SCIENCE NEWS
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RNAs on the brain
massive stars are heavyweights
identified by a hair
green light for solar cells

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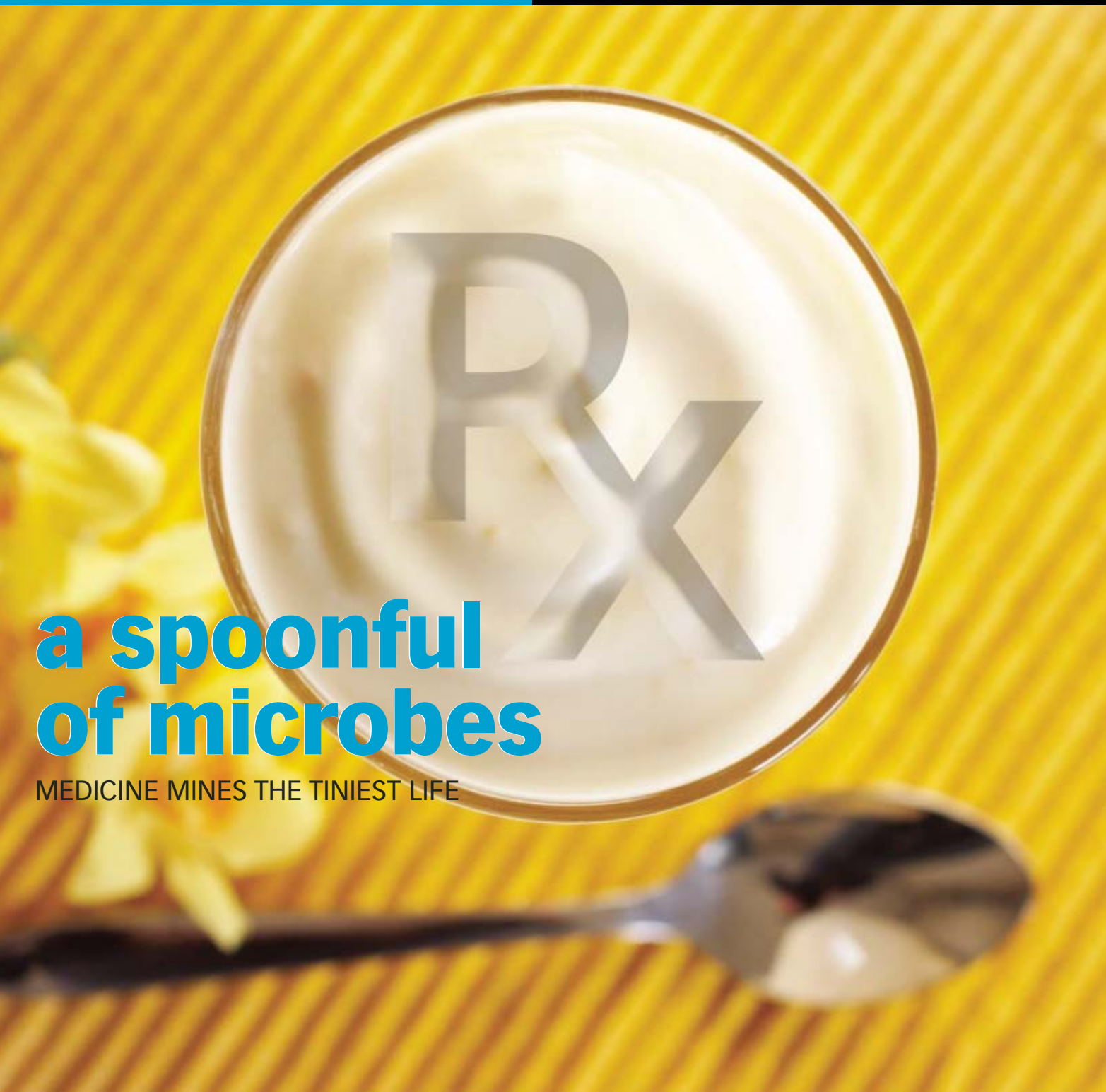

a spoonful of microbes

MEDICINE MINES THE TINIEST LIFE

SCIENCE NEWS
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This Week

Of Note

Meetings

Departments

Cover The bacteria that ferment milk into yogurt also perform a host of beneficial functions in the gastrointestinal tract. They are among microbes that can alter immunity, modulate the body's ability to mine nutrients, and more. How they achieve such varied feats can be far more subtle—and varied—than previously thought, new data show. (iStockphoto/E. Roell) Page 138

Hairy Forensics

Isotopes can identify the regions where a person may have lived

Judging people by their hair isn't shallow, it's sound science: The proportions of certain chemical isotopes in someone's tresses can help detectives pin down that individual's region of origin and recent movements, a new study suggests. The finding could be particularly useful in identifying the victims of crimes or mass disasters and in poking holes in the alibis of suspected criminals.

Water, made of hydrogen and oxygen, makes up more than half of an adult human's body weight. Via various metabolic processes, some of that water is broken apart and the constituent atoms are incorporated into body tissues, fingernails, and hair. Hair is made of keratin, a remarkably stable protein, so most of its hydrogen and oxygen atoms aren't readily lost to the environment. Because much of the water that people consume comes from the area where they reside, any variations in the concentrations of hydrogen and oxygen isotopes in that water should be recorded in the hair, says James R. Ehleringer, an environmental chemist at the University of Utah in Salt Lake City.

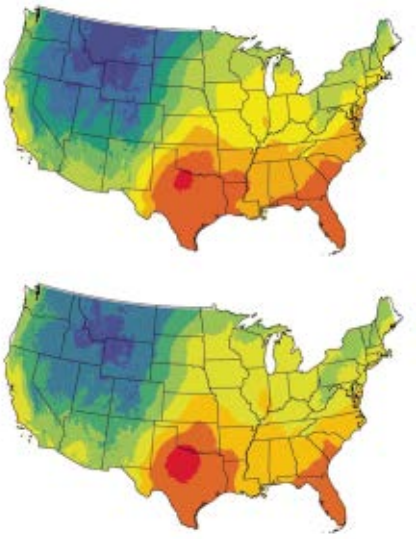
To test that idea, he and his colleagues collected random hair samples from barbershops in 65 cities in 18 states. Those cities are located in regions that span the full range of concentrations of hydrogen and oxygen isotopes found in tap water throughout the lower 48 states, says Ehleringer. Hair samples were presumed to have come from local residents.

Analyses suggest that about 27 percent of the hair's hydrogen and 35 percent of its oxygen come from local tap water. Overall, about 86 percent of the variations in the hair samples' hydrogen and oxygen isotopes derive from the isotopic signature of the local water, the researchers found. Although consumption of bottled water is increasing, much of the water in the liquids that a person drinks—including milk, sodas, beer, and reconstituted juices—are probably derived from local sources. Also, most food is cooked in local tap water.

The team's findings, presented last week in Washington, D.C., at a meeting of the American Academy of Forensic Sciences, also appear in the Feb. 26 *Proceedings of the National Academy of Sciences*.

Using a database of how isotopes vary in tap water across the continental United States, Ehleringer and his colleagues developed a model that estimates the concentrations of hydrogen and oxygen isotopes that would be present in the hair of people from various regions.

Concentrations of hydrogen and oxygen isotopes in hair aren't definite proof of a person's region of residence, because the concentrations may represent the isotopic signature of groundwater in several regions. Nevertheless, "this work could be especially valuable for helping law-enforcement authorities in limiting the search areas for the origins of unidentified human remains," says Jurian A. Hoogewerff, an isotopic chemist at the University of East Anglia in Norwich, England.



PNAS/NATIONAL ACADEMY OF SCIENCES

HOME RANGE New research predicts the average concentrations of hydrogen-2 (top) and oxygen-18 (bottom) that would be found in the hair of U.S. residents. Red depicts the highest concentrations of each isotope, blue depicts the lowest.

Wolfram Meier-Augenstein, an analytical chemist at Queen's University Belfast (Northern Ireland), agrees: "This [technique] doesn't allow you to find the needle in a haystack, but it reduces the size of the haystack." A similar technique enabled forensic anthropologists to narrow down the country of origin for many of the victims of the tsunami that struck southern Asia in December 2004 (*SN: 1/8/05, p. 19*).

Hair analysis also may offer a way to refute the alibis of suspected criminals. One hair sample that Ehleringer and his colleagues analyzed came from a donor who had recently moved from Beijing to Salt Lake City, a move chronicled in the hair that grew in the 6 to 8 weeks following the change in residence.

Hoogewerff's advice: "If you're a criminal, shave." —SID PERKINS

True Blue

Electron jumps make protein shine like an LED

A protein known to chemists for its bright blue fluorescence may not be fluorescent after all. Instead, it gives off light by a mechanism similar to that of light-emitting diodes (LEDs), chemists report. The finding suggests that some of the oceans' many bioluminescent animals may have been using the principle behind LEDs for millions of years.

The protein, antibody EP2-19G2, works in concert with an artificial organic molecule called stilbene, and is often used to label DNA molecules and to detect mercury contamination. Stilbene likes to lodge in a cozy hollow within the antibody's structure. When ultraviolet rays strike, they excite one of stilbene's electrons. In its free form, stilbene would then release its extra energy by letting a ring-shaped arm spin. But if stilbene is locked into place inside the antibody, it will instead release the energy by giving off a blue photon.

