuments thousands of years old that may represent chiefs.

It's like eating your cow, too. The Tsaatan put reindeer milk in their tea and use it to make cheese. Fitzhugh struggles to find familiar terms to describe the cheese's flavor. "It's pungent," he says, finally giving up and saying, "It tastes like reindeer."

This small-dairy operation may reflect the earliest form of reindeer domestication, says Fitzhugh. In contrast, other reindeer herders in the high latitudes of Europe and other Arctic regions tend several thousand animals on seasonal migrations of 300 to 400 miles. These herders concentrate on meat production.

**RESEARCH LEADS** During the expedition, Fitzhugh suspected that he might find Mongolian ties to the Arctic cultures that he has studied for years. Consider Mongolian deer stones, which are 2,000 to 3,000 years old. Fitzhugh says that the carvings on these stones reflect beliefs in animal spirits like those that many Arctic peoples hold. Some motifs of traditional Alaskan and Canadian art also might have roots in Mongolia. "Right now, it's just a hunch," Fitzhugh says, "but I actually think Mongolia is crucial."

Insights about the early history of reindeer herding may emerge from a Neolithic site that Fitzhugh discovered in 2002 at Soya near the herders. "It's almost impossible for an archaeologist to be poking around in this part of Mongolia and not discover something," he says. Preliminary digging revealed artifacts 4,000 to 5,000 years old: well-preserved bones, ceramics, and stone leftovers from making blades.

Fitzhugh also returned to an intriguing location he had found in his initial trip in 2001. In a depression in the landscape, he had noticed flints that appeared to be ancient. In the intervening months, Fitzhugh mentioned to his Mongolian colleagues that he hoped to make an exploratory excavation. They warned him that the Tsaatan believed only reindeer can safely perturb the ground under which spirits dwell.

Not entirely discouraged, Fitzhugh in 2002 delicately broached

## Reindeer Here

### Climate change may challenge herders in Alaska despite modern conveniences

The United States has its own reindeer-herding traditions to worry about as climate change plays out. Reindeer herding didn't come to Alaska until 1881, when a Presbyterian missionary imported some reindeer from Siberia to try to create new prosperity among native peoples. Reindeer became meat-producing livestock and have since been bred to be "55-gallon drums on legs," says Greg Finstad, director of the Reindeer Research Program at the University of Alaska, Fairbanks.

Reindeer also served as pack animals for miners during the Alaska Gold Rush and even for special reindeer mail services. Herders still raise reindeer in Alaska, though now they must get government permits for grazing land, and they patrol their herds, winter and summer, on snowmobiles.

Finstad worries about the hard-to-predict impacts of climate change on the Alaskan herders. "It's not just: It gets warmer, bad for reindeer; it gets colder, good for reindeer," he says.

The animals routinely balance near the brink of starvation in winter, and dozens of weather nuances can drive them closer to annihilation or ease the pressure. For example, earlier springs could nudge sedges or grasses to invade the no-plant zone where lichens now rule. If the newly arriving vegetation is a reindeer-friendly sedge, the herds will still have food, says Finstad. However, another species of the same genus of sedge is less nutritious. A triumph of this species as climate changes unfold could bring disaster to the reindeer and their herders.

To study such subtleties, Finstad and his colleagues have set up an array of fenced habitats that will be modified each year to mimic various climate scenarios. The project has yielded data for 3 years, but Finstad says that he needs 10 or 15 years of results before he can make a solid prediction about how the complex ramifications of climate change may affect Alaskan reindeer. —S.M.

