SCIENCE NEWS
THE WEEKLY NEWSMAGAZINE OF SCIENCE
SEPTEMBER 29, 2007 PAGES 193-208 VOL. 172, NO. 13

the risk from plastics
mammoth hair's trove of dna
lifesaving mosquito nets
kelp's tropical locale

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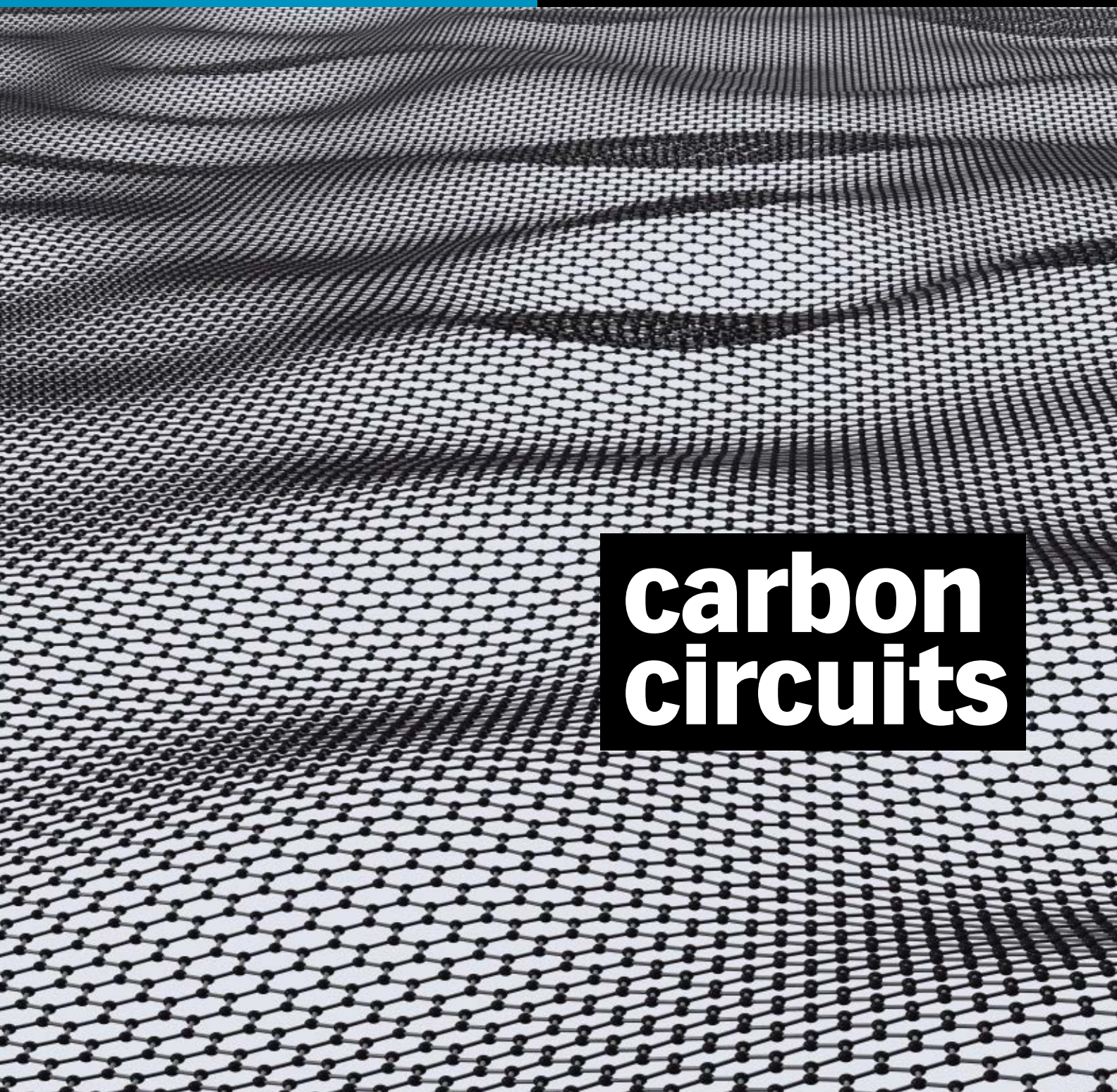

carbon circuits

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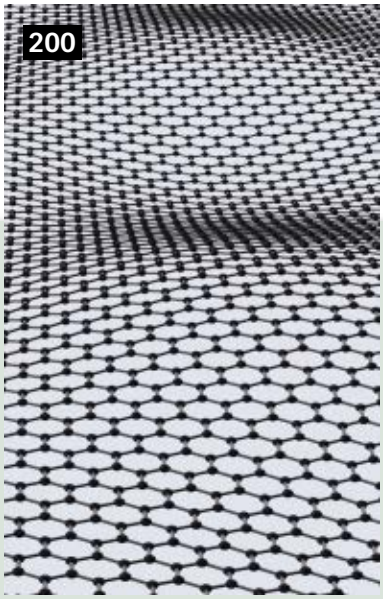

Features

This Week

THIS WEEK ONLINE
http://blog.sciencenews.org/

Food for Thought Easily digestible carbohydrates induce obesity and liver disease in a test on rodents.

Of Note

Meetings

Departments

Cover Carbon atoms link up in a network of hexagonal cells to form the one-atom-thick sheet called graphene, shown in this illustration. Graphene's unusual strength and electronic properties make it a promising material to replace silicon in computer chips. (J. Meyer) Page 200

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Unexpected Archive

Mammoth hair yields ancient DNA

Analysis of hair from several ancient mammoths suggests that even tiny samples that are tens of thousands of years old can contain enough genetic material to allow reconstruction of portions of the animal's genome. The new findings hint that museum collections could be untapped troves of genetic treasure.

The largest part of a creature's genome appears in a cell's nucleus and includes DNA from both parents. A smaller amount of genetic material appears in mitochondria, the energy factories of the cells, which are passed down only from the animal's mother, says Stephan C. Schuster, a genomicist at Pennsylvania State University in University Park. A cell typically has only one nucleus, but it can have a thousand or more mitochondria.

Scientists have compiled only a handful of mitochondrial genomes of ancient creatures, says Schuster. And those analyses scrutinized genetic material extracted only from bones. Although they persist in the environment longer than soft tissues do, bones are porous and prone to bacterial contamination. In fact, more than 50 percent of the DNA collected during one study of mammoth-bone material came from bacteria and other sources.

Recently, Schuster and his colleagues looked for mammoth DNA within shafts of the ancient creatures' hair. As cells in each hair follicle die and are forced outward, fragments of their DNA are locked within.

Mammoth hair is commonly preserved in the cold, arid conditions where the creatures lived, says Schuster. Moreover, he notes, any bacterial or fungal contamination on the hair can be removed with a little bleach.

Most of the mammoth hair that the researchers examined contained abundant mitochondrial DNA. Even the smallest sample, about 0.2 gram, yielded enough genetic material to reconstruct at least seven copies of the mitochondrial genome, says Tom Gilbert, a geneticist at the University of Copenhagen and a coauthor of the report in the Sept. 28 *Science*. In future research, the scientists intend to reconstruct the mammoth's nuclear genome.

"This is a very nice study and a clever use of hair as a DNA source to get around the problem of contaminating bacteria, fungi, and other microorganisms," says Alan Cooper, a paleogeneticist at the University of Adelaide in Australia.

Results of the team's analyses suggest that the genetic material was preserved because keratin, the material of which hair is made, repels water, a major source of DNA degradation. Many other biological materials, including horns, hooves, feathers, and the sheaths on claws, are made of keratin.

The smallest sample that the team analyzed was also one of the oldest, says Schuster. It came from a 41,000-year-old mammoth that was recovered in 1806 and whose hair had been stored since then at room temperature in a Russian museum.

The new findings could spawn a stampede to collect genetic information from the multitude of specimens collected decades ago during field trips and that are now gathering dust in museums. Schuster says that the new activity could be called "museomics." The technique could be especially useful for species whose preserved bones are rare, if not absent, but whose keratinous tissues are common.