Scientists had assumed that this was banal fluorescence—an excited electron releasing a photon as it falls back to its normal state, says Richard Lerner of the Scripps Research Institute in La Jolla, Calif.

However, Lerner and his collaborators noticed that the antibody behaves differently than the common fluorescent dyes used in biology and chemistry labs do. For example, at lower temperatures it gives off less light, while fluorescent dyes give off more. Perhaps, the researchers thought, the luminescence could be the result not of an electron falling back to its lower-energy state, but of an electron jumping between molecules.

When an electron in stilbene jumps to an excited state, the lower-energy state is left with a void, Lerner explains. To fill the void, an electron could jump from the protein—specifically, from a tryptophan amino acid within it—to stilbene, leaving behind a positive charge. An electron would then jump from the stilbene to the tryptophan to fill that void. That electron would be jumping to a lower-energy state (in another molecule), and so emit the blue photon. This would make the complex an analog of LEDs—semiconductors that shine when a

voltage helps some of their electrons fall into positively charged spots.

To test this assumption, the researchers tried a mutant version of the antibody in which a different amino acid replaced the tryptophan. "If you took out tryptophan, the whole phenomenon disappeared," Lerner says, which points to the amino acid's role in luminescence. The chemical reactivity of the light-emitting mixture also indicates that electrons are jumping between the two molecules, the researchers report in the Feb. 29 *Science*.

Nicholas Turro of Columbia University says that non-protein organic molecules are known to emit light by transferring charges. This case is unprecedented because it is a protein and is orders of magnitude brighter.

If proteins can shine like LEDs, says Lerner, perhaps nature has already discovered the trick and has been using it all along. "In biology, everything that can happen, will."

Finding natural LEDs might be a long shot, says Mikhail Matz of the University of Texas at Austin. But, "we'll be on the lookout." —DAVIDE CASTELVECCHI

Hefty Find

Density has starring role in making stars massive

From their earliest moments, massive stars play the heavy. As infants, their fierce winds and harsh ultraviolet radiation tear away at the fragile gas clouds in which their lighter-weight cousins are born. Eventually, these behemoths explode, dumping vast amounts of energy into space along with an assortment of heavy elements.

Yet for all the drama, astronomers aren't quite sure how these rare, oversized stars form. Gas clouds—the material out of which all stars coalesce—typically divide into fragments much too small to make stars 10 to 100 times as massive as the sun.

In the Feb. 28 *Nature*, two theorists offer a partial solution to the puzzle. Mark Krumholz of Princeton University and the University of California, Santa Cruz, and Christopher McKee of the University of California, Berkeley, calculate that the gas in star-forming regions must have a minimum density in order to produce massive stars. The proposed threshold density not only explains the circumstances in which these stars form but accounts for their rarity, the researchers say.

HEFTY White dots in the central area are massive stars whose ultraviolet radiation disrupts the growth of hundreds of smaller stars in the nearby Orion star-forming region.

Gas density plays a key role because it mediates star formation's tug of war between gravity's pull and gas pressure's push. Gravity tends to break a large, star-forming gas cloud into chunks barely big enough to make sunlike stars. But the heat generated by these first, low-mass newborns increases the pressure in neighboring parts of the cloud, enabling them to resist breaking into such tiny pieces.

The larger fragments that are created would contain slightly more gas and therefore collapse to make a slightly more massive star—but still not enough to produce a true heavyweight. If the gas cloud has an unusually high density, though—packing roughly 100 times more mass than typical in the same small volume—then the larger cloud fragments could indeed produce stars many times as massive as the sun, Krumholz and McKee calculate. The density must exceed 100 times the usual density of a star-forming cloud, the researchers report.

Those densities are indeed attained in stellar nurseries known to contain massive stars, such as the Orion nebula and the Cygnus X region, Krumholz notes.

Observers are also providing new insight into the birth of massive stars. Using a submillimeter telescope to peer into 21 dense, massive star–forming regions, Henrik Beuther and his colleagues at the Max Planck Institute for Astronomy in Heidelberg, Germany, have for the first time found a chemical compound present throughout the process of massive star birth. The reactive molecule ethynyl (C_2H) persists, so its emissions can reveal the temperature, density, and other properties of massive star–forming regions, the researchers report in the March 1 *Astrophysical Journal Letters*.

Within a massive star–birthing region, "one usually finds one [gas] molecule at early evolutionary stages that then vanishes with time, whereas other molecules need time to form and are only found in later stages," notes Beuther. His team's findings suggest ethynyl "could be a very good tool to investigate the gas properties [from] the earliest stages of massive star formation."

Massive star–forming regions have a rich chemistry, but it has been difficult to fit all the chemical compounds "into some sort of evolutionary sequence," notes Krumholz. "The ethynyl result is very promising for this." —RON COWEN

Drug or No Drug

Placebos may be more than appeasing

Antidepressant drugs such as Prozac gen- erally fall short of providing significantly more relief to depressed patients than placebo pills do, according to a new analysis of multiple clinical trials obtained from the Food and Drug Administration (FDA).

Antidepressants substantially outper-

M. ROBBERTO/STSCI & ESA, NASA, ESA, AND THE HST ORION TREASURY PROJECT TEAM

form placebos only among extremely depressed individuals, says a team led by psychologist Irving Kirsch of the University of Hull, England. In these cases, relatively weak placebo responses, rather than any heightened reactions to antidepressants, explain the medications' superiority, the researchers hold.

"There is little evidence to support the prescription of antidepressant medication to any but the most severely depressed patients, unless alternative treatments with fewer side effects have failed to provide benefit," Kirsch says.

Alternative depression treatments with demonstrated effectiveness include physical exercise, several forms of psychotherapy, and even certain self-help books, in his view.

Kirsch and his colleagues obtained data from 47 clinical trials submitted to the FDA as late as May 2007. They then weeded out 12, focusing on 35 clinical trials that typically lasted 6 weeks and also showed substantial completion rates and consistent monitoring of depression symptoms. Those trials compared randomly assigned placebo treatment to treatment with any one of four antidepressants—fluoxetine (Prozac), venlafaxine (Effexor), nefazodone (Serzone), and paroxetine (Paxil).

A total of 5,133 depressed patients participated in the clinical trials.

The researchers statistically combined data from qualifying trials and calculated the extent to which antidepressants and placebos alleviated depression. Their findings, based on both published and unpublished data, appear in the February *PLoS Medicine*.

The placebo response "was exceptionally large," Kirsch says. Statistically, it accounted for more than 80 percent of the symptom alleviation observed in antidepressant-treated patients. Final depression scores for patients taking antidepressants generally did not indicate any greater effects than those observed for placebo patients, Kirsch holds.

For as yet unclear reasons, the placebo effect, while it remained substantial, was weaker in the most severely depressed patients.

All of the antidepressants, which belong to the newest generation of these medications, alleviated depression comparably well.

Still, the FDA data are from patients with a narrow range of scores on a standard depression-rating scale, Kirsch notes. These clinical trials focused primarily on patients who, at the start of treatment, scored as having "very severe" depression. Only a small number of patients started out with moderate to severe depression.

Future studies with data for patients with a wide array of depression scores might alter the results, Kirsch notes.

The placebo response identified in the new analysis parallels that reported in a previous assessment of FDA data directed by psychiatrist Arif Khan of the Northwest Clinical Research Center in Bellevue, Wash. The team analyzed 52 clinical trials of depression conducted between 1985 and 2000. Antidepressants outperformed placebos in only 25 of those trials.

Clinical trials recruit a select group of patients who, typically, are seriously depressed but not suicidal and not suffering from other psychiatric ailments, as often happens with depressed patients seen in clinical practice, Khan asserts. Thus, clinical trials don't negate the usefulness of antidepressant medication for depressed patients seen in physicians' offices.

Moreover, depression symptoms fluctuate over time, so it's hard to know whether changes observed in clinical trials reflect patients' spontaneous progress or deterioration.

Despite the drawbacks of clinical trials, "at this point, they're all we can rely on to assess the effects of antidepressants," Kirsch responds. —BRUCE BOWER

Greener Green Energy

Today's solar cells give more than they take

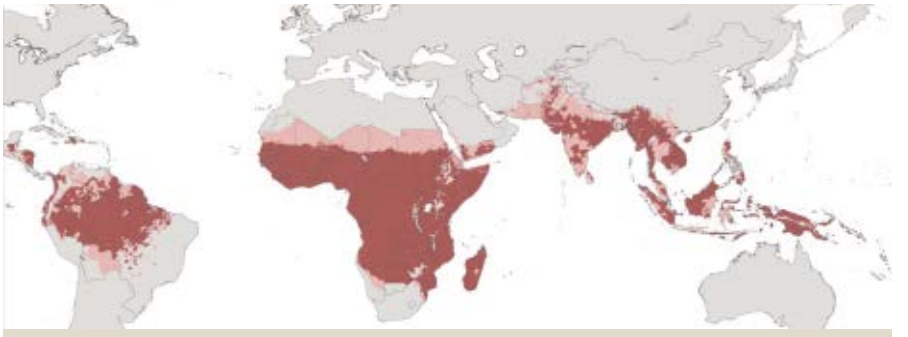
Solar power produces, per unit of energy, only about one-tenth as much carbon dioxide and other harmful emissions as does conventional power generation, a new study shows.