SMITHSONIAN

# DELIVERING THE GOODS

## Gene therapy without the virus

BY JESSICA GORMAN

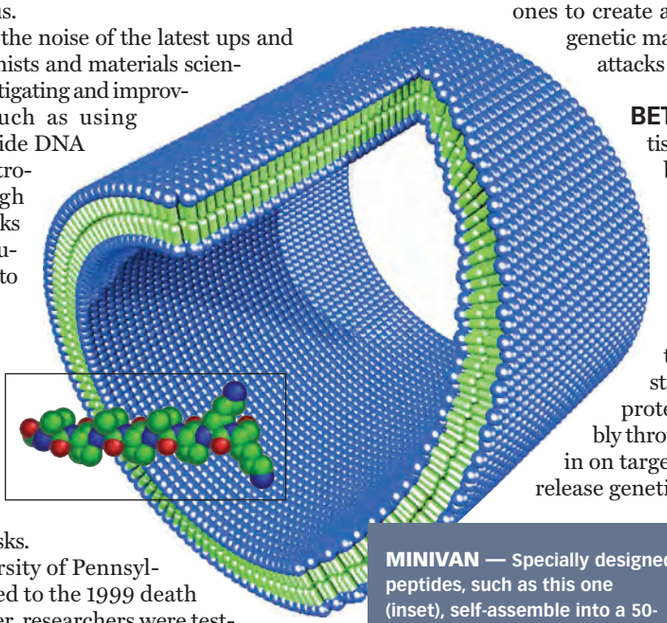
Gene therapy has been on a roller coaster in recent years. Experiments in adding genes directly to patients' cells have shown promising signs, but the technical and clinical momentum has been drained repeatedly by bad results. These include the death of a young man in 1999 and two recent cases of cancer in children. The clinical trials in these instances used inactivated viruses as vectors to shuttle genes into patients' cells. Scientists hold those viruses to be partly to blame for the devastating outcomes. So, many researchers are focusing attention on ways to introduce DNA into a patient without using a virus.

For 2 decades, away from the noise of the latest ups and downs for viral vectors, chemists and materials scientists have been doggedly investigating and improving on other strategies such as using capsules that protect and guide DNA into cells and methods of introducing naked DNA. Though these techniques remain works in progress, they may eventually present a safer alternative to viral transporters of DNA.

**VIRUS TROUBLE** Natural viruses can target and deliver genetic material with the utmost efficiency. That's why most gene therapy trials have employed them as vectors. However, even inactivated viruses pose certain risks.

In the study at the University of Pennsylvania in Philadelphia that led to the 1999 death of 18-year-old Jesse Gelsinger, researchers were testing the safety of a new version of adenovirus, a type of natural virus that usually causes respiratory infections. Gelsinger had a nonfatal deficiency in a liver enzyme that removes ammonia from the blood. The scientists gave Gelsinger adenovirus containing therapeutic DNA, but he developed a massive immune response to the virus and died just days after the injection.

In the cases of the children who developed cancer, French scientists were using a virus known as a retrovirus to put healthy genes into 11 children suffering from severe combined immunodeficiency syndrome. Children with this disease contract infections easily, and many die before their first birthday. The genetic disease is sometimes called bubble-boy syndrome because a boy born in 1971 survived 12 years by living within a protective bubble.



ZHANG

**MINIVAN** — Specially designed peptides, such as this one (inset), self-assemble into a 50-nanometer tube that can encapsulate and transport DNA.

Retroviruses seem promising as vectors because they're efficient at getting genes into cells and the human immune system doesn't usually react strongly to them. But experiments have shown that these viruses sometimes incorporate new DNA into a cell in deleterious ways. Researchers suspect that such a viral mistake led to leukemia in one 3-year-old boy, who was diagnosed with the cancer in September. Then last week, the U.S. Food and Drug Administration placed about 30 trials using retrovirus vectors on hold after a second child in the French trial developed a leukemia-like condition. Both children are now being treated with chemotherapy.

Despite these problems, many researchers are optimistic that someday they'll develop a genuinely safe viral vector. For that reason, investigators are devising new viral vectors and tweaking old ones to create agents that will efficiently deliver genetic material without triggering immune attacks or other deadly side effects.

**BETTER FAKERS** While some scientists are working to improve carriers based on viruses, others are betting on a nonviral option. Boosting the strengths of synthetic vectors—while ridding them of their weaknesses—is the goal of many laboratories.

Chemists and materials scientists have been creating virus-size structures to temporarily encase and protect genetic material, diffuse nimbly through three-dimensional tissue, zero in on target cells, enter those cells, and then release genetic cargoes at the proper locations. "What we're all trying to do is recapitulate the properties of a small virus," says Francis Szoka of the University of California, San Francisco.

