SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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fighting celiac disease

snake's cool sensors

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paradox of youth

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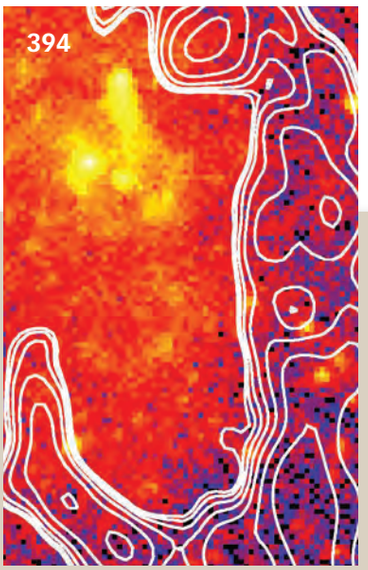

Features

This Week

THIS WEEK ONLINE
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Prime-time cicadas Some cicadas emerge after a prime number of years. See Ivars Peterson's MathTrek.

Of Note

Meetings

Departments

Cover Galactic center, as seen by the emission of hydrogen cyanide molecules (white contours) overlaid on an X-ray image. Researchers are puzzling about stars that closely orbit the black hole (bright yellow at center). (C. Howard/OVRO; X-ray image: M. Morris *et al.*/Chandra) Page 394

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Hot Mama

Has matter's mother paid a call?

Physicists have found new signs that fiery particle collisions within a giant accelerator two years ago created a state of matter identical to what might have been the stuff of the newborn universe.

Stunning results announced this week are prompting a growing chorus of physicists to say that it's time to declare success in a decades-long quest to make quark-gluon plasma—an extremely hot, dense soup of matter that contains loose fundamental particles known as quarks and gluons (*SN: 8/26/00, p. 136*).

"This really is a decisive moment," says theorist Miklos Gyulassy of Columbia University. "I feel, at this stage, we've actually seen it."

While mainly theorists take this stand, experimental physicists largely remain cautious.

Theorists have predicted that smashing together heavy atomic nuclei accelerated to nearly the speed of light can create a quark-gluon plasma. The resulting fireballs, which can reach temperatures measured in trillions of degrees, are expected to melt the protons and neutrons that compose ordinary nuclear matter. That process would briefly liberate the quarks and gluons that make up protons and neutrons.

Producing a quark-gluon plasma would replay in miniature the critical scene early in the cosmos when the plasma gave birth to ordinary matter, researchers say. Studying the plasma, scientists could expose the fundamental nature of matter and the vacuum that permeates the cosmos.

In experiments conducted earlier this year, physicists at Brookhaven National Laboratory (BNL) in Upton, N.Y., smashed heavy gold nuclei with much lighter nuclei called deuterons—the nuclei of deuterium, a hydrogen isotope. The researchers produced those collisions in the lab's Relativistic Heavy Ion Collider, or RHIC—a giant device that is now the main tool in the hunt for the quark-gluon plasma.

Creating a quark-gluon plasma wasn't the aim of these experiments. The goal was to determine whether observations from earlier RHIC experiments could be explained with theories that don't summon the quark-gluon plasma.

The new gold-deuteron tests focused on jets of particles emanating from the collisions. Jets are produced when two highly energetic quarks bounce off each other. If one or both escape the fireball, they break up into sprays of other particles. Such jets may show up as single bursts or oppositely directed pairs.

However, during the previous RHIC experiments, scientists had observed that collisions between pairs of gold nuclei yielded fewer jets than would be expected at that collision energy.

Physicists had come up with two explanations for the discrepancy. In one scenario, if energetic quarks collide at a fireball's edge, the quark heading away from the collision's center might get away while its partner bogs down in the soup of still agitated, colliding particles—the quark-gluon plasma.

Alternatively, some physicists suggested, a subtle property of nuclei known as gluon saturation could have caused the jet suppression.

To sort out what was happening, the RHIC teams turned to the less energetic collisions between gold ions and deuterons. If gluon saturation were at work, jet suppression would persist at these lower energies. If not, jets would emerge in undiminished numbers because the gold-deuteron impacts generate too little energy to create a jet-absorbing quark-gluon plasma.

Jets weren't suppressed, three independent RHIC teams announced Wednesday at a BNL colloquium. The stunning implication is that a quark-gluon plasma had been present in the gold-gold experiments.

Nonetheless, most of the hundreds of physicists who have been conducting the RHIC experiments don't consider the case closed, say members of those teams. Despite the new findings and other, previous hints of quark-gluon plasma at RHIC, a stronger case will require observing several additional features of collision debris to rule out some other form of hot, dense matter.

The experimentalists' reticence stems in part from fallout from an announcement 3 years ago by the European Laboratory for Particle Physics, or CERN, near Geneva. Researchers stated that something akin to the quark-gluon plasma, if not the plasma itself, had been produced in an accelerator there (*SN: 2/19/00, p. 117*). To many other scientists, the announcement gave the impression that CERN researchers were prematurely claiming discovery of the quark-gluon plasma when rigorous proof of such a claim was still lacking. —P. WEISS

Stellar Top

Astronomers find a squashed star

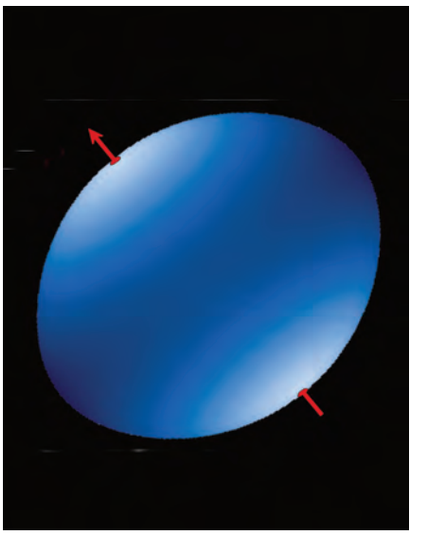
Think of the sun and other giant balls of gas that twinkle in the heavens. Conventional wisdom has it that all these stars are round. But because stars spin, they're not perfect spheres. The rotation moves material outward more strongly at the equator than at the poles. This nudges the star into a shape reminiscent of that of a toy top.

For a slow rotator like our sun, the effect is tiny. But for a rapidly rotating star such as Achernar, which is 145 light-years from Earth and six times the sun's mass, that distortion can be significant. Although astronomers already knew that Achernar spins at least 225 kilometers per second, they were flat-out astonished by their newest observations. The squashed star is more than 1.5 times as wide as it is tall.

That makes Achernar the flattest star known, report Pierre Kervella of the European Southern Observatory in Santiago, Chile, and his colleagues in an upcoming *Astronomy & Astrophysics*.

Conventional models can't explain such a distortion, Kervella notes. In the simplest theory, a star is assumed to be a solid ball with its interior rotating more slowly than its surface. But such a star would fly apart long before it became as distorted as Achernar, says Marc H. Pinsonneault of Ohio State University in Columbus.

The only way Achernar can be so flat is if "the star is rotating much faster in the



EUROPEAN SOUTHERN OBSERVATORY

OUT OF ROUND Artist's rendition of the star Achernar. The red arrow indicates the star's rotation axis.

core than it is at the surface," notes Pinsonneault. The new data thus give "the first peek" inside a rapidly rotating star, he says.

The finding is "extremely interesting," Pinsonneault adds, because a star whose interior turns more rapidly than its surface would mix the interior materials, producing less-distinct layers than other stars have. According to models, the mixing would carry metals forged at the core to the surface, enabling the star to more efficiently seed the interstellar medium with heavy elements. At the same time, the churning action would draw into the core a surrounding layer of hydrogen, a star's main fuel. This could double a star's lifetime, Pinsonneault says.

Gerard van Belle of the California Institute of Technology in Pasadena cautions that instead of representing an intact, flattened star, the Achernar observations may indicate a star that has exceeded its rotational speed limit and fallen apart, hurling a disk of material from its equator. The disk might be mistaken for a flattened star.

Kervella says his team's spectroscopic observations make that possibility highly unlikely.

For their study of Achernar, the researchers used a recently installed interferometer at the Paranal Observatory in Chile. Carefully combining the light from two small telescopes tens of meters apart, the astronomers achieved a resolution comparable to that of a single telescope the size of a football field. —R. COWEN

HEAT TEST A western diamondback rattlesnake lost its skill at spotting cool refuges when researchers blocked its heat-sensing pits with tiny balls and aluminum foil (inset).

KROCHMAL AND BAKKEN

Snake Pits

Viper heat sensors locate cool spots

Researchers who glued minuscule plastic balls onto the faces of live rattlesnakes say the project has revealed the first experimental evidence of an overlooked role for the viper's heat-sensing organs. The newly tested function: finding places for the desert snake to hide from the scorching sun.

