SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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better danger detectors

ears regrow sensory cells

tale of the "gecko tape"

can nonstick make you sick?

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do herbs measure up?

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Features

This Week

THIS WEEK ONLINE
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Feast and famine Meal skipping may have health benefits.
See Food for Thought.

Of Note

Meetings

Departments

Cover Ground and stuffed into capsules, ginkgo leaves have become a popular treatment intended to fight memory loss. However, many of these and other herbal supplements don't contain what their labels claim.
Page 359

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SCIENCE NEWS
This Week

Getting an Earful

With gene therapy, ears grow new sensory cells

Whether it's the whisper of a lover or the shouts of rapper Eminem, the hearing process works the same. Sound waves bend lashlike projections on cells within the inner ear, and these so-called hair cells respond by sending electrical impulses to the brain.

Conventional wisdom holds that once damaged, hair cells in people and other mammals don't regenerate. But by using a virus to deliver a gene into the inner ear, scientists have now coaxed the ears of adult guinea pigs to sprout new hair cells.

"It's the first time anyone has shown new hair cells can be grown in a mature mammalian ear," says Yehoash Raphael of the University of Michigan in Ann Arbor, who led the study.

Even though the study didn't determine whether the new hair cells detect sound or properly connect with the brain, other investigators hail the work and suggest it will one day lead to treatments for many types of hearing loss, including the kind commonly suffered by elderly people. "It's another major step toward hair cell regeneration in the human ear," says Wei-Qiang Gao of Genentech in South San Francisco, Calif.

In the 1970s and 1980s, scientists got their first inklings of such regeneration in vertebrates when they observed that sharks grow hair cells throughout life and that birds can regrow the sensory cells. No mammal exhibits similar regenerative powers.

In 2000, Gao and his colleagues reported growing new hair cells in inner ear tissue taken from newborn rats and then kept alive in laboratory dishes (*SN: 5/27/00, p. 342*). The scientist infected the tissue with a virus engineered to carry a gene called *Math1*. Earlier studies had shown that an active *Math1*, which encodes a protein that turns on other genes, triggers an immature ear cell to become a hair cell.

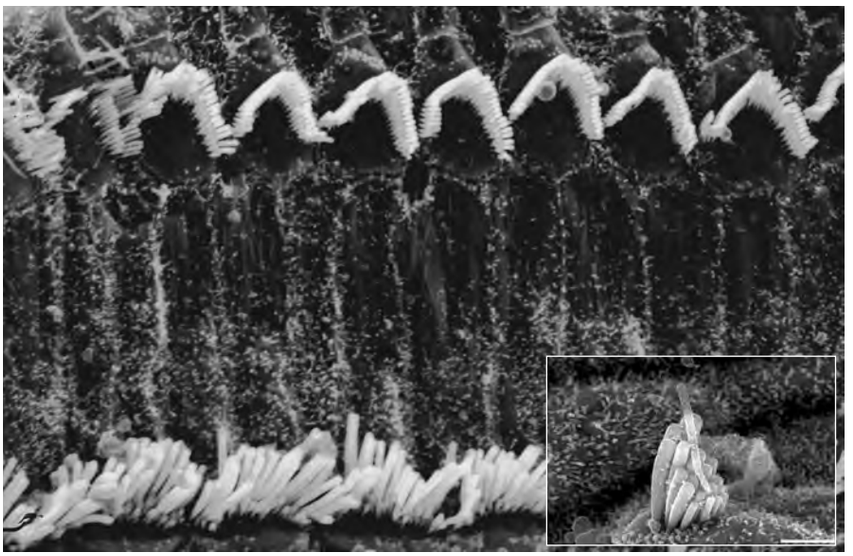
This gene "seems to be the one that gets the ball rolling," says Douglas Cotanche of Children's Hospital in Boston, who studies hair cell regeneration in birds.

It wasn't obvious, however, that *Math1* could transform adult cells of live animals, so Raphael's team injected a virus carrying the gene into the inner ear fluid of guinea pigs. A month or two later, the scientists examined tissue slices from each animal's ear and saw what looked like hair cells at places where the sensory cells normally don't grow.

Since there was no way to distinguish between any *Math1*-induced hair cells and preexisting ones, Raphael's team couldn't prove that new hair cells had grown within the part of the inner ear that usually holds them, the organ of Corti. Still, there were immature hair cells within this area in the treated guinea pigs but not in the untreated animals, the scientists report in the June 1 *Journal of Neuroscience*.

Raphael and his colleagues also found nerve fibers extending toward the fresh hair cells that were outside the organ of Corti. That's "exciting," says Cotanche, because it suggests that new hair cells may naturally integrate themselves into an ear's auditory system and be able to send signals to the brain.

To gauge whether gene therapy can restore hearing, Raphael and his colleagues plan to work with animals whose hair cells have been destroyed. The researchers will also test the strategy on guinea pigs older than those in the current experiments, to see whether aging inhibits the ability to grow new hair cells. —J. TRAVIS



K. KAWAMOTO AND Y. RAPHAEL/UNIV. OF MICHIGAN MEDICAL SCHOOL

LISTEN UP Guinea pig hair cells, the ear's sensory cells, sport bristles (white) that bend when sound waves strike them. Inset: After gene therapy, new hair cells grew in a guinea pig's ear.

Sticky Situation

Nonstick surfaces can turn toxic at high heat

Teflon and related nonstick materials are made from an ultraslippery compound, polytetrafluoroethylene (PTFE). Studies conducted during the past 40 years by many research groups demonstrate that at high temperatures, the polymer can emit airborne poisons, an environmental group reported in a self-published review last week. The fumes can kill birds, and people breathing the emissions can develop flulike "polymer-fume fever," the reviewers find.

With widespread use of nonstick cookware, it's likely "there is a fair amount of polymer-fume fever" each year, says Richard Wiles of the Environmental Working Group in Washington, D.C. Because the symptoms in people resemble those of a viral infection, they simply "go unrecognized," he suspects. The group has just petitioned the Consumer Product Safety Commission to require mandatory warning labels on PTFE-bearing products that are expected to get hot.

For their analysis, the Environmental Working Group amassed 50,000 pages of peer-reviewed papers, reports, and internal company investigations of PTFE and related compounds. To date, much of this information escaped notice, Wiles says, because it was published in obscure journals and reports, many of which appeared before the federal government got tough on toxic pollutants in the mid-1970s.

As far back as the 1960s, workers in factories making polymer products were getting sick from hot PTFE, says Jane Houlihan of the Environmental Working Group. Manufacturers responded by requiring the use of respirators wherever PTFE reached 400°F or hotter. In tests just last month, Houlihan's group demonstrated that an empty nonstick pan on a home-kitchen stovetop can reach 400°F within 2 minutes

and 730°F in 5 minutes.

At DuPont Co. in Wilmington, Del., a major U.S. maker of PTFE products under its Teflon trademark, employees wear respirators—but not from any concern about Teflon-degradation products or polymer-fume fever, says company spokesman R. Clifton Webb.

He maintains that even at 500°F, PTFE-coated cookware won't release material harmful to human health. "DuPont is aware of one published incident of a [cook] pan left unattended which resulted in a case of polymer-fume fever," says Webb.

The Environmental Working Group says it turned up many reports linking overheated PTFE to accidental poisonings. For instance, a 1964 *Aerospace Medicine* paper recounted polymer-fume fever in 39 of 40 people on a plane where insulation containing PTFE overheated. A 1975 report in *The Veterinary Record* described polymer-fume fever in a man—and the death of five cockatiels—after a PTFE-coated fry pan overheated. And a 2000 paper in *Avian Diseases* traced more than 1,200 broiler-chick deaths in 3 days to the use of new heat lamps coated with PTFE.

An empty pan on a hot stovetop "can reach temperatures that would break down PTFE," says inhalation toxicologist Günter Oberdörster of the University of Rochester (N.Y.) Medical School. His studies have shown that at 900°F (486°C), PTFE emits a mix of gases and ultrafine particles that quickly kills rats. However, neither the particles nor the gases proved toxic alone. Oberdörster suspects the fine particles, which are emitted at the higher temperatures, carried toxic gases such as hydrogen fluoride deep into the lungs.

Most intriguing, he says, is that rats inhaling nontoxic quantities of PTFE fumes for a few minutes on several days, and later exposed to typically lethal concentrations, weren't harmed.

Oberdörster notes that with food in it, a pan will never reach temperatures that produce toxic PTFE-derived gases. In fact, he says, "you have to put it in perspective . . . . Cooking with such pans is less dangerous than driving a car." —J. RALOFF

HOT STUFF A researcher uses a gun-style, noncontact thermometer to take the temperature of a PTFE-coated pan.