"The information is already sitting there" in specimen collections, he notes. "The hard part of the work is done." —S. PERKINS

WOOLLY DATA **Mammoth hair, including this 25,000-year-old sample from Siberia, may contain enough genetic material to allow reconstruction of mitochondrial DNA.**

A. SHER AND F. SHIDLOVSKIY/ICE AGE MUSEUM, MOSCOW

Keep Out

Treated mosquito nets limit child deaths

By sleeping under chemically treated mosquito nets, children cut their risk of death almost in half, researchers in Kenya report. Their study, which included thousands of young children, bolsters the case that increased use of insecticide-coated netting can prevent malaria.

Treated nets repel mosquitoes that transmit malaria and fend off flies that carry other diseases. Carefully controlled studies had already shown that the nets could prevent disease in malarial areas of sub-Saharan Africa, but experts were unsure whether real-world use of treated nets would actually lower death rates.

Epidemiologist Greg W. Fegan and his colleagues at the Kenyan Medical Research Institute in Nairobi monitored 3,484 children in 72 towns and villages to examine the impact of recent net-distribution campaigns in parts of Kenya. In 2004, just 7 percent of children under age 5 in these malarial zones were sleeping under nets. By 2006, subsidized sales and giveaway programs had upped that rate to 67 percent.

The researchers monitored use of the nets for an average of 21 months per child, visiting the homes periodically. They recorded 100 deaths from any cause among children between 1 month and 5 years of age. They excluded infants less than a month old from the analysis, because such neonates often die of causes other than malaria. Of the 100 deaths, 81 occurred among children who slept without the protection of treated nets, the scientists report in the Sept. 22 *Lancet*.

After statistical adjustment, the authors estimated that children sleeping under nets were at 44 percent lower risk of death than unprotected children were. For every 1,000 nets distributed and used regularly, 7 child deaths can be averted, the authors calculated.

"With this work, the use of insecticide-treated bed nets is confirmed as a major child-survival intervention," declare Christian Lengeler and Don deSavigny of the Swiss Tropical Institute in Basel, writing in the *Lancet*.

The nets had been treated with insecticides that are approved for human use. While some insecticide treatments need to be reapplied periodically, others last for the lifetime of the net.

On the basis of this study and earlier research, the World Health Organization this month endorsed distribution of nets treated with long-lasting insecticide, specifically targeting infants and pregnant women.

Meanwhile, governments and nongovernmental health agencies are now grappling with distribution alternatives. "It's all about whether the nets are seen as a public good, like vaccines, and should be heavily subsidized and/or delivered for free," says Katherine C. Macintyre, an infectious-disease researcher at Tulane University in New Orleans.

Donor agencies should regard resources devoted to subsidized or free distribution of

treated nets as "money well spent" and recognize that the challenge is now to maintain and increase funding to expand such coverage, Fegan and his colleagues conclude. —N. SEPPA

Jungle Down There

What's a kelp forest doing in the tropics?

Biologists say that they've found dense, underwater forests of kelp, a cold-water lover, off the tropical Galápagos Islands.

And a new computer model predicts that many more of these richly productive ecosystems could lie undiscovered in low-latitude oceans, say Michael Graham of Moss Landing (Calif.) Marine Laboratories and an international team of collaborators.

Marine biologists had known that at least three species of the supersize brown algae called kelp turn up sparsely in a few spots in the tropics, says Graham. But the new model identifies a total of 23,500 square kilometers of potential sweet spots for kelp in the tropics around the world. The first real-world test of those predictions led divers to eight uncharted Galápagos patches, Graham and his colleagues report online and in an upcoming *Proceedings of the National Academy of Sciences*.

Kelp forests and other marine-algae beds are cold water's answer to tropical coral reefs. The stands of giant kelp off California, for example, grip the ocean bottom and send stalks sprouting as much as 30 meters toward the water's surface. These forests house abundant marine creatures, from vulnerable fish larvae to sea otters.

A recent flood of data about the oceans inspired the kelp-habitat model, says Graham. He and his colleagues used low water temperature as an indicator of dissolved nitrogen adequate to support kelp. It needs cold, nutrient-rich water welling up from the deep plus enough sunlight and a seafloor suitable for anchoring.

Graham says that the possible habitats identified by the model included all the tropical spots where sparse kelp had been collected to date, even a spot in the Philippines that he hadn't previously known about. One of his collaborators, Louis Druehl of the Bamfield (British Columbia) Marine Science Center, had kept that location secret from other team members as a test of the model's power. Only when Graham mentioned that the model predicted kelp in the Philippines did Druehl reveal a decades-old Russian-language article reporting a few kelp specimens there.

In the Galápagos, biologists already knew some locations for *Eisenia galapagensis* kelp, but the modelers hoped to find more.

After the researchers lost two remotely operated underwater vehicles on the first day, they had to explore by diving. When he and a student made the first dive to a predicted kelp-friendly spot, Graham reports that "I went down, cleared my mask, and there was kelp right in front of me."

Brenda Konar of the University of Alaska, Fairbanks says that the highlight of the work for her is its suggestion that deep tropical kelp forests have served as stepping-stones allowing the forests' species to spread around the world.

James Leichter of the Scripps Institution of Oceanography in La Jolla, Calif., points out that biologists already know of other kinds of algae patches growing in deep water near coral reefs, such as that at a site he studies off the Florida Keys. He calls the Graham group's paper "an indication of the extent to which we still know surprisingly little about basic ecosystems" at these depths in the ocean. —S. MILIUS

S. CONNELL

LEAFY LUNCH Marine creatures such as this Galápagos iguana feed on productive beds of kelp. Tropical kelp grows at least 25 meters deep.

Double Trouble

Tumors have two-pronged defense

To survive long enough to form a tumor, cancer cells must ward off attacks by the body's immune system. Some cancers protect themselves by vacuuming up the amino acid tryptophan, which nearby immune system cells need in order to attack.

Now scientists have discovered that these cancer cells simultaneously pump a poison into their surroundings, killing those immune system cells when they get too close.

These two actions—soaking up tryptophan and dumping out the toxin—are intimately connected, the researchers found. Whenever a pore in the cancer-cell membrane lets in a tryptophan molecule, it ejects some other molecule, like two people passing through a revolving door in opposite directions. Usually, the expelled molecule is the poison.

"We show for the first time that these amino acid transporters are capable of exchanging these two molecules," says lead scientist Thijs Kaper, now at the biotechnology company Genencor in Palo Alto, Calif. "The [toxin] is actually driving the uptake of more tryptophan, so it's a cycle that keeps itself going."

All cells create the proteins that they need by stringing together amino acids. Cells can manufacture some of these amino acids, but others—the so-called essential amino acids, including tryptophan—must be acquired from the cell's surroundings.

The attack dogs of the immune system, killer T cells, are particularly sensitive to tryptophan scarcity. They need the amino acid to produce signaling proteins that switch the T cells to search-and-destroy mode. "Tryptophan seems to be one of the big choke points for controlling the immune response," says Lawrence Steinman of Stanford University, a member of the research team.

In addition, notes Andrew L. Mellor of the Medical College of Georgia in Augusta, T cells stop multiplying when they sense low tryptophan concentrations. Mellor says that this control mechanism, normally used by the immune system to keep T cells in check, is one that some kinds of cancer cells appear to have hijacked.

Such cancer cells can continuously drain tryptophan from their surroundings. They contain an overactive form of a protein that breaks down the amino acid and converts it to kynurenine, which the cells expel. Completing the double whammy, from the cancer cells' perspective, kynurenine kills nearby T cells.

To track concentrations of these two compounds in human-oral-cancer cells grown in the lab, Kaper's team used a fluorescent molecule-sensing technology that the researchers had developed. When a sensor molecule binds to one of the two compounds, the light it emits changes color. By monitoring the color fluctuations under a microscope, the team was able to measure changes in the concentrations of these compounds as they occurred.

The scientists showed that tryptophan enters cells through a specialized pore called L-amino acid transporter 1 (LAT1) and that as tryptophan moves in, the molecule that moves out is most often kynurenine. LAT1 enforces a "one in, one out" policy, the team reports in the October *PLoS Biology*.