Szoka has been investigating nonviral gene–delivery methods since 1978. He works with liposomes, which are layers of lipids that assemble into vesicles 100 nanometers or so in diameter, or about the size of a big virus.

Recently, Szoka has been developing vesicles composed of both lipids and polymers. These 70-nm-wide structures can be loaded with DNA and are sensitive to the acidity, or pH, around them. If injected into the bloodstream of test animals, they can circulate intact at the near-neutral blood pH of 7.4, he says. However, once they enter a cell, the acidity in the uptake compartment increases to a pH of 5 to 6 and the vesicles fall apart, releasing their genetic loads into the cell's cytoplasm. From there, the delivered genes make their way to the nucleus, where they can initiate production

of specific proteins.

When Szoka and his colleagues tested their vectors in animal cells growing in laboratory dishes, the vesicles were efficient at carrying genetic material into cells. Beyond that, the inserted genes then directed the cells to make the proteins they encode, Szoka says.

> "What we're all trying to do is recapitulate the properties of a small virus."
>
> —FRANCIS SZOKA

In experiments on mice, toxicity doesn't seem to be a problem. The vectors seem to go primarily to the liver, which naturally removes particles of this size from the animal. Szoka suggests that the best use for his potential vectors will be for treating genetic diseases, especially those of the liver.

Mark Davis of the California Institute of Technology in Pasadena is taking another approach to virusfree gene delivery. With the goal of developing treatments for cancers that have spread from their tissue of origin, he and his students design nanoscale structures made of polymers.

Previously, most polymers used in new vectors had been derived from materials already made for other applications, Davis says. When researchers have adapted these substances for gene delivery, they've often been too toxic. They also haven't proven as effective as viruses at entering cells.

For now, it's a tradeoff, at best: Exchange the risk posed by viruses for potentially safer synthetic substitutes, but lose nature's efficiency. "There's always a balance between the good and the bad," says Jean-Paul Behr of the Université Louis Pasteur–Strasbourg in Illkirch, France.

If scientists used a vector made from a polymer specifically designed to have low toxicity, they might be able to administer multiple doses of gene-bearing treatments and thereby overcome the vectors' relative inefficiency, Davis suggests.

Toward that end, he and his coworkers are designing nanoscale delivery vehicles made primarily from molecules called β-cyclodextrins, which have been used successfully in other biological systems. The vectors will need to survive in patients' bloodstreams and dispense genetic material after they enter a target cell.

Davis calls his 100-nm-diameter spheres "smart nanoparticles." By changing the chemistry of their surface, Davis says, he can direct them to different types of cells.

At an American Chemical Society conference on drug delivery last October in Boston, Davis reported that these particles did go to the targeted cells in mice. In one experiment, the goal was mouse liver cells; in another, it was human prostate-tumor cells transplanted into mice. The DNA carried by the polymer vectors directed the mouse cells to make specific proteins.

Many other researchers use genetic material that, when successfully assimilated into targeted mouse cells, produces an easily identifiable marker protein. Davis' nanoparticle system delivered genes that could produce both a marker protein and a therapeutic protein, such as the tumor suppressor p53. Davis' colleague described this work, which is being commercialized, at a meeting in San Diego on Dec. 10, 2002.

In a vector, it's useful to have several components, each one performing a special function, says Behr. For example, one molecule might condense DNA into a tight package for delivery to a cell. Others would bind to receptors on specific cells. Adding certain protein fragments, or peptides, to the DNA would help it enter the nucleus of a cell. Behr and his colleagues are exploring such methods.

Polymers are particularly versatile for designing nonviral vectors, says Robert Langer of the Massachusetts Institute of Technology (MIT). However, creating the best one for delivering genes to a specific bodily location is, in his words, "a real engineering challenge."

In an effort to speed the discovery of effective vectors, Langer and his coworkers have now developed a way to rapidly screen the toxicity and efficiency of 2,400 structurally different polymers at once. The team has examined varieties of biodegradable polymers known as poly(β-amino esters). Several polymers that made it through the screenings look particularly promising, and those will be tested in animals, says Langer.