Solar panels don't release harmful gases during use, but making the solar cells does consume materials and energy—mainly from conventional power sources such as coal-fired power plants, which in turn produce emissions. Industrial techniques for making glass and other materials in solar panels also produce gases such as carbon dioxide.

In the 1970s, manufacturing a solar cell required about as much energy as the cell could produce over its 20-year lifetime, so using solar power provided little if any energy gain. Also, as recently as 10 years ago, total emissions from solar cells were about twice what the new study shows. "Solar power has been criticized in the past" for requiring too much energy to produce, says Vasilis M. Fthenakis of the Brookhaven National Laboratory in Upton, N.Y. "But what we find out is that those criticisms are not true with the new technologies."

Fthenakis and his colleagues compiled production records from manufacturers of four popular kinds of solar cells: multicrystalline silicon, monocrystalline silicon, ribbon silicon, and thin-film cadmium telluride. They calculated that, for each unit of energy produced by solar cells, the net emissions of greenhouse gases and other pollutants due to the cells' manufacture were between 2 and 11 percent of what power plants in the United States and the European Union would emit to make the same amount of energy, the scientists report online and in the March 15 *Environmental Science & Technology*.

The new tally shows that net emissions from solar power have decreased signifi-



MALARIA ATLAS PROJECT, PLOS MEDICINE

Pinning down malaria's global reach

Local governments and organizations that fund malaria research need proper maps of its spread to allocate resources effectively, but it has been 40 years since scientists last cobbled together an accurate worldwide view. Using data from more than 4,000 clinical surveys from 2002 to 2006, researchers have now assembled the up-to-date map shown here. Red shading identifies zones where people live at high risk of malaria caused by the parasite *Plasmodium falciparum*, which causes the most severe disease. Pink shading denotes where *P. falciparum* malaria is less frequent but still prevalent. Scientists at the University of Florida in Gainesville and at Oxford University–Wellcome Trust in Nairobi, Kenya, and Oxford, U.K., note that roughly 2.4 billion people live in these at-risk areas. Their report appears in the February *PLoS Medicine*. —NATHAN SEPPA

cantly in recent years. "There have been studies before, but they've become outdated because technology has been changing," says Fthenakis, the study's lead scientist.

"It's a really solid piece of analysis," comments Robert M. Margolis, senior energy analyst at the National Renewable Energy Laboratory in Washington, D.C. "It's the most up-to-date analysis on solar that's out there."

Much of the improvement is from reducing energy and materials for making solar cells. Compared to those made in the 1970s, modern panels contain about one-third as much purified silicon, which is energy intensive to make. And thin-film solar cells trim back even further by depositing silicon or other materials in layers only a few thousandths of a millimeter thick.

These improvements in efficiency mean that today's solar panels can "pay back" in only 1 to 3 years the energy needed to make them, the study concludes.

Improvements in manufacturing efficiency could reduce emissions from solar power by another 50 percent within 5 to 7 years, the researchers say. —PATRICK BARRY

Digging that Maya blue

Before plucking the hearts from humans and tossing the bodies into the sacred cenote, the sacrificial well, the Maya of Chichén Itzá painted their offerings blue—Maya blue. The process for making the unusual pigment, also found on pottery, sculpture, and murals from roughly 400 to 1519, has long puzzled researchers. Now an analysis of a 600- to 700-year-old pot (above) found in the well suggests that the pigment was made on the spot during ceremonies honoring the rain god Chaak. Indigo and palygorskite, a mineral clay, were probably heated over a fire of copal, a gummy incense derived from tree resin, says Dean Arnold of Wheaton College in Illinois, who led the study, to appear in the March issue of *Antiquity*. —RACHEL EHRENBERG

KRILL ZONE **This female krill, full of eggs, from the surface waters of the Southern Ocean belongs to the same species glimpsed 3,000 meters down, researchers say.**

Hidden Depths

Antarctic krill startle deep-ocean scientists

Biologists looked into the abyss and the abyss looked back, with lots of little compound krill eyes.

The shrimplike Antarctic krill, a major player in polar ecosystems, is supposedly a creature of the upper ocean. Yet the first science cruise to lower a camera to the abyssal seabed of the Southern Ocean off Antarctica found what looked like krill 3,000 meters down, says Andrew Clarke of the British Antarctic Survey based in Cambridge, England.

The cruise, during the South Pole summer of 2006–2007, inaugurated the United Kingdom's remotely operated, camera-carrying Isis vehicle. Clarke says that he and several other biologists were just piggybacking on a mission primarily designed for glaciologists and geophysicists to examine the deep continental slope and seabed beyond.

By that time of year, photosynthesizing plankton have multiplied in a great burst at the surface of the ocean and drifted down. When the scientists lowered their camera to the sea bottom, they saw a layer of still-green plankton-fall—and the krill feeding on it. These animals were the classic Antarctic krill species, *Euphausia superba*, say Clarke and Paul Tyler of the National Oceanography Center in Southampton, England, in the Feb. 26 *Current Biology*.

The Antarctic krill species matures to 6 centimeters in length, a giant among krill kind, and its red markings show up in the Isis video. The animals, including females ready to spawn, even made nosedives into the sediment, a behavior seen in shallow water that sends up puffs of fallen plankton. The krill then scooped debris out of the water with spiny structures on their legs, held to form what biologists call a feeding basket.

Based on the video evidence, "there isn't really much else it could be" other than the Antarctic krill, says Stephen Nicol of the Australian Antarctic Division in Kingston, Tasmania. Previous camera missions at some 600 m down have sighted these krill now and then, he says.

With so few observations of krill in the deep, biologists can only speculate about what's going on. Nicol says krill swarm in ravenous schools at the surface, reminding him of locusts. He guesses that krill feeding on a plankton bloom may have just kept eating as their lunch sank.

"Maybe what you've got is another link between the bottom and the surface," Nicol says, a matter of import in the study of nutrient cycling. If masses of krill routinely do this, the already uncertain estimates of their population could be even more so, he adds.

"I have heard rumors about this finding," e-mailed Peter Wiebe, of the Woods Hole Oceanographic Institution in Massachusetts, who is currently shipboard on a krill survey cruise. "If the observation proves true about the krill at 3,000 m, then it shows how little we really understand about how the ocean ecosystem is structured and functions." —SUSAN MILIUS

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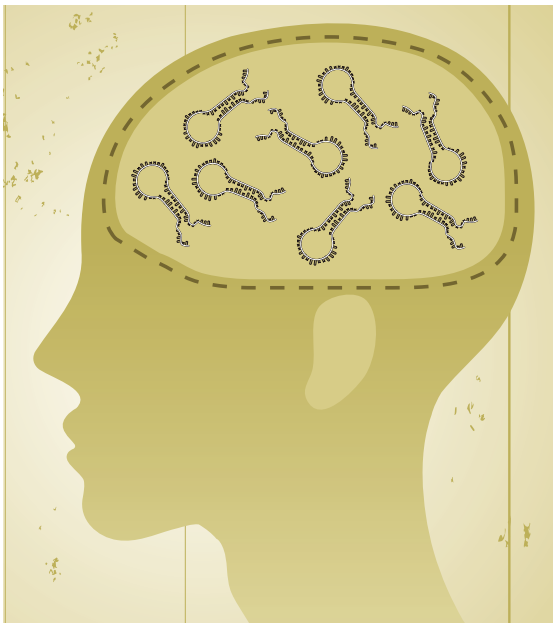
MICROMANAGERS

New classes of RNAs emerge as key players in the brain

BY TINA HESMAN SAEY

RNA compels Georges St. Laurent III to go to the gym. The genetic molecule inspires him to eat right and take care of himself. His efforts are all aimed at maintaining the delicate machinery housed in his cells.



But while he cares for his body, it's the supercomputer in his brain he's really trying to preserve. After all, the human brain is evolution's finest achievement, says St. Laurent, a computational and molecular biologist at George Washington University in Washington, D.C. And while many have focused on the import of DNA's genetic information, he believes that DNA's chemical cousin, RNA, is the true hero.

"All of the finer capacities that we have—to play an instrument, make art, do science" we owe to RNA, St. Laurent says. "If we didn't have these little RNAs floating around [in the brain], we wouldn't be able to remember mathematics or color patterns."

Many people regard ribonucleic acid, as RNA is formally known, as "just a middleman between DNA and protein," says Claes Wahlestedt, a neuroscientist and genome researcher at the Scripps Research Institute in Jupiter, Fla. Shuttling genetic information from DNA to a cell's protein factories has long been recognized as RNA's day job, summarized in the mantra that "DNA makes RNA makes protein." Historically, RNAs that don't encode proteins have gotten about as much respect as Rodney Dangerfield.