"I think it's an important step in understanding the underlying biochemistry of how cancer cells control the immune response," Mellor comments. —P. BARRY

Lack of Evidence

Vaccine additive not linked to developmental problems

A mercury-containing vaccine preservative is not associated with problems in speech, intelligence, memory, coordination, attention, or other measures of childhood development, a large new study finds.

Child-health experts say that the results should allay concerns that thimerosal, a preservative first added to vaccines in the 1930s, affects children's brains.

"The study was enough to convince me that this small amount of mercury ... was not harmful to the children," says Michael Goldstein, vice president of the St. Paul, Minn.–based American Academy of Neurology.

"I think it's one more piece of evidence that thimerosal doesn't have any negative association with health outcomes," says Penelope Dennehy, professor of pediatrics at the Brown University School of Medicine in Providence, R.I.

QUOTE

"It's one more piece of evidence that thimerosal doesn't have any negative association with health outcomes."
PENELOPE DENNEHY, Brown University School of Medicine

The study, funded by the Centers for Disease Control and Prevention (CDC) in Atlanta, enrolled 1,047 children, from 7 to 10 years old, whose health needs had been covered from birth by four health maintenance organizations. The researchers combed the health plans' records to assess how much thimerosal each child received through the first 7 months of life.

Each child took a battery of 42 tests of language, memory, motor coordination, attention, and intelligence. The researchers then attempted to correlate the amount of mercury each child received—from 0 through 187.5 micrograms—with performance on the tests.

"We found no consistent pattern between increasing mercury exposure ... and performance on neuropsychological tests," CDC epidemiologist William W. Thompson and his team say in the Sept. 27 *New England Journal of Medicine*.

However, of 378 different statistical measures derived from the test results,

Bugs in Space

Genes explain why salmonella grow deadlier when freed from Earth's gravity

Bacteria that flew in a space shuttle overtook their earthbound counterparts in toxicity. The finding could have implications not only for protecting astronauts from sickness as spaceflights become longer and more frequent but also for understanding bacteria on Earth.

Previous experiments using a spaceflight stimulator had hinted that bacteria might grow more virulent in the absence of gravity. To see whether real space flight would produce a similar result, a team led by Cheryl Nickerson of Arizona State University in Tempe sent samples of *Salmonella typhimurium*, a leading cause of food poisoning, into orbit on the Space Shuttle Atlantis in September 2006. The bacteria grew in closed tubes, and shuttle crew members tended to them—controlling their temperature, for example, or adding nutrients. Meanwhile, scientists on the ground mirrored the astronauts' procedures on cultures kept in a room designed to reproduce conditions on the shuttle. The only difference: gravity.

When the space shuttle landed, the scientists compared the two sets of pathogens by testing their effects on mice. They found that animals injected with *S. typhimurium* that had traveled to space died faster than those injected with bacteria that hadn't made the trip.

To explore this difference in virulence, the team analyzed what genes were active in each group of bacteria.

The researchers found that 167 genes showed more than twofold differences in activity, either higher or lower, between bacteria grown in the shuttle and those grown on Earth. Moreover, 64 of the genes were related, all of which were involved in controlling a protein called Hfq, which is known to help bacteria cope with changing external conditions. The results, which appear online and in an upcoming *Proceedings of the National Academy of Sciences*, suggest that Hfq has a surprising role in mediating bacterial virulence in space, and perhaps on Earth.

Some aspects of life on a spaceship aren't that alien to organisms on Earth. A liquid medium in low gravity provides conditions resembling those inside the human body. Bacteria grown in labs are often shaken vigorously in flasks to speed their growth. Such treatment may approximate conditions in fast-moving blood flows, but not the more-sedate settings within urinary or gastrointestinal systems, where bacteria also would have adapted to survive.

The similarity of weightlessness to some internal environments suggests an evolutionary reason why many kinds of bacteria might be adapted to ramp up virulence in space, Nickerson says.

Microbiologist David W. Niesel of the University of Texas Medical Branch in Galveston calls the study "the ultimate validation" of older results from flight stimulators. He adds that he isn't too surprised by the fact that bacteria behave differently in space and in a lab on Earth, "because the way bacteria have persisted for eons is to be completely adaptable." —S. WILLIAMS

19 did show some small associations with thimerosal exposure. Twelve such measures were positive—that is, higher thimerosal exposure led to better outcomes—while seven were negative. "Five percent of the [measures] showed significant associations, and that's what you would expect by chance," says Thompson.

If thimerosal did hurt the children, "you would have found results in one direction only," says Paul Offit, chief of the division of infectious diseases at Children's Hospital of Philadelphia. "If you want to believe that thimerosal's positive association with tics [one of the results of the analysis] is real, then you also have to believe that it makes [the children] perform better in school."

Concerns about thimerosal flared in 1999 when the U.S. Public Health Service and the American Academy of Pediatrics recommended that the preservative no longer be used in childhood vaccines. With more and more vaccines being recommended, the groups were concerned that children could be exposed to amounts of mercury that exceeded Environmental Protection Agency guidelines. By 2003, no childhood vaccines contained thimerosal.

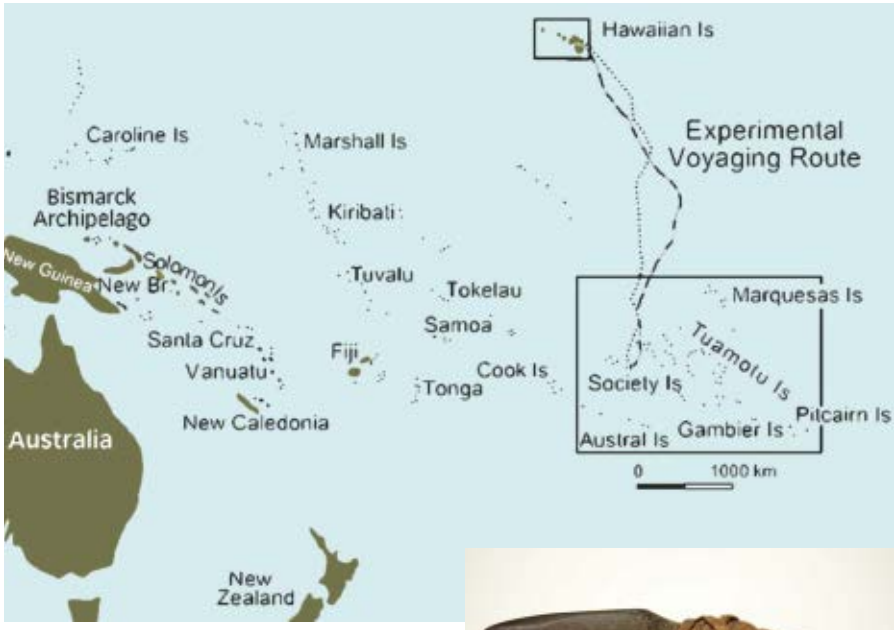
Because mercury can cause brain damage, many parents of children with autism latched on to thimerosal as a possible cause for soaring rates of the disease. In 2004, the Washington, D.C.–based Institute of Medicine concluded that available evidence refutes the thimerosal-autism connection. The current study did not assess autism directly, but another ongoing CDC study is expected to weigh in on the issue next year.

One of the 14 outside experts that the CDC consulted while designing and analyzing the current study disagrees with the published conclusions. Sallie Bernard, executive director of the parent-advocacy group SafeMinds in Tyrone, Ga., says that the study's limitations, including a low participation rate, mean that it "was unable to prove either the presence or absence of a causal relationship" between thimerosal and developmental problems. —B. VASTAG

Sail Away

Tools reveal extent of ancient Polynesian trips

The ocean wasn't enough to hold back the daring seafarers who settled the islands of East Polynesia beginning around 4,000 years ago. A new analysis of stone tools underscores the nautical skill of ancient Polynesian mariners. It indicates that, about 1,000 years ago and prior to European contact, these intrepid canoeists transported rocks for toolmaking from Hawaii to islands more than 4,000 kilometers to the south.



ADZE AHOY Map shows East Polynesia inside box, as well as the 1976 round-trip route between Hawaii and Tahiti of a replica Polynesian canoe. Adzes similar to the one at right provided clues to ancient Polynesian ocean journeys.

