SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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candle wax as rocket fuel

mutation for binge eating

duo-evolution of bugs

nuke-detection discovery

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full-body buzz

NICOTINE ITSELF MAY SPAWN DISEASES

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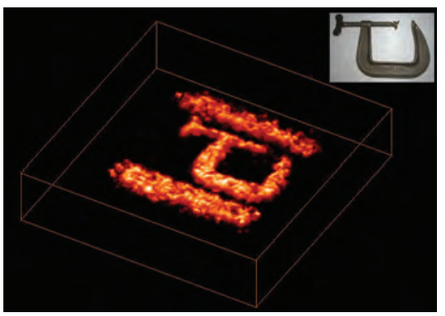
Muon Manna?

Particle shower may spotlight loose nukes

At U.S. ports and border crossings, agents are increasingly using X-ray surveillance of shipping containers and trucks to foil attempts to smuggle nuclear weapons or radioactive materials into the country. A new study indicates that radiation from the heavens may provide a way to detect such threatening cargoes without requiring potentially dangerous X-ray sources.



COSMIC-RAY VISION A book-size, steel C-clamp (inset) shows up in a radiograph because cosmic rays bounce off the metal at larger angles than they do off lighter materials. Stripes are from muons deflected by steel bars in the apparatus.

L. SCHULTZ/LANL

Konstantin N. Borozdin of Los Alamos (N.M.) National Laboratory and his coworkers have demonstrated in a laboratory experiment that they can use the relentless rain of cosmic rays to detect chunks of heavy metal. The researchers report their findings in the March 20 *Nature*.

The presence of such weighty metals in a vehicle could tip off authorities that dangerous nuclear contraband is onboard. Many radioactive elements—particularly the uranium and plutonium used in nuclear weapons—are among the heaviest elements.

To test their approach, the Los Alamos scientists placed a 10-kilogram cylinder of tungsten about the size of a hamburger and its bun into a cosmic-ray detector made up of two stacks of thin, aluminum chambers, each one filled with argon gas and electrified steel wires. One stack was situated above the tungsten target and another below, an arrangement that could be realized in a port or border post by placing chambers above and below a truck.

When electron-like muons, the most common type of cosmic ray, hit argon molecules in the chambers, they free up electrons that generate electric pulses in nearby steel wires. From the pulses, the team determines the trajectories of cosmic rays passing through the device and sees a characteristic bending of those paths by the tungsten.

Since cosmic rays ricochet off the nuclei of heavier elements at larger angles than off those of lighter elements, the trajectories of the cosmic rays can betray the location of heavyweight nuclei. The Los Alamos researchers report that in a minute they can acquire telling images of, say, uranium surrounded by much lighter materials.

That sounds promising, but if the contraband materials were nestled among steel or other weighty materials, the technique would probably take too much time to be practical, says physicist Simon P. Swordy of the University of Chicago.

Moreover, if faster scans are needed, there's no way to turn up the muon rate, notes Ralph James of Brookhaven National Laboratory in Upton, N.Y. "It's determined by extragalactic events. We're not going to change that."

The ultimate impact of exposure times remains to be seen, say champions of the cosmic-ray technique. George A. Greene of Brookhaven rates the approach as "an absolutely genius idea." To speed detection, scientists working in labs may be able to reference a library of "signatures" of nuclear materials hidden within common, heavy materials, he proposes. —P. WEISS

Genetically Driven

Mutation shows up in binge eaters

Overweight binge eaters are more likely to harbor a genetic mutation that disrupts brain signals governing satiety than are people of normal weight or obese people who don't regularly eat far more food than is needed to satisfy hunger, researchers report. The finding suggests that disruption of a particular gene underlies some binge eating, which until now has been classified as a psychiatric disorder. Another study shows that up to 6 percent of childhood obesity might stem from an inherited mutation in this gene.

Previous studies in animals associated binge eating with a mutation of the gene for a brain protein called melanocortin 4 receptor (MC4R). To test the effect of this gene defect on human behavior, Fritz F. Horber of the Hirslanden Clinic in Zurich and his colleagues obtained blood samples from 469 severely obese volunteers, average age 41. Genetic analysis of their blood revealed that 24 carried a mutated gene for MC4R.

These 24 individuals then completed a questionnaire on their eating habits. Next, the scientists identified 120 other people in the obese group who matched the mutation-carrying volunteers in age, sex, and weight. The researchers obtained blood samples and questionnaire answers from these volunteers and from 25 normal-weight people, average age 48, who had no history of dieting and no obesity in their families.

While all the obese people carrying a mutation in the gene for MC4R reported binge eating at least twice a week over 6 months, less than 15 percent of the other obese participants—and none of the normal-weight volunteers—did, the researchers report in the March 20 *New England Journal of Medicine*.

Although the cause of binge eating isn't fully understood, clues are emerging from studies of the body's molecular signals for satiety. MC4R proteins are receptors on brain cells that, when functioning properly, signal satiety. The new work provides evidence that when the gene for MC4R is mutated, the stop-eating sign doesn't go up, says Joel F. Hebener of the Howard Hughes Medical Institution and Harvard Medical School in Boston.

In the other study, which appears in the same journal issue, researchers sought to determine what proportion of obesity is attributable to a mutated gene for MC4R. Blood tests of 500 people with obesity that began before age 10 revealed that 29, or about 6 percent, carry mutations in the gene, according to Stephen O'Rahilly of Cambridge University in England and his colleagues.

Six of these 29 people showed a double dose of the mutated gene. These 6 individuals, who had been severely obese since childhood, had more body fat than the 23 who carried a single copy.

The two studies establish that "there are individuals out there who overeat not because they lack will power but because they have a physiological syndrome," says Roger D. Cone of the Oregon Health and Science University in Portland. "These

people are genetically bound to overeat."

Pharmaceutical companies are devising drugs that could provide proper signaling to combat obesity in people with mutations in the gene for MC4R, Cone says.

Meanwhile, animal studies indicate that the signaling of satiety also relies on several other genes, Hebener says. By identifying mutations in them, scientists may provide drug companies with more targets for preventing obesity. —N. SEPPA

Cosmic Afterglow

Gamma-ray bursts may one-up themselves

Bursts of gamma rays that originate beyond our galaxy are already known to be the universe's most energetic flashes. But new observations suggest that these cosmic outbursts may pack an even greater wallop than scientists had estimated.

Last Oct. 4, just 11 seconds after NASA's High-Energy Transient Explorer II satellite recorded a gamma-ray burst, the craft alerted astronomers to the event. For the first time, researchers closely monitored the visible-light afterglow of a burst almost as soon as it appeared. Since then, another gamma-ray burst has been observed from start to finish (*SN: 2/1/03, p. 77*).

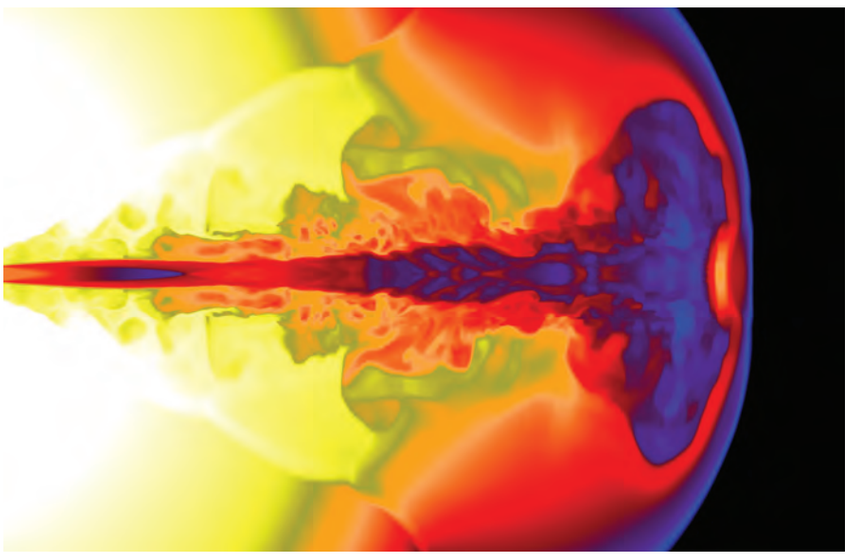
The first half-hour of the observations is the most puzzling, report Derek W. Fox of the California Institute of Technology in Pasadena and his colleagues in the March 20 *Nature*. During that time, the afterglow decayed more slowly than the scientists had expected. The finding may be linked to the origin of gamma-ray bursts.