In recent years, though, scientists have discovered an extended family of RNA molecules that perform various crucial jobs in the cell's information technology department. In fact, Wahlestedt, St. Laurent, and a growing number of other researchers think that noncoding RNAs hold the information necessary to create and maintain human brains. Without noncoding RNA, the human brain would be unthinkable, St. Laurent says.

The human brain is dynamic, containing roughly 100 billion neurons, each one with up to 100,000 synapses connecting it to other neurons.

"All those synaptic connections are constantly being remodeled by environmental interactions," says Mark Mehler, a clinical neurologist and molecular biologist at Albert Einstein College of Medicine in Bronx, N.Y. "Every millisecond of your life you have millions and billions of sensory inputs" converging on the brain.

Mehler has devoted himself to understanding how the brain works and learning to fix it when it breaks down. He long ago decided that the only way to heal an ailing brain is to coax specialized stem cells to replace damaged, dying, or dead brain cells. But the task isn't easy. The brain contains thousands, if not millions, of specialized cells. Reprogramming millions of cells using the toolbox of just 20,000 or so protein-coding genes contained in the human genome seems like an impossible task.

"The math just doesn't add up," Mehler says. "There's just not enough molecular diversity" in proteins to create the complexity of the brain.

"For a while, I despaired of ever being able to even think about this in my lifetime in a rational way," Mehler says. Then he heard about noncoding RNA.

CONTROL FREAKS Some researchers estimate that as much as 98 percent of the human genome is copied into RNA, says Sofie Salama of the University of California, Santa Cruz. That figure is vastly different from what was originally postulated. Initial observations of the genome showed islands of protein-coding genes separated by vast oceans of DNA—sometimes called junk DNA—where nothing happened. That would mean that only about 2 percent of the human genome is transcribed into RNA. But recent efforts to map all of the RNA transcripts show that virtually every base pair of DNA in the human genome is copied into at least one RNA molecule, and sometimes more.

"The big question is, 'Is this transcription meaningful?'" Salama says.

More than 20 classes of noncoding RNA have been discovered in the past decade. Many of these RNAs are much smaller than their protein-coding cousins, the messenger RNAs. Some noncoding RNAs contain a mere 20 nucleotides, the chemical units corresponding to letters in the genetic alphabet. Scientists used to throw away such short bits of RNA, thinking the tiny pieces were nothing more than breakdown products of larger molecules—basically garbage, Wahlestedt says.

Researchers now know that noncoding RNAs get involved in virtually everything that happens in or to a cell, St. Laurent says. The molecules are control freaks, touching every piece of cellular machinery. They monitor temperature, chemical conditions, electrical currents, and other signals from the environment and then tell the cell how to respond.

One class of noncoding RNAs, known as microRNAs, modulates production of proteins. MicroRNAs get their name from their minuscule size—most are only about 22 nucleotides long. These short pieces of RNA find and bind to complementary sequences in messenger RNAs. Usually that binding causes the ribosome, the protein-building machinery in a cell, to grind to

ISTOCKPHOTO/S. NORCROSS

a halt. The ribosome remains paused until other signals allow it to resume making protein or until the RNA message is destroyed.

Each microRNA can have multiple targets. Computer searches have predicted that a single microRNA could bind to hundreds to thousands of different messenger RNA sequences, although scientists don't know how many of those possible targets are actually used.

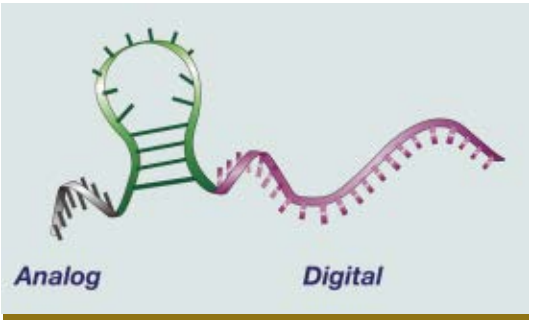
"It's not only important that you make a particular protein, but when and where you make it," Salama says.

The brain is one place where such precise control of protein production is crucial.

NEURAL REMODELING Protein production at the synapses where neurons connect in the brain is vital for learning and memory, says Gerhard Schratt, a molecular neurobiologist at the University of Heidelberg in Germany, in the Nov. 2 *Scientific World*.

To study how connections between neurons are strengthened or weakened, Schratt and his colleagues examined the growth of spines on dendrites. Dendrites are the branchlike extensions of neurons that receive signals from other neurons. Spines look like leaf buds on the dendrite branches.

Receptors for neurotransmitters are located within the spines, which form part of the synapse. The spines are also believed to be repositories for memories, Schratt says. When incoming messages from another neuron stimulate the spine, its protein production is turned on and it grows. The total volume of the spine correlates with the strength of the synapse, Schratt says.



DATA PROCESSORS — Noncoding RNA molecules are versatile conveyors of information in cells and can carry both analog and digital messages.

But just as synapses can be built and strengthened, irrelevant connections can be severed and dismantled. The connections between neurons are constantly being remodeled. And each spine on a neuron can behave independently of its neighbors, making the problem of where and when to synthesize which proteins of critical importance. Strengthen the wrong synapse and you could form a faulty memory. Sever important connections and you'll forget something you should have remembered.

Schratt and his colleagues looked for molecules that control production in space and time in the dendritic spines. The researchers found a microRNA called miR-134 that is made only in the brain. miR-134 binds to messenger RNAs from at least four different genes and probably many others, Schratt says.

Scientists still don't know how microRNAs find their way to the proper location in the neuron, Schratt says. He sees two possibilities: microRNAs may hitch a ride on their target messenger RNAs already heading for the spines. Or precursors of the microRNAs may contain homing signals that guide the molecules to the correct spot, bringing their target messages along, he says.

Although some of the details of how microRNAs direct protein production in spines remain fuzzy, the big picture is clear. "You need these micromanagers to be able to respond correctly," Schratt says.

BRAIN POWER RNA is an energy saver. Tremendous amounts of energy are required to get a protein to change its shape. RNA is more efficient. Each shape shift requires only about one-fifth of the energy it takes to force a protein into a new conformation, Mehler says.

Those energetic considerations are no small matter when you're trying to build a better brain. If RNA wasn't so "green," humans would never be able to generate enough energy to power the brain. Evolution probably would have stalled at brains about the size and complexity of a mouse's, Mehler says.

Indeed, there is some evidence that noncoding RNAs might be responsible for the emergence of the human brain.

Salama's team was looking for regions of the human genome that had been conserved throughout most of evolution, but contained changes that separate humans from chimps and other mammalian relatives. The researchers reasoned that such DNA sequences could be genes that were once important in our ancestors, but are no longer required in humans and so have become inactive and riddled with mutations. Or, just the opposite: the sequences could be responsible for making humans human.

The researchers found 49 such sequences, called HARs for "human-accelerated regions." About a quarter of the sequences are located next to genes known to be involved in brain development.

One sequence contained more changes than any other, making it the fastest-evolving region of the human genome. The researchers dubbed it HAR1 and discovered that the region gives rise to two different noncoding RNAs—*HAR1F* and *HAR1R*.

In a stretch of the HAR1 DNA only 118 base pairs long, the researchers found 18 differences between the human sequence and the chimp sequence. A region of that size should have only one mutation if it were evolving at the same rate as the rest of the genome. Some of the mutations altered hairpinlike structures in the RNA. Other mutations caused changes in loops of RNA that may be responsible for interacting with proteins or environmental triggers.

If HAR1 were in a protein-coding gene, it almost certainly would not have undergone as many changes, Salama says. It is very difficult to make changes without damaging a protein's function. But RNA is more forgiving of alteration. The pool of noncoding RNA in a cell may be fodder for evolution, Salama speculates. But that doesn't mean that RNAs can change forever without consequences.

Scientists don't yet know how *HAR1F* works but do know that it is found with a protein called reelin in a group of brain cells called the Cajal-Retzius neurons. The neurons are important for establishing the six-layered structure of the cortex, the outer layer of the brain.

HAR1 may be involved in laying down the six layers of cortex properly or it could have helped expand the surface area of the cortex in humans, giving more room to think, Salama theorizes.

The last changes to HAR1 happened about 1 million years ago, she says. That means Neandertals and early human ancestors likely carried the same form of HAR1 as modern humans.

"HAR1 is probably not the thing that makes *Homo sapiens Homo sapiens*, but it could be important for being *Homo*," Salama says.

RNA can also act as translator between the digital language of genetic material and the analog type of information contained in protein shapes, ionic concentrations, and other environmental signals, St. Laurent and Wahlestedt propose in the December *Trends in Neurosciences*.

Noncoding RNAs, such as the heat shock RNA, contain a sequence of bases that can pair with other bases. The pairing of bases is an on-or-off proposition, in other words, binary information. But RNA can also bend into many shapes, which can change with conditions. That gives it analog capabilities too.

The heat shock RNA changes conformation with only a 3 degree change in temperature. The shape change allows heat shock proteins to bind the RNA, setting off a cascade of reactions designed to protect the cell from heat, St. Laurent said.

For the brain to function, billions of such reactions must take place in every neuron every day. It's a staggering engineering feat, Mehler says.