Legends recounted by Polynesian islanders refer to ancestors in the distant past who used canoes with sails to travel south from the Hawaiian Islands to Tahiti and then east to the Tuamotu Islands. Chemical studies of stone tools previously recovered in the Tuamotu Islands back up those local accounts, say geologist Kenneth D. Collerson and archaeologist Marshall I. Weisler of the University of Queensland in St. Lucia, Australia.

The Tuamotus and the nearby Society Islands "could be approached from all quarters and were thus probably important in Polynesian trade," Collerson and Weisler conclude in the Sept. 28 *Science*.

The scientists assayed a variety of trace elements and isotopes in 19 basalt adzes—woodcutting implements resembling hoes, with stone blades fastened to the ends of wooden shafts. The late Polynesian archaeologist Kenneth Emory found the artifacts on nine coral atolls in the Tuamotus between 1929 and 1934.

Collerson and Weisler also characterized 28 volcanic-rock sources throughout Polynesia by their trace elements and isotopic compositions.

Comparisons of the Tuamotu adzes with these rocks showed that all but one came from surrounding island groups, such as the Marquesas, Pitcairn, Austral, and Society Islands.

The chemical signature of the final adze places its origin in Hawaii. The likely sea route between Hawaii and Tahiti, one of the Society Islands, via the Tuamotus has favorable winds and currents for round-trip sea voyages, the researchers say.

Archaeologist Ben Finney of the University of Hawaii in Honolulu agrees. In 1976, he demonstrated that people could have settled Polynesia by navigating canoes across thousands of kilometers of open sea. He and his colleagues built a 19-meter-long reconstruction of an early two-masted Polynesian voyaging canoe. Taking roughly 2 months, they sailed the craft from Hawaii to Tahiti and back, passing through the Tuamotus along the way.

Ancient canoe voyagers must have passed their knowledge from one generation to the next until around 550 years ago, when most open-sea journeys ceased in East Polynesia, the Australian researchers suggest.

The new findings follow a report that Polynesian seafarers reached what's now Chile by about 620 years ago (*SN: 6/9/07, p. 356*). A bone from a Chilean archaeological site contains an exact copy of a genetic sequence that appears in DNA from 600- to 2,000-year-old chicken bones found in Tonga and American Samoa.

That evidence "provided archaeological support for Polynesians having reached South America in pre-Columbian times," Finney says. "Now we need to look for Polynesian basalt adzes there." —B. BOWER

SCIENCE; (INSET) J. WILLCOCK/ANTHRO. MUSEUM, UNIV. QUEENSLAND

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ELECTRON SUPERHIGHWAY

Can graphene overtake silicon as the essential ingredient of computer chips?

BY DAVIDE CASTELVECCHI

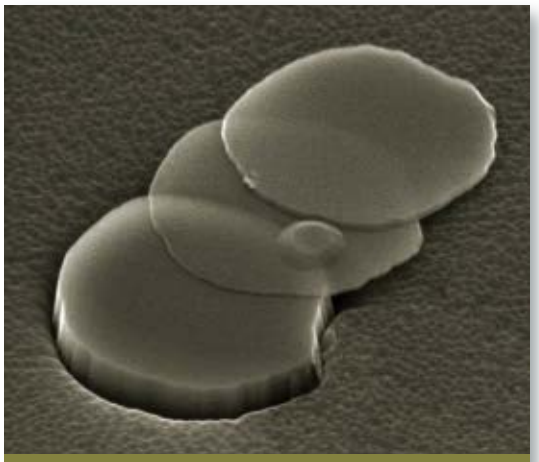
"Graphene has always been before our eyes, but no one ever tried to look," says Andre Geim, a physicist at the University of Manchester in England. A single-atom-thick, chicken wire web of carbon atoms, graphene forms the layers that stack up to make the graphite found in pencil lead and carbon soot.

However mundane the stuff may be, physicists have long predicted that if it were possible to isolate single graphene sheets, they would be sturdier than diamond and would have almost preternatural abilities to manipulate electrons. That could make graphene a better material than silicon for making computer chips. Until recently, though, no one had been able to isolate graphene sheets, let alone do anything useful with them.

In 2004, Geim and his collaborators startled the physics community by announcing that they had peeled graphene layers off graphite using common adhesive tape. The discovery raised a buzz in physics circles reminiscent of the excitement that greeted carbon nanotubes a decade ago.

In fact, graphene is nothing but a large, unrolled carbon nanotube, and the two materials share many qualities, including strength and conductivity.

Though promising, nanotubes have proved devilishly difficult to assemble into circuits. Nanotubes don't readily connect to one another, and attaching them to metal contacts creates spots where electrons tend to scatter, dissipating energy as heat.



CARBON PANCAKES — Electron microscope image shows the layered structure of graphite smeared onto a surface. The thinner layers here are an estimated 30 atoms thick, but researchers have been able to peel off single-atom-thick layers using adhesive tape.

Graphene, on the other hand, comes in sheets. It may be possible to etch graphene circuits, just as circuits are now etched into silicon wafers. Forming circuits from one sheet of graphene could be much easier than assembling them from nanotube pieces. "We want to be able to use the essential properties of carbon nanotubes in a material that can be patterned easily," says Walt de Heer of the Georgia Institute of Technology in Atlanta. "It could realize the dream people had of carbon-nanotube electronics."

Graphene circuits could in principle work efficiently even with components measuring only a few atoms across—scales that can't be achieved with ordinary semiconductors. In recent months, scientists have learned how to make graphene-based transistors and diodes—the basic elements of computer chips. And they have begun trying to connect graphene to other materials, including carbon nanotubes.

But that's only a beginning. If graphene is to replace silicon one day, scientists and engineers will have to figure out how to manufacture large numbers of circuits with nearly atomic precision.

CAUGHT ON TAPE Geim's adhesive tape stratagem could hardly be the basis for a new chip-fabrication plant, but it continues to be researchers' favorite way of making graphene for experimentation.

Anyone who uses a pencil is likely to leave some single-layer graphene flakes scattered on paper, he says. The graphene sheets in graphite are bound to one another only by weak electrostatic forces. That's why pencil lead is so soft.

After gently rubbing graphite on a silicon-oxide crystal, Geim stuck strips of tape on the carbon debris, hoping that when he peeled off the tape, thin stacks of a few graphene sheets would stick to it. To further pry apart the sheets, he repeatedly folded the pieces of tape, sticky sides together, and peeled them open again. Then, by dissolving the tape in a solution, he let the graphene flakes settle onto the surface of a silicon-oxide crystal.

Through an ordinary microscope, Geim spotted graphene stacks of varying thicknesses stuck to the crystal's surface. The translucent flakes created rainbows of colors "like oil on the surface of a rain puddle," he says. With a bit of experience, Geim learned how to recognize single sheets by their colors. "If it's blue or red, you know it's thick," he says. To find single layers, "you look for another shade of purple" (*SN: 10/23/04, p. 259; 8/13/05, p. 110*).

To confirm that they had actually found single sheets of graphene, Geim and his collaborators tested how the flakes conducted currents. Measurements showed that electrons were able to travel microns—enormous distances by atomic-scale standards—without bumping into atoms.

These findings confirmed crucial predictions about single-layer graphene. In graphene sheets, as in carbon nanotubes, each carbon atom binds strongly to three neighboring atoms, creating a web of hexagons resembling chicken wire. In addition, the atoms form bonds by sharing electrons from barbell-shape orbitals that are perpendicular to the chicken wire plane. These sideways orbitals fuse with their neighbors, creating veritable electron superhighways above and below the graphene plane.

In 2005, Geim and his colleagues made another important discovery. Placing graphene samples in magnetic fields whose intensities the researchers ratcheted up, they saw the electrical resistance increasing in discrete steps, a phenomenon known as the quantum Hall effect. Around the same time, a group led by Philip

UNIV. MANCHESTER

Kim of Columbia University made the same discovery after learning of Geim's tape-peeling technique.

Obscure as it may sound, the quantum Hall effect was what sparked the physics community's interest in graphene. "It put an enormous spotlight on the field," de Heer says. That's because the resistance steps produced by the effect had a pattern peculiar to graphene, so it convinced scientists that the new material really had "quite unique physics," Kim says (*SN: 11/12/05, p. 309*).