Theorists hold that gamma-ray bursts are generated when high-speed particle jets in the cosmos are dramatically slowed, probably by collisions between clumps of material within them. The afterglow is created when the jet slams into the surrounding interstellar medium.

The slow decay of the afterglow observed last October suggests that something is giving the jet an extra kick, Fox's team concludes. That dovetails with a popular explanation for the origin of the jet: the collapse of a massive star into a black hole. As a black hole pulls in material from its surroundings, it generates jets of particles and then reenergizes them, suggests Stan E. Woosley of the University of California, Santa Cruz. If that model is correct, he adds, the total energy poured into a gamma-ray burst and its afterglow could be two to three times more than what some theorists had calculated from other models. The total power would be equivalent to that of more than a million trillion suns.

However, Tsvi Piran of the Hebrew University of Jerusalem says another mechanism accounts for the data even better, including a steep energy decline recorded after the first 30 minutes of the afterglow. The radiation from a jet moving near the speed of light beams outward in a cone-shaped zone, he notes. As the jet slows in the interstellar medium, the cone enlarges, and an observer sees more of more of the radiation. As the observer samples more of the radiation, the average energy may go up or down. In this model, the afterglow may appear brighter not because the jet is reenergized but because the larger area includes regions of high energy. Later, the overall area might include more regions of low energy, producing a steep decline in the observed afterglow.

A reenergized jet can't account for the rapid falloff observed, notes Piran. But he acknowledges that both a revived jet and the enlargement of the radiation cone may play a role in the particular burst recorded last fall. "These observations are a new window on gamma-ray bursts, and when you open up a new window, there are often new surprises," says Piran. —R. COWEN



W. ZHANG, WOOSLEY

BIRTH OF A BURST Simulation of the beginnings of a gamma-ray burst shows a jet of material 9 seconds after its creation, as it plows to the right through the surface of a massive star. Blue and yellow represent regions of lowest and highest density, respectively.

Original Kin

Six-legged bugs may have evolved twice

Six legs, new; more legs, old. That could be an adage for biologists who hold that all six-legged terrestrial bugs evolved from a single relatively recent branch of the ancient lineage of arthropods. Earlier, they say, that tree had sprouted branches of crustaceans, spiders, millipedes, and other organisms with more legs.

New genetic data may invalidate that view. In the scenario that these findings support, insects and other six-legged arthropods parted evolutionary paths before insects split off from crustaceans. This would mean that six-leggedness arose twice—once within the lineage of insects and once on a lower branch of the tree. The new theory intrigues arthropod biologists, but many are skeptical.

The matter focuses on an order of minuscule hexapods called collembolans, or springtails, which includes thousands of species. Springtails turn up in nearly every habitat on Earth. Like true insects, adult springtails have hard, segmented bodies and six legs, but they display some unique biological traits that set them apart.

Springtails' proper place among arthropods has long vexed scientists, says Nipam H. Patel of the University of Chicago, who studies arthropod development.

To place springtails on the arthropod family tree, molecular biologist Francesco Nardi of the University of Siena in Italy and his colleagues analyzed the genetics of cell structures called mitochondria in two springtail species and an insect. For 27 other arthropods, they examined corresponding information from a scientific database.

Previous studies had suggested that insects and springtails lie close together on the evolutionary tree of arthropods and come from a common six-legged ancestor. Crustaceans are less closely related to

insects than springtails are, in this view.

However, the new tree described in the March 21 *Science* shows springtails arising before insects and crustaceans split. So, despite the resemblance of the six-legged arthropods, insects are more closely related to crustaceans than to springtails, it implies.

If the new tree is accurate, insects and springtails went along their separate evolutionary ways when their ancestors were still aquatic and had more than six legs. That means that "today's terrestrial hexapods are products of at least two independent invasions of land," Richard H. Thomas of the Natural History Museum in London says in the same issue of *Science*. Six-leggedness and some other features that insects and springtails share would reflect the convergence of two independent evolutionary paths toward the same anatomical form, he says.

INSECT GENEALOGY Springtails such as this millimeter-scale *Gomphiocephalus hodgsoni* have six legs but might not be closely related to insects.

To rigorously test that scenario, scientists will need to examine more than just mitochondrial genes, says Gonzalo Giribet of Harvard University. They'll also need to look at four other orders of hexapods that, like springtails, aren't true insects.

Most comparative studies of arthropods' nonmitochondrial genes, anatomy, and developmental biology don't support the newly proposed tree, says Michael F. Whiting of Brigham Young University in Provo, Utah. Whiting, Giribet, and other researchers who spoke with *Science News* suggest that deceptive information contained in some mitochondrial genes may have led Nardi and his colleagues astray.

Nevertheless, says Whiting, "they could be correct. It's a very interesting hypothesis."

The new tree is a plausible alternative to existing ones, says Patel. With the arthropods' evolutionary tree still in flux, however, "there are plenty of changes to be seen," he predicts. —B. HARDER

No Rest for the Waking

Brain cells for alertness fire without cues

The brain cells that keep people awake fire spontaneously and continuously on their own, neuroscientists have found. This result suggests that sleep depends on signals from other brain regions that quiet these neurons.

Scientists previously discovered these brain cells while studying people and animals with narcolepsy, a condition marked by sudden bouts of deep sleep. Human narcolepsy generally stems from a shortage of the neurons, which produce the excitatory neurotransmitter known both as hypocretin and orexin (*SN: 9/2/00, p. 148*). In contrast, narcoleptic dogs' brains are short on molecules that bind the neurotransmitter (*SN: 8/14/99, p. 100*).

The alertness cells are in a forebrain region known as the hypothalamus. They aren't the only brain cells that control sleep and waking, but these so-called hypocretin-orexin (Hcrt/Orx) neurons seem to be at the top of the brain's wake-promoting chain of command, says neuroscientist Michel Mühlethaler of Centre Médical Universitaire in Geneva, Switzerland. To investigate further, he and his colleagues prepared thin hypothalamus slices from young rats and then used electrodes to record the activity of individual Hcrt/Orx neurons.

The nerve cells fired continuously, Mühlethaler's team reports in the March 1 *Journal of Neuroscience*. That activity persisted even when the researchers prevented the Hcrt/Orx neurons from receiving signals from surrounding neurons and neighboring brain cells in the slices remained inactive. The wake-promoting cells' activity is "completely intrinsic," says Mühlethaler.

Most nerve cells at rest are electrically polarized, with positive ions on the outside of the membrane and negative ions on the inside. Neurons usually fire only when their membranes depolarize in response to signals from other neurons. In contrast, Hcrt/Orx neurons are always depolarized to their trigger point for firing, Mühlethaler explains. As a result, the cells fire repeatedly, even without any input.

Treatment with gamma-aminobutyric acid (GABA), a neurotransmitter that inhibits neuron firing, dampened Hcrt/Orx neurons' activity. Nerve cells that produce GABA are known to connect with the brain region containing Hcrt/Orx neurons, Mühlethaler says. Presumably, activity of GABA-producing cells suppresses the wake-promoting system and lets people get some sleep, he adds.

"It's rather surprising," says neuroscientist Emmanuel Mignot of the Stanford University Center for Narcolepsy. "It suggests that the hypocretin system is indeed very special—having physiological properties that make it always active." Perhaps syndromes characterized by overactivity, such as mania, result from a malfunction in the brain centers that normally suppress Hcrt/Orx neurons, Mignot speculates. The cells may also underlie sleep disturbances associated with head trauma and other ailments, he says.

"It's a nice demonstration" of how wake-promoting neurons work at the cellular level, adds neurobiologist Jerome M. Siegel of the University of California, Los Angeles Center for Sleep Research. However, nerve activity measured in brain slices might not accurately reflect the workings in a living animal, he cautions. —K. MORGAN

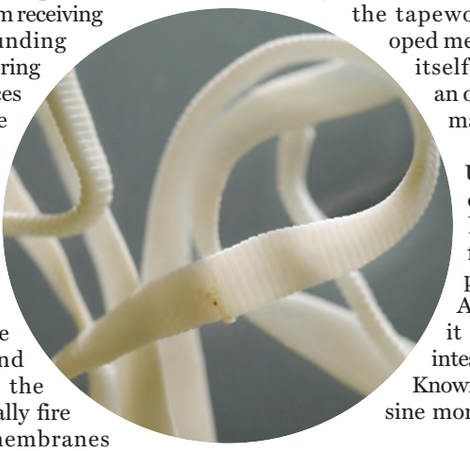
NARDI; J. MILLER

A Tale of the Tapeworm

Parasite ploy suggests drug-delivery tactic

For the tapeworm *Hymenolepis diminuta*, heaven is a rat's intestines. A single, nearly foot-long parasite can live there for years. It's no wonder then that the tapeworm has developed means for keeping itself lodged within an often undulating mammalian gut.