And nothing but RNA has the power, sophistication, and subtlety to perform all the tasks required for this feat, both RNA aficionados say. St. Laurent and his ilk hope the underappreciated molecule will soon get its due. ■

M. MAZAITIS

NURTURING OUR MICROBES

Stewardship of the life teeming within us can pay health dividends

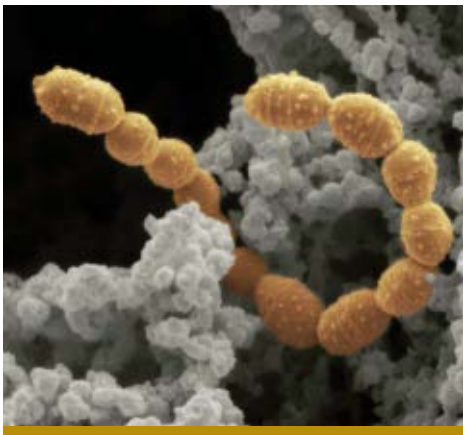
BY JANET RALOFF

Each of us is a metropolis. Bustling about in everyone's body are tens of trillions of microbes. Some are descended from starter populations provided by mom during birth. Additional bacteria, yeasts, and other life forms hitchhike in with foods. By age 3, everyone's gut hosts a fairly stable, yet diverse, ecosystem.

Most of the tiny stowaways hide out in the gastrointestinal tract—the gut—stealing a share of everything we eat or drink. But that's only fair, because most of these bugs give as good as they take, explains microbiologist Jeffrey I. Gordon. They not only help us digest food, he says, but they also harvest nutrients, manufacture certain vitamins, kill germs, neutralize bacterial toxins, and modulate the immune system. Sickness, antibiotic therapy, or stress, however, can disrupt the ecological balance among gut dwellers—known as flora—diminishing their benefits.

Because these benefits are vital to health—and to averting disease—drug manufacturers are eyeing gut microbes as potential therapeutic targets. In the future, "pharmaceutical companies might be drugging your bugs, not drugging you," suggests Jeremy Nicholson of Imperial College, London.

In the meantime, over-the-counter therapies exist to bug, not drug, the bugs. Known as probiotics, these yogurts and other foods or dietary supplements introduce or replenish beneficial gut species in the digestive system (*SN: 2/2/02, p. 72*).



MICRO PHARMACY — This scanning electron micrograph of yogurt shows bacteria that can both make lactic acid and, in some cases, promote health.

MEDISCAN/CORBIS

Probiotic microbes' role in fighting generic diarrheal disease is old hat, but in the past decade, other influences on human immunity and metabolism have emerged. Certain microbial supplements show the potential to reduce the severity of colds and other infections, temper body weight, and even help the elderly fight osteoporosis.

The rub: Research is showing that a probiotic's benefits can be very specific. In fact, it might be more appropriate to view these microbes as a cornucopia of diet-based, over-the-counter micro-pharmacists—each able to dispense only a few therapies or services.

But for all the promise that probiotics offer, they're no panacea, many researchers caution, and may even exhibit disturbing effects (see sidebar). Within a given species, some strains may confer health benefits, others may not.

Yet when the right bug is ingested for a particular condition, even a small dose can trigger dramatic health benefits.

DINING PARTNERS "The total number of microbes associated with our adult bodies exceeds the total number of our human cells by a factor of 10," says Gordon, of Washington University in St. Louis. So effectively, "we're sort of a superorganism—one that's 90 percent microbial."

Other animals have evolved a similar symbiosis with—or even dependence on—gut microbes, the scientist notes. Rodents born by cesarean section (so they get none of their moms' intestinal flora) and raised under germfree conditions end up smaller than normal, his group found—despite eating "about 30 percent more food than their microbe-laden counterparts."

Germfree animals not only appear less efficient at harvesting calories, he explains, but also "are prone to certain vitamin deficiencies" because gut microbes synthesize certain nutrients, such as vitamins B_{12} and K.

Gut flora also help the body mine minerals from the diet. "We have measured this for calcium," says Jürgen Schrezenmeir of Germany's Federal Research Center for Nutrition and Food, in Kiel.

His team showed that supplementing rats' diets with a probiotic strain of bacteria, *Lactobacillus acidophilus*, kept the animals from losing bone, a symptom of early osteoporosis.

This probiotic, renowned for its copious production of lactic acid, occurs naturally in some yogurts and other fermented dairy products. Bonus intestinal acid should increase the solubility of several minerals, including calcium, Schrezenmeir explains. Extra lactic acid should also spur the growth of cells lining the gut, he says, creating a bigger cadre to sop up released minerals.

To test these hypotheses, his group removed the ovaries from 6-month-old female rats. The ensuing drop in the rodents' production of estrogen mimicked the hormonal environment of postmenopausal women. Over the next 16 weeks, the rats began losing bone, modeling what happens in many elderly women. However, calcium uptake from the diet was somewhat higher—and bone loss somewhat reduced—in animals given *L. acidophilus*.

Calcium uptake and bone mass improved even more when the researchers simply supplemented the animals' diet with a material on which lactic acid bacteria prefer to feed. That supplement—known as a *pre*biotic—contained carbohydrates that only bacteria can digest.

Rodents receiving both prebiotics and probiotics retained the most bone and dietary calcium, the German team reported in the March 2007 *Journal of Nutrition*. Indeed, the combination restored bone mineral density and bone structure to about the level in rats with intact ovaries, Schrezenmeir says.

TUNING IMMUNITY Probiotics are usually promoted as supporting intestinal health—a polite way of hinting that they may reduce the risk of diarrhea or bloating. Far less appreciated is the broad range of immune conditions for which they show promise.

The gut "is the body's largest immune organ," notes Arthur C. Ouwehand of the University of Turku, Finland, and of Danisco Innovation, a company that makes probiotics-enhanced foods. That's why investigators at his and other research centers are exploring probiotics to improve immunity.

A study in 2005 by Schrezenmeir and his colleagues showed that daily treatment with a trio of probiotics didn't reduce the incidence of colds. But the supplementation did reduce the severity and duration of cold symptoms—including fever—compared with a group of people that didn't get probiotics.

"We don't know the mechanism" for the probiotic advantage, Schrezenmeir says. However, in individuals given probiotics, the number of activated helper T cells—white blood cells that fight infection—increased, as did the number of germ-killing cells.

Probiotics may move the immune system in the opposite direction as well. Over the past year, several research teams reported some success with probiotics in treating inflammatory bowel disease. At least one study found they could help control exaggerated inflammation in intensive care patients at high risk for multiple organ dysfunction syndrome—a hyperinflammatory condition. And in a paper last August, Ouwehand recounted how probiotics administered to pregnant women and babies reduced the likelihood that high-risk infants developed food allergies.

In its newest work, Schrezenmeir's team incubated immune cells from the blood of healthy or allergic individuals together with several immune-stimulating substances. Cells from all of the people responded, but only cells from allergic people showed an exaggerated response to allergens.

Adding four probiotic microbes or the naked DNA from probiotic bacteria to the mix substantially ratcheted down the response of immune cells, especially for people with allergies. About half of the immune-dampening effect in probiotic-treated cells was attributed to the live bugs, and half to their DNA—released when the beneficial bugs died. The work will appear in an upcoming *Immunobiology*.

Probiotic benefits are typically attributed to the fact that supplemented microbes were alive. However, receptors on the surfaces of both immune cells and cells lining the gut can bind DNA, Schrezenmeir notes. Probiotic DNA won't be accessible to those cells until the microbe dies. His team's new data suggest that probiotics—dead or alive—can affect systems in the body, perhaps by contributing to the communications among the gut's native microbes.

WEIGHT MODULATORS A number of food companies are investigating new health applications for probiotic supplements and fortified foods. Among novel functions being explored at the Nestlé research center in Lausanne, Switzerland, is probiotics' control over calorie use.

Company scientists teamed up with researchers in England and Sweden for rodent experiments using strains of *L. paracasei* and *L. rhamnosus*, probiotics that Nestlé discovered years ago.

To create gut ecosystems in rats that model those of humans, the scientists seeded the guts of newborn mice—animals that were still germfree—with microbes from the digestive tracts of human babies. Beginning 6 weeks later, the researchers doctored the animals' drinking water for 14 days with one or the other of the probiotics.

In the Jan. 15 *Molecular Systems Biology*, Nestlé biochemist Sunil Kochhar and his colleagues report that both strains of tested lactobacilli increased the hosts' breakdown and use of simple carbohydrates. The data suggest that by helping people absorb more of the calories present in carbs, these or related probiotics might one day help fight malnutrition in parts of the world where carbohydrate-based diets are common, Kochhar says.

But probiotics can push this metabolic pendulum the other way.

Bile acids, produced mainly in the liver, play an important role in emulsifying dietary fats, a step that readies such lipids for digestion. The Nestlé probiotics broke down taurocholic acid, an especially efficient emulsifying bile acid. The resulting cholic acid "is not a good fat emulsifier," notes Nicholson, a coauthor of the study—and after the probiotic treatment there was a 50-fold higher ratio of cholic to taurocholic acid in the treated animals' guts.

This change diminished the rodents' uptake of dietary fat and also reduced their synthesis of potentially harmful fatty substances in the blood, such as low-density lipoprotein cholesterol.