Rattlesnakes can sense heat via special receptors sunk in two tiny pits on their faces, explains Aaron Krochmal of Indiana State University in Terre Haute. Decades of experiments have focused on how the pits enable the animal to turn into a heat-seeking missile for warm-blooded prey.

Now, Krochmal and George Bakken, also of Indiana State, report on the first tests of whether the facial pits also help western diamondback rattlesnakes protect themselves from overheating. After researchers blocked rattlesnakes' facial pits, the animals had trouble finding cool refuges, Krochmal and Bakken report in the Aug. 1 *Journal of Experimental Biology*.

Bakken says that experiments on seeking refuge may help ecologists learn how animals deal with a patchy environment.

Krochmal adds that the need for thermoregulation may have driven the evolution of early pits and the snakes' spectacular prey targeting came later.

When Krochmal decided to test rattlesnakes, he hadn't ever handled poisonous snakes. He practiced for months with a harmless but cranky black rat snake. Still, he says, "the first time [working with a rattlesnake] was the most unnerving experience of my natural-born life."

First, he tested 12 wild-caught snakes in a simple Y-shaped tube with one branch kept comfortably cool at 30°C and the other heated to a stressful 40°C. Snakes put into the Y's stem, also at 40°C, slipped into the cool end about 75 percent of the time.

Then Krochmal anesthetized all the snakes and blocked their 2-millimeter-wide facial pits with tiny plastic balls and aluminum foil temporarily glued on top. Snakes with blocked pits ended up in the cool spot only half the time, as if by chance. When Krochmal unblocked the pits, though, the snakes' performance bounced back.

The researchers repeated this test with a choice of four boxes, one of them cool, and then with four natural-looking burrows. Each time, the snakes' performance dipped when their pits were blocked but bounced back when the paraphernalia came off.

Snake specialist Harry Greene at Cornell University asks how well the test setups, where there's less than 1 meter from a snake's decision point to the cool nook, represent choices in the real world. He suggests yet another important use for the pits: assessing danger from predators. However, he says that the idea that facial pits evolved for body-temperature control "deserves serious consideration." —S. MILIUS

Lithium Sees the Light

Images of tiny ion may help battery designers

Hidden within cell phones, laptops, and digital cameras, lithium-ion batteries increasingly power the world. For the first

time, researchers have imaged individual lithium ions, an achievement that could lead to better battery designs.

Researchers in the past few years have devised electron microscopes that can resolve most lightweight atoms and their charged counterparts, ions. Yet the lightest atoms—hydrogen, helium, and lithium—have remained out of sight.

For this reason, scientists have had to infer the internal structure of materials in lithium-ion batteries by combining information from techniques such as X-ray diffraction and theories of how materials form.

In these batteries, lithium ions diffuse in and out of the electrodes. "If you can see lithium at the atomic level, it's going to help us tremendously in understanding the way these materials work," comments Michael Thackeray, a battery researcher at Argonne National Laboratory in Illinois.

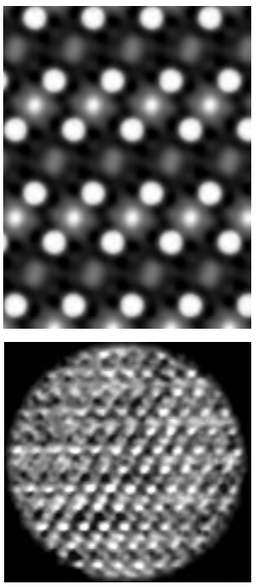
That, in turn, could lead to battery materials that produce more energy and can be recharged more times than can today's materials, says Yang Shao-Horn of the Massachusetts Institute of Technology.

In the July *Nature Materials*, Shao-Horn and her coworkers at Lawrence Berkeley National Laboratory (LBL) in California and the University of Bordeaux I in Pessac, France, describe how they produced a picture of the arrangement of atoms in the electrode material lithium cobalt oxide. Using a high-resolution transmission electron microscope at LBL, the scientists took 20 pictures of lithium cobalt oxide—each one deliberately defocused a little differently—with a nearly atomic resolution of 1.6 angstroms. Using image-processing tools, the team reconstructed from those pictures a much crisper image with a resolution of 0.8 Å.

The reconstructed image reveals for the first time individual lithium ions in the material.

The most significant revelations may lie ahead, says Shao-Horn. She and her colleagues now aim to modify their microscopy technique to image samples in which some of the lithium ions have been removed. So far, she says, the material has been too unstable for imaging when not fully filled with lithium.

Imaging vacancies that could host lithium ions is important for designing better battery materials, concurs John Spence, who works at both Arizona State University in Tempe and LBL but is not involved in Shao-Horn's research.



LITHIUM UP CLOSE A computer simulation (top) indicates the expected arrangement of lithium, cobalt, and oxygen atoms in an electrode. Actual electron microscope image (bottom) shows a similar pattern.

SHAO-HORN, M. O'KEEFE, AND NCEM

The effective resolution that Shao-Horn's group achieved opens the door for meeting another energy challenge. Says Spence, "This throws down the gauntlet to image hydrogen for hydrogen-storage materials." Such images may contribute to use of hydrogen as a clean-burning fuel. —J. GORMAN

New Guinea Went Bananas

Agriculture's roots get a South Pacific twist

Situated in the South Pacific islands, remote New Guinea seems an unlikely place for the invention of agriculture. Yet that's precisely what happened there nearly 7,000 years ago, according to a new investigation.

Inhabitants of this tropical outpost cultivated large quantities of bananas about 3 millennia before the arrival of Southeast Asian seafarers, say archaeologist Tim P. Denham of Flinders University in Adelaide, Australia, and his colleagues. Agriculture thus arose independently in New Guinea, the scientists conclude in an upcoming *Science*.

Until now, convincing evidence for ancient agriculture came only from the Middle East (*SN: 10/28/00, p. 280*), China, the eastern United States (*SN: 9/20/97, p. 180*), South America, and a region encompassing parts of Mexico and Central America (*SN: 5/24/97, p. 322*). Reports in the 1970s that New Guinea belonged in this group were criticized for relying on patchy remains and uncertain dates from an excavation of a swampy highland site called Kuk.

"Only a few regions were geographically suited to become homelands of full agricultural systems," says archaeologist Katharina Neumann of J.W. Goethe University in Frankfurt, Germany, in a commentary accompanying the new article. "New Guinea seems to have been one of them."

This discovery challenges the traditional notion that agriculture inevitably led to the rise of large civilizations with stratified social classes, Denham and his coworkers assert. Current New Guinea societies are relatively small and grounded in egalitarian practices, much as they seem to have been before the rise of agriculture, according to the researchers.

In renewed investigations at Kuk, which included radiocarbon dating of charcoal in separate soil layers, Denham's team identified three early phases of land use. Limited planting of bananas and digging of starchy taro roots in a plot abutting a drainage ditch occurred between 10,220 and 9,910 years ago. The researchers unearthed microscopic crystals from bananas and found starch grains from taro on the edges of stone tools.

From 6,950 to 6,440 years ago, cultivation expanded, say the researchers. The region's inhabitants built large mounds of soil on which they planted bananas, including a wild species from which the world's largest group of domesticated bananas later arose. Recent genetic research suggests that bananas were initially domesticated in New Guinea and subsequently spread to Southeast Asia, the scientists note.

Crop growing on New Guinea was further refined between 4,350 and 3,980 years ago. Networks of ditches connected to major drainage channels improved banana cultivation in the waterlogged setting.

Archaeologist Matthew Spriggs of Australian National University in Canberra, a critic of previous reports of prehistoric cultivation at Kuk, recruited Denham to direct the new investigation. "Denham's finds and further analysis of [the] earlier data have convinced me that there really [was] agriculture at Kuk as early as anywhere in the world," Spriggs says.

The New Guinea practices later moved west into Southeast Asia, in Spriggs' view. From there, a hybrid agricultural system featuring both New Guinea—based root crops and Chinese-based rice spread across the Pacific as far as Hawaii, Easter Island, and New Zealand, with root crops eventually gaining favor, Spriggs contends. —B. BOWER

Double Duty

Diabetes drug protects reopened heart vessels

A drug normally prescribed to hold blood sugar in check provides an unexpected benefit to heart patients, a new study from South Korea finds. In people who have undergone the blood vessel–opening procedure called angioplasty, the diabetes drug limits the propensity of vessels to close again, a chronic problem.

Moreover, this study and one done in the United States show that the drug, rosiglitazone, lowers blood concentrations of C-reactive protein, a compound that's been linked to heart problems.