Scientists at the University of Wisconsin–Madison have now identified one of the parasite's tools: A chemical that it secretes slows intestinal pulsations. Known as cyclic guanosine monophosphate, or cGMP, the chemical may also play a role in the normal control of any mammal's digestive system. Given that possibility, the Wisconsin investigators have filed for a patent on the idea of adding cGMP to drugs in order to lengthen the amount of time they



INTESTINAL INSIGHT Tapeworms, such as this preserved one, secrete a chemical that may inspire an improved way to deliver drugs.

spend in the gut and thus increase how much medicine a person absorbs.

John Oaks and his colleagues in Madison have long studied how tapeworms such as *H. diminuta* thrive inside a mammal's intestinal tract. "The tapeworm knows when the animal is going to feed and migrates from one end of the bowel to where the food is coming out of the stomach," Oaks says. "It comes back down the small intestine as food is digested."

Between meals, a mammal's intestinal muscles normally contract rhythmically to sweep out bacteria and waste. This action poses a danger to tapeworms. About a decade ago, however, Oaks' team discovered that the parasite mounts a counterattack by somehow slowing down this sweeping wave of intestinal motility.

Recently, the researchers found that tapeworm secretions by themselves could achieve the same result. The key chemical in those secretions turned out to be cGMP, says Oaks, and that was a surprise.

That chemical typically operates in cells, where it participates in conveying signals from the inside of a cell's membrane to other parts of the cell. The new research suggests that cGMP also serves as a signal outside of cells. The investigators are now racing to identify cGMP's receptor, a molecular binding site that they presume resides somewhere on the surfaces of intestinal cells.

Oaks and his colleagues speculate that animals use cGMP to regulate natural muscle contractions within the intestinal tract. "It's probably an in-place system in every animal," says Oaks. "The tapeworm was adaptive enough to take advantage of this to provide for its own survival."

"This could tell us a lot about the regulation of intestinal function," adds Norman W. Weisbrodt of the University of Texas in Houston, who studies gastrointestinal motility.

Like the parasite, Oaks and his colleagues hope to take advantage of cGMP. They've already shown that an easily tracked molecule takes longer to pass through the intestines when rodents are infected with tapeworms. They're now testing whether drugs combined with cGMP also move more slowly and, if so, whether extra travel time enhances absorption of medicine.

Oaks notes that for some pills, only 1 percent of a drug is taken up into the bloodstream. The rest is excreted into the sewage system—or in the case of medicated livestock, into the environment. Scientists are just beginning to explore the impact of such drug waste in polluting water and soil (*SN: 4/01/00, p. 212*).

With cGMP, says Oaks, "we could perhaps lower the amount of drug necessary for treating an individual and minimize environmental contamination." —J. TRAVIS

AVIAN UTENSILS This New Caledonian stamp honors a crow species that nips twigs and leaves to make tools (at right) for working food out of crevices.

Techno Crow

Do birds build up better tool designs?

New Caledonian crows don't have cell phones, yet, but researchers propose that these birds may ratchet up the sophistication of the tools they do have and pass along the better designs.

The crow *Corvus moneduloides* fashions tools for snagging insects from crevices. New Zealand researchers surveyed a kind of tool cut from the edge of a stiff leaf. They found a location where crows use all three known tool types, a surrounding zone where they use two types, and the greatest expanse featuring only one, report Gavin Hunt and Russell Gray of the University of Auckland. The most widely distributed tool appears to be the most sophisticated.

This pattern suggests that the crows developed the basic leaf tool once and then improved it over generations, Hunt and Gray contend in an upcoming *Proceedings of the Royal Society of London B*.

"As far as we know, it's the first report in a species other than humans of cumulative change of tool design," says Hunt.

The idea of cumulative tool improvement "seems perfectly plausible," comments Alex Kacelnik, who studies the same crow species in his laboratory at Oxford University in England. Yet he cautions that before fully accepting such a bold claim, researchers still need to show that birds learn detailed techniques from each other.

The old notion that people are the sole users of tools has collapsed in recent decades in response to reports of tool-wielding chimps, orangutans, and Galapagos woodpecker finches.

Hunt happened upon the crows' tool-making in the mid-1990s. Although New Caledonian crows are hard to observe directly, Hunt and Gray analyzed the edges of straplike pandanus leaves left behind on trees after a bird has cut out its tool.

The researchers have now collected data on some 5,550 pandanus-leaf tools. They report three types of strips—wide, narrow, and tapered with steps cut along one side. Each shape requires a different sequence of rips and snips. The variety of processes suggests cumulative tool development, the researchers say.

In human technological advancement, "you don't make the old cell phone and then modify it to a new design," says Hunt. A manufacturer instead works out a new plan for making the improved model.

Hunt argues that the most probable explanation for the crow-tool zones is that improved designs radiated from a center of discovery. If the tools had multiple origins, he'd predict a patchwork distribution. He finds no correlation between major ecological factors, such as rainfall, and the zones of different designs.

Christophe Boesch of the Max-Planck Institute for Evolutionary Anthropology in Leipzig, Germany, raises the alternative possibility that different functions for tools in different places might explain the zones. He'll soon publish a report proposing that chimps accumulate tool improvements. —S. MILIUS

HUNT

MORE THAN A KICK

On its own, nicotine might promote tumors and wrinkles

BY KENDALL MORGAN

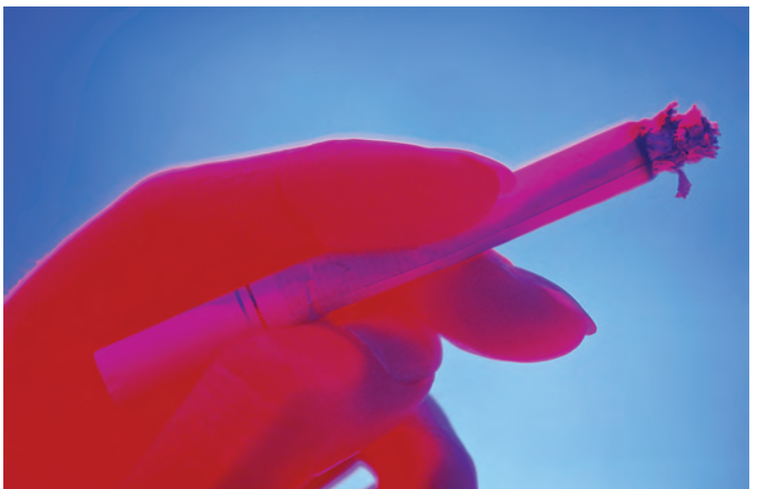
Nicotine shifts the body into high gear. Whether from a puff on a cigarette or a patch stuck to the skin, the drug enters the bloodstream and bathes the internal organs. But scientists generally attribute nicotine's power solely to the activity it sparks in the brain. That stimulation makes smokers feel good, even euphoric. It's also what makes them crave more. Physicians, however, generally finger tobacco's thousands of other chemical constituents, including known carcinogens—not nicotine—for cigarettes' nastiest side effects. Each year, tobacco accounts for 400,000 deaths among 48 million smokers in the United States alone.

Beyond its addictive appeal, nicotine itself might have devastating consequences throughout the body, some scientists now say. Acetylcholine—the natural nerve-signal carrier that nicotine mimics—is a jack-of-all-trades. The chemical acts on many cells, including those in the lungs and skin. Therefore, nicotine may goad many tissues into hyperactivity—a possibility that raises scientists' suspicions about its role in disease.

"It's an eye opener. Nicotine isn't just a drug that stimulates neurons. It does the exact same thing to cells outside of the nervous system," says dermatologist Sergei A. Grando of the University of California, Davis, who studies nicotine's effects on skin.

A handful of recent studies has suggested a link between nicotine and ailments ranging from sudden infant death syndrome (*SN: 9/14/02, p. 163*) to cancer. Scientists have found that the stimulant spurs the formation of blood vessels that could feed tumors and promote plaque buildup in arteries (*SN: 7/7/01, p. 6*). The body may also convert nicotine into the chemical precursors of the carcinogen that scientists call NNK (*SN: 10/28/00, p. 278*).