Shuguang Zhang, also of MIT, is looking at even smaller elements in his approach to nonviral-vector discovery. By choosing and linking specific sequences of amino acid, he and his coworkers have created short peptides that have a positively charged end made of the amino acids lysine or histidine. When placed in a solution with DNA, these synthetic protein fragments assemble themselves into nanoscale capsules and tubes containing DNA.

When Zhang tested these molecular devices, they successfully delivered their DNA to at least some cells growing on laboratory plates. Zhang detected marker proteins encoded by the inserted DNA in 5 to 10 percent of the cells. Other labs are in the process of testing Zhang's vectors in animals.

Although he's still far from his goal of inserting working genes into 50 percent of the test cells, Zhang views these and other self-assembling peptides as promising.

**NAKED DNA** If viral vectors are risky and nonviral vectors are difficult to develop, why not get rid of the carrier altogether? Consider naked DNA.

If scientists could introduce pure DNA into target cells and tissues without encasing it in a virus, a polymer, or other material, they would eliminate concerns about the toxicity of those substances.

One of the earliest naked-DNA approaches coated tiny gold particles with DNA and then shot them through skin with a gun-like device. In another method, called electroporation, researchers send pulses of high-voltage current through tissue while simultaneously injecting solutions of DNA.

"Naked DNA is great, but it needs help," says Leaf Huang of the University of Pittsburgh, who is also pursuing this approach, as well as lipid and polymer-based vectors. For one thing, he notes, unprotected DNA typically degrades in the body before it gets to its target.

Huang and his Pittsburgh colleague Feng Liu recently modified the electroporation process so that a metal syringe can double as the electrode. In the March 2002 *Molecular Therapy*, Huang and Liu reported that this technique is just as efficient as those using independent electrodes at much higher electric field strengths. Therefore, this new approach minimizes tissue damage.

In mouse studies, cells that received the naked DNA produced a marker protein for a day or two before the animals were killed and examined.

In another, decidedly less conventional experiment, reported in the June 2002 *Hepatology*, Huang and Liu found that they could induce mice to take injected DNA into their cells by massaging the animals' abdomens. "Nothing can be as noninvasive," says Huang. The physical pressure of this stimulation probably generates small pores on cell membranes that allow entry of DNA, Huang suggests.

Whether it's viral, nonviral, or vectorless, all methods of gene delivery have a long way to go before becoming part of routine therapies, and scientists agree that there probably won't be one best way to deliver genetic material for all of the diseases that gene therapy might treat.

But the difficult work that will be required to build these vectors is crucial to medicine. Says Davis: "It's the delivery problem that's holding back the field." ■

# OF NOTE

ARCHAEOLOGY

## Old legend dies hard

Despite the legendary curse of the mummy, archaeologists and aristocrats who entered King Tutankhamen's tomb over 7 decades ago lived about as long as their peers, according to an unusual historical study.

Mark R. Nelson of Monash University in Prahran, Australia, pored over the diaries of early-20th-century archaeologist Howard Carter and obituary records to learn what became of Westerners who entered the tomb between 1923 and 1926. Nelson compared the individuals' lifespans with those of other, mostly wealthy Westerners who traveled to Egypt with the expedition team but didn't enter the tomb. His results appear in the Dec. 21-28, 2002 *British Medical Journal*.

Nelson found that, on average, the 24 men who entered the tomb lived to be 70 years old. This doesn't amount to a statistically significant difference from the average lifespan of 75 for the seven male bystanders on the trip, Nelson says.

Nelson notes that he left the handful of women travelers out of his final analysis because he couldn't find birth or death dates for most of them. But he did discover that Lady Evelyn Herbert, the only woman to enter the tomb, outlived all the men who did so. She died in 1980 at age 79.

Overall, the findings don't surprise Nelson, who says that competing newspapers probably started the rumor of a mummy's curse soon after the sudden death in 1923 of expedition backer and tomb explorer Lord George Carnarvon. He was Lady Herbert's father.