Caught on Tape

Gecko-inspired adhesive is superstrong

As it scurries along the ceiling, a gecko has the sticking power to support not just its own body weight, but about 400 times as much. Besides that sticking power, the natural adhesive on this animal's feet is clean and reusable, and it works on all surfaces, wet or dry.

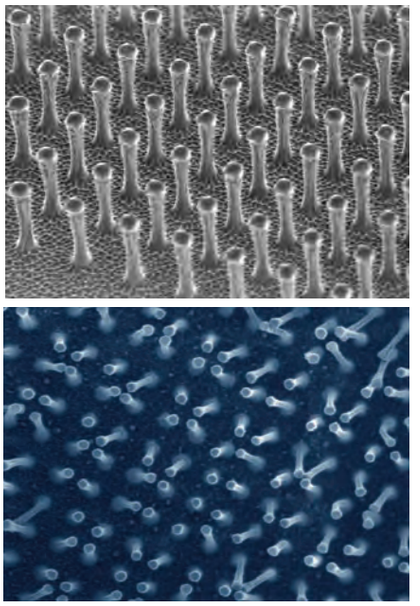
Scientists at the University of Manchester in England and the Institute for Microelectronics Technology in Russia have emulated the animal's adhesive mechanism by creating "gecko tape." It comes closer to the lizard's sticking power than any other gecko-styled adhesive so far.

The 1-square-centimeter prototype patch can bear about 3 kilograms, almost one-third the weight that the same area of gecko sole can support.

In the July *Nature Materials*, Andre Geim of the University of Manchester and his colleagues claim that the tape is scalable to human dimensions: Wearing a "gecko glove," a person could dangle from the ceiling. In theory, the tape could hold tissues together after surgery or support stunt doubles climbing around movie sets.

The gecko tape is modeled on the gecko sole, an intricate fingernail-size surface covered with a half-million microscopic, hairlike structures known as setae. Each seta's tip branches into even finer hairs that nestle so closely with every surface the gecko touches that intermolecular attractions called van der Waals bonds and capillary forces kick in. These bond the gecko's foot to the surface (*SN: 8/31/02, p. 133*).

Geim and his team made their synthetic gecko adhesive by fabricating a tidy array of microscale hairs out of polyimide, a flexible and wear-resistant plastic. When mounted on a flexible base, the arrangement and density of the hairs maximize the number of hairs contacting a surface.



COMING UNSTUCK An array of tiny plastic pegs (top) emulates the microstructure of a gecko's sticky sole. Adhesion declines when the pegs clump (bottom).

EWG; GEIM/UNIV. OF MANCHESTER

"The smaller the hairs are, and the more of them you have, the greater the adhesion," notes Ron Fearing, an engineer at the University of California, Berkeley.

Unlike a gecko's feet, however, the tape begins to lose its adhesive power after about five applications. Geim blames this shortcoming on polyimide's hydrophilicity, that is, its tendency to attract water. With repeated applications, some of the gecko tape's hairs get soggy, bunch together, and then clump onto the tape's base. This happens even when the tape is attached to surfaces that are dry to the touch, because they carry a layer of water two or three atoms thick.

By using hydrophilic material, Geim departed from the gecko's design—its setae are made of keratin, a so-called hydrophobic protein that repels water. Geim says hydrophobic materials, which include silicone and polyester, are more difficult to mold into setae-like structures than is polyimide. Even so, both he and Fearing agree, it will take water-repellant substances to produce a long-lasting gecko tape. —S. MCDONAGH

Slowdown on Saturn?

Windy doings on the ringed planet

The winds in Saturn's upper atmosphere are some of the swiftest in the solar system, but recent findings suggest there's been a

dramatic slowdown. Observations with the Hubble Space Telescope indicate that the band of wind circling Saturn's equator is now traveling 270 meters per second, a 40 percent drop from the supersonic speed it had just 22 years ago.

If confirmed, the data offer the first evidence "that wind speeds in the atmospheres of the giant planets can suffer strong changes," says Agustín Sánchez-Lavega of the Universidad del Pais Vasco in Bilbao, Spain. He and his colleagues describe their findings in the June 5 *Nature*.

The researchers cite several explanations for a possible slowdown. Because Saturn, like Earth, is tilted on its axis, different parts of the ringed planet receive different amounts of sunlight during its 29-year orbit around the sun. If this variation accounts for changes in equatorial wind speed, that speed should change noticeably in about 7 years, the next time Saturn's equator is tipped toward the sun, comments John T. Clarke of Boston University.

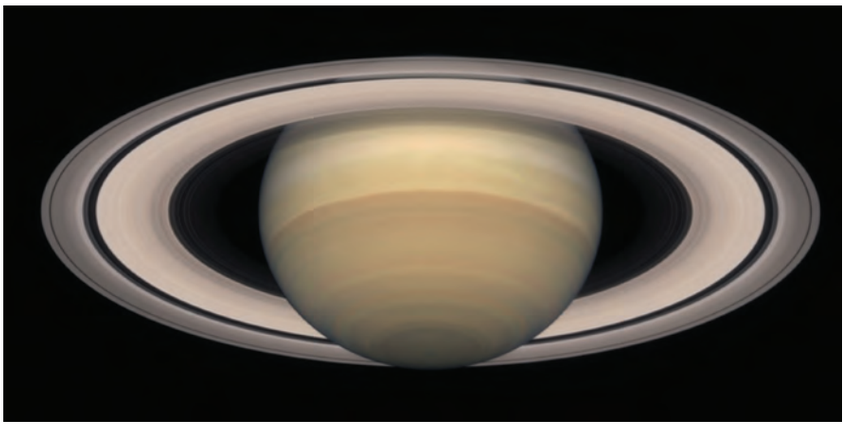
The shadow cast by the planet's giant ice rings also might affect wind speed by blocking varying amounts of sunlight at the equator. Another possibility, notes Sánchez-Lavega, is that a huge equatorial storm system, dubbed the Great White Spot (*SN: 11/24/90, p. 325*), has disturbed the band of wind.

However, Sánchez-Lavega's team acknowledges that what appears to be a slowdown in wind speed might simply be an artifact of the data. Hubble examined Saturn from 1996 to 2002, and the Voyager spacecraft did so in 1980 and 1981. A comparison of the measurements might be misleading if Hubble measured winds at a higher altitude than those examined by Voyager. Higher-altitude winds on Saturn move more slowly.

Given the "sheer magnitude of the change" in speed, the results are intriguing but demand some skepticism, says Adam P. Showman of the University of Arizona in Tucson. Winds on all planets are directly or indirectly powered by the absorption of sunlight and its radiation into space at infrared wavelengths, Showman notes. He asserts that there isn't enough solar energy reaching Saturn to slow its equatorial winds at any significant depth below the cloud tops.

On the other hand, if the slowdown is confined to the uppermost altitudes, says Showman, there should be an obvious difference in temperature between the center of the equatorial band and its upper and lower edges.

The atmospheric model that Showman's criticism relies on isn't valid in Saturn's equatorial region, counters Sánchez-Lavega. Moreover, no one knows whether major temperature differences exist because measurements weren't made there during the years Hubble examined the region, he says.



NASA, HUBBLE HERITAGE TEAM

EYE ON SATURN Hubble Space Telescope image of the ringed planet, taken in November 2000.

With the Cassini spacecraft scheduled to begin orbiting Saturn in July 2004, "the analysis is quite timely," notes Reta F. Beebe of New Mexico State University in Las Cruces. Cassini will give researchers "the capability of observing Saturn's clouds . . . with the best camera and infrared spectrographs we have ever taken to the outer planets," she says. —R. COWEN

Babble Rousers

Babies find their voice when given social push

Eight-month-old infants utter more complex, speechlike sounds when their mothers encourage them with well-timed touches and smiles rather than with words offered as models to imitate, a new study finds.

This provides the first evidence that nonverbal interactions with caregivers shape babies' vocal learning, says psychologist Michael H. Goldstein of Franklin and Marshall College in Lancaster, Pa. The power of maternal behaviors to ramp up babies' babbling corresponds to the way certain bird species learn to sing, propose Goldstein and his coworkers Andrew P. King and Meredith J. West, both of Indiana University in Bloomington.

"This is a basic type of social learning," Goldstein asserts. "At 8 months of age, kids may already make complex speech sounds occasionally, but they produce them regularly in response to [certain encouraging] interactions with a caregiver."

The new findings, slated to appear in an upcoming *Proceedings of the National Academy of Sciences*, support the view that learning language doesn't hinge solely on the ability to imitate spoken sounds.

Goldstein's group studied 30 infants averaging 8 months of age and their mothers. Each mother-child pair first played in a room stocked with toys for 10 minutes. Then half the mothers were told to respond immediately during the next 10 minutes to a baby's vocalizations by smiling, moving closer to the child, and gently touching him or her—but not by talking. The rest of the mothers were instructed through headphones to react in the same ways, but usually not right after a baby made sounds.