The latest experimental work strengthens the connection between nicotine and disease and highlights additional ways that the chemical might promote tumors, age skin, and stall wound healing. Researchers say the drug may also literally cook proteins in the blood.



TROUBLEMAKER — Nicotine, cigarettes' chemical lure, might also be an accomplice in many of the ailments spawned of tobacco.

DEATH CAN BE GOOD Nicotine probably doesn't cause cancer, but new research suggests it might keep cancer cells alive. And it apparently does so in two different ways.

First, the drug prevents a cellular form of suicide, called apoptosis, that normally eliminates nascent cancer and other damaged cells, says clinical oncologist Phillip A. Dennis of the National Cancer Institute in Bethesda, Md.

In many cancers—including those of the breast, ovaries, prostate, and brain—a protein that normally keeps apoptosis under control gets stuck in its active form and thus shuts down the suicide sequence. More recently, Dennis' team discovered that the same molecule, called either Akt or protein kinase B, jams in the on-position in most lung cancer cells. The finding led the team to wonder whether constituents of tobacco activate Akt in the lung.

To find out, they tested the effect of nicotine and its derivative NNK on normal lung cells in lab dishes. Nicotine activated Akt at concentrations comparable to those that have been measured in smokers' blood, and the cell-suicide rate fell by 60 percent, the team reports in the January *Journal of Clinical Investigation*. It took more stress—ultraviolet radiation exposure, for example—to kill nicotine-activated cells than normal cells required, Dennis says.

Nicotine-treated cells acted abnormal in other ways, too. In lab dishes, lung cells usually stop growing when they become crowded, Dennis explains. "When treated with nicotine, lung cells kept growing to the point of coming right out of the plastic," he says.

NNK also enhanced cell survival by stimulating Akt. Therefore, NNK might exacerbate nicotine's cancer-promoting ability, Dennis suggests.

Nicotine's boost to cell survival could be important to other cancers associated with tobacco, including those of the head, neck, kidney, and bladder, he says.

Nicotine has a second talent for enhancing tumor growth, two lines of research suggest. The drug makes tumor-nurturing blood vessels sprout. Tumors can only grow to a certain point before they must be fed, says John P. Cooke of Stanford University. "They don't continue to grow and become malignant unless they can call blood vessels into themselves," he says.

Cooke's team has found that nicotine increases the speed at which human blood vessel cells grow in lab dishes. What's more, lung-tumor cells in mice given nicotine-laced water expanded faster than those in mice not given the drug (*SN: 7/7/01, p. 6*).

Nicotine may encourage blood vessel formation by stimulating the production of vascular endothelial growth factor, or VEGF, a second team of researchers has found. Vascular-system researcher Brian S. Conklin, now at Baylor College of Medicine in Houston, and his colleagues knew that VEGF shows up in the majority of cancerous tumors. It's also a player in plaque formation along blood vessel walls. Because vascular disease and cancer are both linked to smoking, Conklin and his colleagues wondered whether nicotine might ramp up blood concentrations of the growth factor.

The team tested the effects of nicotine and cotinine—the primary product of nicotine breakdown in the liver—on blood concentrations of VEGF in a pig artery. Both compounds hiked concentrations of the growth factor, the researchers reported in the February 2002 *American Journal of Pathology*.

FULL SPEED AHEAD Just as nicotine sparks activity in nerve and tumor cells, it speeds up normal cellular activity in the skin. For example, some cells exposed to nicotine might go through the same life stages in 10 days that would normally take 10 weeks, says dermatologist Grando.

Such hyperactivity occurs in cells called dermal fibroblasts that control the skin's texture by regulating the production of support proteins including collagen and elastin. When skin gets wounded, these fibroblasts send out proteins that clean the site. The cleanup crew acts like "biological scissors," Grando says, clearing the way for healing to begin.

In the February *Laboratory Investigation*, the team reports that nicotine sends fibroblasts into inappropriate activity. In the laboratory, the researchers exposed human fibroblast cells to the drug. Enzymes normally unleashed to clean wound sites were deployed in the absence of injury. Those proteins then chewed up the scaffolding that keeps skin flexible and strong. That effect would leave skin sagging and wrinkled, Grando explains.

On the other hand, in regular users of tobacco, another mechanism of skin healing slows down as a result of nicotine's ability to speed cells up. Normally at a cut, skin cells called keratinocytes crawl out from the edge of a wound and cover the broken surface. Acetylcholine sets those cellular healers in motion. That led Grando and his colleagues to ask whether nicotine interferes with keratinocyte migration.

The researchers grew human skin cells in lab dishes and treated some cells with growth factors and others with growth factors in combination with nicotine. Nicotine-treated cells started to move as if on a healing mission but stopped short of the distance that cells not given nicotine traveled, the team reported 2 years ago. The span traveled by keratinocytes declined further as more nicotine was added to the lab dishes.

The fast-paced lifestyle that nicotine induces in cells might explain why, Grando says. Nicotine cuts skin cells' active life short, leaving them with too little time to seal a wound before they conk out, he hypothesizes.

NOW WE'RE COOKING Nicotine's widespread effects result primarily from its imitating the natural stimulant acetylcholine. But a new study suggests that a derivative of the drug might also interact with the blood to literally fry proteins.

While poring over the chemical structure of nornicotine—a minor metabolite of nicotine—chemist Kim D. Janda of Scripps Research Institute in La Jolla, Calif., recognized that the compound has the potential to mangle proteins. The metabolite could spur the same chemical transformation that occurs when potatoes are fried, he suspected, a reaction familiar to food scientists as the browning effect. A similar reaction can occur without the high temperatures, Janda explains. Proteins altered in this way have been implicated in diabetes, cancer, and normal aging.

In the laboratory, Janda and his colleagues added nornicotine to solutions of blood proteins. Nornicotine attached to the proteins, so that at the molecular level, the product looked like "Christmas trees with nornicotine lightbulbs on them," Janda says. When food browns, similar structures result.

In separate experiments on whole blood from smokers and nonsmokers, the team found that smokers' blood contains more such nornicotine-altered proteins than nonsmokers' blood does. The researchers reported their findings in the Nov. 12, 2002 *Proceedings of the National Academy of Sciences*.

"It's pretty shocking," says Janda. "Nornicotine can be involved in a chemical reaction no one had thought about." The

Not All Bad

A once-good-for-nothing drug improves its reputation

The properties that make nicotine a health hazard might also make it a useful therapy for more than smoking cessation. "Nicotine is a drug—not a poison or carcinogen—but a drug," says Sergei A. Grando of the University of California, Davis. "Nicotine is often a bad guy," he adds, "but it can also be a good guy."

For one, nicotine can help alleviate the mind-numbing symptoms of Alzheimer's disease. Alzheimer's patients lack the normal number of one type of receptor that binds acetylcholine in the brain, making them less responsive to that nerve signal. The deficit leads to learning and memory problems, says neurobiologist Alfred Maelicke at Johannes-Gutenberg University in Mainz, Germany.

A similar shortfall plagues people with schizophrenia and epilepsy, among other disorders, he adds.

In such cases, intermittent nicotine boosts to the brain can help, Maelicke says. Nicotine patches may also fight depression (*SN: 5/11/02, p. 302*). And there's more good news. Although regular nicotine use can delay wound healing, a new study finds that the stimulant speeds healing in mice with diabetes—a disease that normally impairs wound healing.

Prompted by his earlier discovery that nicotine spurs blood vessel growth, John P. Cooke of Stanford University wondered whether the drug might help close wounds. His team injured diabetic and nondiabetic mice and then applied a solution containing nicotine to some of the animals in each group.

After 5 days, diabetic mice receiving the nicotine treatment had healed substantially more than diabetic mice not getting the drug had, the team reported in the July 2002 *American Journal of Pathology*. Nondiabetic mice didn't benefit from the treatment with nicotine.

That result makes sense to Grando. "Like any drug, the dose is important," he explains. "At low doses, nicotine can favor faster wound healing, while in larger doses it has the opposite effect."

The challenge in all nicotine's possible uses is to identify people for whom the drug's benefits outweigh its risks and to develop targeted delivery methods, says Phillip A. Dennis of the National Cancer Institute in Bethesda, Md. —K.M.

team is now conducting studies to find out how common the nornicotine-blood reaction is in animals and people.