Rosiglitazone, marketed as Avandia by GlaxoSmithKline of Philadelphia, is cur-

rently prescribed for type II, or adult-onset, diabetes because it helps insulin regulate how the body burns sugars (*SN: 4/14/01, p. 238*).

To test the drug's effect on reopened blood vessels, the Korean researchers identified 95 people, average age 60, with type II diabetes who were slated to receive angioplasty in coronary arteries. All the patients received pills to control high blood sugar. About half also got daily oral doses of rosiglitazone, while the others got a placebo. Both regimens started at the time of the angioplasty, a procedure in which the obstructed vessel is opened with a balloon-tipped catheter. The doctors also propped the vessels open by inserting mesh cylinders called stents.

After 6 months, 21 of 48 patients getting the placebo showed vessel blockage of at least 50 percent. In contrast, only 5 of 47 people getting rosiglitazone had that much obstruction, Sunghee Choi of Yonsei University College of Medicine in Seoul reported in New Orleans at a meeting of the American Diabetes Association this week.

The findings suggest the drug's benefits extend well beyond insulin regulation, she says.

Choi also noted that concentrations of C-reactive protein in patients getting the placebo were more than double those in the group getting rosiglitazone. C-reactive protein is elevated in people at high risk of heart attacks (*SN: 4/20/02, p. 244*) . Other studies have hinted at a link between C-reactive protein and diabetes (*SN: 8/31/02, p. 136*).

James W. Chu of Santa Clara Valley Medical Center in San Jose, Calif., reported at the same conference that his team gave rosiglitazone for 3 months to 29 people—half of whom had mild type II diabetes. The others had insulin resistance, a precursor condition to diabetes, although they were outwardly healthy. In both groups, the drug significantly lowered C-reactive protein concentrations in blood.

Because other studies have linked C-reactive protein to inflammation, the two new studies suggest that quelling inflammation—and thus slowing a rush of cells to the site of angioplasty inside a blood vessel—is central to rosiglitazone's effects against vessel blockage, Choi says.

While Choi's work represents "a fascinating study," it needs to be replicated in a larger group, says Richard Kahn, chief scientific and medical officer at the American Diabetes Association in Alexandria, Va.

Heart disease is the largest killer of people with diabetes. These studies represent steps toward "a unifying hypothesis" that will ultimately reveal the biological mechanisms linking diabetes, heart disease, and inflammation, Kahn predicts. —N. SEPPA

Spawning Trouble

Synthetic estrogen hampers trout fertility

When women take birth control pills, some of the hormones in the pills ends up in sewage effluent and waterways where it may be harming trout populations. Researchers now say that even short-term, low-level exposures to one such hormone, ethynylestradiol (EE2), can reduce a male trout's fertility by half.

Toxicologist Irv Schultz and his colleagues at the Battelle Marine Sciences Laboratory in Sequim, Wash., exposed three groups of adult male trout in tanks to different concentrations of ethynylestradiol for 2 months. All the trout exposed to 1,000 parts per trillion (ppt) of EE2 died of liver and kidney hemorrhages before the experiment's end. The two groups that were exposed to lower concentrations of the estrogen—10 and 100 ppt—appeared to remain healthy. However, further work showed EE2's effect on reproduction.

To measure fertilization rates, Schultz's team checked how many embryos were present 28 days after sperm were introduced to eggs from unexposed females. At this time, a trout embryo's eyes are visible, and the embryo is about to hatch. The scientists found that the sperm from unexposed males fertilized 45 percent of the eggs, while sperm from trout exposed to a mere 10 ppt of EE2 fertilized only 22 percent of the eggs. Ten ppt is at the upper end of the range of EE2 concentrations normally found in the wild.

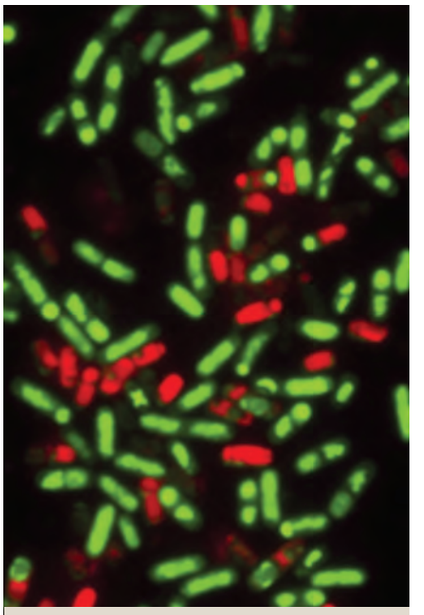
"I was surprised that such an incredibly low dose had a real effect on these animals—to the point where long-term population problems might exist," says Lou Guillette, a zoologist at the University of Florida in Gainesville.

In the June *Environmental Toxicology and Chemistry*, Schultz and his team say the lower fertility rates for the exposed trout seem paradoxical. These fishes' sperm were just as mobile as those of their unexposed counterparts, and the exposed trouts' sperm counts were higher.

"If you stopped at sperm counts, you'd conclude from this study that estrogens must be good for male fish," Guillette says. But the fertilization rates indicate that the opposite is true.

Guillette says this focus on fertility sets Schultz's study apart from previous EE2 studies with zebra fish and medaka. In those investigations, researchers used sperm count, gonad development, and liver size to measure EE2's effects. Schultz says that he did a fertility trial because he wanted "a more reproductively relevant" benchmark.

Still, Schultz says, these laboratory tests only hint at the complexity of what happens in the wild. EE2 is just one of an array of contaminants entering waterways from sewage systems (*SN: 3/23/02, p. 181*). Guillette speculates that the effect of EE2 on wild trout may be amplified, blocked, or otherwise altered when the hormone is accompanied by other compounds. "At this point, we don't know," he says. —S. MCDONAGH



LOSICK ET AL./SCIENCE

Attack of the cannibalistic bacteria

When the going gets tough, watch out for *Bacillus subtilis*. The green rods in this micrograph are living members of this bacterial species that have killed nearby *B. subtilis* members (red rods) for food. Like many soil-dwelling bacteria, *B. subtilis* forms a hardy spore when confronted with rough conditions. Before irreversibly committing to sporulation, however, some of these microbes secrete two proteins, Richard Losick of Harvard University and his colleagues report in an upcoming *Science*. One protein delays sporulation in adjacent *B. subtilis* members, and the second bursts the neighbors, liberating nutrients from them. This cannibalistic behavior is unusual. "It came as a big surprise because here the bacterium is making an antibiotic to kill its own siblings," says Losick. "It's fratricide." —J. TRAVIS

TARGET: CELIAC DISEASE

Therapies aimed to complement or replace the gluten-free diet

BY BEN HARDER

Not many kids can imagine a world without cereal, pizza, or cookies. But these are just a few of the foods that Stanford University biochemist Chaitan Khosla has had to teach his 6-year-old son to avoid. The boy has celiac disease, an inherited immune disorder, and it has sentenced him, for life, to refrain from eating anything that contains wheat gluten or similar proteins in barley and rye. In the boy's small intestine, those grain components would trigger a chain of events that can cause bloating, diarrhea, and malnutrition. Without the restricted diet, the condition can lead to fatigue, migraines, dermatitis, anemia, and osteoporosis.

Khosla's son isn't alone in enduring his gluten-free lifestyle. Although celiac disease was considered rare in the United States a decade ago, recent tallies indicate that it may affect as many as 1 in 150 people, or 2 million in all. Many people with the condition aren't properly diagnosed and suffer unexplained symptoms and potentially grave complications.

Before an astute pediatrician diagnosed celiac disease in Khosla's son, the researcher had never heard of the disease. Neither had his wife, although she'd had gastrointestinal and skin problems for years. "She was one of the hundreds of thousands of misdiagnosed [people] out there," Khosla says.

People in whom the disease is recognized must give up not only most grain-based foods but also soups, sauces, canned foods, and hundreds of other items. Manufacturers frequently add gluten to those processed foods, and they charge hefty premiums for products prepared instead with rice proteins or other innocuous additives.

After sugar, Khosla says, gluten is the second most prevalent food substance in Western civilization. At a typical supermarket, "chances are you're not going to be able to fill a grocery bag with gluten-free products," he notes. Raising a young child to be accordingly vigilant about what he or she eats is "gut-wrenching," Khosla says. If the pun is intended, his solemn tone doesn't betray it.

With the aim of releasing his son, wife, and other people from their strict, lifelong diets, Khosla and other scientists have turned their attention to therapeutic alternatives that could short-circuit the disease's development. The right drug might block the degeneration of the intestinal lining—the hallmark of celiac disease.