In those cases in which mothers timed their smiles and touches with their babies' vocalizations, the infants' babbling almost instantly became more mature, the scientists say. Compared with during the initial play period, these babies enunciated substantially more syllables such as "da" and "gu." They also drew deeper breaths while vocalizing, which improved their articulation of speech sounds and removed the nasal tone that many of them had at first.

During a final 10-minute stretch, both groups of mothers played without restrictions with their babies. Those infants that had received nonverbal encouragements continued to produce more syllables and more finely articulated speech sounds than their counterparts, although all infants vocalized less frequently during this final phase.

Several songbird species exhibit a type of social learning that parallels the impact of mothers' behavior on their babies' babbling, the researchers contend. For instance, in brown-headed cowbirds, young males transform immature songs into polished form by heeding the nonvocal responses of adult females, such as subtle wing movements.

The new findings reiterate how the social environment influences the use of language in infancy, remarks psychologist Michael Owren of Cornell University. However, it's not clear that a common mechanism underlies learning in songbirds and babies, he says. Because song learning is restricted to male cowbirds instructed only by females, the process may rely on a specialized procedure, Owren says.

"Goldstein's study is important because it puts more of the responsibility for the infant's language learning on the caretakers, rather than depending entirely on a

special mechanism within the infant—imitation," says Indiana University psychologist Susan S. Jones. —B. BOWER

Skin Scam

Parasite's host provides an insect hideaway

A group of parasitic insects tough enough to kill fire ants have shown researchers a nasty new trick. The creatures hide inside their victim by making the host form a protective bag of its own skin.

The order of tiny insects called Strepsiptera can live only as parasitoids inside the bodies of other insects, says Jeyaraney Kathirithamby of the University of Oxford in England. When she began studying the life cycle of a Pacific species, she noticed that the insects become enclosed in a sheath of thin tissue as they jab their way into the victim.

DNA tests showed that this bag of skin comes from the host, probably disguising the invader from the host's immune defenses, Kathirithamby and her colleagues report in an upcoming *Proceedings of the National Academy of Sciences*. Investigations of other Strepsiptera species are turning up the same strategy, says Kathirithamby.

Understanding how Strepsiptera parasitoids outwit host defenses is particularly exciting, she says, because the order's 500-plus species manage to prey on insects in 34 families. Some of these parasite-host relationships are quite unusual. For example, in some of the parasitic species, the males infiltrate ants while the females take up residence in grasshoppers. Also, Kathirithamby says, uncovering the biology of these superb insect killers may lead to biological controls for pests.

The particular species (*Stichotrema dallatorreanum*) that Kathirithamby discovered in skin bags targets the katydids of Papua New Guinea, which damage oil palms. The parasitoid's youngest larval stage attacks the host. The larva burrows through the katydid's outer cuticle into the first layer of living tissue, the epidermis. The larva wriggles around for a day or two at this level until a loose sheath of epidermal tissue encloses it.

In effect, Kathirithamby says, "the parasitoid hijacks the [host's] wound-repair system."

Some insects kill invading parasitoids by encapsulating them. The host's skin bag works differently, says Kathirithamby, noting that larvae thrive within these thin and apparently permeable sheaths.

When *S. dallatorreanum* finally matures, the top of its body grows to the surface of the victim and pokes out. The species has no males, so some 800,000 larvae develop without fertilization inside each adult. They emerge from her body, which remains embedded in the host. This new generation moves on to new victims, and the old host dies.

Strepsiptera don't attack people. Even so, notes Michael Strand of the University of Georgia in Athens, "there's a real recognition now that understanding more about parasite-host interactions really does matter." The strategies in their battles, as well as the underlying genetic and molecular mechanisms, are pervasive in nature, he says. Besides, he adds, some of these interactions "are really elegant." —S. MILIUS

INTRUDER A parasitic Strepsiptera insect in its victim-searching form (top) burrows into the tissue of a katydid host, which wraps the invader in a skin bag (arrow, bottom).

KATHIRITHAMBY

Cancer Advance

Treatment combinations stall colorectal cancer

Two experimental drugs can buy precious months of remission in some people with colorectal cancer that has spread to other tissues, new research shows. While both drugs are synthetic antibodies, they take distinctly different approaches to fighting the malignancy.

In one trial, scientists show for the first time that patients can benefit from a compound that blocks blood vessel growth, also called angiogenesis, and thus disrupts a tumor's nutrient supply. In the other trial, a separate substance seems to reawaken a signal within colorectal cancer cells that directs them to commit suicide.

The first drug, bevacizumab, works by inhibiting vascular endothelial growth factor, a protein that directs blood vessel formation in growing tissues, including tumors. The researchers randomly assigned 403 people with untreated colorectal cancer to get bevacizumab, while 412 similar patients received a placebo. Both groups were also given standard chemotherapy.

Tumors shrank by at least half in 45 percent of the patients receiving bevacizumab and 35 percent of those getting the placebo. The group getting the drug averaged nearly 11 months' of remission while the placebo group averaged 6 months', reports Herbert I. Hurwitz of the Duke University Medical Center in Durham, N.C. The first group survived, on average, 20.3 months after starting the trial, and those taking the placebo lived only 15.6 months.

Bevacizumab, called Avastin by its maker Genentech in South San Francisco, Calif., failed to stop breast and kidney cancer in earlier studies.

In the other trial, researchers enrolled 329 people who had colorectal cancer that had spread despite chemotherapy with the drug irinotecan. The scientists randomly selected one-third to get the drug cetuximab, while the rest got cetuximab plus irinotecan.

The patients' tumors, which hadn't responded to irinotecan alone, shrank in 23 percent of those getting both drugs and in 11 percent of those getting just cetuximab. People receiving both treatments went 4 months on average before relapsing, whereas patients getting cetuximab alone experienced remission for only 45 days, reports David Cunningham of the Royal Marsden Hospital in Sutton, England.

Cetuximab, also called Erbitux by its maker ImClone Systems of New York, targets a molecule displayed on cancer cells. The scientists aren't sure how cetuximab may reactivate chemotherapy, but Cunningham notes that irinotecan often works by igniting a self-destruct reaction in cancerous cells.

The scientists presented their work in Chicago at the 39th annual meeting of the American Society of Clinical Oncology this week. Neither drug has yet been approved in the United States or Europe.

While neither bevacizumab nor cetuximab offers a cure for advanced colorectal cancer, they represent significant progress against the disease, says Mace L. Rothenberg of Vanderbilt University in Nashville. Twenty years ago, the average survival outlook for patients such as those in the trials was 6 months. Now—with these experimental results—survival time can more than triple, he notes. "I can't think of any other solid-tumor cancer that's had that magnitude of progress over that time," he says. —N. SEPPA

HERBAL LOTTERY

What's on a dietary supplement's label may not be what's in the bottle

BY JANET RALOFF

Echinacea is a commercial success. The dietary supplement—made from the flowers, stems, and leaves of the purple coneflower—has become a popular and lucrative over-the-counter cold remedy. It's also one of the few nutraceuticals—natural products with medicinal reputations—that have substantial scientific evidence to support its purported functions: Various studies suggest that echinacea supplements can boost immunity or shorten the duration of colds.

Several years ago, however, Christine M. Gilroy of the University of Colorado Health Sciences Center in Denver was unsure whether to trust data from those experiments because few reports included biochemical proof of which species of purple coneflower had been used. That's important, she notes, because three species—*Echinacea pallida*, *Echinacea purpurea*, and *Echinacea augustifolia*—turn up in supplements "and only the first two have data indicating they might make colds better."

Curious about *E. pallida*'s reputed power against colds, Gilroy designed a study and then ordered dried samples from three suppliers. She sent some of each delivery out for analysis of chemicals that were known to distinguish the species and that might even have therapeutic activity.

The data that came back put her study on hold. They showed no batch containing pure *E. pallida*. The one from a bulk wholesaler that supplies herbal-products companies contained almost no *Echinacea* from any species, and what little there was consisted solely of *E. purpurea*. The other batches, acquired directly from coneflower growers, did contain *E. pallida*—but also contaminating plants, including *E. augustifolia*.

Gilroy then turned to 59 commercial echinacea products from local stores. Her team's analyses, reported in the March 24 *Archives of Internal Medicine*, show that none offered consumers what had been promised by its label. Six contained no evidence of any echinacea, and 28 failed to contain the specific species that was listed on the box. Some offered echinacea in quantities exceeding or, more often, falling below the quantity on the label, sometimes substantially.

These findings call into question the conclusions of the many earlier studies of echinacea's purported cure for the common cold, says Gilroy. At the least, they suggest that health effects seen with one sample of supplement might not hold for others.