Where obesity is a problem, the same bugs might help people limit weight gain by diminishing their absorption of fats. "You only need to take in 20 to 30 more calories a day than you expend to make you fat in 2 or 3 years," observes Nicholson. "What we're interested in is looking for [probiotic] microbes that might help you absorb 50 calories less a day."

These metabolic findings complement observations by Gordon's team. The ecology of guts in lean and obese rodents is dominated by different bacteria, the Washington University researchers reported in 2006 in *Nature* (*SN: 5/19/07, p. 314*). The same holds for people.

Not without Risks

Probiotics exhibit a dark side

By design, probiotics should be helpful at best, benign at worst, notes Jeremy Nicholson of Imperial College, London. Side effects can occur, however, so unless people are battling an illness, he warns against consuming such microbes indiscriminately.

"If it ain't broke," he argues, "don't fix it."

The downside of probiotic therapy usually amounts to unexpected diarrhea. However, infections in the liver, heart, and other organs have also been linked to probiotics, according to a 2006 review by Robert J. Boyle of Royal Children's Hospital in Victoria, Australia and his colleagues. Although the infectious agent in some cases was identical to the probiotic used, Boyle's group notes that an indicted strain of microbe may sometimes also "be found in the internal microbiota of healthy humans, so the source of infection in these cases is not conclusively [due to probiotics]."

Last year, researchers reported in the September *Pediatric Intensive Care Medicine* that they had shut down a pediatric trial with *Lactobacillus rhamnosus* GG (LGG), a widely used probiotic, owing to growing concern that it might actually spawn infections.

Looking to cut the risk of hospital-acquired infections in severely ill children, Travis C.B. Honeycutt of WakeMed Health and Hospitals in Raleigh, N.C., and his team began randomly assigning kids to receive a probiotic or a placebo capsule daily while they were hospitalized in an intensive care unit. However, when three reports of LGG blood-borne infections in children emerged in quick succession from neighboring physicians outside the trial, the North Carolina researchers decided to perform an interim analysis to check whether LGG was as benign as they had told their patients' parents it was.

"That analysis showed no benefit in our patients," Honeycutt recalls, "and a trend—although it was not statistically significant—towards increasing infections in our probiotics group."

But the really big wake-up call came last month, when Dutch researchers published findings of a trial using probiotics in people with acute pancreatitis. Patients provided nutrition laced with six probiotics experienced a death rate nearly triple that of people fed just the nutrients (*SN: 2/23/08, p. 115*). —J.R.

After collectively identifying all of the microbial genes present in the guts of the naturally lean and obese mice, "we found that genes involved in breaking down otherwise indigestible complex carbohydrates were much better represented in the obese animals' gut communities," Gordon says.

His group then transplanted gut flora from a lean or obese mouse into a germfree animal and fed all treated rodents the same amounts. Animals that had received the gut microbes from obese animals gained more fat than did the animals given flora from a lean mouse.

Such experiments "show that differences in gut ecology influence the efficiency with which the bugs extract energy from foods," Gordon says. However, his team's data also show that gut microbes can alter what share of consumed energy will be stored as body fat.

Identifying the specific microbes responsible for these effects could point to new classes of weight-controlling probiotics, Gordon suspects.

SPECIAL EFFECTS For all of their potential weight-modulating similarities, the two Nestlé probiotics had additional—and very different—actions. While the *L. rhamnosus* treatment dramatically decreased gut populations of potentially lethal bacteria known as *Clostridium difficile* (*SN: 2/18/06, p. 104*), the *L. paracasei* probiotic offered no defense against these germs.

There may be some direct effect of the probiotic microbes on these germs, or even on food metabolism, Nicholson says. But his new data suggest that many of the probiotics' effects might best be characterized as microbial diplomacy—where small delegations of ingested germs persuade an army of resident microbes to adopt activities that better benefit their host.

"Bacteria talk to each other all of the time," he says. Although there may be billions of local organisms, most "tend to behave like multicellular organisms," he explains. These mega-beings coordinate their activity via microbial chatter. They signal their intent through the production and secretion of specific molecules.

"What we think is happening," Nicholson says, "is that the probiotic bugs enter the gut, producing their chemical signals." Relative to the hordes of microbes living in the gut, the incoming microbes make up only a teensy minority. However, based on the chemical dispatches issued during their transit through the intestines, the gut's longtime residents "start to change what they're doing."

In the new study, Nicholson's group showed that the messages relayed by each of the Nestlé probiotics seem to hit different families of resident flora, leading to different metabolic effects. One implication, he says, is that depending on which microbes permanently inhabit any particular individual's gut, the probiotic's message may resonate loudly or fall on deaf ears.

Gut flora might make good targets for medicines.

So which probiotic is most likely to work for an individual may depend on the precise nature of his or her flora, Nicholson maintains. The challenge, he says, will be to find out which flora are present and in what numbers. In a paper due out soon in the *Proceedings of the National Academy of Sciences*, his group will report the ability to get a rough inventory of those flora by analyzing their metabolic detritus in human urine.

Because of "the significant involvement of the gut microbiota in human health and disease," gut flora might make good targets for medicines, Nicholson and his colleagues argue in the February *Nature Reviews: Drug Discovery*.

Consider that there are only about 3,000 human genes available to target with drug therapy—but "probably 100,000 gene targets in your gut microbiome," Nicholson says.

To succeed, drug companies will need a better picture of the human gut's microbial genome. It so happens that the National Institutes of Health recently established the Human Microbiome Project to nail that down. ■

OF NOTE

BEHAVIOR

Gene variants shield against depression

Not all child-abuse survivors are created equal. A minority possess specific variations in a stress-regulating gene that protect them from developing serious forms of depression as adults, a new study finds.

Adults who were abused as children physically, sexually, or emotionally, but hadn't inherited the key gene variations, displayed twice as many symptoms of moderate or severe depression as did abuse survivors who carried the protective variations, says Kerry J. Ressler of Emory University in Atlanta.

These DNA alterations occur along a gene that spurs production of a cell receptor for corticotropin-releasing hormone, a stress hormone thought to influence depression. Researchers suspect that abuse or other extreme childhood stress lead to overactivity of various stress hormones, thus raising the likelihood of later depression.

The scientists interviewed 621 adult survivors of childhood abuse and obtained blood samples for DNA testing. About 1 in 3 volunteers possessed gene variations linked to having no or mild symptoms of depression, Ressler's group reports in the February *Archives of General Psychiatry*.

Inheriting a set of three genetic variations from both parents provided child-abuse victims with the strongest buffer against depression as adults. Depression worsened among abuse victims who inherited one copy of the protective set of variations and reached a peak of severity among those who possessed no copies of it. —BRUCE BOWER

AGRICULTURE

Resistance to Bt crops emerges

Some caterpillars are cottoning to transgenic cotton.

Genetically engineered cotton and corn produce a toxin that kills caterpillar larvae and other pests, but a new study shows that resistance to this toxin could be spreading among one species of caterpillar.

Farmers worldwide plant more than 400 million acres of these transgenic crops each year. A bacterial gene inserted into the plants' DNA enables the crops—called Bt crops—to kill insects without sprayed pesticides.

But killing vulnerable caterpillars can drive the evolution of resistance to the toxin, since only the survivors reproduce.

To keep resistance in check, farmers plant refuges of unaltered crops for the pests to eat. That way, caterpillars susceptible to the toxin may mate with the few individuals that have developed resistance. Offspring from these mixed matings are usually vulnerable to the Bt crops.

The strategy is likely working with five caterpillar species observed between 1992 and 2004 in Spain, Australia, China, and the United States, according to a paper in the February *Nature Biotechnology*. "There's lots of solid evidence that resistance is not evolving in those pests," says study leader Bruce E. Tabashnik of the University of Arizona in Tucson. But for one species (*Helicoverpa zea*), resistance has become more widespread. The reason, in part, is that mixed matings among *H. zea* produce toxin-resistant offspring—progeny that can pass that resistance on. —PATRICK BARRY

MEETINGS

American Association for the Advancement of Science
Boston, Mass., Feb.14–18

ECOLOGY

Predators return

Antarctica may be the battleground for the next world war. Crabs, sharks, and other predators vanquished from the frigid continent millions of years ago are ready to strike back, researchers say.

Propelled by the fast-warming Southern Ocean, the invaders' return will hit hardest animals such as brittle stars, which evolved within a food chain of little predation, says Richard Aronson, an ecologist at the Dauphin Island Sea Lab in Alabama.

Beginning about 40 million years ago, temperatures in Antarctic waters plummeted by 10°C, Aronson says. While crabs, sharks, and other bony fish fled to warmer waters, benthic marine animals flourished. Without shell-crushing predators, Antarctic animals developed few defenses, such as thick, ridged shells. "They are ecological throwbacks to an earlier time," Aronson says.