The effect implied that the electrons move in graphene's conduction superhighways unlike the way they move in any other conductor. In a piece of metal, electrons that carry current act like gas particles, jittering mostly at random and moving faster the more energy they have. In graphene, on the other hand, conduction electrons tend to move in lockstep as a single quantum entity. Like photons, the swarms of electrons move at the same speed, regardless of their energy.

Graphene's uniqueness makes it an intriguing playground for physicists and materials scientists. Researchers say that it could even inspire new ways to manipulate information. Meanwhile, several teams are working on shaping graphene into transistors and other traditional electronic components.

NO ASSEMBLY REQUIRED Because electrons in graphene move at high speeds, graphene-based transistors could in principle switch currents on and off faster than semiconductor-based transistors do. Like carbon nanotubes, graphene is an excellent conductor of heat, so graphene chips could stay cooler than silicon chips. But the feature that makes graphene most appealing to scientists is its toughness.

"The graphitic bond—the carbon-to-carbon bond—is the strongest in nature," even stronger than the bonds between carbon atoms in diamond, says de Heer. That strength gives graphene its remarkable stability, and means that graphene circuits could in principle be miniaturized to sizes of a few nanometers without falling apart.

By contrast, molecular-scale circuits made of silicon or other materials would quickly fail. "All other materials oxidize, decompose, move around, or melt," Geim says. Furthermore, conventional transistors are made from silicon or another semiconductor that has been "doped" to modify its electronic properties. In negative doping, addition of a small amount of another element increases the number of current-carrying electrons. In positive doping, addition of a different element creates gaps in the electron distribution, which move around like positively charged carriers of currents. At nanometer scales, it becomes almost impossible to dope a material uniformly because the dopant atoms are so few and far between.

These limitations mean that individual features in silicon chips, already as small as 65 nm and with 45-nm technology in the offing, will probably reach their smallest possible size within 10 to 15 years.

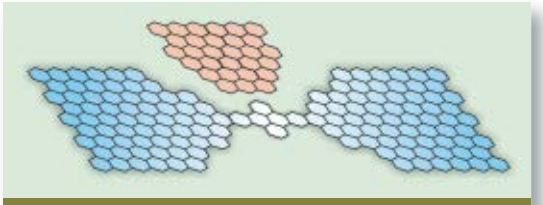
Future graphene-chip technologies, meanwhile, could borrow many of the methods already used for creating silicon chips. Chip production uses a top-down approach, which starts with large sheets of crystalline silicon and uses sophisticated lithography techniques to etch circuitry into them. "In principle, the processing technology could work exactly the same" for graphene, says Pablo Jarillo-Herrero, a physicist in Kim's lab at Columbia.

Jarillo-Herrero is one of several scientists who are seeking ways of chiseling narrow strips, called nanoribbons, out of graphene sheets. He has made nanoribbons as narrow as 20 nm across but says that it could take years to bring their width down to less than 10 nm. Because the hexagonal rings are about 0.2 nm in diameter, it gets harder to control the shape of a nanoribbon's edges as the structures become narrower. Irregular edges would "suppress part of the unique properties of graphene," says Jarillo-Herrero.

A more immediate goal is to make a field-effect transistor (FET) from graphene. FETs are the bread and butter of silicon chips. In a typical FET, a slice of negatively doped silicon is sandwiched between two pieces of positively doped silicon. In the transistor's off state, no current flows because the middle section acts as an insulator, but applying an electric field to the middle layer turns it into a conductor, switching the transistor to on.

For graphene, the equivalent of doping is applying an external field that increases the local concentration of charge carriers of one type or the other. In a prototype graphene FET, a nanoribbon links two graphene sheets. An insulating layer is deposited on the structure, and electrodes lying just above apply controlling fields. In an alternative design demonstrated this month by the Columbia team, the electrodes and the nanoribbon lie side by side, carved out of the same graphene sheet.

The narrowness of a nanoribbon alters its electronic properties so that its conductivity is normally low. Applying an electric field sharply increases its conductivity, a team of Jarillo-Herrero's Columbia colleagues reported in the May 18 *Physical Review Letters*.



GATEKEEPER — Engineers may one day be able to carve devices such as this transistor out of a single layer of carbon atoms. The voltage at an electrode (red) controls whether or not the link connecting two other electrodes (blue) conducts electricity, switching the transistor on or off.

E. PLOTKIN/PHYSICS TODAY

The nanoribbon thus acts as the middle layer of a conventional FET does, allowing the device to be turned on or off. In an upcoming *Physical Review Letters*, Jarillo-Herrero and his collaborators at Columbia and at the Massachusetts Institute of Technology describe their first steps toward making nanoribbon-graphene transistors. Charles Marcus of Harvard University and his collaborators independently describe a similar achievement in the Aug. 3 *Science*.

Still, graphene electronics is far from proved as a viable candidate for the postsilicon era. As yet, graphene transistors are slower than silicon ones and much slower than transistors made with competing materials such as carbon nanotubes.

DÉJÀ VU AGAIN The best way to control graphene at the molecular scale may be through chemistry. In de Heer's vision, engineers might someday insert atomic-scale components into carbon-based electronics by synthesizing molecules and attaching them to an etched template. This would combine the top-down method used in silicon-chip technology with a bottom-up approach of assembling components piece by piece.

De Heer says that his team has already succeeded in connecting two sheets of graphene with a carbon nanotube. In addition to nanotubes, polycyclic aromatic hydrocarbons or other organic molecules also have orbital structures that could merge seamlessly with those of graphene, de Heer says, making them ideal molecules for integration into graphene circuits.

Most experts caution that graphene research remains in its early stages. No one is ready to make promises, especially in light of the experience with carbon nanotubes. "Carbon nanotubes promised so much and so far [have] delivered so little, and we should naturally be cautious about promising too much for graphene," Geim says.

Cees Dekker of Delft University of Technology in the Netherlands, who a decade ago created the first nanotube transistor (*SN: 5/09/98, p. 294*), says that scientists' excitement about graphene gives him a feeling of déjà vu. "Sometimes, people are enthusiastically rediscovering the properties of graphene which were already heavily discussed 10 years ago in conjunction to nanotubes," he says.

Geim observes, however, that basic research in graphene has made remarkable strides in just over 2 years. He says that the new research field is here to stay. "It's not a blip on the screen." ■

CLEARLY CONCERNING

Do common plastics and resins carry risks?

BY JANET RALOFF

It's hard to avoid bisphenol A. One of the highest-volume chemicals in commercial production, it's the starting material used to make polycarbonate plastics. Those are the hard, clear plastics used in baby bottles, flatware, watercooler bottles, and the work bowls of food processors. Bisphenol A (BPA) also serves as an essential ingredient of epoxy resins used to line food and beverage cans and even to seal cavity-prone teeth.

But BPA doesn't stay put. It inevitably leaches into foods and people's mouths, such that traces of the chemical now show up in everyone's body.

The universal presence of BPA has raised concerns because hundreds of animal studies have shown that this largely unregulated pollutant can tinker with the development and function of a wide range of tissues. These studies show, among other effects, that BPA can alter rodents' and other lab animals' sex-specific behaviors, perturb developmentally important hormones, boost fat cell numbers and their accumulation of lipids, foster precancerous changes in cells, and induce insulin resistance, a harbinger of diabetes.

If all of this happens in animals, can any of it happen in people too?

That's what the National Institute of Environmental Health Sciences decided to investigate, explains Jerrold J. Heindel, who works at the institute in Research Triangle Park, N.C. Two years ago, its National Toxicology Program (NTP) recruited two panels of experts to review masses of data on BPA's reproductive and developmental effects. Last month, these panels issued reports offering different— and in some ways conflicting—assessments. One panel found many areas of concern. The other turned up few.

Ultimately, NTP will issue a single report that integrates conclusions from both panels, along with any new information on BPA that comes to light during the next few months. That report probably won't emerge for at least a year, says the institute's Michael D. Shelby, whose office will prepare the final document.

In the meantime, how worried should consumers be?