This is just the latest in a string of studies revealing variability in the ingredients of dietary supplements on the market today. Uniform products require consistent ingredients and processes throughout every stage of manufacturing. The troubling findings suggest that many herbal-product makers aren't maintaining adequate quality control.

Several weeks ago, the Food and Drug Administration proposed rules designed to stem quality-control problems in dietary supplements, including nutraceuticals. The agency would mandate so-called good manufacturing practices, or GMPs, in the industry. Under GMPs like those now governing pharmaceuticals, all manufacturers of dietary supplements would have to chemically validate their ingredients and keep stringent records. These would include temperature readings from each batch as it's made and notes about any breakdowns of factory equipment.

NOT TWINS — ***Echinacea pallida*** **(left) and** ***Echinacea purpurea*** **(right) look different, but manufacturers sometimes swap one for the other in dietary supplements—even though the plants contain different chemicals and may perform differently.**

CHICAGO BOTANIC GARDEN

However, representatives of the nutraceutical industry say they plan to call for amendments to the proposed FDA rules. They're currently analyzing the hundreds of pages of details before requesting changes. Moreover, any set of standard practices may be severely challenged by the complex makeup of herbal products, several scientists told *Science News*.

"For the most part, with [herbal] supplements, we still don't know what all the active ingredients are," so nobody knows the ideal formulation of most supplements, observes Bill J. Gurley of the University of Arkansas for Medical Sciences in Little Rock.

Says David J. Newman of the National Cancer Institute in Frederick, Md., "The bottom line remains *caveat emptor*," or let the buyer beware.

BEYOND ECHINACEA There's evidence for poor quality control in the making of many dietary supplements, says Chien M. Wai of the University of Idaho in Moscow. His work focuses on those made from leaves of the maidenhair tree (*Ginkgo biloba L.*). Ginkgo supplements fight memory loss and reinvigorate blood flow in the brain, according to users of the herb.

Scientists have identified five purported active ingredients in ginkgo. In most cases, Wai finds, a product's label describes only how much bulk ginkgo tissue a tablet, powder, or tincture contains without quantifying the active agents. Concentrations of those

agents can vary widely in plant tissue.

In 2001, Wai's group reported data showing that, for instance, supposedly equally potent ginkgo supplements could contain anywhere from 0 to almost 4 milligrams of active compounds. Brands varied in which active chemicals dominated them, and some brands exhibited large batch-to-batch variation.

His subsequent studies, Wai says, indicate "the situation is not getting better."

Consumers can't use his team's reports to avoid supplements with weak or erratic ingredients because the researchers haven't published any brand names. Companies challenge any implied criticism of their products, Wai explains, and "we can't afford the time to fight lawsuits."

Gurley has named brands in his published analyses of supplements containing the weight-loss stimulant ephedra and indeed "stirred up a hornet's nest," he notes. It started 3 years ago, when his team first surveyed 20 over-the-counter ephedra products. As Gilroy found with echinacea, the ingredients often didn't match label claims.

Tissues from the *Ephedra sinica* plant, like ginkgo, contain at least five purported active ingredients, which are in the chemical family named alkaloids. Each alkaloid has a different effectiveness as a stimulant, and its concentration varies among individual plants. Most supplements that are labeled with ingredient information claim only to have some specified quantity of mixed ephedra alkaloids—information too general to offer much gauge of potency, says Gurley.

Although one brand that his team tested contained none of the five stimulant alkaloids, most had several, but the amounts varied among brands. When the researchers tested several batches of a brand, some differed in concentration by up to tenfold. Only 13 of the 20 products listed a total quantity of alkaloids on the label; others just listed quantities of the raw source plant. In many cases, Gurley says, those values bore no relation to what was present. His group published its findings in 2000. Since then, the researchers' tests of 130 additional ephedra products found far fewer discrepancies between labels and contents, "although they do still occur," says Gurley.

His team has lately turned to St. John's wort (*Hypericum perforatum*), a possible antidepressant. The researchers are finding a wide range of concentrations of St. John's wort's purported active ingredient, which is called hyperforin. Batch-to-batch hyperforin differences in one supplement brand varied 15-fold.

Gurley acknowledges that some herbal-supplement companies reliably produce what their labels promise. The trick is identifying them, Gurley says, a task beyond the capability of most consumers.

MANY EXPLANATIONS Quality-control problems in herbal supplements often start with the hundreds of chemicals that plants contain. The type and quantity of these compounds vary in response to the environment in which a plant grew: its soil type and nutrition, water availability, excessive heat or cold, exposure to toxic minerals, degree of shading, and any hybridization.

One team is studying horticulturally triggered variations in several citrus compounds that are regarded as potential nutraceuticals because they've inhibited cancers in laboratory animals. Data collected by Bhimanagouda S. Patil and his colleagues at Texas A&M University in Weslaco show that concentrations of one such chemical—limonin glycoside—peaks midway through the crop's harvest season. So, when it comes to this agent, Patil says, "you must eat two grapefruit in May to get what one picked around Christmas will give you."

NOT SO SIMPLE — The chemical complexity of plants, like this ginseng—reputed to ease menopause and recovery from injury and disease—can contribute to large batch-to-batch variation in the potency of herbal products.

He's also been quantifying lycopene, a potential anticancer carotenoid that turns plants red. When his group planted Florida-derived rootstock of Star Ruby grapefruit in Texas, the fruit produced some 50 percent more of this carotenoid than it had in Florida.

Researchers at the University of Newcastle in Ourimbah, Australia, are studying effects of manufacturing techniques on nutraceutical quality. For instance, Douglas L. Stuart and Ron B.H. Wills report that high temperatures reduce concentrations of one of the potential therapeutic agents derived from *E. purpurea*. The scientists report in the March 15 *Journal of Agricultural and Food Chemistry* that drying the plant at 40°C results in one-third more cichoric acid than drying it at 70°C does.

Moreover, Wai's team has shown that whether oil, alcohol, or water is used can effect which chemicals are extracted from a plant. These products can have different potencies.

Even if purported active ingredients make it into a supplement, poor manufacturing techniques can yield tablets that don't effectively release those chemicals, notes Larry L. Augsburger of the University of Maryland in Baltimore.

Working with a synthetic version of melatonin, a hormone that promotes sleep, seems to fight jet lag (*SN: 5/13/95, p. 300*), and maybe even battles cancer (*SN: 10/17/98, p. 252*), his team showed that tablets don't always release their contents in a timely fashion. Although industry standards for the breakdown of conventional drugs is generally 30 minutes or less, his test-tube studies showed that some commercial melatonin supplements didn't disintegrate or release their contents for periods of 4 hours to more than 20 hours, by which time an ingested tablet may well have been excreted.

HELP ON THE WAY? In the early 1990s, nutraceutical manufacturers feared that FDA would challenge their label claims. Then, the 1994 Dietary Supplement Health and Education Act was passed, permitting the sale of nutraceuticals and other supplements that are nontoxic and make no curative claims.

Immediately following the act's passage, sales of herbal supplements skyrocketed, with many companies regularly reporting up to 11 percent annual growth. But by 2000, U.S. sales started flagging, observes Clare M. Hasler of the University of Illinois at Urbana-Champaign. Reports were emerging of health risks associated with some products, such as ephedra; uncertain efficacy of others; and quality-control problems in the industry.

Because that last item appears to be the easiest for manufacturers to fix, some nutraceutical makers have been voluntarily adopting GMPs of their own design, says Nancy Childs of St. Joseph's University in Philadelphia. These companies tend to be the large prescription-drug manufacturers that have entered the nutraceuticals market in the past half-decade, she adds.

Most nutraceutical makers are far smaller than those companies, notes Kim Smith, an attorney with the National Nutritional Food Association (NNFA) of Newport Beach, Calif. Since 1999, her trade group—which represents many nutraceutical makers with 20 to 500 employees—has provided guidance for developing voluntary GMPs. NNFA also officially supports FDA's March 28 proposal for mandatory GMPs. "It will go a long way toward improving credibility in the industry," Smith says.

However, she adds, small firms could have a hard time paying for stringent FDA-required monitoring and record keeping. The

agency estimates that first-year costs for small firms will run about $100,000, with annual costs of $60,000 or so thereafter. In fact, Smith says, her group suspects FDA is substantially underestimating those costs.

Success in complying with mandatory GMPs, Hasler suspects, "is going to sort out the [nutraceutical industry's] major players from the fly-by-night companies and probably put some small players out of business." She adds, " I'm not sure that's a bad thing."

Allen Montgomery, executive director of the American Nutraceuticals Association in Birmingham, Ala., which represents pharmacists and other health professionals, agrees. He says, "I don't know of any other billion-dollar industry that makes ingested products for which [mandatory] GMPs are not in place."