The researchers' latest findings offer new insights to the disease's biological mechanisms and an unprecedented understanding of at least three potential molecular targets for drugs.

The challenge ahead is to develop medications that can effectively strike these targets in the body. Although the trigger for symptoms comes from the diet, celiac disease—which is also called celiac (or coeliac) sprue, and gluten intolerance—is not an allergy. It's more similar to complex immunological disorders such as multiple sclerosis, insulin-dependent diabetes, and rheumatoid arthritis, for which effective drugs have proven difficult to develop.

Even if scientists can devise a drug for celiac disease, it might complement the gluten-free diet rather than fully supplant it. Nevertheless, Khosla maintains hope that a prescription pill for celiac disease will exist by the time his son goes to college, 11 years from now.

TAKING AIM Because gluten is a complex protein, normal digestion doesn't completely break it down. Surviving pieces called peptides come in contact with the lining of the small intestine and the molecules of the immune system there. Whether that molecular encounter results in the immune overreaction at the heart of celiac disease depends on the type of immune molecules present.

Nearly all people with the disease have one of two immune-molecule types: About 90 percent carry so-called DQ2 molecules, and most of the rest carry DQ8 molecules. Genetics determines whether a person has either or both of these disease-associated molecules. For reasons not yet understood, a few people develop celiac disease despite having neither DQ2 nor DQ8 molecules, and not all people with the molecules develop the disease.

Early in both normal digestion and the pathological cascade that marks celiac disease, an enzyme called tissue transglutaminase (tTGase) alters gluten peptides. When these altered peptides encounter DQ2 or DQ8 molecules in the intestine, they form molecular complexes that activate immune cells called T cells, which then mount an attack on the intestinal lining.

> Many people with celiac disease aren't properly diagnosed and suffer unexplained symptoms.

Under the assault, that stretch of the digestive tract becomes inflamed and loses the fingerlike projections, or villi, that normally provide a vast surface area for absorbing digested nutrients. Many of the symptoms of celiac disease, including malnutrition and anemia, develop in response to the small intestine's reduced effectiveness in absorbing nutrients.

To forestall this cascade from occurring when a person with the disease ingests gluten, a drug could potentially dismantle all gluten peptides into their individual amino acids. That approach essentially treats gluten as a pathogen, Khosla says, and aims to detoxify the protein before it can cause trouble. Since the feat would probably require some sort of peptide-destroying enzyme, or peptidase, researchers refer to this approach as enzymatic therapy.

Two alternative approaches to blocking gluten's toxicity would inhibit the activation of T cells by breaking other links in the pathological chain of events. A drug could bind up tTGase, or another might fuse directly to DQ2 or DQ8 and take them out of the action.

If a single therapy can't break a link in the chain, the best treatment might be a drug combination that weakens several links. A pill could theoretically deliver both enzymatic therapy to dismantle gluten peptides and compounds that inhibit tTGase, the disease-linked DQ molecules, or both, says Frits Koning of Leiden University Medical Center in the Netherlands.

Khosla and his colleagues have recently made progress on both

these fronts. To figure out which peptides are most important in celiac disease, he, immunologist Ludvig M. Sollid of the University of Oslo, and other researchers tested peptides left intact after the team exposed gluten to mammalian digestive fluids. Among the digestion-resistant products, they discovered a peptide of 33 amino acids that seems to be a major source of the problem.

The researchers recognized that, given the order of its amino acids, this large peptide contains half a dozen locations at which it can interact with tTGase and DQ2. That may give it "exceptional toxic potency" in celiac disease, the researchers suggested in the Sept. 27, 2002 *Science*.

Khosla and his colleagues then sought a way to neutralize the newfound peptide. In experiments in rats' small intestines, the scientists determined that a peptidase enzyme from the bacterium *Flavobacterium meningosepticum* rapidly breaks down the peptide. In the October 2002 *American Journal of Physiology*, they suggested that the bacterial peptidase could lead to an enzymatic treatment for celiac disease.

Looking also for an inhibitory approach to therapy, Khosla and several of his colleagues are investigating a way to bind up tTGase with an altered version of the recently discovered 33–amino acid peptide. Their artificial peptide differs by only one amino acid from the natural one, but it binds tightly to and thereby disables tTGase, the researchers report in the March *Chemistry and Biology*. That suggests that the artificial peptide could act as a tTGase inhibitor in the body, Khosla says.

Khosla's recent publications are "certainly the most significant immunological findings" on celiac disease in years, says immunologist Allan Mowat of the University of Glasgow in Scotland. Nevertheless, Mowat says in the April 12 *Lancet*, barriers remain before the new insights can be turned into therapies.

One barrier facing the enzymatic approach, he says, is the difficulty of formulating a pill so that it releases a peptidase at just the right time. The enzyme could stay inside an acid-resistant coating as it passed through the stomach, but if taken with a meal, it would need to emerge rapidly as it and the food enter the small intestine. Otherwise, gluten would make mischief before the peptidase could kick into action. However, a pill taken before a meal wouldn't remain in the intestine long enough to work.

Once in the right place at the right time, the enzyme would still need to penetrate the chemically complex mass of food being digested and find its specific molecular targets, Mowat says.

Even a peptidase that can knock out the 33–amino acid peptide might not fully preempt the immune response that defines celiac disease. Other amino acid sequences on other peptides also appear to trigger the pathological cascade, says Koning.

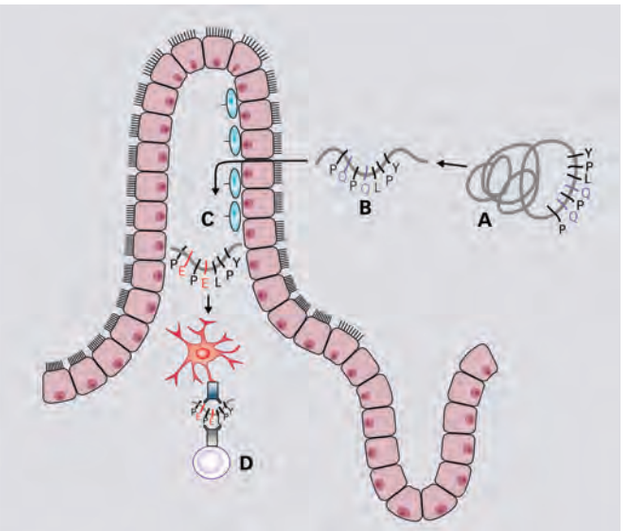
In the June 2002 *Gastroenterology*, he, Willemijn Vader, and their Leiden University colleagues identified several amino acid sequences on peptides that survive digestion and appear to trigger celiac disease in some children. In the September 2002 issue of that journal, Sollid and his colleagues described other amino acid sequences that act similarly in some adults. Exclusively targeting the 33–amino acid peptide, therefore, "is an oversimplification of the problem," Koning and Vader contended in the Jan. 24 *Science*.

A separate problem applies to the strategy of inhibiting tTGase. This enzyme plays an important role in the normal repair of the stomach lining, so inhibiting it might reduce the body's upkeep of that tissue and thereby cause intestinal bleeding, says Koning.

The safest possible therapy for celiac disease would probably be to block DQ2 and DQ8. Other immune molecules back up their functions in the body, Koning says.

Sollid, who helped identify the central role of DQ2 in celiac disease, agrees. Teams of researchers led by Khosla and Koning are currently focused on blocking DQ2.

However, Koning says, finding an effective inhibitor for DQ2 may take time because its binding site doesn't grab onto molecules as tightly as the tTGase binding site does. Given how few of the disease-triggering immune molecules it takes to cause trouble, a drug might need to bind to DQ2 1,000 times as strongly as the gluten peptide does, Koning says.



CELIAC LINKS — Digestion breaks down gluten (A) into peptides (B) that are absorbed by the small intestine. There, the enzyme tissue transglutaminase (C) modifies certain peptides, which are picked up by dendritic cells and, in people with celiac disease, stimulate immune cells (D) to attack the intestine.

MOWAT/LANCET

LONG PIPELINE With such hurdles ahead, Sollid and other researchers estimate that it will take at least 5 years, and probably about 10, to bring to market any new drug for celiac disease.

Given that timeframe, researchers shouldn't limit their current efforts to novel drugs, says John H. Griffin, chief scientific officer of Pharmix Corp., a small biotech firm in Redwood Shores, Calif. Numerous therapies that are already approved for other immune disorders of the gut—for instance, ulcerative colitis and the inflammatory bowel condition called Crohn's disease—might prove capable of serving double duty against celiac disease, he suggests.

Because drug development and safety trials are already complete for such drugs, they could be tested with "no delay between the idea and the experiment," Griffin says.