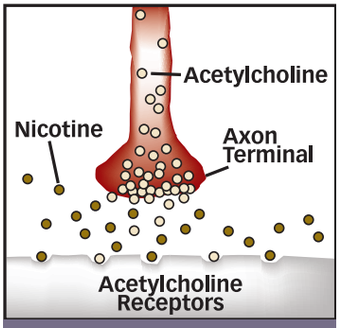
For people trying to kick the cigarette habit, gums, patches, lollipops, and lip balms that contain nicotine are often useful. High-dose nicotine replacements can deliver the stimulant at concentrations comparable to those in cigarettes while giving a person a more constant blood-nicotine concentration than smoking does and avoiding many of cigarettes' harmful components.

"It's still most important that people stop smoking—if they need [nicotine-replacement therapy] to do that, fine," says oncologist Dennis. "But nicotine itself might be harmful in the long term," he adds.

Some people use quitting aids for longer than the recommended few months. Ann N. Dapice, an educator at the addiction treatment center T. K. Wolf in Tulsa, Okla., says she's worked with people who have used nicotine patches and gums for years.

Although scientists don't know all of nicotine's long-term effects in people, emerging evidence makes a "whole new case" for the drug's potential to cause problems outside the nervous system, says oncologist John D. Minna of the University of Texas Southwestern Medical Center in Dallas.

And once scientists look closer, he adds, they might find disease connections to nicotine that haven't been considered yet. ■



MISBEHAVING — Nicotine derails the body's natural messenger, acetylcholine, causing neurons and other cell types to overreact.

E. ROELL

REFUELING ROCKETS

Could spacecraft powered by a new wax be safer and cheaper?

BY JESSICA GORMAN

On the campus of NASA's Ames Research Center in Mountain View, Calif., you periodically hear—and feel—a thunderous roar as engineers ignite experimental rocket engines that are chock full of the same paraffin wax that illuminates candlelight dinners. The idea of using wax as rocket fuel isn't new. People tried it years ago but couldn't get the wax to work well enough to launch a heavy rocket into space. The engineers now bracing against the roar of their wax-filled engines suspect, however, that their predecessors were indeed onto something. If that's true, paraffin wax could become the world's cheapest, safest, most environmentally friendly rocket fuel.

FUEL FOR THOUGHT It all started with a trip to San Diego in 1995. Arif Karabeyoglu, then a graduate student at Stanford University, and David Altman, a longtime rocket scientist affiliated with the university, were checking out research presentations at a conference on rocket propulsion. A talk on an Air Force rocket-fuel project set their own research trajectories in a new direction.

Unlike the standard solid or liquid fuels used today, the Air Force material was part solid, part liquid. The solid portion was frozen pentane, a hydrocarbon, and the liquid was pure oxygen. Just as a fire needs oxygen-bearing air to burn, all rocket fuels require an oxidizer for combustion. In this case, the oxidizer was the oxygen. Inside an engine, as the liquid oxygen became gaseous and blew across the fuel's solid component, the pentane burned.

So-called hybrid-rocket fuels have been around for half a century, but they haven't taken off, so to speak. Compared with more widely used fuels, they don't burn quickly enough or provide enough thrust to launch heavy loads. Moreover, the solid component of a hybrid needs to be molded into complicated and often fragile shapes to provide a great enough surface area for burning.

NASA and other rocketeers usually choose liquid or solid fuels. Liquid fuels include hydrogen and kerosene. Here, the oxidizer is either oxygen or another compound that accepts electrons readily enough and fast enough to drive the heat-releasing chemical reactions that underlie burning. Liquid fuels take up a lot of precious space on a rocket, as the large external tank on the space shuttles vividly shows. Some liquid fuels also require refrigeration. Nonetheless, they have an important benefit: Their combustion can be easily switched on and off to provide reliable and safe control.

The two booster rockets flanking the space shuttle's liquid-fuel engine run on solid propellant. These materials are typically made of an aluminum fuel with an ammonium perchlorate oxidizer built right into them, so they're very compact. Unfortunately, this setup also makes them dangerous. Like July 4th sparklers, once a solid rocket is ignited, it's hard or impossible to stop. Safety concerns make production, storage, and transport of solid fuels enormously expensive, says Brian J. Cantwell, an aeronautical engineer at Stanford.

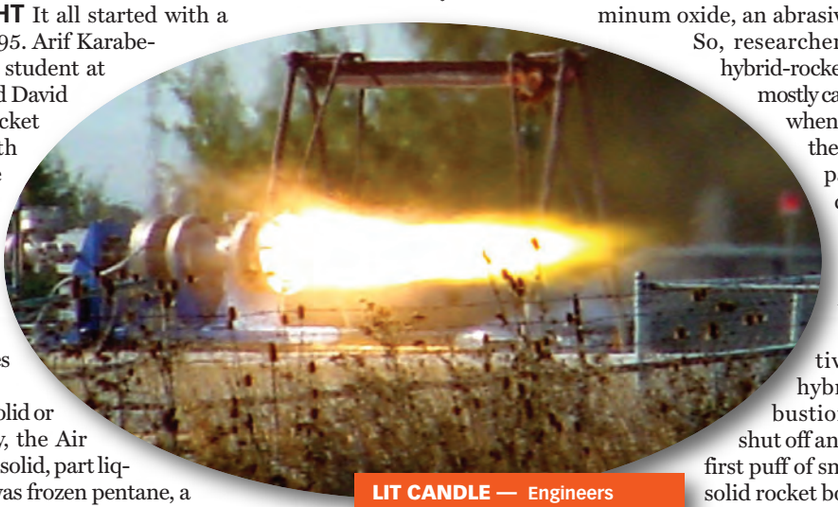
Moreover, solid fuels are made of toxic materials. Perchlorates, which have been linked to thyroid problems, may end up in ground water during fuel production or after a launch (*SN: 07/29/00, p. 77*). As they burn, solid fuels may also produce hazardous emissions, such as hydrogen chloride, which forms hydrochloric acid when it encounters water vapor, and aluminum oxide, an abrasive white powder.

So, researchers continue to study hybrid-rocket fuels. Some produce mostly carbon dioxide and water when they burn. Moreover, these fuels are more compact than liquids, and compared with solid fuels, hybrid-rocket fuels are safer and their thrust can be regulated.

A particularly attractive feature is that hybrid-rocket-fuel combustion can be completely shut off and restarted. When the first puff of smoke appeared from a solid rocket booster on Challenger's doomed takeoff in 1986, the spacecraft was still sitting on the launch pad. Even if mission controllers had suspected a problem at that moment, they couldn't have prevented the shuttle from lifting off, says Cantwell. Nothing could stop the solid fuel that was already burning.

A hybrid rocket could have been shut off with the flip of a switch.

What has kept hybrid-rocket fuels out of shuttle designs, as well as out of any existing plans for rockets that carry heavy loads, is the fuels' slow burning rate. And that's what sparked Karabeyoglu's and Altman's interest in the Air Force fuel. For some reason, it burned three times faster than other hybrid fuels.



LIT CANDLE — Engineers test-fire a rocket containing a paraffin-based hybrid-rocket fuel.

NASA AMES

BETTER BURNING After learning about the Air Force fuel at the propulsion conference, Karabeyoglu and Altman began searching for an explanation for the fuel's accelerated rate of combustion.

As it turns out, the answer lay in the library. After extensive searches of the chemistry and physics literature, Karabeyoglu finally

traced the reason for the quick burning rate to a property of some thin liquid films that was first reported in 1966. From what he could gather, Karabeyoglu surmised that a 100-micrometer-thick layer of liquid pentane had formed on the surface of the Air Force fuel's solid pentane while the fuel was burning. Meanwhile, he theorizes, oxygen vapor blowing over this thin layer created a spray of small pentane droplets. The large collective surface area of these droplets caused the fuel to burn especially quickly.

The availability of a fast-burning hybrid fuel was great news, but the fuel still had a big drawback. To stay frozen, the pentane would require a refrigeration system that could maintain the pentane at nearly 200°C below the freezing point of water.

"You don't want to have to take your rocket and put it in a deep freeze before launch," says Cantwell. "It's not practical."

Now that Karabeyoglu had figured out why the pentane in the Air Force fuel burned so quickly, he and his colleagues wondered whether they could find a related material that burns as fast but is solid at room temperature.

The new fuel would also need to have the appropriate viscosity and surface tension to create an unstable, thin film of liquid on its surface that would rustle up a spray of fuel droplets when oxygen or some other oxidizer blew over it. The material that could meet all of these criteria turned out to be a mechanically strong paraffin, or wax. Like pentane, paraffins are alkanes—hydrocarbon molecules that have as many hydrogen atoms as the molecule's carbon backbone can accommodate. To chemists, they're known as fully saturated hydrocarbons. Pentane has 5 carbon atoms and 12 hydrogens. Soft paraffins with Vaseline-like consistency have about 15 to 20 carbon atoms, and stronger paraffins have about 25 to 30 carbons.