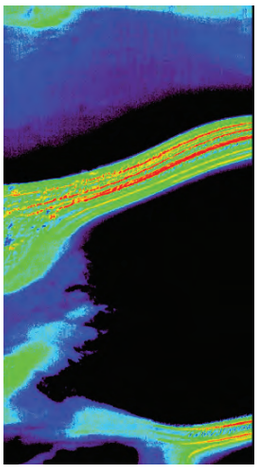
David P. Silverman, an Egyptologist at the University of Pennsylvania in Philadelphia, agrees that newspapers probably started the rumor. This doesn't rule out the possibility of a mummy's curse, he quips. The ancient Egyptians left written curses on the outside of several tombs, but not on King Tut's, he notes. —C.M.

ASTRONOMY

## Mars reveals more frozen water

Planetary scientists have discovered another reservoir of frozen water on Mars. Using the Mars Odyssey spacecraft, researchers have discovered ice near the edge of Mars' south polar cap, which is usually covered by frozen carbon dioxide.

The researchers made their discovery because some carbon dioxide at the cap's edge evaporated during the south pole's summer last February. Odyssey's infrared camera revealed that an exposed kilometer-wide region was colder than neighboring areas. Further measurements showed that the temperature in this region varied little between day and night, strongly suggesting the presence of water ice.



NASA/JPL/ASU/USGS

**COOL PICTURE** Infrared image of the edge of Mars' south polar cap. Blue-purple regions indicate exposed patches of water ice.

The frozen water appears to have persisted on the Red Planet for several decades, the researchers report in an upcoming *Science*. Images taken with the Mars Global Surveyor spacecraft since 1997, as well as some from the Viking spacecraft in the 1970s, show signs of water ice late in south pole summers, report Timothy N. Titus and Hugh H. Kieffer of the U.S. Geological Survey in Flagstaff, Ariz., and Phillip R. Christensen of Arizona State University in Tempe.

Odyssey's temperature measurements indicate that an area adjacent to the patch of frozen water also contains ice but is covered by a veneer of dust.

"This water ice may be just the tip of the iceberg," says Titus. "There may be a whole mass of water ice underneath the southern polar cap." —R.C.

BIOLOGY

## It's a tough job, but native bees can do it

Conservationists fretting about the dwindling of North American bee species have new evidence of the insects' importance.

North American farmers typically rely on a single European honeybee species to pollinate crops, explains Claire Kremen of Princeton University. This focus on one species for such a vital service raised alarms in the mid-1990s as diseases and other menaces attacked honeybees. Adding to the concern, biologists noted that native bee species, indeed, were disappearing.

Kremen devised a study to assess the pollinating capabilities of wild bee communities, which can include dozens of native species.

As a test crop, she and her colleagues chose watermelon, which is known to be particularly challenging for pollinators. Each female flower needs to receive between 500 to 1,000 pollen grains to yield a marketable melon. The researchers monitored bee activity at several watermelon farms in California. They found that the European honeybees cruised all the farms but that the farms nearest to a habitat of wild bees had the largest workforce of native bees.

To measure pollen loads delivered by each species in the field, the researchers fastened virgin female watermelon flowers to a stick and counted the pollen grains delivered to it by an individual bee. "We call it interviewing the bees," Kremen says.

The researchers calculated that if the imported honeybees would vanish, the native bees could save the crop on the farms near these bees' habitat, but not on the farms far from such habitats. The message, Kremen says, is that farmers could do themselves a favor by restoring bee habitats around their farms.

The research appears in the Dec. 24, 2002 *Proceedings of the National Academy of Sciences*. —S.M.

BIOMEDICINE

## Cheap hypertension drug works best

An old-fashioned pill for preventing high blood pressure and some heart disease appears to work better than newer, more expensive drugs, according to the most recent research. In a 5-year study at 623 health centers, physicians compared the older drug, the diuretic chlorthalidone, with the drugs amlodipine and lisinopril.

Until now, researchers hadn't tested either of the newer drug types against a diuretic, which costs about 10 cents per pill. Amlodipine is a calcium-channel-blocker and lisinopril works by inhibiting a blood-pressure-related enzyme. These drugs range in price from 50 cents to $1.50 per pill.

The absence of a direct comparison has left doctors unsure of which treatment they should use, says Barry R. Davis of the University of Texas Health Science Center at Houston.