Within the nutraceutical industry generally, Gurley charges, "there are so many bad actors right now, that it's giving the whole industry a bad name."

Fortunately, Montgomery notes, several independent groups—such as the U.S. Pharmacopoeia (USP) of Rockville, Md.—have already begun validating voluntary GMPs for several products. USP is the official standards-setting body for all U.S. medicines and dietary supplements.

Companies that want to carry the USP logo must submit products for a series of stringent tests of such features as a product's purity, potency, and consistency. Also, USP inspectors visit factories to confirm that GMPs are in place, notes Sherrie L. Borden, the organization's spokesperson. "Then we do postmarket surveillance [of a supplement] once a product is on the shelf. It's very rigorous," she notes, "because this mark carries a lot of credibility."

PHARMAVITE

GOT THE LOGO? — A few manufacturers of vitamin, mineral, or fish-oil supplements have met the U.S. Pharmacopeia's product-reliability requirements, which permit use of the USP logo on labels. Pharmavite says it plans to submit its Nature Made herbal line for USP testing soon.

All this sounds comforting, Gurley says, except that pharmaceutical-grade uniformity in herbal products may be amazingly difficult to achieve, and FDA's new rules don't address the complexity of a plant's make-up. Synthetic drugs and vitamins tend to have only one or two well-characterized active ingredients, he explains, while herbal supplements "are a veritable pharmacological Pandora's box."

Indeed, the 48 nutraceuticals that USP recently vetted—all produced under the Nature Made or Kirkland Signature labels—contain only vitamins, minerals, or fish oil—not complex herbal products.

Since plant tissue may contain hundreds of compounds with perhaps dozens of active ingredients, Gurley asks, who knows which of these should be standardized in each product? This "truly daunting" problem would challenge the best pharmaceutical manufacturer, he says, let alone a 30-employee herbal-products company.

Wai and Newman say that they'd like to see the herbal-supplements market develop into a natural-products offshoot of the over-the-counter drug industry. They argue that the best route for making safe and effective nutraceuticals would be to identify each plant's active agents, isolate them for testing in the same kind of trials that conventional pharmaceuticals go through, and then package the proven chemicals in carefully measured doses.

An advantage to this approach for manufacturers, Newman argues, is that unlike an herb, the recipe for a cocktail of natural chemicals is patentable. Thus, it might be market forces after all that bring consistency to the nutraceutical marketplace. ■

DANGER DETECTION

Old and new sensors are aimed to protect troops and commuters

BY JESSICA GORMAN

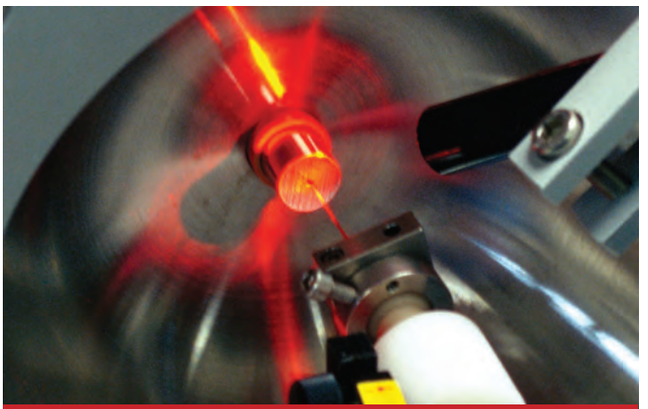
Early in the recent war with Iraq, sandstorms buffeted U.S. troops, choking lungs, guns, and tanks. But it was the potential presence of invisible threats in the air—sandstorm or not—that was most worrisome. At any time or place, it seemed, nerve gas could be lurking. Or anthrax. Or maybe some brand new chemical or biological weapon.

Such concerns go beyond the battlefield. Back home, while on "orange alert" during the combat phase of the Iraq war, subway riders wondered how safe, exactly, was the air underground.

While the tanks waited in the sand this March, scientists at a national meeting of the American Chemical Society in New Orleans paused in front of convention-hall monitors tuned to CNN. They had a special interest in the situation's complications. "There is this clear and present danger that only analytical chemistry will be able to do something about," said Anthony Czarnik, a researcher at the Germantown, Md., company Sensors for Medicine and Science.

In the fictional universe of Star Trek, a device called a tricorder spits out a complete list of chemical and biological contaminants. Unfortunately, there's no real-world instrument that can instantly sift through the messy brew in the air of the Iraqi desert or the New York subway.

Instead, there's a host of limited analytical techniques for scrutinizing the air, soil, and water on the battlefield and at home. Some analytical chemists now aim to step up those systems to make them better matched to the tasks at hand. Meanwhile, other chemists are developing novel technologies intended to be more sensitive and more portable than existing methods. Some of the new approaches incorporate ideas from many disciplines, ranging from microengineering to biomedical science.



SENSITIVE DETECTION — A capillary tip emits ions during mass spectrometry. Researchers use this method to identify proteins, including those that might serve as markers of disease. Eventually, this technology may detect early signs of infection in troops.

H. SCHULMAN/SURROMED

ON GUARD On the battlefield—and to a lesser extent at home—an array of devices detects chemical and biological weapons and sends out a warning. The instruments range from low-tech, chemically sensitive paper to leading-edge laboratory equipment.

There is no tricorder, says Barbara Seiders of the Pacific Northwest National Laboratory in Richland, Wash., and it's unlikely there ever will be a detector that can work in all situations. Today's detectors must be tuned for certain chemical or biological threats and suit specified environmental conditions.

Two of the simplest tools used by the military are an indicator paper called M-8 and a tape called M-9. Troops can place these on their uniforms or vehicles to detect nerve gas or blister-causing compounds. Coated with chemical-sensitive dyes, the paper changes color when at least one of these agents is present. But simplicity comes with drawbacks. The paper isn't very sensitive, working well only when it's in a location that's "dripping" with the chemical, says Seiders. It's also not very selective about which chemicals cause its color to change, so harmless compounds sometimes trigger a response.

On the battlefield, small handheld detectors employing ion-mobility spectrometry are more sensitive and selective than indicator paper. This technology, sometimes called the poor-man's mass spectrometry, is also used in airports. These systems break up a substance into electrically charged pieces and then interpret how the molecular fragments move. The pattern in which the pieces arrive at a charge-sensitive element constitutes a signature for the original molecule. Ion-mobility spectrometers can detect a variety of molecules but can't necessarily tell the difference between chemically similar molecules, such as certain pesticides and nerve agents.

The military also has reconnaissance vehicles with larger instruments, including mass spectrometers. Although more effective than current handheld devices, they're less powerful and sensitive than laboratory-scale machines, says Seiders.

For detecting agents at a distance, there are systems that include lasers that the military can aim, for example, at a cloud that's suspected of harboring dangerous chemical or biological agents. These instruments can give troops an idea of the chemical composition of a cloud or indicate whether the cloud contains small aerosol particles that are the size of biological agents that they suspect the enemy possesses.

"Then, the idea is, you could go the other way," says Seiders. "Or tell your guys to suit up."

None of these systems, or other currently used methods of detection, provides results as conclusive as rigorous sample testing in a state-of-the-art laboratory facility. So, military troops usually ship potentially hazardous materials to a lab, says Seiders.

However, by asking thoughtful questions, analytical chemists can help the military make the current field methods more valuable, Seiders says. They must consider how detectors will work in different settings: Can the device work fast enough? Is it sensitive

enough? Is it giving too many false alarms? Is it displaying enough information to guide decisions?

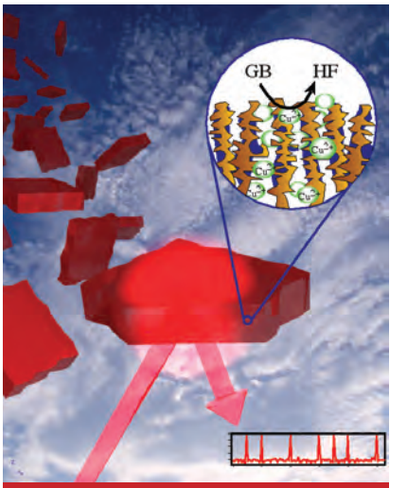
SENSOR SUCCESSORS While there's already a wide range of instrumentation available for detecting chemical and biological agents, many researchers are heading off in new directions. In some cases, they're applying ideas from microengineering and biomedical science.

Ideally, a threat would be detected long before it comes close enough to harm anyone. That's the aim of the "smart dust" being developed by chemist Michael Sailor of the University of California, San Diego, who reported his work at the American Chemical Society meeting.

These tiny sensors, built of a porous form of silicon, just look like sparkly specks of dust, but each one is designed to change color in a characteristic way when a particular organic material alights upon it.