But many predators are banging on Antarctica's door. Aronson's team found that king crabs have inched closer to the shore and now hover half a kilometer from the continental shelf, at depths of around 1,100 meters, where the water has warmed. They could spread to nearshore waters in 50 years, Aronson says. Spiny dogfish, a shark found off South America, may also be ready to pounce. "This is the last stand for pristine marine communities," he says. —EWEN CALLAWAY

NANOTECHNOLOGY

Diamond detectors

Diamond impurities can detect extremely weak magnetic fields. Probes with diamond tips might soon become sensitive enough to track single atomic nuclei in molecules by their magnetism, enabling the observation of atoms' motion during chemical reactions.

Diamond is an all-carbon crystal, consisting mostly of non-magnetic carbon-12. The nuclei of the relatively rare carbon-13, however, are magnetic. Harvard University physicist Mikhail Lukin and his collaborators used the carbon-13 nuclei scattered inside a thin layer of artificial diamond as tiny bar magnets to detect external magnetic fields as weak as 10 nanotesla—about one-five thousandth of the Earth's magnetic field.

Because the orientation of a single carbon-13 nucleus is hard to measure directly, the team devised an approach that takes nuclear magnetic resonance (NMR) down to the atomic level.

All diamonds have impurities, such as a nitrogen atom replacing a carbon in the crystal lattice, or voids where carbon atoms would otherwise be. If a nitrogen atom happens to be right next to a void, its electrons' orbits will expand into the void. As a result, these electrons will show a signature response to light. Nitrogen-vacancy pairs are also few and far between, so the states of such electrons can be manipulated individually using a laser.

The alignment of carbon-13 nuclei will also affect that of the nitrogen-vacancy electrons. Thus, as the carbon-13 nuclei align to an external magnetic field, the nitrogen electrons also respond, a difference detectable with a laser. Lukin and his collaborators could thus take magnetic readings using single nitrogen-vacancy pairs. —DAVIDE CASTELVECCHI

ENVIRONMENT

Dioxin's long reach

Breast development is delayed in teenage girls exposed to the pollutant dioxin in the womb and as infants, finds a long-term Dutch study that tracked mother-baby pairs from birth through puberty.

"Dioxin throws a monkey wrench into a number of cellular processes," says Linda Birnbaum of the U.S. Environmental Protection Agency, whose rat studies support the new results.

Scientists became aware of dioxin's detrimental health effects in the early 1970s. Janna Koppe, a pediatrician at the University of Amsterdam, says she and her colleagues began their study after research showed that people in the Netherlands were exposed to dioxin levels twice as high as in other European countries. In addition to 14 mother-baby pairs originally enrolled in 1987, 120 pairs joined the study in 1990 and 1991.

Dioxin levels, as well as a number of other factors, were measured in each mother's and newborn's blood and in the mother's breast milk at birth. Fat in the body routinely moves from one area to another, says Koppe, making fat-rich breast milk an excellent yardstick for measuring fat-binding contaminants such as dioxin in the body.

Researchers did a number of follow-ups during the children's first year, and again at 30 months, 8 to 12 years, and, most recently, 13 to 18 years.

All 18 girls who consented to follow-ups as teens showed delayed initiation of breast development, perhaps due to dioxin's ability to counter the actions of estrogen, the researchers speculate. This harmful effect was just the latest in a series found over the length of the study. It's known that the chemical binds to the body's aryl hydrocarbon receptor, which is involved in a number of developmental pathways and processes, says Birnbaum. —RACHEL EHRENBERG.

OCEANOGRAPHY

New dating finds oldest coral yet

A black coral collected near the Hawaiian Islands may set a new record for age among coral kind: some 4,200 years.

The meter-plus–tall specimen of *Leiopathes glaberrima* turns out to be older than corals previously studied by Brendan Roark of Stanford University and his colleagues. The team used submersible vehicles to pluck a few Hawaiian corals from deep water. The researchers determine the coral ages by radiocarbon dating, based on the known decay rate for carbon-14. In 2006, the group reported that a sample of a *Gerardia* species, one of the gold corals prized for jewelry, had lived around 2,700 years.

Deep-sea corals are often blithely described as long-lived, but there's little hard evidence, Roark says. His team measured the carbon-14 in the black coral's distinctive hard skeleton, a flattened branching tree structure created by generations of the hundreds of tiny, soft-bodied polyps that make up a single coral colony.

OLD ONE A living fuzz of orange polyps covers the black skeleton of the oldest coral yet to be sampled and dated.

The ancient *L. glaberrima* came from a depth of 400 meters, below the reach of sunlight. The skeleton had grown less than 5 micrometers a year. Its polyps, like those of other deep-water corals, snagged food bits from the water instead of relying on the live-in photosynthetic algae that nourish corals in shallow, sunny water.

The black coral's age fuels Roark's hopes of using old corals as what he calls an "archive of climate changes." Also, the age highlights concerns about trawling fisheries that smash through coral beds. "These are not renewable resources," he says. —SUSAN MILIUS

BIOMEDICINE

Sun, inflammation speed aging of skin

Sun exposure leads to wrinkles in double time, new research shows.

Inflammation makes the difference between young, supple skin and aged skin, say researchers at P&G Beauty, a cosmetics company in Cincinnati. Company scientists, led by immunologist Michael Robinson, compared skin from a group of 18- to 20-year-old Florida women with skin from 60- to 67-year-old women who had spent a lifetime in the Florida sun.

Researchers collected skin from the women's buttocks and outer forearms.

Comparing buttock samples allowed the researchers to determine how skin ages where the sun doesn't shine. The researchers examined which genes are turned on and off in young skin and aged skin.

Older skin cells turned up production of enzymes called proteases that break down collagen and elastin, proteins that give skin its spring and structure, Robinson says. As collagen breaks down, skin collapses into wrinkles.

"It's the equivalent of taking the air out of a balloon. The tension goes out of it, and it begins to sag and fold in on itself," Robinson says.

Inflammation also sets off other skin-damaging processes, such as inhibiting skin's regenerative abilities and changing fatty acid and cholesterol metabolism, which lead to erosion of the protective barrier that holds in moisture.

Arm samples showed that sun exposure hastens "this chronic march down the calendar," Robinson says. Exposure to ultraviolet radiation from the sun increases inflammation, speeding the aging process, he says. —TINA HESMAN SAEY

ZOOLOGY

Great spots for white sharks

Great white sharks, supposedly ravenous nomads scouring the seas for hapless seals and surfers, show serious site fidelity, returning to the same neighborhoods every summer along the California coast.

Data from more than 100 tagged sharks show that the animals stick to specific routes and destinations, and preliminary genetic work suggests that the eastern Pacific population may be isolated genetically from the world's other white sharks, a finding that has implications for conservation and population management.

The sharks tend to split their time between the coast and the ocean, says Salvador Jorgenson, a researcher at Stanford University. His Stanford colleague Carol Reeb leads the genetic work.

Tracking the tagged sharks revealed that when the animals leave the coast in winter they head either to Hawaii, or to an area about halfway between Hawaii and the mainland. It's unclear what the sharks are doing in this region, dubbed "the white shark café" by the research team. "It's intentionally ambiguous," says Jorgenson. "You might go to a café to get something to eat or you might go to see or be seen." —R.E.

T. KERBY AND M. CREMER/ HAWAII UNDERSEA RESEARCH LABORATORY

Books

A selection of new and notable books of scientific interest

YOUR INNER FISH

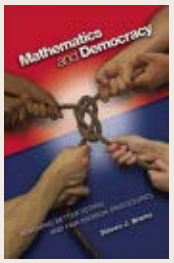
NEIL SHUBIN

With a title that could easily be *A Fish's Inner Human*, this book commences from the eerie resemblance of fin bones to human arm and wrist bones seen in a 375-million-year-old fossil of the fish *Tiktaalik roseae*. Paleontologist Neil Shubin and his colleagues unearthed the fossil from the Arctic in 2006. Finding that the creature bore a crocodilelike head, a flexible neck, and fins, the team realized it had found a relic from a major event in the history of life: the transition to land. Thoughts on this transition began in the mid-1800s with observations of air-breathing lungfish. Here, Shubin waxes poetic about the similarities between traits of "lesser" animals and those of the human corpse he dissected in anatomy class. The story moves from naming new fossils to naming genes shared by every human, mouse, and fly. Shubin provides evidence to make his overriding claim: "We are not separate from the rest of the living world." ***Pantheon Books, 2008, b&w illus., 229 p., hardcover, $24.00.***

MATHEMATICS AND DEMOCRACY

STEVEN J. BRAMS

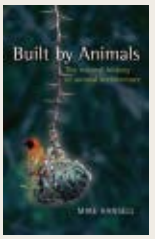
In the 2000 presidential election, the Green Party candidate Ralph Nader received only 2.7 percent of the vote, yet this percentage affected the close contest between the Republican and Democratic candidates. Brams suggests that such an outcome evolves from plurality voting, the most common voting system in the United States. Each voter can select only one candidate among more than two choices. One result is that a candidate can win by garnering more votes than opponents, but not necessarily by winning a majority. Brams explains how game theory could be used to make political and social institutions more democratic. He examines an alternative voting system in which citizens could vote for as many candidates as they wished. Readers may need a background in mathematics and game theory to tackle the analyses in a few sections of this book; however, Brams notes that those chapters can be skipped. A glossary defines most poli-sci jargon, such as bandwagon strategy, in which one player misrepresents his position in order to benefit from a majority coalition. ***Princeton Univ. Press, 2008, 373 p., paperback, $27.95.***



BUILT BY ANIMALS

MIKE HANSELL

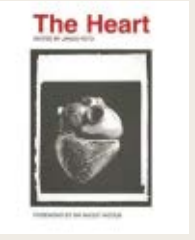
"Wombats Detected from Space" is the title of a scientific article published in a 1980 *Remote Sensing of Environment*. Burrows of these hardy mammals may stretch more than 260 feet deep, creating bare patches visible from Earth orbit. Hansell, an evolutionary biologist, analyzes the complicated construction of animal refuges built by architects ranging from amoebae to apes. He asks why wombats—fairly sedate, herbivorous animals—go to all that trouble. Then he suggests they don't. Like the European badger, wombats may only extend burrow systems that are several hundred years old. Both animals add complexity to their environments; by digging tunnels, they create places for other, different animals to live. The phenomenon is one Hansell connects to goby fish hiding in shrimp tunnels and burrowing owls nesting in prairie dog holes. Covering the who, what, and why of animal construction, Hansell reveals the blueprint of structures that can rival human architectures. ***Oxford Univ. Press, 2007, 268 p., b&w photos, hardcover, $29.95.***



THE HEART

JAMES PETO, ED.