Unfortunately, at least one such attempt bore no fruit. In recent, unpublished experiments, Christophe Cellier of the Georges Pompidou European Hospital in Paris and his colleagues gave an anti-inflammatory drug designed to treat Crohn's disease to three people with celiac disease, who then abandoned their gluten-free diets. But Cellier quickly halted the trial when the volunteers developed symptoms of celiac disease, he told *Science News*.

Researchers did report in the Nov. 7, 2002 *Nature* that statins, typically used to combat heart disease, provided a benefit to some patients with the immune disorder multiple sclerosis. If statins achieve this effect by clogging the receptors of misbehaving immune molecules, they may also confer benefits in celiac disease, says Khosla.

Since celiac disease is a lifelong condition, any drug that can help people manage it could offer the company that provides it a steady stream of revenue, says Griffin. "Given the true size of the patient population . . . that's a substantial market opportunity," he observes.

Yet even the discovery of a therapy that alleviates apparent symptoms may not permit people with the disease to eat a normal diet, Griffin adds. Researchers would have to follow people for years to determine whether any treatment mitigates the long-term dangers as well as does the diet alone or combined with the drug.

Such obstacles aren't enough to discourage Khosla. He's motivated by his son's struggle through a childhood burdened by constant vigilance, occasional slips, and painful consequences.

Says Khosla, "When it's late at night and I have one more thing to do, that's what keeps me going." ■

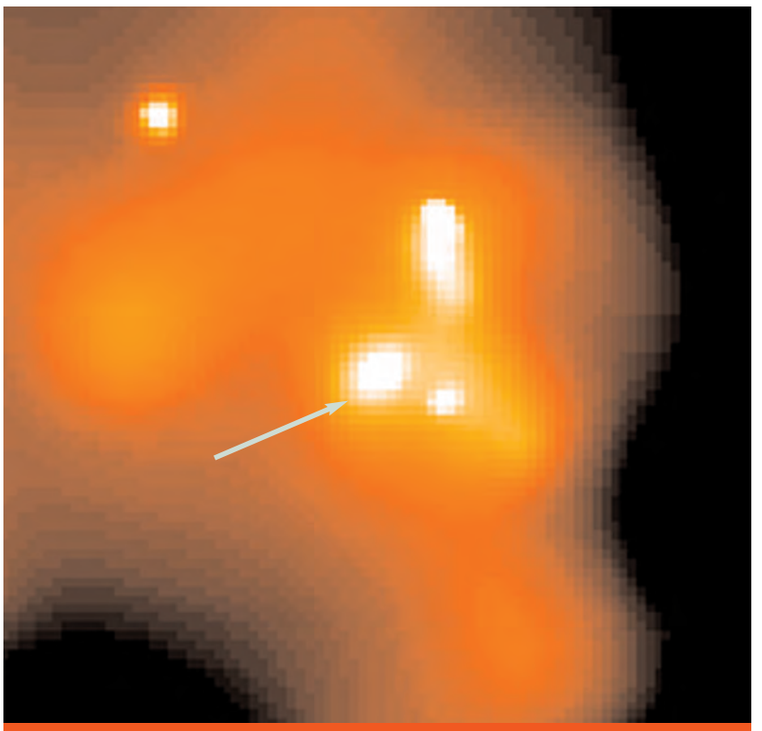
MYSTERY IN THE MIDDLE

A stellar riddle turns up at the Milky Way's core

BY RON COWEN

For nearly a decade, Andrea M. Ghez has tracked the motion of stars at the Milky Way's core. The great speed with which these centrally located stars whirl around provides the best evidence to date for the existence of an extremely dense and massive object—a supermassive black hole—right in the bull's-eye of the galaxy. Like most astronomers, Ghez, who is based at the University of California, Los Angeles, had assumed these closely orbiting stars were relatively old and lightweight.

Last summer, she had her first inkling that something was wrong with this picture. In June, the prime month for viewing the galactic center with the Keck Telescope's ultrasharp optics on Hawaii's Mauna Kea, her team took the highest-quality spectrum ever of any of these close-in stars. So puzzling were the results that the young astronomer passed up an opportunity last July to share the new data at a research conference. By August, however, Ghez was confident: The spectrum of the star dubbed SO-2 confirmed that it and the other stars circling near the galaxy's core are unusually young and massive—some 15 to 20 times as heavy as the sun. One of the stars lies as close to the galactic center as twice Pluto's distance from the sun.



BULL'S-EYE — X-ray image shows the region within 10 light-years of the center of the Milky Way. X-ray glow emanates from an extended cloud of hot gas surrounding the supermassive black hole at the galaxy's core, indicated by arrow.

NASA/MIT/PSU

Such stars have no business being anywhere near that close to the galactic center. Massive stars are short-lived. They burn their nuclear fuel so fast that they can last no more than 10 million years, Ghez and her colleagues note in the April 1 *Astrophysical Journal Letters*.

"These are stars . . . that are short-lived, in astronomical terms, in a region that's incredibly inhospitable to star formation," notes Ghez. "In fact, given our current understanding of how stars form and the properties of the galactic center, it's not allowed to happen."

Under ordinary conditions, no star could be born so close to a supermassive black hole. Stars arise from the gravitational collapse of cold clouds of mostly hydrogen gas. A typical cloud outside the galactic center has a diameter of 30 light-years and a low density. The tidal forces exerted by the supermassive black hole—the differences in the gravitational tug the black hole exerts on the different parts of such a cloud—would be so enormous that it would rip the cloud to shreds long before stars could emerge.

On the other hand, models in which massive stars are born at a safe distance from a black hole—about 100 light-years—and then migrate toward its galaxy's core have their own problems. Since massive stars last only a few million years, they should die out long before they complete the journey inward.

Making sense of the massive stars near the Milky Way's core "is a real challenge," says Reinhard Genzel of the Max Planck Institute for Extraterrestrial Physics in Garching, Germany. Genzel has tracked the motion of stars orbiting the galactic center since the late 1980s. Theorists, he notes, first began to worry a decade ago, when researchers found massive stars about a light-year out from the core. Now, with the find of apparently massive stars at one-hundredth that distance from the core's black hole, theorists are faced with a much tougher puzzle.

SUPERDENSE GAS CLOUDS There's an outside chance that stars might form in the immediate vicinity of a supermassive black hole, but the birthing process would be unlike any other known in the galaxy, says Mark Morris of UCLA. For example, if a gas cloud can compress to a million times the usual star-forming density, it should withstand the black hole's tidal forces and remain intact long enough to make stars.

If such a process actually unfolded at the Milky Way's center, however, the gas density would have to have been dramatically

"We need some kind of astronomical Botox, some way of making stars look young when they're, in fact, old."

—ANDREA M. GHEZ

larger 5 million to 7 million years ago, when the stars were forming, than it is today.

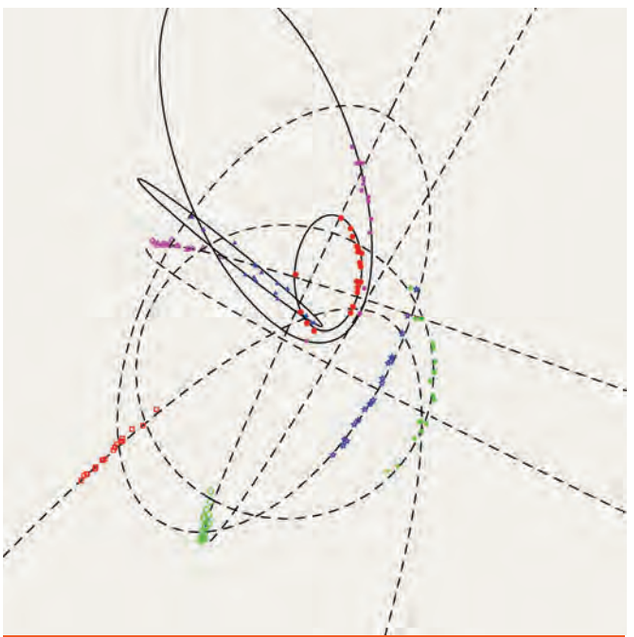
Nonetheless, Morris notes, there's a possible source for such gas clouds: a ring of gas, about 6 light-years in diameter, that encircles the galactic core. This ring might even be responsible for multiple episodes of star birth at the galaxy's center, he speculates.

As Morris envisions it, the gravity of the supermassive black hole lures the ring inward, compressing parts of the ring's gas to enormously high densities. When the ring approaches the center, its density might be high enough to form stars like the massive ones that astronomers have recently imaged.