PLASTIC? OH NO — Plastic household products that are hard and clear are typically made of polycarbonate plastic, which tends to leach bisphenol A with age and after heating. When the plastic crackles, as often happens, the leaching accelerates.

Previous evaluations "support the conclusion that BPA is not a risk to human health at the extremely low levels to which consumers might be exposed," according to a statement issued last month by the American Chemistry Council, a chemical-industry group based in Arlington, Va. It interpreted a recent report on BPA by the European Food Safety Authority as indicating that "consumers are not at risk from use of products made from BPA."

Such reassurances don't satisfy a number of BPA researchers, however—among them Randy Jirtle of Duke University in Durham, N.C. He recently published a rodent study showing that fetal BPA exposure can reprogram lifelong gene activity in the agouti breed of mice and even change the animals' coat colors (*SN: 8/11/07, p. 84*). Those data alone prompt Jirtle to say that "if I was a woman who was pregnant—or thinking about becoming pregnant—I would try hard to avoid exposure to BPA."

The chasm between such opinions explains why NTP's judgment is so eagerly awaited. Moreover, Heindel says, it emphasizes why human studies that can confirm or refute BPA effects seen in animals and test tubes must become a research priority.

GLASS HALF EMPTY Ample evidence exists that BPA can harm lab animals at concentrations below those already occurring in most people. That was the primary conclusion of a consensus statement published in the August-September *Reproductive Toxicology* by 38 scientists on one of the two NTP panels. Several additional scientists on the panel declined to sign the statement because they work for government agencies that didn't want them weighing in officially or because they professed inadequate expertise on certain topics, says Heindel.

He commissioned the group to evaluate the strength of data from more than 700 BPA studies. Participants met last fall in Chapel Hill, N.C., to review their findings and identify human-health concerns about which they were "confident" and ones they deemed "likely."

The panel labeled as "confident" its assessment that BPA at low doses has had negative effects on experimental animals.

For example, the panel concluded that BPA exposure in the womb can permanently alter genes of animals, impair the function of organs in ways that persist into adulthood, and trigger brain, behavioral, and reproductive effects, including diminished

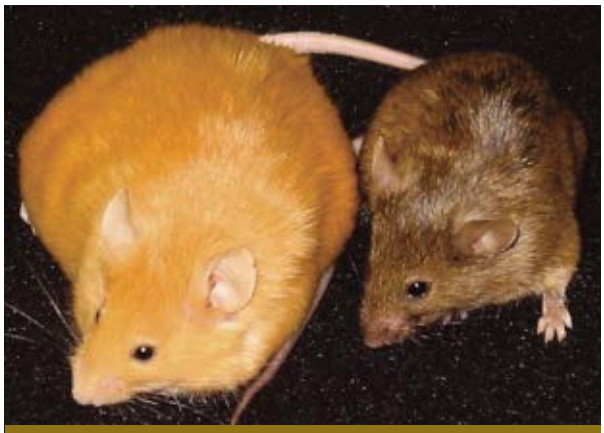
RALOFF

sperm production. Effects deemed likely included a heightened sensitivity to carcinogens, impaired immunity, and diminished insulin sensitivity.

The scientists also expressed confidence that many of these effects can be explained by data from test-tube studies of the chemical's properties.

Although the panel didn't officially put the "confident" or the "likely" label on any human effects of BPA, "the consensus was that there is no reason to think that effects that occur in animals in response to low doses of BPA would not also occur in humans," says participant Frederick S. vom Saal of the University of Missouri in Columbia. Although his and others' studies have identified an animal's most critical windows of susceptibility to harm as its time in the womb and shortly after birth, he notes that the scientists agreed that BPA exposures even in adult animals can trigger adverse effects.

Peer-reviewed summaries of the panel's conclusions in the areas of human exposures, molecular mechanisms, rodent data, carcinogenicity, and wildlife effects appear in the August-September *Reproductive Toxicology*.



TELLTALE BLOND — Agouti-breed mice ordinarily grow into svelte, brown specimens (right). However, when a fetus is exposed to bisphenol A, it can turn into a blond, obese adult (left), showing signs of a gene alteration.

DUKE UNIV. MEDICAL CENTER

GLASS HALF FULL At a meeting in Alexandria, Va., less than a week after Heindel's panel unveiled its conclusions, a second expert panel—organized by NTP's Center for the Evaluation of Risks to Human Reproduction—finished roughing out its review of the data in 450 to 500 published scientific papers. These experts concluded that current BPA exposures appear to pose little risk to people.

The only substantial exception to that conclusion, this panel reported, was that exposure to the chemical might perturb neural development in the womb or shortly afterward.

Panelist Jane Adams, a neuroscientist at the University of Massachusetts, Boston, observes that only "a handful of papers—fewer than 10" raised "red flags" suggesting neural damage from BPA. In some studies, various brain parts of animals exposed to BPA during development later exhibited altered numbers of cells or of cellular receptors that respond to hormones. One paper described altered behavior—such as a diminished propensity for male rodents to explore a novel environment, a trait more characteristic of females.

Although no human study has ever suggested comparable impacts, Adams says that the panel expressed concern on these points because BPA blood concentrations associated with the animal effects are comparable to concentrations known to exist in people. That suggests, she says, that BPA residues in pregnant and lactating women might pose risks to their babies.

INGESTION VERSUS INJECTION Why did the two NTP panels come to such different conclusions about the potential risks of BPA to people? Expert-recruiting strategies suggest an answer, vom Saal says.

Most participants in the Chapel Hill meeting, Heindel says, were selected on the basis of their experience in conducting studies on BPA. Other panel members had substantial experience with other pollutants that can mimic estrogen. All these scientists knew the good qualities and shortcomings of past experiments in the field.

Members of the panel that met in Alexandria, by contrast, were selected precisely because they had no direct BPA experience and, therefore, no obvious vested interest in judging the quality of data on the chemical. The team members' experience spanned a range of disciplines, including toxicology, neuroscience, statistics, and reproductive health.

This second panel rejected many of the studies that had raised concerns for the first one. For instance, the Alexandria group largely discounted findings from animal studies in which BPA had been administered by injection rather than by mouth.

The reason for that decision, the Alexandria panelists explained, was their concern that anything but oral administration of BPA wouldn't represent the normal route of the chemical into people's bodies. Ingested compounds enter the blood and then circulate to the liver, which can filter out some BPA. It is then shed in urine. Injected agents can bypass the liver and potentially build up unrealistically high BPA concentrations in the body, this panel worried.

That's a valid concern, especially for studies evaluating adult exposures, agrees Patricia A. Hunt of Washington State University in Pullman, a member of the Chapel Hill panel. However, her own research group has evidence that oral and nonoral administrations of BPA can have comparable impacts.

In a study of genetic effects on fetal mice, her team administered the chemical orally or via slow-release pellets implanted under pregnant animals' skins. In the January *PLoS Genetics*, Hunt and her colleagues reported no difference in the genetic effects from either dose.

Via both routes, low doses of BPA to mother mice affected their female pups. The daughters' chromosomes were less stable than normal when the pups grew up and mated. Upon fertilization, their eggs' genes exhibited error-prone separations and copying, leading to chromosome abnormalities in some 40 percent of fetuses developing in female mice whose only exposure to BPA had been in the womb. That's at least 20 times the incidence of such abnormalities in mice unexposed to the chemical.

"We were stunned to see this effect of an estrogenic substance," Hunt told *Science News*.

The BPA dose producing the effect was small: 20 micrograms per kilogram (μg/kg) of body weight per day, which is 40 percent of what the Environmental Protection Agency has judged, extrapolating from other animal data, to be the likely "lowest observable-adverse-effects level," or LOAEL, in people.

The researchers used BPA-laced implants in the experiment because getting daily measured doses of a substance by mouth stresses pregnant mice. "It's a good way to lose [fetal] pups," says Hunt.

Vom Saal adds that the liver in fetal mice isn't very effective at removing toxic agents anyway, so slow-release implants and even injections probably deliver chemical exposures to the animals comparable to an oral dose.

Indeed, physiologist Angel Nadal of Universidad Miguel Hernández de Elche in Alicante, Spain, and his colleagues obtained comparable effects with oral and implanted BPA in their study using 100 μg/kg doses. Even a single dose by either method triggered insulin resistance in mice.