The wax that the Stanford scientists chose isn't exactly dinner-table candle wax, but it's pretty close. It includes a small amount of carbon black, a fine soot, to block radiation from heating and softening the inside of the material. It also contains other additives, which the scientists won't reveal, to improve the material's structural properties. A person can hold the wax, carve it, and melt it, and—unlike liquid or solid rocket fuel—there's no risk of explosion or fire. In fact, the researchers have shipped the material by FedEx.

Cantwell notes that rocket science has considered wax before. The California Rocket Society launched a small rocket with a synthetic wax fuel in 1938. There aren't any accounts of what happened, but it "probably didn't work out," he says. Cantwell suspects the wax used then would have softened and not burned well.

Sixty-five years later, there may be a more promising ending to the wax fuel story. With a small motor on a laboratory bench top in a basement at Stanford, Karabeyoglu, Cantwell, and Altman have performed more than 200 tests on their wax fuel with gaseous oxygen as their oxidizer. In doing so, they've optimized the combustion of their room-temperature wax so that it now burns as fast as the frozen pentane hybrid did.

WAX WORKS — Stanford researcher Arif Karabeyoglu installs a cardboard tube of paraffin-based fuel into the combustion chamber in NASA Ames' Hybrid Rocket Test Facility (top). Ames engineer Greg Zilliac seals the test chamber.

BIGGER AND BETTER The big question is whether this laboratory promise can translate into launch pad reliability. A basement at Stanford is not the place for taking the next steps in that direction.

So in 2000, the Stanford team convinced engineer Greg Zilliac of NASA's Ames Research Center in nearby Mountain View to buy in on the project. "It looked like an exciting new avenue of research for our [Ames] group," says Zilliac.

At Ames, Zilliac had a large motor constructed, and the researchers have now completed 41 test burns. This January at an aerospace meeting in Reno, Nev., the researchers reported that the fuel burned at the same brisk rate at Ames as it had in the smaller Stanford trials—three to four times that of conventional hybrid fuels. Tests using nitrous oxide instead of oxygen as an oxidizer yielded similar results.

"Stanford has brought the [paraffin] technology a long way," says Martin Chiaverini of Orbitec, a Madison, Wis., company that does aerospace research and development.

Meanwhile, other researchers continue to work on conventional hybrid-rocket technologies, he notes. For example, at the Pennsylvania State University in State College, where Chiaverini did his graduate studies, engineers are adding nanoscale aluminum particles to a conventional hybrid rocket fuel—hydroxyl-terminated polybutadiene—in order to improve the fuel's performance. And at Orbitec, scientists have found a way to create a double vortex—like a tornado inside a tornado—in a hybrid-rocket engine, which increases the fuel's burning rate.

Combining varied hybrid-rocket research may yield even better burn rates, says Chiaverini, who hopes to test Orbitec's double-vortex system on the Stanford paraffin.

These are signs that wax fuel could soon become suitable for full-scale use in a suborbital research rocket, where the material's compactness may reduce drag, says Zilliac. Later, wax could potentially fuel larger rockets. And someday, Cantwell says, it's conceivable that safe wax fuel may even replace the solid fuel in space shuttle booster rockets.

To Zilliac, the optimal use for the wax fuel would be in robotic crafts on multiyear missions to explore the solar system. Wax offers some great benefits, he says. It's compact and doesn't need refrigeration. It's also easily turned off and restarted, even after 2 years or so.

Before the wax-fuel saga takes off in those directions, more tests will have to be done at Ames and other NASA centers. A new facility at Ames has just been completed for studying the physics of how the fuel melts and burns, and the first tests are now under way. The new testing complex has sapphire windows for researchers to set up detailed optical studies of the burning process. With that additional knowledge, the researchers expect to fine-tune these fuels. If they succeed, candlepower could become part and parcel of leading-edge rocket science. ■

NASA AMES

OF NOTE

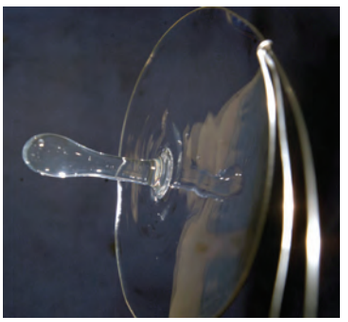
PHYSICS

In orbit, water makes the stretch

It's well known that water behaves differently in the near-zero gravity of a spacecraft than on Earth. Yet scientist-astronaut Donald R. Pettit, now aboard the International Space Station, was startled recently when he watched this most familiar of liquids stretch across a large metal hoop.

The odd behavior showed up just as Pettit was about to do some just-for-fun experiments with soap bubbles in his off-duty hours.

Using a wire twisted into a bubble wand, Pettit dipped the loop first into plain water to see what would happen. To his surprise, the wand's loop emerged holding a glistening film. On Earth, such unsupported water membranes break as soon as they form. Pettit found he could make the films as large as saucers.



SPACEY WATER Vigorously shaken, a water film aboard the International Space Station sheds a droplet without breaking.

PETTIT

What's more, the films were able to withstand strong shaking—though a drop or two might fly off—and could last up to half a day. Pettit attributes their tenacity to ordinary surface tension no longer being overpowered by the tug of gravity.

Besides being amusing, Pettit's observations of films, as well as of floating water droplets, may be relevant to theories of fluid turbulence, says physicist Francis H. Harlow, one of Pettit's former colleagues at Los Alamos (N.M.) National Laboratory. Harlow has been in e-mail contact with Pettit about the odd water structures.

NASA spotlighted Pettit's unpublished findings recently in its Web-zine (*http://science.nasa.gov/headlines/y2003/25feb_nosoap.htm?list1079*). —P.W.

BIOLOGY

Discovery of bitter-taste gene is sweet

Variations in a gene on chromosome 7 seem to explain why people can differ in their sensitivity to bitter substances.

The capability to sense bitterness may have evolved because it keeps animals from eating harmful plants. "We have a sense of bitter taste to protect us from ingesting toxic substances," says Dennis Drayna of the National Institute on Deafness and Other Communication Disorders in Bethesda, Md.

For decades, taste researchers have used a chemical called phenylthiocarbamide (PTC) to assay a person's capability to sense a bitter taste. About 70 percent of people find PTC intensely bitter, but the rest can barely taste it.

Scientists know that this difference in sensitivity is inherited, but they've struggled to find the gene or genes responsible. In the Feb. 21 *Science*, Drayna and his colleagues pinpoint a single crucial gene they discovered by studying large families in Utah. The gene encodes a protein that is a component of a known bitter-taste receptor in taste buds. Drayna's group found that family members who could sense PTC had a different version of the gene from those who couldn't sense the chemical.

Other researchers testing people with a different chemical have argued that some people are extraordinarily sensitive to bitter substances. These so-called supertasters may risk certain diseases because they avoid eating vegetables, the scientists theorize (*SN: 7/12/97, p. 24; SN: 3/1/03, p. 142*).

Drayna isn't convinced that supertasters exist, but he plans to investigate whether the gene variants his group identified can help resolve that issue. —J.T.

BIOMEDICINE

Plot thickens for blood pressure drugs

Scientists reported last December that an inexpensive drug for hypertension, a diuretic, prevents heart failure and stroke better than newer, more costly blood pressure medicines do *(SN: 1/18/03, p. 45)*. The findings prompted doctors to rethink treatments for some patients.

Not so fast. Researchers in Australia now report that one of the more costly drugs—a so-called angiotensin-converting-enzyme (ACE) inhibitor—prevents heart attacks and other heart problems better than a diuretic does. The study appears in the Feb. 13 *New England Journal of Medicine*.

The researchers tracked 6,083 people, ages 65 to 84, for 4 years. Half received an ACE inhibitor (most often enalapril) and half got a common diuretic (usually hydrochlorothiazide). During the study, 58 people in the ACE-inhibitor group had heart attacks, compared with 83 in the diuretic group. Also, volunteers in the ACE-inhibitor group were slightly less likely to die from any cause than were people getting the diuretic.

A closer look at the data reveals that ACE inhibitors protected men from heart problems better than diuretics did, but that women gained equal protection from the two drugs, report Christopher M. Reid of the Baker Heart Research Institute in Melbourne and his colleagues.