Massive stars often have fierce winds, notes Morris. In the Milky Way, such winds might have pushed the ring back outwards, where it now resides. However, a few million years from now, after the massive stars at the core have died out and the winds have vanished, the black hole may pull the ring of gas back toward it, ripe for yet another round of star formation.

MIGRATING STARS For scientists who are reluctant to justify a change in the common view of how dense gas clouds near supermassive black holes can behave, there's another scenario. In this model, notes Morris, the stars now in the neighborhood of the supermassive black hole weren't born there.

The main challenge to this model is that if these massive stars formed beyond the gravitational grasp of the black hole, they must have traveled to the center in a hurry or they would have burned out. If each star were initially a member of a heavy, tightly bound cluster, however, this fast migration would be possible. A cluster that forms some 10 to 30 light-years from the core would lose energy as it passes through fields of stars and spiral rapidly inward, lured by the collective mass of all the stars and gas that lie closer to the galactic center. If the cluster were still intact as it came within 4 light-years of the core, within the gravitational grasp of the supermassive black hole, it would soon disintegrate, spilling its stars into orbits around the black hole.



GHEZ ET AL.; D. FIGER ET AL.

AROUND AND AROUND — Orbits of some of the stars closest to the supermassive black hole at our galaxy's center.

There's now evidence that such clusters exist. Over the past decade, researchers have found two stellar groupings that lie within 100 light-years of the galaxy's center. If such a cluster of stars were to migrate within a few light-years of the supermassive black hole, the black hole's tidal forces could split it up. In that case, the cluster's most massive members, now traveling solo or perhaps in pairs, would journey even further inward.

In an upcoming *Astrophysical Journal*, Andrew Gould of Ohio State University in Columbus and Alice C. Quillen of the University of Rochester in New York describe details of one such migration scenario. Their model focuses on the final step—a cluster of stars that rips apart as it comes within 0.1 light-year of the supermassive black hole.

CENTRAL CLUSTER — The Arches, a cluster of stars about 30 light-years from the galactic center, may be the origin of some of the seemingly young, massive stars circling the supermassive black hole at our galaxy's core.

The researchers calculate that for a massive star from that cluster to come as close to the galactic center as the stars that Ghez' and Genzel's teams have studied, it must have a partner several times as heavy, perhaps 60 times the sun's mass. The black hole at the galaxy's center will ultimately disrupt this pas de deux, and in some cases, will capture the lighter star into an orbit about 25 times as large as that of Pluto, Gould and Quillen say.

The most intriguing part of this model, notes Quillen, is that the massive, short-lived stars found at the galactic center may have had companions that were even more massive and therefore shorter lived. That would mean that the stars that now closely orbit our galaxy's supermassive black hole are widows of much more massive stars.

These survivors could harbor important clues about their former megapartners. Little is known about the evolution of such extreme heavyweights, but cosmologists speculate that such stars first lit up the universe almost 13 billion years ago.

After considering all the known populations of stars that lie near the Milky Way's core, Brad Hansen of UCLA and Miloš Milosavljević of the California Institute of Technology in Pasadena find that none can exert a strong enough gravitational tug to rapidly draw in a group of massive, short-lived stars born a few light-years from the core. Instead, the astronomers propose in an article posted online June 3 (http://xxx.lanl.gov/abs/astro-ph/0306074) the most likely gravitational source is an unidentified intermediate-mass black hole, some 1,000 to 10,000 times the mass of the sun. This middleweight, which would closely orbit the supermassive black hole, could easily form at the center of a dense star cluster that formed farther out and then sank towards the center, dragging young stars along with it, the researchers note.

Supporting evidence for an intermediate-mass black hole may come from high-resolution radio wave maps that track the motion of the supermassive black hole at the galaxy's core. Its motion across the sky would be slightly altered by the presence of an intermediate-mass black-hole companion, Hansen and Milosavljević suggest.

Making that model more credible is the first evidence for an intermediate-mass black hole residing near our galaxy's center. Morris and his collaborators have made as yet unpublished observations with the Chandra X-ray Observatory that hint that such a black hole resides about a light-year from the core, Morris told *Science News*.

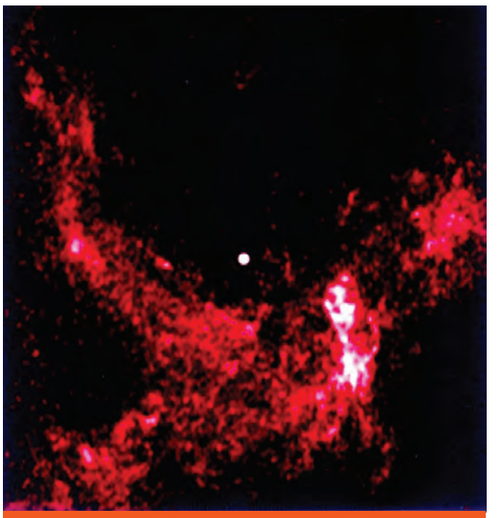
YOUTHFUL MASQUERADE In early May, Ghez latched onto another hypothesis that she thought might solve the conundrum of the central stars.

In this model, the stars that her team has observed aren't really young and massive. They just look that way. Because stars that have lower mass are much longer-lived, they could have formed far from the galaxy's core and then taken hundreds of millions of years to migrate there.

To flesh out this idea, Ghez says, "we need some kind of astronomical Botox, some way of making stars look young when they're, in fact, old." One potential mechanism for such a disguise intrigues Ghez: Bash together two elderly stars known as red giants. Although they're no more massive than the sun, these stars have bloated atmospheres. A collision would blast away the stars' atmospheres and expose their hot, bright cores. From a telescopic perspective, such a stripped-down star, which looks hot and bright, could well be mistaken for a young, massive star, notes Ghez.

The model would also appear to explain one puzzling feature of the stars nearest the supermassive black hole. No two orbits lie in the same plane. Multiple collisions involving red giants and other stars might yield the random orbits her team has observed.

But by early June, Ghez told *Science News*, she was no longer confident of that model's promise. Calculations by other astronomers have shown that red giants whose envelopes are stripped by collisions cool down in 10,000 years—a mere blink of an eye in astronomical terms. That means the youthful-looking stars that closely orbit the supermassive black hole are too hot to have formed this way.



CLOSE-IN STARS — Our galaxy's supermassive black hole appears as the bright spot at the center of this radio wave map of the central Milky Way. Streams of hot, ionized gas surround this feature, identified in radio wave maps as Sagittarius A*.

J.-H. ZHAO, M. GOSS

Furthermore, a closer analysis by Ghez and her colleagues has revealed that the orbits of the close-in stars are not random in all their properties. Although no orbit is in the same plane as another, all the orbits are elongated and many are elongated in roughly the same direction.

Researchers have proposed other explanations for how old stars at the galactic center may look young. In one model, several elderly, low-mass stars merge to form a single massive body that appears bright and young. A more exotic model posits the existence of small black holes not far from the supermassive one at the galactic center. Each of these black holes might attract gas and stars around it, creating a spherical atmosphere. To a telescope, the combination of a small black hole and an atmosphere could resemble a young star.

"Scientifically, this has been one of the most exciting few weeks of my life," says Ghez. "I've been bouncing ideas off colleagues, and we're all trying to come up with a [satisfying] theory."

Whatever the solution to the mystery of the massive stars in the galaxy's middle, the answer "is bound to be a new and incredibly interesting twist on how star formation and movement can take place in the extreme environment surrounding a supermassive black hole," says Morris. ■

OF NOTE

ASTRONOMY

Telescope spies a galactic satellite

A huge gas cloud once considered a remnant from when the Milky Way or nearby galaxies formed is, in fact, a satellite of our galaxy, new radio telescope observations indicate. Unlike most satellites of the Milky Way, the body is orbiting in the direction opposite that of the galaxy's rotation.

The object, known as Complex H, is crashing through the outer parts of the galaxy, reports Felix J. Lockman of the National Radio Astronomy Observatory in Green Bank, W. Va., in the July 1 *Astrophysical Journal Letters*.

Previous studies of Complex H were limited because the cloud is passing behind the galaxy's outer disk, where gas and dust block visible light emitted by the cloud. Astronomers had assumed the body was a so-called high-velocity cloud, a type of fast-moving mass of atomic hydrogen commonly found far from the galaxy. Such objects may ultimately be incorporated into the galaxy.

Complex H's radio emissions show that the object is much closer than high-velocity clouds and that its motion is tied to that of the Milky Way.

Observations with the Green Bank Telescope reveal that a diffuse tail trails Complex H's core. This structure supports a model in which the cloud is a Milky Way satellite whose outermost layers are being torn apart by our galaxy's gravity, says Lockman.