Nadal says that such doses produce blood concentrations comparable to values that have been recorded in pregnant women. However, in the January 2006 *Environmental Health Perspectives*, his team reported that it took doses of only 10 μg/kg BPA to impair insulin and blood sugar regulation in mice.

This month, Nadal and his team are launching a study to evaluate whether long-term oral exposure to BPA triggers type 2 diabetes or obesity.

NEW DEVELOPMENTS Some BPA studies were too new to be evaluated by the NTP panels. For example, researchers led by Ana M. Soto of Tufts University in Boston and her colleagues recently reported that a pregnant rat's exposure to low doses of BPA "resulted in early puberty in female offspring." Moreover, those daughters' mammary tissues exhibited changes suggesting elevated susceptibility to cancer. Indeed, when the scientists subsequently exposed these daughters to a carcinogen, the rats were more likely to develop abnormal tissues or outright cancer than were unexposed litter mates. The team reported these findings in the January *Environmental Health Perspectives*.

Vom Saal's team reported in the same journal in June that genital cells from fetal-male mice develop additional cellular receptors for estrogens and androgens—female- and male-sex hormones, respectively—when exposed to low doses of BPA. These extra receptors magnified the cells' sensitivity to the sex hormones, which in other studies have been shown to fuel prostate cancer growth. The authors note that the cell-altering effects of BPA "occurred within the range of concentrations currently measured in human serum."

These findings may help explain a finding in rats by a group led by Gail S. Prins of the University of Illinois at Chicago. The researchers found that exposure to low doses of BPA in the womb increased the tendency of prostate glands in adult-male offspring to become precancerous upon exposure to extra estrogen.

"Men develop elevated estrogen levels, relatively speaking, as they age," Prins notes. Although BPA didn't appear to cause cancer directly, she notes that naturally produced estrogen can. In the June 1, 2006 *Cancer Research*, her team showed that BPA-exposed animals exhibit a heightened cancer vulnerability to estrogen concentrations typical of advanced age.

Her team also showed that BPA can reprogram genes in the fetal prostate in ways that affect a cellular process that's been linked to cancer development.

Retha R. Newbold of the National Institute of Environmental Health Sciences led a study that found that female mice exposed to BPA as fetuses had a dramatically increased risk of developing uterine cysts, precancerous changes, and additional types of reproductive-tract disease in middle age (*SN: 8/11/07, p. 84*). The team's findings appear in the August-September *Reproductive Toxicology*.

> "If I was a woman who was pregnant … I would try hard to avoid exposure to BPA."
>
> — RANDY JIRTLE, DUKE UNIVERSITY

Finally, Hiroshi Masuno of Ehime Prefectural University of Health Sciences in Japan says that his group will publish data in the next few months on the obesity-fostering potential of BPA in mice. In the new study, the exposure of pregnant mice to BPA increased their offspring's adipose tissue mass, serum-cholesterol concentrations, and blood-triglyceride readings, the biochemist says.

HELP WANTED The biggest shortcoming of data on BPA's effects is that human studies are all but nonexistent, Heindel says. However, he notes, concerns articulated by the two NTP panels will guide what kind of human studies his agency should fund.

Where do all these hints of danger from a ubiquitous chemical leave consumers? "I don't want to cause undue worry," Newbold says, "but I don't think we can ignore the possibility BPA can pose risks. There's just too much science [suggesting it can]."

As a precaution, she recommends that pregnant and nursing women limit their BPA exposures "in whatever way they can." One of her tips: If a new mom must use plastic kitchenware, keep it out of the microwave and dishwasher. That's one answer that BPA research has already provided: Heating polycarbonate plastics frees more BPA, which then leaches into foods. ■

OF NOTE

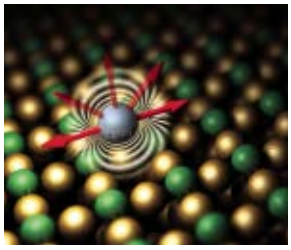
PHYSICS

Not flipping out

Scientists have shown for the first time how single atoms may be able to magnetically encode single bits of information.

Hard disks store data by magnetizing small domains of a disk's surface so that the magnetic axis points in one of two opposing directions. Each orientation is stable because the domain's energy is at a minimum. Such stability helps keep the magnetic axis from wandering, which would corrupt the data.

To fit more data onto a surface, engineers would like to shrink the domains, working toward the ultimate limit of single atoms. But reliable data storage would still require energy-minimizing orientations to prevent random flips.



IBM

ONE WAY OR THE OTHER
An iron atom (silver sphere in this artist's impression) on a surface has a few preferred orientations (red arrows), and will require a push to switch from one to the other.

Cyrus Hirjibehedin of IBM's Almaden Research Center, in San Jose, Calif., and his colleagues used a scanning tunneling microscope to place iron or manganese atoms on a copper-nitrogen surface and to sense the atoms' spins—the atomic version of their magnetic axes. The interaction of the atoms with the surface's structure gave rise to preferred, energy-minimizing directions, the team reports in the Aug. 31 *Science*.

The surface was kept at just 0.5 kelvin, but Hirjibehedin says that the team's method may eventually lead to configurations of one atom or more that will produce a stable magnetic orientation at higher temperatures. —D.C.

BIOMEDICINE

Exhaust fumes might threaten people's hearts

Grimy diesel exhaust doesn't just stink up highways. The nanoparticles in diesel fumes also thwart proteins that dissolve blood clots, researchers have discovered, perhaps increasing the risk of heart attacks.

Studies had already shown that diesel fumes worsen cholesterol's ill effects (*SN: 8/11/07, p. 93*), and that people living in highly polluted areas are more likely to have heart attacks. David E. Newby of Edinburgh University and his colleagues decided to study the latter connection in a controlled environment: a chamber into which they could pump either filtered air or air contaminated with diesel exhaust.

"The diesel levels in the chamber are about what you'd expect at roadside in a busy city," says Newby.

One at a time, each of 20 volunteers alternated 15-minute periods of exercise and rest in the chamber. The researchers found that blood vessels of healthy subjects exercising in diesel-filled air didn't relax as easily as when they worked out in filtered air. When people with coronary heart disease, whose blood vessels were already too stiff to relax easily, exercised in smoggy air, their vessels released fewer clot-dissolving proteins than when they exercised in clean air.

The findings, reported in the Sept. 13 *New England Journal of Medicine*, suggest that people at risk for heart attacks shouldn't exercise outside on highly polluted days, said Newby. —S.C.W.

ZOOLOGY

Honeybee mobs smother big hornets

Honeybees of the Cyprian strain can kill an attacking hornet by ganging up and smothering it.

That tactic is new to scientists, says Alexandros Papachristoforou of Aristotle University of Thessaloniki in Greece, although it resembles an Asian honeybee species' so-called heat-balling defense. When using that maneuver, the Asian bees cluster around a marauding hornet of another species and cook it to death with their body heat.

With Cyprian bees and the hornet *Vespa orientalis*, however, "we noticed some things that didn't match," says Papachristoforou. Cyprian bee balls warm to only 44°C. Tests show that a hornet kept at that temperature takes almost 2.5 hours to die, but Cyprian bees dispose of their foe in just 1 hour.

The researchers observed that Cyprian bees first surround the abdomen of the hornet, where its breathing holes are. Unlike most other insects, a hornet breathes by abdominal contractions.

To see whether suffocation contributed to a hornet's demise, Papachristoforou and his colleagues smother proofed hornets by positioning tiny plastic blocks under each abdominal plate to keep the bee mob from pressing them down and covering the holes. With breathing holes propped open, hornets survived twice as long as usual in bee mobs, the researchers report in the Sept. 18 *Current Biology*. —S.M.

BOTANY

Water-saving grain

Rice is the staple food for more than half the world's population, including many people in developing countries. But the rice plant consumes more than twice as much water as other grain crops do, leaving some countries especially vulnerable to drought.

Now, an international team of scientists has identified a gene that, when added to rice's DNA, reduces the plant's water consumption and boosts its growth.