# OF NOTE

"The purpose of [our] study was to see whether [the newer] drugs' theoretical benefits would hold up as real benefits," explains Davis.

The researchers randomly assigned 33,357 people with hypertension to get one of the three drugs daily for at least 5 years. The male and female volunteers were all 55 or older but otherwise diverse.

"The biggest surprise was that the diuretic was better than the new medicines," says Davis. For example, participants taking chlorthalidone were 38 percent less likely to have heart failure compared with those taking amlodipine. And participants taking lisinopril had a more than 15 percent higher risk of having a stroke or heart attack than did people taking the diuretic.

The findings, which appear in the Dec. 18, 2002 *Journal of the American Medical Association*, prompted the National Heart, Lung, and Blood Institute to advise doctors to consider adding diuretics to their hypertensive patients' treatments or switching to the older treatment altogether. —C.M.

BIOMEDICINE

## Drug protects mouse eggs from radiation

A drug that might preserve the fertility of women undergoing radiation treatment for cancer has met an important challenge. Female mice treated with the drug and then irradiated give birth to healthy offspring, according to a new study.

When women undergo radiation therapy, the treatment usually causes most of their egg cells to die, apparently because the radiation damages the cells' DNA. Over the past few years, researchers have explored the potential of sphingosine 1-phosphate (S1P), a type of lipid, to protect egg cells. S1P counters an enzyme that destroys radiation-damaged egg cells, and previous research has shown that injections of S1P into mice receiving radiation reduced egg deaths (*SN: 10/7/00, p. 228*).

However, that result left open the question of whether the surviving egg cells were normal. At the American Society for Cell Biology meeting last month in San Francisco, Richard N. Kolesnick of Memorial Sloan-Kettering Cancer Center in New York reported that irradiated female mice pretreated with S1P are fertile and that their offspring and a subsequent generation don't have increased rates of genetic or physical defects. Kolesnick and his colleagues detailed some of their findings in the September, 2002 *Nature Medicine*. —J.T.

ENVIRONMENT

## Why didn't the beetle cross the road?

A road that a person strolls across with barely a thought proves a deadly barrier for many other creatures and can disrupt the usual traffic of their genes throughout a population.

Most of the recent studies of this effect have focused on vertebrates, note Irene Keller and Carlo R. Largiadèr of the University of Bern in Switzerland. These researchers turned their attention to the ground beetle *Carabus violaceus*.

This insect doesn't fly but proves to be a plucky traveler on the ground. Other researchers had observed that another species of ground beetle is extremely wary of crossing roads.

Keller and Largiadèr collected their beetles from eight places in a Swiss forest sliced by three roads. The biggest genetic differences appeared between beetles living on opposite sides of roads. Also, beetle populations confined to specific forest areas by the roads seemed to have lost some of their genetic diversity, the researchers report in an upcoming *Proceedings of the Royal Society of London B*. The scientists warn that expanding networks of roads could be reducing healthful genetic diversity in invertebrates. —S.M.

FOOD AND NUTRITION

## Stroke protection: A little fish helps

Eating as little as one serving of fish per month may reduce a man's risk of certain strokes by 40 percent, a new study finds. Indeed, eating fish more frequently offers no additional benefit, the data suggest.

More than 80 percent of strokes are of the ischemic variety, which means they're caused by blocked blood vessels in the brain. Most of the blockages are caused by clots. Ruptured blood vessels account for the rest, which are called hemorrhagic strokes.

In the new study, Ka He and his colleagues at the Harvard School of Public Health in Boston documented 377 cases of ischemic stroke and 106 cases of hemorrhagic stroke during a 12-year follow-up of nearly 44,000 men participating in a survey of male health professionals. The Harvard researchers correlated the incidence of these different types of stroke with dietary data collected from the volunteers.

This analysis revealed that men who ate fish monthly, including shellfish, suffered dramatically fewer ischemic strokes. The rate of hemorrhagic stroke wasn't different in the fish versus nonfish eaters. The findings appear in the Dec. 25, 2002 *Journal of the American Medical Association*.

Although other studies have also found evidence that eating fish protects against stroke, most had been too small to investigate effects by stroke type.