Differences between findings from this study and the one reported last December might result, in part, because the specific diuretics and ACE inhibitors were different in the two trials, says Edward D. Frohlich of the Alton Ochsner Medical Foundation in New Orleans. The first study tested the diuretic chlorthalidone against the ACE inhibitor lisinopril and amlodipine, a calcium-channel blocker.

A lesson of these studies, Frohlich says, is that rather than stampeding to one treatment or the other, doctors will need to tailor prescriptions to patients' individual needs. —N.S.

EARTH SCIENCE

More Arctic clouds may lessen warming

Nearly 2 decades' of satellite observations suggest that an increase in Arctic cloudiness at certain times of the year may partially counteract the effects of global warming in the region.

On a year-round basis, the total cloudiness at latitudes above 60°N—a latitude that swings near Oslo, the southern tip of Greenland, and Seward, Alaska—hasn't changed significantly in recent years. However, cloud coverage at different seasons has varied, says Jeffrey R. Key, a climatologist with the National Oceanic and Atmospheric Administration in Madison, Wis. That fluctuation is affecting the region's weather.

Between 1982 and 1999, winter cloud coverage decreased at the rate of nearly

6 percent per decade. Because there are now fewer nighttime clouds to keep the region's warmth from radiating back into space, Arctic temperatures for December, January, and February have dropped accordingly, about 0.34°C per decade on average, says Key.

During the same 18-year period, spring and summer cloudiness has risen about 3 percent and 1.5 percent per decade, respectively. Daytime clouds block incoming sunlight and thus tend to cool Earth's surface. Currently in the Arctic, however, other factors associated with global warming mask that effect, the researchers say. For instance, snow melts earlier in the spring than it used to, so the ground absorbs more warming sunlight. Overall, satellites show that surface temperatures in the Arctic during summer have risen about 0.7°C per decade.

If cloud coverage in June, July, and August hadn't increased in recent years, Arctic temperatures might have risen even further. Key and his colleague Xuanji Wang of the University of Wisconsin–Madison present their findings in the March 14 *Science*. —S.P.

PHYSICS

Squirming through space-time

Just as a bicyclist can summon gravity's help by turning onto a descending street, it might be possible to use the topography of space itself for a propulsion assist, albeit a tiny one, says a relativity theorist.

The scheme starts with Einstein's general theory of relativity, which says that space-time curves near massive objects (*SN: 12/21&28/02, p. 394*). In such a universe, certain idealized machines, such as one made of balls attached to long, adjustable struts, can propel themselves through curved space-time by shifting the relative positions of their parts, suggests Jack Wisdom of the Massachusetts Institute of Technology in the March 21 *Science*.

By means of mathematical and physical analyses, Wisdom argues that such machines can "swim" through space-time without thrust from an engine or other external forces. In effect, the contortions of such machines and probably more complex bodies would be like the acrobatics of a cat held feet up and then dropped to the ground, Wisdom says. The cat reorients itself and lands on its feet.

Wherever space-time isn't curved—as is effectively true in the weak gravitational field of Earth—such rotations only produce changes in an object's orientation. However, in strongly curved space, the same gyrations cause a simultaneous shift in location, Wisdom shows. For example, a contorting cat might actually move sideways even if it weren't falling. Unfortunately, it would take forever to move anywhere.

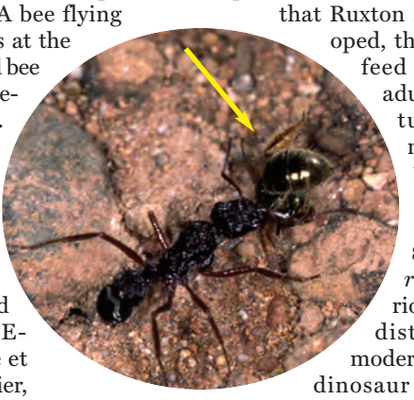
"When I started this, I hoped it would be a practical way of moving around," Wisdom confesses. However, a swimmer would travel only as far as the diameter of a proton after even 100 million strokes, he calculates. Nonetheless, Wisdom's proposal might point to new ways of testing general relativity. —P.W.

ZOOLOGY

Ants lurk for bees, but bees see ambush

A tropical ant hunts bees by setting ambushes. However, the bees have developed a trick or two of their own.

The New World ant *Ectatomma ruidum* waits outside the tiny holes in the ground that lead to nests of the sweat bee *Lasioglossum umbripenne*, explains William T. Wcislo of the Smithsonian Tropical Research Institute headquartered in Balboa, Panama. A bee flying home typically pauses at the entrance while a guard bee checks her chemical credentials as a nest mate. During this brief delay, the ant lunges, grabs the bee in her mouthparts, and then stings the captive to death.



CARRY OUT After an ambush, an ant carries home a dead bee (arrow).

Wcislo and Bertrand Schatz of Centre d'Ecologie Fonctionnelle et Evolutive in Montpellier, France, described such ambushes in 1999. Now, in the February *Behavioral Ecology and Sociobiology*, the researchers report bee countermeasures.

When an ant is hanging around the nest, 97 percent of returning bees interrupt their first swoop to the nest and veer away. Nearly half make a second approach, trying to slip in from the far side. Others land at a distance and walk home. This can save the bee if the ant keeps scanning the sky or moves on.

The warning for bees seems to be visual, say the researchers. Bees shied away from a dead ant beside the nest, even a dead ant that researchers had washed in solvent to remove body odors. A little black square or rectangle, however, didn't alarm the bees.

Once a bee falls into an ant's fatal grasp, it doesn't get a chance to learn from its mistake. So just how bees have come to recognize the ant dangers remains a puzzle, says Wcislo. —S.M.

PALEOBIOLOGY

Was *T. rex* just a big freeloader?

Paleontologists have long debated whether *Tyrannosaurus rex* was a predator or a scavenger. In most previous analyses, scientists have scrutinized the creature's teeth and jaws. Now, Graeme D. Ruxton and David C. Houston at the University of Glasgow in Scotland weigh in on the issue from another angle: whether a *T. rex*–size scavenger could have found enough dead meat to survive.

Ecosystems like the savannas of Africa could have provided sufficient carrion to nourish a scavenging *T. rex*, the researchers report in an upcoming issue of *Proceedings of the Royal Society of London B*.

On Tanzania's Serengeti grasslands, enough herbivores die each day to provide about 4.4 kilograms of carrion per square kilometer. According to equations that Ruxton and Houston developed, that's enough meat to feed a typical 6,000-kg adult *T. rex* if the creature had a reptilian metabolism, spent 12 hours daily foraging, and could detect carrion as much as 80 meters away. If *T. rex* could sense carrion at four times that distance, which some modern reptiles can do, the dinosaur could have missed out on three of every four corpses and still made a scavenger's living, Ruxton says.

Even if *T. rex* had a high-energy metabolism more typical of mammals, the savanna probably still could have provided enough dead meat to support a scavenging lifestyle. Although the dinosaur would need much more food in that case, it also could travel faster and thus cover more ground to find its required calories.

Ruxton notes that the new research doesn't prove *T. rex* was a scavenger; it only suggests that the meat eater didn't have to be a predator. —S.P.

M. GUERRA/STRI

Books

A selection of new and notable books of scientific interest

HIDDEN WORLDS: Hunting for Quarks in Ordinary Matter

TIMOTHY PAUL SMITH

Protons and neutrons are each made up of exactly three particles known as quarks. There are two common types of quarks known as the up and down quarks. A proton is made up of one down and two up quarks; the neutron reverses those numbers. This knowledge in and of itself is interesting, considering that no one has actually seen a quark, nor will they ever. Smith, a nuclear physicist, studies these infinitesimally small things and explains how he and other scientists know what they know without the benefit of ever being able to see what they are working on. Taking readers to the miles-long particle accelerators used to magnify matter in fine detail, Smith introduces the physicists working in this field, who in turn help him explain in this book what quarks are and how they act. The scientists ponder how quarks arrange themselves, what other combinations nature can make, how quarks hold nuclei together, and what else might be happening in the hidden world that these scientists love. The answers to these questions are founded in a few simple principles. ***Princeton U Pr, 2003, 178 p., b&w illus., hardcover, $24.95.***