Complex H lies about 108,000 light-years from the Milky Way's core, stretches 33,000 light-year across, and contains 6 million suns' worth of hydrogen gas. —R.C.

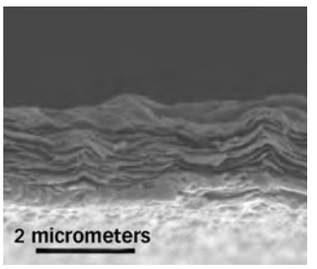
MATERIALS SCIENCE

Material mimics mother-of-pearl in form and substance

Gleaming, iridescent mother-of-pearl possesses more than beauty. The material, technically called nacre, has strength and toughness that materials scientists envy because it's made of highly ordered layers.

Now, researchers have designed a synthetic material that mimics both nacre's internal architecture and its strength.

Nicholas Kotov of Oklahoma State University in Stillwater and his colleagues modeled their material after natural mother-of-pearl, which gets its properties from a brick-and-mortar structure of calcium carbonate held together by a network of proteins. Natural nacre also benefits from so-called sacrificial ionic bonds between proteins, which break under stress but can reform.



STRONG AND BEAUTIFUL A scanning electron micrograph reveals layers in a mother-of-pearl imitator.

Kotov and his coworkers programmed a robot to dip glass slides in alternating solutions of a negatively charged clay known as montmorillonite and a positively charged polymer called PDDA, short for poly(diallydimethylammonium) chloride. This process built up hundreds of layers of clay and polymer, each one a few nanometers thick. The clay acted the part of bricks while the polymer played the mortar. What's more, the resulting film contained sacrificial bonds between PDDA chains. In mechanical tests, the material was as strong as nacre. The researchers describe their work in the June *Nature Materials*.

Kotov's team plans to improve the strength and other characteristics of the synthetic nacre. Eventually, the material could prove useful in the construction of artificial bones, body armor, and aircraft and automobile parts, Kotov says. —J.G.

BOTANY

Sun-tracking dads make better pollen

In a rare test of paternal behavior in plants, snow buttercup flowers kept from following the sun produced less-viable pollen than unfettered flowers did. Also, in maternal flowers receiving pollen, the grains germinated better if these blooms, too, were free to track the sun, according to Candace Galen of the University of Missouri in Columbia.

Sun tracking turns up in a handful of plant families, mostly among species in cold locales, says Galen. She and Maureen Stanton of the University of California, Davis study snow buttercups (*Ranunculus adoneus*) that poke flowers up through melting snow in the Colorado Rockies. The researchers left some blooms free and kept others from tracking the sun by slipping a drinking straw around their stems, constraining them in one orientation.

When researchers dabbed pollen from these flowers onto female flower parts, 32 percent more of the pollen from the solar trackers started growing pollen tubes toward the ovaries, compared with pollen from straitjacketed flowers. The boost in pollen power might come from higher temperatures or higher humidity within donor flowers that track the sun, Galen speculates.

In a similar test of maternal behavior, the researchers let insects do the pollen delivery. The team reports that 40 percent more pollen grains germinated in sun trackers than in blooms restrained at random angles. Another test suggested that this difference came not from the delivery of extra pollen, but from the effect of the flowers' orientation on pollen growth, the researchers say in the May *American Journal of Botany*. —S.M.

NEUROSCIENCE

Brain perks up to uncertain threats

The brain shows particular sensitivity to facial expressions that convey ambiguous threats rather than clear ones, according to a new brain-imaging investigation.

In their study, Reginald B. Adams Jr. of Dartmouth College in Hanover, N.H., and his coworkers assumed that an angry facial expression indicates a clear threat to an observer if it's combined with eyes looking straight ahead, but an ambiguous threat if combined with eyes looking away. They also assumed that a fearful face with eyes looking to one side indicates clearly to an observer where a nearby threat is located, whereas eyes looking directly at an observer from a fearful face portray a vague threat.

Functional magnetic resonance imaging of the brains of 11 adults supports this perspective, Adams' team reports in the June 6 *Science*. The left-hemisphere portion of the amygdala, an inner-brain structure regulating emotion, exhibited intense blood flow—an indirect sign of vigorous brain-cell activity—when volunteers looked at faces conveying the unspecified threats.

Modest amygdala activity occurred when participants viewed faces indicative of direct threats. The imaging data indicate that the brain takes special note of vague threats as it strives to identify just what the danger is, the researchers say. —B.B.

Z. TANG, OKLAHOMA STATE UNIVERSITY/NSF

GENETICS

Gene profiles might guide chemotherapy

Profiles of genetic variations in cancer patients could help oncologists predict the outcome of chemotherapy and, in some cases, indicate the most effective course of treatment, two new studies suggest.

Sarada Gurubhagavatula of Massachusetts General Hospital in Boston and her colleagues analyzed blood from 103 patients who had received chemotherapy for advanced lung cancer. The scientists looked for variations in two genes, dubbed *XPD* and *XRCC1*, that encode proteins governing DNA repair.

The scientists compared each patient's genetic profile with his or her progress against cancer while getting chemotherapy. The analysis revealed that 13 patients who had certain forms of both genes survived only 6.8 months on chemotherapy, while 26 people with the most common forms of both genes lived an average of 20.4 months. The remaining patients, who had versions of these genes that apparently compromised DNA repair only slightly, survived 11 to 17 months.

In another study, Mark Ratain of the University of Chicago reports that having one of two known forms of the gene *UGT1A1* precipitates a dangerous side effect in some colon cancer patients receiving irinotecan—a frontline chemotherapy drug. In these people, irinotecan induces a sharp drop in white blood cell count, a side effect that opens the door to infections.

Creating a genetic profile of a patient before treatment could avert this complication by revealing which patients shouldn't get the drug, Ratain says. He notes that the University of Chicago Medical Center has already started compiling some patients' genetic profiles. —N.S.

BIOMEDICINE

Early cancer therapy and heart problems

Numerous studies have indicated that children who receive certain chemotherapy drugs and chest-radiation treatments for cancer face a heightened risk of heart disease later in life. In a new study, researchers report that cardiovascular symptoms show up as early as 10 years after treatment.

Steven Lipshultz of the University of Rochester in New York and his colleagues documented the risk by examining 176 young-adult cancer survivors and 64 of their siblings who never had cancer. The former patients had been treated for leukemia, lymphoma, or another cancer an average of 15 years before the study.

Compared with their siblings, the cancer survivors had more signs of atherosclerosis, the accumulation of fatty plaques in arteries that underpins heart disease. The former patients also had significantly greater weakening of the heart muscle, a higher pulse rate, and higher blood concentrations of a compound called homocysteine that's linked with heart disease. They also were less physically active.

These differences were present even though most people in both groups were outwardly healthy and less than 21 years old—an age when doctors would expect to see few signs of heart disease, Lipshultz says. The indicators suggest the cancer survivors had heart damage and were working harder to maintain circulation, Lipshultz says.

The treatments received by the cancer patients included radiation to the chest and chemotherapy with drugs called anthracyclines. Previous research indicated that such treatments cause chronic inflammation that can damage heart cells, notes Melissa Hudson of St. Jude Children's Research Hospital in Memphis, Tenn.

Hudson says doctors today are better shielding children's hearts from radiation and giving them lower doses of anthracyclines than when the children in Lipshultz' study received treatment. —N.S.

IMMUNOLOGY

Cancer vaccine gets first test in patients

An experimental cancer vaccine given to 58 patients for whom all other treatments had failed induced an immune response in all of them, suggesting the vaccine can sensitize the body to the presence of tumor cells. This is the first human test of the vaccine.

One patient's colon tumor shrank under the therapy, and cancers of the colon, stomach, pancreas, breast, and lung in 22 other people stopped growing, says John L. Marshall of Georgetown University, who conducted the test with several colleagues.

The investigators gave the patients six monthly injections of a vaccine called TRICON, and then one shot every 3 months during the ongoing study, now into its third year. The vaccine uses a genetically engineered virus to carry genes for a protein called carcinoembryonic antigen (CEA) and three other proteins. When produced inside the patient, these proteins stimulate an immune response. Marshall says that CEA normally is displayed exclusively on the surface of tumor cells, making it a good target even though it's usually overlooked by the immune system.

When introduced via a vaccine, CEA draws the attention of the immune system's T cells. They then orchestrate an attack on all CEA-bearing cells. —N.S.

RADIOLOGY

MRI detects missed breast cancers

Women who carry a genetic mutation predisposing them to breast cancer should rely on magnetic resonance imaging (MRI) instead of mammography for their regular screenings, a new study suggests. But for women who don't harbor a mutation in either the *BRCA1* or *BRCA2* gene, the normal forms of which suppress cancer, the high cost of MRI may not be justified, says Christiane K. Kuhl of the University of Bonn in Germany.