Sailor plans for his sensors to be as small as a grain of dust but capable of reliably detecting a particular biological or chemical agent. Hundreds of thousands of these dust grains, tuned to detect many dangerous substances, could be dropped on a battlefield, stuck to vehicles and buildings, or placed in a small box inside a subway air vent.

Next, a laser—say, on an airplane flying over a desert sandstorm—would read the spectrographic signature of the smart dust to see what agents the particles had encountered. Currently, Sailor can read a signature from the dust at 25 meters, and he's aiming for 1 kilometer. In a system for use in subway vents, sensors monitored by a laser hooked to a computer might trigger filters to switch on when they detect a potential threat, such as a nerve agent. This could save money on a filtration system that's too expensive to run continuously, says Sailor, who's working with a company to devise such a system.



SMART SENSOR — Illustration depicts how silicon smart dust could detect airborne chemicals. The porous nanostructure is chemically modified so that its optical code (lower right) changes in a predictable fashion when it's exposed to selected molecules (inset). In this example, the smart dust would detect certain types of nerve-targeted warfare agents, such as sarin.

One of the biggest challenges in chemical and biological weapons detection is how to identify a harmful agent that's never before been seen. "You don't necessarily know what organisms you're going to come across," says Pacific Northwest National Laboratory's Karen Wahl.

This spring, Seiders notes, the world was blindsided by one of Mother Nature's own creations, a virus that causes severe acute respiratory syndrome, or SARS. What if a terrorist were to engineer a new pathogen?

For several years, Wahl has led a team using a system known as MALDI-MS, or matrix-assisted laser desorption/ionization mass spectrometry. Researchers have used this process for a couple of decades. It turns large molecules such as proteins into gaseous ions and then, on the basis of their charge and mass, separates the ions to determine the makeup of the original sample.

Wahl and her team used this technology to analyze proteins from some 20 organisms, including strains of *Escherichia coli*, *Bacillus*, and *Pseudomonas* bacteria. From their experiments, they've developed a library of data that enables them to classify or identify related pathogens. In the Dec. 15, 2002 *Analytical Chemistry*, the researchers reported a particular strength of their technique: It can identify individual bacteria in a mixture.

Sensitive mass spectrometers, including MALDI-MS systems, are generally too large to carry into the field, however. Wahl's group at PNNL is collaborating with Johns Hopkins University's Applied Physics Laboratory (APL) in Laurel, Md., where researchers are developing portable MALDI-MS systems that could take advantage of its bacterial library. Ideally, says Wahl, systems such as these could eventually monitor for bioweapons in the air on a battlefield, in a subway, in an office building, or at a variety of other locations.

Biological warfare may result in a mix of pathogens at very low concentrations. For those reasons, APL's miniaturization work is accompanied by research that aims to discover the best ways for their systems to collect aerosols for analysis.

Indeed, miniaturization is a big area of development in chemical- and biological-agent detection, and the topic was a focus of the analytical chemistry sessions in New Orleans last month. For example, many researchers are now working to miniaturize mass spectrometry. It's the ideal technique for analyzing the proteins of microorganisms, says Robert Cotter of Johns Hopkins University in Baltimore, who is also collaborating with APL scientists on the miniaturization of mass spectrometers. This miniaturization is "not just an engineering problem," he comments, "because you don't just shrink it and get the same results. You actually have to redesign."

DETECTION BY DUST — A microscope image (background) shows particles of porous silicon smart dust, each grain about the width of a human hair. The colorful dust is visible to the naked eye in a vial of liquid (foreground).

Portable mass spectrometry devices could open novel approaches to detecting a bioattack. Cotter's team is one of several looking into a means to detect, within hours of exposure, whether a bacterial or viral agent has infected a person. This technique was developed for medical use, but Cotter says it could have important military applications.

With mass spectrometry, Cotter and his colleagues search for telltale, chemical markers of an immune response in pigs before symptoms appear. They do this by examining the proteins in the animals' expired breath. Such information could enable the military to be better prepared for combat, says Cotter.

For example, a soldier infected with a contagious agent—whether it's a deadly terrorist bioagent or a common cold virus—could be quarantined before he infects the rest of his team, says Michael Natan of Nanoplex Technologies in Mountain View, Calif.

Nanoplex's parent company, SurroMed, uses mass spectrometry and several other technologies to monitor the first signs that a person will develop particular diseases, such as arthritis or Alzheimer's.

SAILOR, UCSD; F. CUNIN, UCSD

To do this, SurroMed scientists track thousands of proteins and watch how cells behave.

SurroMed plans to translate its work on biomarkers into military technology. The company's goal, Natan says, is to discover the first responses that may be shared by infections, whether they're minor or serious, bacterial or viral. For example, there may be five particular molecules in the blood that increase during the first hour after exposure. Even if the cause of this signal in a particular soldier is nothing more than a common cold virus, military commanders still may want to pull him from the front line, says Natan.

Czarnik works along these avenues, too. He's developed a small glucose sensor for eventual use by diabetic people. He proposes that it might be transformed into a system for detecting other substances, such as warfare agents, in the blood.

The Tic-Tac-size sensor, which Czarnik described at the American Chemical Society meeting in March, would be implanted just under the skin of the wrist. It would monitor glucose concentrations in the blood 24 hours a day and wirelessly relay this information to a small display on a watch that could be worn just over the implant. So far, he's tested the system successfully in rabbits, and he plans to try it in monkeys later this year.

One potential pitfall acknowledged by scientists who strive to improve detectors is that the devices are not regulated. Czarnik points out that the Food and Drug Administration regulates glucose sensors for medical use, which forces him to include important safeguards, such as a way to tell the user when the system is failing so that the patient doesn't believe false readings. There is no agency that says whether an instrument is qualified to detect a biowarfare agent, says Seiders.

Developing standards for these detectors is a high priority for the Department of Homeland Security, says Seiders. In the meantime, she says, the analytical chemistry community needs to make sure that any new device does the things that its developers claim. The life of a soldier or commuter could depend upon it. ■

OF NOTE

BIOMEDICINE

Heart drug derails algal toxin

A drug for treating high cholesterol might someday find use relieving the debilitating symptoms of poisoning from some algal toxins, animal data suggest.

Algal toxins accumulate in fish and shellfish, which, when eaten, can cause symptoms ranging from muscular weakness and pain to death. After hearing anecdotes of physicians easing symptoms of such poisonings with the cholesterol-lowering drug cholestyramine, John S. Ramsdell of the National Oceanic and Atmospheric Administration in Charleston, S.C., decided to test it in mice.

He laced the rodents' food with the drug for a week and then exposed the animals to brevetoxin, the poison made by Florida's red tide algae (*SN: 11/30/02, p. 344*). Mice usually respond to this toxin with a quick drop in body temperature. However, temperatures remained normal in animals treated with cholestyramine. Ramsdell reported the finding in April at Experimental Biology 2003, in San Diego.

Although he initially suspected the drug was removing the toxin from the animals' blood, subsequent tests showed that blood brevetoxin was just as high in animals that received cholestyramine as in those that didn't. Those tests used the first diagnostic blood test for brevetoxin, which Ramsdell and his colleagues describe in an upcoming *Environmental Health Perspectives*.

Now, the team is testing an alternative hypothesis for cholestyramine's efficacy. Lowering cholesterol reduces the body's production of cholesterol-carrying molecules known as low-density lipoproteins. Ramsdell suspects those same molecules are responsible for transporting the fat-soluble brevetoxin from the blood into tissues where the poison can do its worst. —J.R.

ASTRONOMY

Satellite begins its ultraviolet survey

Late last month, NASA released the first images taken by the recently launched Galaxy Evolution Explorer satellite. The mission is the first large sky survey at ultraviolet wavelengths and is designed to determine the history of star formation over the past 10 billion years. Such observations will provide clues to how galaxies form and evolve.

It took only 4 minutes of the satellite's observing time to generate each of the two new images, taken on May 21 and 22. Nonetheless, the image taken in far-ultraviolet wavelengths captured more than 400 stars and star-forming galaxies in the constellation Hercules, while the near-ultravi-

OF NOTE

olet picture recorded more than 1,500 such objects. Over the next 28 months, astronomers expect that the satellite will image millions of galaxies. —R.C.

BEHAVIOR

Findings puncture self-esteem claims

High self-esteem may not live up to its reputation. A strong regard for one's own traits and abilities exerts few of the beneficial effects claimed for it by teachers, parents, psychotherapists, and others, according to a new review of the voluminous scientific literature on this issue.

Roy F. Baumeister of Florida State University in Tallahassee and his colleagues find that high self-esteem—whether present in individuals from the start or induced through educational programs—generally doesn't lead to improved school or job performance. However, academic and job successes often boost self-esteem, Baumeister and his coworkers note in the May *Psychological Science in the Public Interest*.