What surprised He most was how little fish it took to impart protection against ischemic stroke. He says the message for men is clear: "Incorporate fish, whether it's lobster, canned tuna, or salmon, into your diet." —J.R.

ASTRONOMY

## Predicting geomagnetic storms

Eruptions from the sun's outer atmosphere can hurl million-ton clouds of electrically charged ions toward Earth. Moreover, solar flares spew high-energy X rays and high-speed charged particles. Recent observations with an Earth-orbiting spacecraft may yield new ways to predict when these solar temper tantrums will cause the geomagnetic storms that disrupt communications systems on Earth and harm satellites.

Using a satellite called IMAGE (Imager for Magnetopause-to-Aurora Global Exploration), researchers for the first time obtained images of the sun pumping material into its plasma sheet, which is made of highly ionized atoms and pierces Earth's magnetic field. The scientists also confirmed that when the magnetic field carried by the plasma sheet points opposite to the direction of Earth's magnetic field, material within the sheet can penetrate Earth's protective magnetic bubble. Only if the plasma sheet is full and it has an oppositely pointing magnetic field can a geomagnetic storm be triggered, according to the 20-day study with IMAGE.

Previous measurements of the plasma sheet and the magnetic field it carries were confined to small regions that couldn't readily be stitched together into a global picture of the forces involved in triggering geomagnetic storms, says David J. McComas of the Southwest Research Institute in San Antonio, Tex.

McComas and his colleagues describe their study in the Nov. 15, 2002 *Geophysical Research Letters*, mailed this month. —R.C.

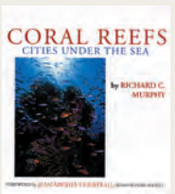
# Books

A selection of new and notable books of scientific interest

### CORAL REEFS: Cities under the Sea

**RICHARD C. MURPHY**

With the benefit of hundreds of glorious color photographs of fish, reefs, and underwater scenery, this guidebook provides an in-depth look at how coral reefs function and how they benefit people. Murphy explains that coral reefs are sustainable communities powered by solar energy, where waste is recycled and raw materials are used efficiently. Residents in this society have individual jobs and rely on each other to repair and rejuvenate their community. Profiles of individual fish species appear throughout the text and bring to light many varieties that possess unusual characteristics for adapting to their environment, for example, the spiny puffer fish gulps so much water that it becomes too big for its predators to eat. Murphy also examines how the warming of the oceans is adversely affecting coral reefs almost as much as pollution and destructive fishing practices are. ***Darwin Pr, 2002, 177 p., color photos, hardcover, $45.00.***




### DARWIN'S BLIND SPOT: Evolution Beyond Natural Selection

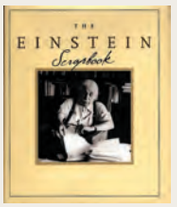
**FRANK RYAN**

Aggression and competition drive Charles Darwin's model of evolution: survival of the fittest. Ryan, however, argues that symbiosis, which he calls selection of the fittest, is an equal component of evolution. Not to give Darwin short shrift, Ryan contends that clearly there is competition between individuals within species to pass on genes to the next generation. However, he cites numerous examples in which interspecies cooperation is just as important. For instance, flowers rely on bees and butterflies, and in human cells, agents that originated in ancient bacteria perform critical functions. Ryan, a physician and author of *Virus X*, traces the history of evolutionary theory as a prelude to his own ideas about how the blending of life forms has advanced evolution. ***HM, 2002, 310 p., hardcover, $25.00.***


### THE EINSTEIN SCRAPBOOK

**ZE'EV ROSENKRANZ**

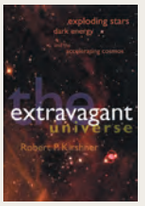
The curator of the Albert Einstein Archives at the Hebrew University in Jerusalem presents an engaging kaleidoscope of documents and photographs from Einstein's personal effects. The collection provides an interesting window through which to view this icon's scientific, political, and social contributions. The book opens with a timeline of the major events in Einstein's life along with images of his birth certificate, a report card (which illustrates that Einstein was, in fact, a good student), and a biography that depicts his family history. This is followed by an assortment of articles, pages from notebooks, and letters detailing the amazing breadth of his scientific legacy. A wealth of letters and speeches written on behalf of peace, freedom, and civil liberties illustrates his impact on behalf of these causes as well as his commitment to the values of Judaism. On a lighter note, the volume includes evidence of Einstein's passion for music and sailing as well as his correspondence with children. Rosenkranz provides context for the images. Photographs are well captioned, and letters and other writings are reprinted for easy reading. Originally published in Israel in 1998. ***Johns Hopkins, 2002, 1999 p., b&w photos/illus., hardcover, $22.50.***