When mummifying a corpse, the ancient Egyptians would discard the brain but leave the heart inside the chest so that the gods could weigh it, Peto writes. Centuries later, the heart remains spiritually significant. It is therefore appropriate that this book, which describes heart medicine, physiology, and anatomy, also embraces social and cultural attitudes about the heart. The book's contributors offer imagery from both religion and rock 'n' roll to explore how the heart is seen as an organ of love and yearning. Alternating with the chapters are interviews with heart-surgery patients and surgeons who describe their experiences. Edited by the curator of the Wellcome Trust's 2007 exhibition in London on the heart, this book features a diverse collection of heart-centric science art, and thought. ***Yale Univ. Press, 2007, 254 p., color photos and illus., hardcover, $35.00.***



DINOMUMMY

PHILLIP LARS MANNING

When Tyler Lyson was 16, he discovered a nearly complete duck-billed dinosaur skeleton, still containing fossilized soft tissue, in the Hell Creek Formation in the Badlands of North Dakota. He contacted Manning, a paleontologist who had appeared on television. Together, they excavated the hadrosaur mummy and named it "Dakota." Lyson, now a graduate student, continues to study aspects of the specimen, such as how the dinosaur may have moved. In this children's book about Lyson's discovery, Manning takes readers back in time to the floodplains of Hell Creek during the age of the dinosaurs, when Dakota lived alongside triceratops and *Tyrannosaurus rex*. Computer-generated photographs lend the story a realistic edge that will captivate any aspiring dino hunter. ***Kingfisher, 2007, color illus., 64 p., hardcover $18.95.***

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LETTERS

Big evolvers

Regarding "Whales Drink Sounds: Hearing may use an ancient path" (*SN: 2/9/08, p. 84*), I have heard that whales evolved millions of years ago into their present form, including their very large brains. We humans must be relatively recent in terms of our brain structures. Are there data concerning evolutionary development in whales?

MATTHEW KABRISKY, DAYTON, OHIO

"Learning to Listen: How some vertebrates evolved biological sonar" (SN: 5/14/05, p. 314*) reviews the evolutionary steps in echolocation development in whales.* —SID PERKINS

Want munchies with that?

Regarding "Pot Downer: Marijuana users risk gum disease" (*SN: 2/9/08, p. 85*), a familiar side effect of marijuana smoking is increased appetite, often for sweet foods. It is doubtful that the marijuana smokers immediately rush to brush their teeth after eating "munchies." If they smoke multiple times throughout a day, they may be constantly nibbling on sweets, leaving food lodged between teeth and gums, a fairly direct cause of gum disease.

LINDA WALSH, SANTA CRUZ, CALIF.

One result of such incessant munching would be plaque buildup. The researchers accounted for differences in plaque, as well as overall dental care, among the participants. These and other things being equal, pot smokers still had more periodontitis than people who didn't smoke the herb. Periodontitis starts out as gingivitis, marked by red, bleeding gums. When this inflammation results in the gums separating from the teeth and jawbone, that's periodontitis, which typically is irreversible. Gums receding from teeth make them look longer. This is often due to periodontitis in old age. Hence the term "long in the tooth." —NATHAN SEPPA

Getting to the heart

Regarding "9/11 attacks stoked U.S. heart ailments" (*SN: 1/26/08, p. 61*): We must dissociate the attacks themselves from the intense media barrage that followed. Under the guise of providing information, the press seemed intent on inflaming our most negative feelings of fear, hatred, and grief. While the attacks were no doubt emotionally distressing, the psychological trauma was amplified a thousandfold by the nonstop and repetitive coverage.

STEPHEN E. SILVER, SANTA FE, N.M.

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States of Matter - Poster

States of Matter - Poster It is difficult to find a good Matter poster, but this one is it! Great in-color graphics suitably depict the five states of matter with information on each. Includes the Bose - Einstein Condensate. There is also a section on the structure of matter and matter research. Size: 26" X 38" Matte Finish, Laminated, Copyright 2008
Produced by Jensan Scientifics, Copyright 2008
Order #JPT-2146, Cost: $21.95,

The Periodic Table in Earth and Sky

The Periodic Table in Earth and Sky Copyright 2008 - With many great new photos and updated essential information this chart has got to be one of the best yet and this subject. Astronomical images include: M-17, Cat's Eye Nebula, Comet Hale-Bopp, Jupiter, Celestial Geode Nebula, Mars, Star V838 Printed on heavyweight stock. 38.5" w X 27"h, Laminated **Order #JPT-7200, Cost: $25, usually $28.95; 2 for $50**

***Through the Sound Barrier* - Poster** One of the extraordinary sights associated with breaking the sound barrier is the production of a sudden visible vapor cloud, as shown around this hornet fighter jet. This picture is one of the most famous ones available. Poster size: 16" X 20" Laminated; **Order #JPT-121, Cost: $24.95,** *Also available in black or walnut frame:* **Order #JPT-1277, Cost: $69.95**

United States - States Birds and Flowers

United States - State Birds and Flowers - This beautiful poster was inspired by the stamps. The fifty states are listed alphabetically. Each bird and flower is identified by both its common and its scientific name. Great color and graphics! Size: 24" X 36" Laminated **Order #JPT-1555, Cost: $16.95, 2 for $30**

EMR Chart

EMR Chart - This chart includes all known ranges of EMR including: gamma rays, X-rays, ultraviolet light, visible light, infrared, microwaves, radio waves (ULF, VLF, LF, MF, HF, long, short, HAM, VHF, UHF, SHF, EHF, cosmic microwave background radiation and brain waves), all organized by octaves. The audio frequency spectrum is also included. Descriptions are included for all ranges and properites of EMR, including reflection, refraction, LASER, television, gravity waves, emission and absorption. Great chart on a difficult subject! Size: 24" X 36" Laminated **Order #EMR-1020, Cost: $19.95**

The Grand Tour of the Periodic Table Museum Display Collection - ideal for use in chemistry, physics, mineralogy, astronomy and Earth Science teaching exhibits. The set presents **60** specimens of minerals that contain specific elements from the Periodic Table. Many of the samples are rare, some are crystals, and all are beautiful examples of the treasure of the Earth. The set includes an 8-part, 350-page in-color *Teacher's Guide*, student hand-out sheets, event questions and answers, and an 11 inch X 14 inch laminated fold-out guide to the Periodic Table keyed to minerals and elements. All specimens are numbered and match an identification chart. **Order #JPT-3057, Cost: $650**

"Force of Nature" Lightning Sand Wind Chime Size: 7" Diameter, 8-9.5" L; 3 Fulgurites 2.5-3"; 3 Quartz Points 2.5-3" Hand made, sterling silver wire-wrapped, **Order #JPT-windsong, Cost: $265** *Available: 22*

Fulgurite "Lightning Sand" Pendant - This piece comes wire wrapped in 14K gold with matching chain. Comes with information and a certificate of authenticity. It also has a pearl accent. **Order #JPT-1664, Cost $225.00**

Lucky Four Leaf Clover Necklace - The four leaf clover is popular as an oddity and its special lucky qualities. Great for St. Patrick's Day or as a unique gift.
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Ancient Legal Tablet Replica

Mesopotamian Legal Tablet Replica (above) This is different from the medical tablet featured on this page. It dates from 1860 B.C.E. and depicts one of the oldest documented laws in history. The writing is cuneiform, an ancient style of writing used by five distinctive languages over a period of 3000 years. This tablet replica predates the Code of Hammurabi by 150 years. Comes with information sheet and attractive stand.
Size: 4 1/2"L X2 1/2"W X 1"D
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Ancient Sumerian Medical Tablet Replica - This piece is a reproduction of a Sumerian medical tablet. It is the earliest known prescription. It is written in cuneiform. Along with the tablet you will receive a booklet which gives you the translation and history of the tablet. The original was found at Nippur. (c. 2100 B.C.) Comes with stand and detailed information sheet Size: 6"L X 3"W X 1"D

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