People who evaluate themselves extremely positively aren't more likely than others to have satisfying relationships, assume leadership positions, or avoid bouts of depression, the researchers say. Also, high self-esteem doesn't prevent children and teenagers from smoking cigarettes, using alcohol and illicit drugs, engaging in sex, or behaving violently.

Overall, high self-esteem enhances pleasant feelings and generally increases a person's willingness to initiate either positive or negative behavior, the scientists note. For instance, schoolyard bullies, as well as those who stand up to them, frequently report high self-esteem. —B.B.

BIOTECHNOLOGY

Zebra mussels to the rescue

Oh, those clever Dutch engineers. They've turned zebra mussels into local environmental heroes.

In the United States, immigrant zebra mussels (*Dreissena polymorpha*) have been setting up ultradense colonies that rob food from native aquatic ecosystems and even clog intake pipes to water-treatment and industrial plants. However, it's their propensity for crowding that makes these reviled bivalves so attractive for water-purification systems, says Mathijs G.D. Smit of TNO, an applied research institute in Den Helder, the Netherlands.

On April 29, at a meeting of the Society for Environmental Toxicology and Chemistry in Hamburg, Germany, Smit described his group's installation of two small mussel-filled test filtration tanks at a pool located in a Dutch zoo's pelican exhibit. The pool usually turns rank and ugly in the summer when bird feed stimulates excessive growth of algae. The mussels removed up to 69 percent of those algae along with other suspended particles.

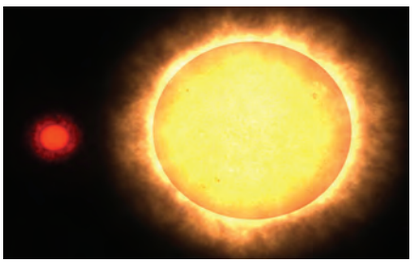
In a second project, Smit and his colleagues floated boxes of mussels in a stream from which agricultural fertilizers feed into a lake, causing summertime algae blooms. The shellfish took in a portion of the fertilizer chemicals but didn't prevent the blooms. Nevertheless, Smit says, the local water authority intends to pursue the zebra mussel tactic as part of a water-purification strategy.

But what if the mussels get loose? "We don't care," Smit told *Science News*. Dutch river bottoms and lakebeds are silty muck. Because mussels must attach to hard surfaces, he says, "they can never become a plague here." —J.R.

ASTRONOMY

Finding a nearby star

Welcome, neighbor! Astronomers have discovered a star that may be among the very closest to us. Only 7 percent as heavy as our sun and only 0.3 percent as bright, the star lies an estimated 7.8 light-years from Earth in the direction of the constellation Aries. By comparison, Barnard's star resides 6 light-years away, and our nearest neighbor, at a distance of 4 light years, is the system of three stars collectively known as Alpha Centauri.



STELLAR NEIGHBOR Artist's drawing of the nearby, newly found red dwarf star (left) in comparison with the sun.

W. FEIMER/NASA

Bonnard Teegarden of NASA's Goddard Space Flight Center in Greenbelt, Md., and his colleagues discovered the star last September during a search for faint, compact objects called white dwarfs. They spied an object that appeared to travel at a relatively fast clip across the sky. From that motion, the astronomers could deduce only that the star—designated as SO25300.5+165258—was either a fast-moving distant star or a sluggish nearby star.

To determine which was the case, the team identified the star in sky images taken at different times of the year by other astronomers. In those images, Teegarden's team measured the star's parallax, the apparent shift in the position of the star as Earth circles the sun. The greater the apparent motion, the closer the star. The parallax, as well as other observations, indicates that the star is a red dwarf and lies in the immediate neighborhood, Teegarden and his colleagues report in an upcoming *Astrophysical Journal Letters*. The researchers caution that it will take improved parallax measurements, which are now under way, to confirm the star's distance. —R.C.

FOOD AND NUTRITION

Whale meat in Japan is loaded with mercury

Hunting and consumption of marine mammals continues in Japan despite an international moratorium on commercial whaling. People there who eat dolphins and other toothed whales are ingesting whopping amounts of the metal mercury, new data suggest.

Tetsuya Endo of the Health Sciences University of Hokkaido and his colleagues measured the mercury content of nearly 200 meat samples collected from vendors or processors of the marine mammals.

The researchers determined that 137 of the samples came from nine species of toothed whales, including false killer whales, pilot whales, and several species of dolphins and porpoises. Another 62 samples came from six species of baleen whales, which eat tiny organisms filtered from water by comb-like mouth structures.

Average mercury concentrations for individual species of toothed whales ranged from 1.3 to 46.9 micrograms per gram (μg/g) of meat. Every sample exceeded 0.4 μg/g, the maximum allowable mercury concentration in foods in Japan.

Unlike toothed whales, baleen whales eat organisms that may be too low on the food chain to accumulate much mercury. Only one meat sample from a baleen whale exceeded the allowable mercury concentration, the researchers report in the June 15 *Environmental Science and Technology*. Other reports have suggested that since the 1986 moratorium on whaling, toothed whales have contributed a larger fraction of the whale meat consumed in Japan. —B.H.

IMMUNOLOGY

Chopping up a microbial tail

Many disease-causing bacteria sport whip-like flagella that propel their movement.Scientists have now found that an enzyme produced by immune cells called neutrophils can chop up flagellin, the main protein in these tails.

Neutrophils are usually among the first immune cells to encounter bacteria. These cells use the enzyme neutrophil elastase to tear up the microbes' membranes. Neutrophil elastase also rips apart flagellin, report Yolanda S. Lopez-Boado of Wake Forest University School of Medicine in Winston-Salem, N.C., and her colleagues. In test-tube studies, the enzyme can destroy flagellin whether it's part of a bacterium's flagella or just free-floating in a solution.

When bacteria infect cells, they typically shed their flagella, releasing flagellin, notes Lopez-Boado. Other researchers have shown that flagellin triggers a strong inflammatory response that probably contributes to the sickness produced by a bacterial infection. Neutrophil elastase's cleavage flagellin may help the host reduce or limit that unhealthy inflammation, says Lopez-Boado. —J.T.

EXTREMOPHILES

Some like it hotter

A microbe found where volcanic activity has cracked the floor of the Pacific Ocean has set a new record for the upper temperature limit for life. This organism grows readily at 121°C in the laboratory and can even survive a few hours at 130°C, Kazem Kashefi of the University of Massachusetts in Amherst and his colleagues report. The previous record was held by a microbe that could grow at a temperature of 113°C.

The new record holder, known as strain 121, was isolated during a submersible dive to a hydrothermal vent, a rift in the ocean floor where water can be as hot as 300°C. A variety of odd animals and microbes thrives on the heat and chemicals released at these vents.

A genetic analysis of strain 121 indicates that the microbe is an archaea, a life form that resembles bacteria but that may be more closely related to plants and animals (*SN: 8/24/96, p. 116*).

Scientists typically sterilize lab dishes and instruments with water heated to 121°C because that temperature kills all previously described microbes, notes Kashefi. Determining the upper temperature limit for life, he adds, may provide clues to how and where life originated on this planet and to where life could exist elsewhere. —J.T.

NICOTINE

Smoking out microbes

Nicotine, the compound that so satisfies smokers, is also a potent killer of bacteria. In test-tube studies, it can destroy more than a dozen types of bacteria, including ones that cause diseases, Saleh A. Naser of the University of Central Florida in Orlando reports.

He and his colleagues observed that nicotine, at concentrations much less than those in the saliva of people who smoke regularly, readily destroys a wide range of bacteria. Germs that cause tuberculosis, as well as gum and skin diseases, were all susceptible. So were bacteria that naturally reside on human skin and in people's mouths and gastrointestinal tracts.

Naser speculates that the reason smokers are prone to gum disease is that the nicotine from their cigarettes eliminates protective microbes that normally ward off disease-causing bacteria that even the nicotine can't check.

It isn't clear how nicotine kills bacteria, but researchers looking to keep microbes at bay still might exploit smokers' favorite compound. "It has the potential to be used as a disinfectant," Naser asserts. —J.T.

ASTROBIOLOGY

Bulletproof bacteria

About a decade ago, a scientific debate erupted over whether there were signs of life on a piece of rock that had been blasted from Mars and traveled to Earth. Today, few researchers believe the infamous rock ever bore microbes, but some are still testing whether a Mars-to-Earth transport of life is possible.

After firing bacteria-loaded projectiles into clay, Wayne Nicholson of the University of Arizona in Tucson and his colleagues argue that microbes could survive the extreme acceleration and shock forces experienced when a rock is blown into space by a major impact on a planetary surface.