LOOKING FOR SPINOZA: Joy, Sorrow, and the Feeling Brain

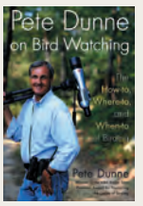
ANTONIO DAMASIO

Damasio continues his quest to understand the neurobiology of feelings and emotions in this third book in a series that includes *Descartes' Error* and *The Feeling of What Happens*. The philosopher Baruch Spinoza pondered the link between emotions, the body, and the mind more than 350 years ago. Neuroscientist Damasio believes that Spinoza was onto something in his belief that living organisms are designed with a capability to react physically to different objects and events and then experience a pattern of feeling. By example, when people hear a loud boom, their hearts race and then they feel fear. Until recently, scientists had despaired at sorting out this biology of feelings. Damasio distinguishes emotions generated by the body, which are visible to others, and feelings of the mind, which are hidden. To illustrate his points, he describes some of his patients with limited brain damage that nevertheless has affected their feelings. For instance, one person could feel fear or happiness but not compassion or embarrassment. This book provides great insight into an evolving field of study. ***Harcourt, 2003, 355 p., b&w illus., hardcover, $28.00.***

PETE DUNNE ON BIRD WATCHING: The How-to, Where-to, and When-to of Birding

PETE DUNNE

Novice and accomplished birders alike turn to Dunne for lessons in the art of bird watching. Now in this beginner's guide, he covers all the basics, from what to look for when viewing birds to where to look for them. In a text full of anecdotes and warm wit, he discusses how to attract avian creatures to one's yard and how not to scare them away. Explanations of how best to identify a specimen are clear, as are the tips for selecting the best equipment. A concluding section details Dunne's favorite ideas for better birding. ***HM, 2003, 334 p., b&w photos/illus., paperback, $12.00.***



PROJECT ORION: The True Story of the Atomic Spaceship

GEORGE DYSON

While most people feared nuclear blasts early in the Cold War, a small group of scientists working and living in La Jolla, Calif., had a different attitude. In the 1950s and 1960s, they saw nuclear explosions as a promising means of sending a spaceship to another planet. Led by physicist Theodore B. Taylor and including the author's father, Freeman Dyson, Project Orion was the attempt by these scientists to create a spaceship fueled by explosions that could release a million times the energy of a conventional rocket. These men spent 7 years trying to get the project off the ground, struggling both in the lab and through the maze of political bureaucracy. Their goal was to send a 4,000-ton spaceship to Mars by 1965 and to Saturn by 1970, but the political obstacles became too daunting. Government leaders just couldn't advocate nuclear blasts in space. Dyson deftly weaves this story from accounts related to him by his father and other scientists who made up the inner circle of the project. Originally published in hardcover in 2002. ***Owl Bks, 2003, 345 p., b&w photos/illus, paperback, $16.00.***

A SHORTCUT THROUGH TIME: The Path to the Quantum Computer

GEORGE JOHNSON

Today, computers are driven by electronic switches so small that 40 million of them fit onto a single silicon chip. In the future, such devices will be old-fashioned behemoths. In quantum computers, switches may be as small as an atom. Quantum computers would make vast numbers of calculations simultaneously, enabling them to quickly and seemingly effortlessly spit out answers to problems that take too long to solve on today's supercomputers. New York Times science writer Johnson dissects computers from their origins to this mind-blowing future, clearly explaining emerging technology and its implications. ***Knopf, 2003, 204 p, b&w illus., hardcover, $24.00.***

LETTERS

Maybe the reindeer flew

"Southern Reindeer Folk" (*SN: 1/18/03, p. 40*) has a picture of a "deer stone." On it are engraved designs of reindeer that bear an astonishing resemblance to a tattoo borne by the 2,400-year old mummy discovered in 1993 in central Asia. Was this noticed by the researchers?

MICHELLE BLANCHARD, OLYMPIA, WASH.

Absolutely. William Fitzhugh, an expedition leader, says he was struck by the similarity to tattoo motifs in central Asia, as well as the art of the polar regions of North America. He contends that one of the big reasons to study this part of Mongolia is to explore these as possible cultural links. —S. MILIUS

Have a safe night

Researchers' conclusions in "Goodnight moon, hello Mom" (*SN: 1/25/03, p. 62*) that there is a "need to revisit controversial claims about the health benefits and risks of bed sharing for babies" seem to me to miss the point. The health benefits and risks of any sleeping environment should be of concern. Focusing solely on bed sharing implies that crib use is inherently safe, which is not the case.

CATHY TSCHUMY, AUSTIN, TEXAS

Clearly a need

I found the "stats" about blood donors and patients in "Getting the Bugs Out of Blood" (*SN: 1/25/03, p. 59*) misleading, with the implication that 8 million volunteer donors are more than enough for 4.5 million patients. A comparison of how many people donate blood during their lives and how many people need blood donations during theirs might have been more informative. We need more blood donors.

JEANNE FERRIS, WASHINGTON, D.C.

Honors

Science News *astronomy writer Ron Cowen is a recipient of the third David N. Schramm award for distinguished writing on high-energy astrophysics. Cowen and one other writer share the honor and a $1,500 prize, to be awarded at a ceremony March 25 during a meeting of the High Energy Astrophysics Division (HEAD) of the American Astronomical Society. HEAD sponsors the award, which it presents every 18 months.*

*In announcing the selection, HEAD cited Cowen's article "Jet Astronomy" (*SN: 11/9/02, p. 299*) as writing "that improves the general public's understanding in and appreciation of" high-energy astrophysics.*

Botanical Bonanza

Ten years in the making, *The Botanical Garden* combines the finest in photography with up-to-date, expert commentary to bridge the gap between gardening books and scientific texts. Each featured plant has been carefully photographed—as a whole and in its parts—to reveal its physical characteristics in exacting detail.

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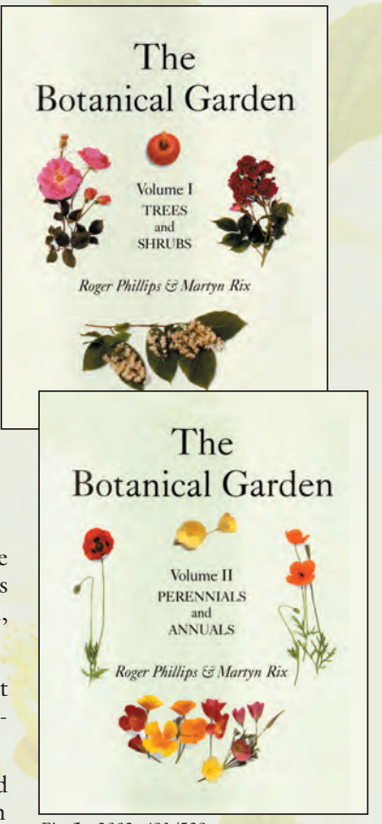

Firefly, 2002, 491/539 pages
8 ⅞" x 9 ¼", hardcover, $75.00 each.

In Volume 1, *Trees and Shrubs*, over 500 genera of temperate woody garden plants are thoroughly covered. Here are highlights from entries taken from the full spectrum of this category including conifers, magnolia, beech, oak, birch, mulberry, apple, dogwood, maples, honeysuckle, and palms and bamboos:

Gingko—The only surviving species in the family Ginkgoaceae, possibly the most ancient of all living trees, excellent for the garden or a street tree; some of these fan-shaped leafed trees in China and Japan are 1,000 years old and still growing.

The family Fagaceae—500 species of Oak, genus *Quercus*, found throughout northern and the American chestnut or chinkapin, genus *Castanea*, which was formerly a dominant forest tree but practically all the large specimens were destroyed by Asian blight in the 1930s.

In Volume II, *Perennials and Annuals*, entries begin with the ancient sphagnum moss and ferns and extend to the modern irises, hostas, and sedges. The more than 500 genera of herbaceous temperate plants include biennals, bulbs, and aquatic plants. The book describes the poppy, cactus, peony, geranium, phlox, impatiens, peas, beans, foxglove, daisies, orchids, grasses, and rushes. Some highlights:

Iridaceae—The iris, with nearly 250 species in the northern hemisphere, is associated with the Virgin Mary in Medieval and Renaissance painting and is commonly planted in Muslim cemeteries.

Compositae—the lovely blacked-eyed Susan, is reliable and easily grown for "any sunny situation." The Compositae family is in the genus Rudbeckia, named after the Swedish botanist Olof Rudbeck, Linnaeus' predecessor at Uppsala University.

As a pair, these two volumes are an all-inclusive source of information and photographs of more than 1,000 genera of temperate plants. Thorough introductory text encompasses numerous themes in botany, from the history of plant development to current DNA studies that are revolutionizing plant classification. —from Firefly

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