Kuhl and her colleagues identified 462 healthy women who carry a *BRCA* mutation and tracked their breast health for 5 years. Such women face an 80 percent lifetime chance of developing breast cancer, compared with about 12 percent for women in general. During the study, 51 breast cancers developed in 45 of the women. MRI detected 49 of these cancers, whereas mammography revealed only 17, Kuhl reports.

In a separate study of 53 women with a *BRCA* mutation, MRI found some tumors that mammography missed and was better at revealing hard-to-detect precancerous lumps, says Mark E. Robson of Memorial Sloan-Kettering Cancer Center in New York. However, MRI also raised false alarms.

Doctors have used MRI to examine breasts for more than a decade, but the medical community has yet to agree on the technique's value in detecting cancer.

Because women harboring a *BRCA* mutation often have a family history of breast cancer, some receive frequent mammograms, which expose them to excessive radiation, Kuhl says. This could be particularly dangerous, she says, because a *BRCA* mutation may degrade these women's ability to repair radiation damage to DNA.

Robson balks at that. "It's unclear whether excess mammograms cause excess cancers," he says. While acknowledging that MRI has the ability to find hidden tumors, he remains hesitant to order it because of its cost and the risk of results indicating a tumor where there isn't one. —N.S.

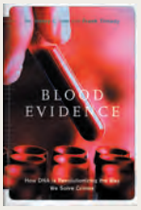
Books

A selection of new and notable books of scientific interest

BLOOD EVIDENCE: How DNA Is Revolutionizing the Way We Solve Crimes

HENRY C. LEE AND FRANK TIRNADY

Lee is best known for his testimony in the O.J. Simpson trial several years ago. However, he was also the chief criminalist for Connecticut for more than 20 years. During that time, he helped introduce

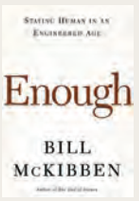


forensic DNA analysis as a routine and reliable category of evidence in criminal and civil cases, as well as a helpful tool in identifying human remains, tracking diseases, and establishing paternity. With writer Tirnady, Lee takes readers behind the yellow police tape at crime scenes to show them how genetic evidence is collected from cigarette butts and bloodstains. They explain the principles and science behind DNA testing. Moreover, they tell the history of how this science evolved over a short period and the implications for it in the future. ***Perseus Publng, 2003, 418 p., hardcover, $26.00.***

ENOUGH: Staying Human in an Engineered Age

BILL MCKIBBEN

Soon, we will be able to genetically modify a human egg or sperm cell with a change that will pass from generation to generation. Theoretically, we will be

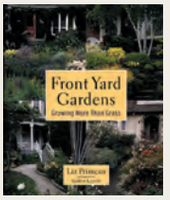


able not only to banish genetic diseases but also to manipulate our children's biology, beauty, behavior, and intelligence with ease. McKibben, the author of *The End of Nature*, argues that if we do these things, we will have gone too far. By allowing ourselves to be built rather than created, we will irrevocably change what it means to be human. Meanwhile, technological advances within the realms of robotics and nanotechnology pose other threats to humanity. For instance, we could build the machine that ultimately outwits us, he asserts. McKibben implores humanity to consider the greater good over individuals' desires to be stronger, faster, smarter, and live eternally. ***Times Bks, 2003, 271 p., hardcover, $25.00.***

FRONT YARD GARDENS: Growing More than Grass

LIZ PRIMEAU

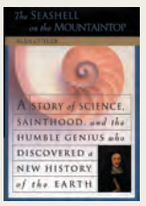
If you're tired of humdrum grass as a sole ground cover, then take a look at this guide featuring 70 different garden designs suitable for front yards. Although some people shy away from the care they think a yard full of blooms, evergreens, and wild grasses requires, Primeau reports that she and her husband have more leisure time since they turned away from time-consuming mowing, seeding, and fertilizing. According to Primeau, her garden requires some maintenance in spring but just irrigation throughout the summer. Opening chapters cover the history of lawns, then give step-by-step details of how to transform a yard of grass into a blossoming bounty of greenery that's both pretty and friendly to wildlife. Hundreds of color pictures bring these ideas to life. Plant lists and blueprints make replicating the pictures easy. Styles and designs are based on taste, as well as climate conditions. Primeau also provides tips for maintaining these plants and landscapes. ***Firefly, 2003, 232 p., color photos, paperback, $24.95.***



THE SEASHELL ON THE MOUNTAINTOP: A Story of Science, Sainthood, and the Humble Genius Who Discovered a New History of the Earth

ALAN CUTLER

In the 17th century, many people believed that the flood depicted in the Bible was responsible for washing seashells and fossils inland. For scientists



of the day, it was a nagging mystery. In 1668, a Danish scientist named Nicolaus Steno published a 78-page book outlining the concept of fossilization and how Earth's history lies within its strata, ideas that would set the course of modern geology. Steno was an established anatomist by the time this book was published. However, he converted to Catholicism, became a priest and eventually a bishop, and left his scientific pursuits behind. Eventually, his ideas, but not his name prospered in the scientific community. Today, he's known mainly as a saintly theologian who was beatified by the Catholic Church in 1988. Cutler weaves a compelling portrait of Steno's accomplishments on both fronts. In the process, he uses Steno's story to illustrate strife between church and science. ***Dutton, 2003, 228 p., hardcover, $23.95.***

WHAT GOOD ARE BUGS? Insects in the Web of Life

GILBERT WALDBAUER

Generally, we view insects as a nuisance. Yet, as a group, they support virtually every ecosystem by pollinating plants, serving as food for other animals, and disposing of dead organisms—just to name a few key tasks. In fact, of 775 tropical plants used as

food by people, 88 percent are pollinated by insects. Waldbauer is an entomologist with an unwavering verve for his pursuits. Here, he catalogs ecologically important insects by their "occupation" within an ecosystem, explaining how they live and how they make possible life in general. Among insects' occupations are their roles in regulating plant and animal populations and tilling the soil. In some cases, their capabilities and behaviors are nothing short of mind-boggling. Waldbauer reports that one species of Great Plains ants brought to the surface about 1.7 tons of subsoil per acre. He writes that an average colony of honeybees harvests 44 pounds of pollen and 265 pounds of nectar a year. Such anecdotes combine with the author's keen insight into the mechanics of ecosystems to make a strong case on behalf of the lowly insect. ***HUP, 2003, 366 p., b&w illus., hardcover, $29.95.***

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

LETTERS

Acid comment

"A Breath of Fresh Air: Bacteria rid sewage of its stink" (*SN: 5/10/03, p. 294*) could have been a little less disingenuous. It would still have been a very good article if you had used "sulfuric acid" instead of "odorless hydrogen sulfate" and admitted that the process still required a little alkali to neutralize this waste stream that is "carried away by water trickling over the foam."

JIM NOTTKE, PFAFFTOWN, N.C.

I would have liked it if the article had mentioned something more about where the bacteria for this were found. Do they occur naturally around us? Were they isolated from deep-sea hydrothermal vents?

RICHARD FELLOWS, PLEASANTON, CALIF.

The investigators used a mixture of naturally occurring bacteria from soil and other nonextreme environments. —J. TRAVIS

Hot stuff

In regard to natural causes of coal fires ("The Fires Below," *SN: 5/10/03, p. 298*), another cause not mentioned in the article involves the oxidation of pyrite, an iron sulfide that commonly occurs in coal beds. When oxygenated groundwater percolates through fractures in the coal, the sulfide in pyrite will be oxidized to sulfate. This reaction is exothermic and may produce enough heat to spontaneously ignite the coal.

BRUCE BARTLESON, GUNNISON, COLO.

Signs of struggle?

I'm doing an elk-calf mortality study in Yellowstone National Park. We can differentiate between scavenging and predation only by such evidence as signs of struggle at the scene, a trail of blood, evidence of a chase, and the pattern of flesh wounds. We cannot make the determination based on bone-consumption pattern alone. Therefore, I question that the researchers in "First Family's last stand" (*SN: 5/10/03, p. 302*) can be certain that the hominids were killed by large predators and not merely scavenged by them.

SHANNON BARBER, UNIVERSITY OF MINNESOTA, ST. PAUL, MINN.

Correction "Cancer Advance: Treatment combinations stall colorectal cancer" (*SN: 6/7/03, p. 358*) states that the anticancer drug bevacizumab, also called Avastin, hadn't stopped breast and kidney cancer in earlier trials. Although it failed in a breast cancer study reported in 2002, the drug showed some effectiveness in a 2001 kidney cancer trial.

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