### THE EXTRAVAGANT UNIVERSE: Exploding Stars, Dark Energy, and the Accelerating Cosmos

**ROBERT P. KIRSHNER**

For the past 30 years, Kirshner has been among the leading researchers studying the nature of exploding stars known as supernovae. He takes readers to the heart of this pursuit by revealing the stunning finding of his team—that the universe is not only expanding, but also accelerating. Kirshner unravels the mysteries of this finding—explaining how this expansion is being fueled by dark energy, how scientists are measuring the rate of acceleration, and moreover, what this all means in the grand scheme of how the universe operates. He draws on years of speculation and study beginning with the work of Albert Einstein and Edwin Hubble. Those two famed scientists shaped popular beliefs until Kirshner turned the field upside down just a few years ago. In fact, Kirshner's work validates what Einstein had thought was an error in his calculations: the need to account for the universal force now known as dark energy. ***Princeton U Pr, 2002, 282 p., color plates/b&w photos/illus., hardcover, $29.95.***




### IN WAR AND PEACE: My Life in Science and Technology

**GUY STEVER**

During his distinguished career, Stever has served as science advisor to two presidents (Richard Nixon and Gerald Ford), director of the National Science Foundation, and chief scientist of the Air Force. He was also president of Carnegie Tech when that university merged with the Mellon Institution. Stever shares his life experiences from the time he was a young man pursuing a physics degree at Colgate University and then a doctorate at Cal Tech. World War II interrupted the latter undertaking, and Stever served in Europe, working as a scientist in the famed Rad Lab. The rest of volume unfolds as an intimate look at a man who helped shape scientific policy for the better part of the 20th century. ***Joseph Henry, 2002, 382 p., b&w plates, hardcover, $29.95.***




# LETTERS

## Yum yum

While reading your article regarding the primitive antibodies found in lancelets ("First Line of Defense: Hints of primitive antibodies," *SN: 11/9/02, p. 294*), it occurred to me that complex immune systems might be merely a highly specialized, evolved form of digestion. Presumably, evolutionary adaptation would tend to favor a critter that found a way to consume even those nasty, yucky, infectious microbes.

**MEL ZERNOW**, COLUSA, CALIF.

## Bright idea

"Jet Astronomy" (*SN: 11/9/02, p. 299*) notes that X-ray radiation from XTE J1550-54 jets is puzzling because the radiation of the nearer jet, which is moving toward Earth, isn't as bright as that of the more distant jet. Perhaps as a jet strikes material, the radiation is dispersed back toward the jet source. Thus, the more distant jet could appear brighter.

**T.L. POPPELBAUM**, CLINTON, N.Y.

## Chip shot

"Hidden Costs: It takes much stuff to make one tiny chip" (*SN: 11/16/02, p. 309*) describes the economic and environmental costs of semiconductor chips. Interestingly, the impacts on the environment are very similar for the manufacture of solar cells. Many environmentalists place such unrealistic expectations on solar cell energy that they overlook certain facts. First, solar cells yield at most 30 percent efficiency. Second, solar cells do not last forever. Most manufacturers only rate cells for 25 years. Third, manufacture of solar cells still requires large amounts of fossil fuel because growing a single crystal requires lots of heat.

**SEAN WALTON**, COLUMBUS, OHIO

**Correction:** *In "Unfounded Fear: Scared to fly after 9/11? Don't reach for the car keys" (*SN: 1/11/03, p. 20*), we miscalculated the risk of death per kilometer traveled on commercial airline flights from the researchers' findings. Our figure should have been 1 fatality for each 15 billion passenger-kilometers rather than for each 15 trillion.*

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