Some investigators have concluded that microbes within rocks could survive the long transit between planets and the plunge through Earth's atmosphere, but there has been little focus on the initial launch into space, notes Nicholson. To reach a velocity high enough to escape Mars' gravitational pull, material on the planetary surface would undergo acceleration up to 3.4 million meters per second per second (m/s/s). That's about 35,000 times the force of Earth's gravity, or G. In contrast, shuttle astronauts experience up to 3 Gs during a launch.

To investigate the effects of this extreme acceleration on life, the researchers loaded two kinds of bacteria—the spore-forming *Bacillius subtilis* and the radiation-resistant *Deinococcus radiodurans* (*SN: 12/12/98, p. 376*)—into lead pellets and used an air rifle to fire the pellets into chilled modeling clay. The deceleration of some of the pellets reached 4.5 million m/s/s, and survival of the bacteria ranged from 40 to 100 percent. "We're not reducing viability by a lot," says Nicholson.

The investigators plan to use a large gas gun owned by NASA to fire extremely high-velocity projectiles into bacteria-covered concrete. They'll search the resulting debris, which should reach speeds close to that needed to escape Mars, for any microbial survivors. "This is the closest simulation we can get on Earth," says Nicholson. —J.T.

MYCOLOGY

Salamander moms use bacteria to save eggs from fungi

Female salamanders that slither around on top of their eggs for hours may be protecting their offspring from more than hungry predators. The skin of these amphibians is inhabited by bacteria that secrete fungal-fighting compounds, according to Julia van Kessel of Utica College in New York and her colleagues.

The researchers studied the red-backed salamander *Plethodon cinereus*. Females maintain body contact with their eggs. Some scientists had hypothesized that this is a defense against fungi because mold often grows excessively on untended eggs.

The Utica group expected to find that the skin of salamanders contained an antifungal compound, but experiments pointed instead toward two species of bacteria. The microbes belong to the *Pseudomonas* group of bacteria and produce secretions that inhibit the growth of five different kinds of fungi, van Kessel reports.—J.T.

Books

A selection of new and notable books of scientific interest

FIGURING IT OUT: What Are We? Where Do We Come From? The Parallel Visions of Artists and Archaeologists

COLIN RENFREW

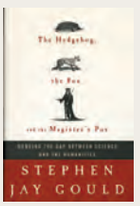
While cosmologists are defining the origins of the universe and geneticists deciphering evolution, archaeologists are tracing the path of humans from hunter-gatherers to urbanites. Visual artists also seek to understand the world but do so by acting upon it. Renfrew considers how the convergence of archaeology and art is shaping our view of the world. He examines how practitioners of both fields investigate the human condition.

With a focus on painters and sculptors, he examines how artists through time have guided others' understanding of the human body and spirit. Renfrew explains that the interaction that artists have with the material world mimics the development of human societies. It's this interactive process that distinguishes human activity from natural phenomena. Renfrew examines artists' fresh perspective on archaeology in a lively text that's wonderfully illustrated. ***Thames Hudson, 2003, 224 p., color/b&w photos, hardcover, $50.00.***

THE HEDGEHOG, THE FOX, AND MAGISTER'S POX: Mending the Gap Between Science and the Humanities
TRIUMPH AND TRAGEDY IN MUDVILLE: A Lifelong Passion for Baseball

STEPHEN JAY GOULD

Essayist and naturalist Gould had these two very different books in the works when he died in May 2002. *The Hedgehog, the Fox, and the Magister's Pox* is a collection of original essays finished shortly before Gould's death and presented here unaltered by his editors. In this volume, Gould dissects the dichotomy of science and the humanities (religion included) that has endured for millennia. The title is in part from a proverb attributed the 7th century B.C. Greek soldier-poet Archilochus: "The fox devises many strategies; the hedgehog knows one great and effective strategy." Gould likens the humanities to the cunning fox and science to the persistent hedgehog, but he argues that, with care, the two seeming opposites can be unified. He states, "What a power we could forge together if we could all pledge to honor both of our truly different and equally necessary ways, and then join them in full respect." Drawing on a wealth of natural history texts and arcane but compelling references, he builds his case. *Triumph and Tragedy in Mudville* is an assortment of essays Gould wrote over the years on baseball—Gould's passion that began when he was growing up in New York City in the 1940s and 1950s. These pieces have been published elsewhere, except for one on stickball. A diehard Yankees fan, Gould finds much to dissect in the lore of that club and others, too. In one case, he compares the fall of the Alamo to the ball bouncing through the legs of Boston Red Sox first baseman Bill Buckner in the sixth game of the 1986 World Series. Gould also pays homage to some lesser-known figures including Babe Pinelli, the umpire who called Don Larsen's perfect World Series game in October 1956. In all, these writings show Gould's wonderful range of thought, devotion to his subject matter, and love of life. ***Harmony, 2003, 274 p., hardcover, $25.95. Norton, 2003, 342 p., b&w illus/photos, hardcover, $24.95.***



THE TENDING INSTINCT: Women, Men, and the Biology of Our Relationships

SHELLEY E. TAYLOR

The classic psychological theory of stress was based on the fight-or-flight response. In the course of her research on stress, psychologist Taylor realized that the theory was based mostly on studies of men. Taylor proposes a new paradigm, the "tend-or-befriend" theory. With data from neuroscience, psychology, genetics, and evolutionary biology, she builds the case that people are biologically programmed to care for one another. While this quality is more evident in women than in men, Taylor argues that it is prevalent in both sexes and conforms to Darwin's survival-of-the-fittest model of evolution as well as strength and aggression do. In fact, she asserts that development of the human brain has been driven by our instinct to tend one another. She shows that our responses to stress—from staying calm or fending off illness—are directly connected to the quality of tending that we receive as children and adults. Originally published in hardcover in 2002. ***Owl Bks, 2003, 290 p., paperback, $16.00.***

VITAL SIGNS 2003: The Trends that Are Shaping Our Future

THE WORLDWATCH INSTITUTE

This annual produced by the environmental watchdog organization the Worldwatch Institute isolates trends affecting the planet's environmental health. This year, the focus is on the differences between the world's richest and poorest citizens. The volume reports that while the global economy has increased sevenfold since 1950, the disparity in per capita income between the 20 richest and the 20 poorest nations more than doubled between 1980 and 1995. Worldwatch asserts that this imbalance is contributing to global instability in the form of terrorism, war, and disease. Among the trends the authors isolate are the rise of infectious diseases, armed conflicts over natural resources, the harvesting of illegal-drug crops, and the displacement of an estimated 50 million environmental refugees from their homes by dam building, drought, and flooding. The report defines some progress toward solutions to these problems: widespread treatment for AIDS in Botswana, Brazil, and Costa Rica; increased use of mobile phones in rural areas; and developments in clean energy. ***Norton, 2003, 153 p., b&w photos/illus., paperback, $14.95.***

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LETTERS

Cowpox it's not

"The Vaccinia Dilemma" (*SN: 4/5/03, p. 218*) twice refers to vaccinia as "cowpox virus." The two are actually two separate viruses. It is unclear exactly where vaccinia comes from, as it isn't a naturally occurring virus. It is thought that the strain of cowpox used for vaccinations has, over the years, mutated into a new, genetically distinct virus.

PAUL MATZ, PHILADELPHIA, PA.

In the beginning?

The iron-sulfide hypothesis of life's origin that Michael J. Russell and William Martin propose in "A Rocky Start" (*SN: 4/26/03, p. 264*) is attractive because it provides an inorganic cell wall and a matrix with some catalytic capabilities. But even if the Russell-Martin hypothesis is true, it isn't a comprehensive theory of bioorigins. The cardinal difficulty in the origin of life is the inception of the genetic code. The code itself is predicated on a number of chemical improbabilities. I don't see how iron-sulfide chambers adequately account for these.

KELLEY VINCENT, TYLER, TEXAS

Bad copies

"Egg's missing proteins thwart primate cloning" (*SN: 5/3/03, p. 286*) spoke of a very interesting phenomenon that makes the cloning of primates seemingly impossible. Perhaps the nature of our DNA will resist our attempts to clone it because it was never meant to be cloned.

MARK WEILNAU, ST. LOUIS, MO.

The article notes that it is "almost impossible to clone a person by using the same techniques that work in mice and other nonprimates." Should we be so fast to claim success even in nonprimates? Has our world forgotten the fate of Dolly? Behind the guise of scientific advancement, cloning research has left nothing but death in its wake. Regardless of its intended end, the deformation and death propagated by cloning research on humans is a price the scientific community should never be willing to pay.

MIKE VON BEHREN, ST. LOUIS, MO.

Although some scientists speculated that Dolly aged more quickly than normal because she was cloned from an adult sheep cell, there's no solid evidence that her death was a result of her unique beginnings. Whether cloning can produce normal, healthy offspring remains a matter of great debate. —J. TRAVIS

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