The gene, called *HARDY*, comes from thale cress, a weedlike plant that's commonly used in genetic research. Andy Pereira of the Virginia Polytechnic Institute and State University in Blacksburg, and his colleagues found a variant of this gene in thale cress plants that had unusually small, thick leaves and extensive roots.

When Pereira and his colleagues engineered thale cress to have an overactive version of this variant, the plants were able to survive 12 days without water. Unmodified plants lasted no more than 9 days.

Inserting the overactive form of *HARDY* into the rice genome increased the plants' water efficiency by 50 to 100 percent. When water was plentiful, the plants grew up to 80 percent more leaves and shoots than other plants did, the researchers report in the Sept. 25 *Proceedings of the National Academy of Sciences*. When water was scarce, most of the extra growth occurred in the roots, which helped the plants survive.

"I think it's a very important experimental step," comments Susan R. McCouch, a specialist in plant breeding and genetics at Cornell University. However, the research doesn't address whether the increase in leafy growth comes at the expense of grain yield, she notes. —P.B.

ASTRONOMY

Out-of-focus find

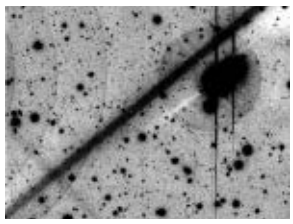
While focusing a telescope on objects in deep space, researchers happened to collect images that enabled them to answer a

question much closer to home: How wide are the glowing vapor trails known as meteors?

When extraterrestrial objects blaze through Earth's atmosphere, they typically start to glow at heights of about 100 kilometers. Telescopes that observe deep-space phenomena are focused at infinity, so any meteor that shows up in images is far out of focus, says Masanori Iye, an astronomer at the National Observatory of Japan in Tokyo. Previous research had suggested that these incandescent trails are less than 1 meter wide, but the images didn't allow further precision, he notes.

Some of the images that Iye and his colleagues made while observing the Andromeda galaxy in August 2004 also captured the ghostly streaks of meteors. To infer their true width, the researchers first estimated how many photons the telescope detected at a particular wavelength, radiated by oxygen atoms after high-energy collisions. Then they could estimate the number of such photons that the meteor had radiated in all directions, says Iye. Finally, knowing the density of oxygen atoms at an altitude of 100 km, the researchers could estimate the width of a vapor trail.

The brightness of a meteor provides a good idea of the size of particle creating it. For an object about the size of a sand grain, the researchers estimate that the resulting trail measured just over 1 centimeter wide. On average, each vapor trail that they analyzed was about 10 times as wide as the object that had vaporized to create it. The researchers report their findings in the Aug. 25 *Publications of the Astronomical Society of Japan*. —S.P.



THAT'S HOT The incandescent vapor trail of this meteor (out-of-focus diagonal line from lower left to upper right) was probably no more than about 1 centimeter wide.

IYE ET AL.

INFECTIOUS DISEASES

Malaria's sweet spot

A sugar molecule in the guts of mosquitoes is crucial in spreading the malaria parasite from person to insect to person, scientists have discovered.

After a mosquito takes blood from an infected person, parasites in that blood must bind to the inner wall of the insect's gut and then pass through it. Sugar molecules called chondroitin glycosaminoglycans cover the cells that form the wall's surface, and these molecules give the parasite a place to grab on, the research shows.

The scientists injected laboratory mosquitoes with a molecule that blocked production of these sugars. The treatment reduced by about 95 percent the number of malaria parasites that passed through the wall, the team reports online and in an upcoming *Proceedings of the National Academy of Sciences*.

"What is new in our work is that we found some transmission-blocking [molecules] that are not derived from the parasite itself but from the mosquito," says lead scientist Marcelo Jacobs-Lorena of Johns Hopkins University in Baltimore.

If scientists find the protein on the parasite that binds to the sugars in the mosquito's gut, they could perhaps design a vaccine for that protein, Jacobs-Lorena says. People inoculated with such a vaccine would remain vulnerable to malaria, but their immune systems would produce antibodies that biting mosquitoes would ingest, which would then block transmission of the parasite. —P.B.

MEETINGS

Fourth International Scientific Symposium on Tea and Human Health
Washington, D.C., Sept. 18

NEUROSCIENCE

Tea compound aids dying brain cells

A constituent of green tea can revive moribund brain cells, Israeli researchers report. The team experimented with animal neurons that had been chemically poisoned to model the death of dopamine-producing cells in Parkinson's disease.

In a test-tube study, low doses of epigallocatechin gallate (EGCG)—the primary antioxidant in green tea—revived sick and dying neurons, reports Silvia Mandel of the Technion Faculty of Medicine in Haifa. Withered cells became fatter and more robust, she says, and the cells' shrunken appendages regrew and began reaching out to contact neighboring cells.

In a second study, mice got oral doses of EGCG for 2 weeks. Treatment started only after the animals had already lost about half their dopamine-making brain cells. The daily doses—a few milligrams of EGCG per kilogram of body weight—were comparable to what people might obtain from 3 to 4 cups of tea, Mandel says. Although preliminary data suggest that dopamine production rebounded in the treated animals, she notes that it's too early to say whether EGCG permanently rescued the cells or just bought them some extra time. —J.R.

FOOD AND NUTRITION

Distracted? Tea might help you focus

Many people reach for a cup of coffee when they need to concentrate. People with flagging focus might, however, get more bang for the buck with a cup of tea. Theanine, an uncommon amino acid found almost exclusively in tea, works with caffeine to boost the activity of brain neurons, new data show.

John J. Foxe of the Nathan S. Kline Institute for Psychiatric Research in Orangeburg, N.Y., and his colleagues recruited 16 people for tests of attentiveness on four days. Before testing, each individual drank a glass of water. On 3 days, the drink was spiked with 100 milligrams of theanine, 60 mg of caffeine, or both. The theanine dose was equivalent to that in 4 to 5 cups of tea, and the caffeine translated to about 2.5 cups of tea.

In the difficult tests, participants watched a computer screen and pressed a button when a designated shape appeared on the side of a busy visual field to which an arrow had previously pointed. Participants' accuracy differed little between days when they got water alone or with only one additive. Accuracy improved dramatically, however, on the day that they got the theanine-caffeine combination. The attention benefit lasted throughout the 3 hours of testing.

Brain activity, measured throughout each test, showed that theanine induced strong alpha waves in neurons, suggesting restfulness. But that lasted only until focus was required. Then, Foxe says, alpha activity dropped precipitously if a person had gotten theanine—especially in combination with caffeine—indicating that idling neurons had suddenly revved up their activity.

The study was funded by Unilever, which sells Lipton teas. —J.R.

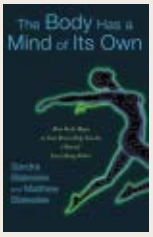
Books

A selection of new and notable books of scientific interest

THE BODY HAS A MIND OF ITS OWN: How Body Maps in Your Brain Help You Do (Almost) Everything Better

SANDRA BLAKESLEE AND MATTHEW BLAKESLEE

By imagining yourself crossing the finish line of a grueling marathon, you may actually increase your chances of reaching that goal. And the onset of a movement disorder known as the yips can send even a seasoned golfer's putt wildly off line. Representing two generations of science writers, the Blakeslees look at the intimate relationship between body and mind. They examine how body maps—representations of the body in physical space—are affected by various physical and psychological states. Far from being set in childhood, the body's representation in the brain is flexible. People can incorporate objects such as a hat on one's head or a tool in one's hand as extensions of their bodies. The brain is even able to remap the location of an amputated limb. Phenomena occur when body maps go awry, such as the feeling that a limb is foreign to one's body. The body-mind connection extends beyond each individual, and our ability to mirror the positions of other people's bodies helps us build empathy and connection. ***Random House, 2007, 228 p., b&w illus. Hardcover, $24.95***.



THE PLENTITUDE: Creativity, Innovation, and Making Stuff

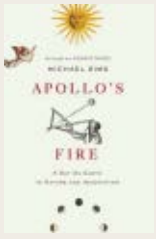
RICH GOLD

Throughout our lives, we collect things that themselves are composed of even smaller things. Gold calls this collection of stuff "the Plentitude" and notes that the creation of some things necessitates the invention of other stuff, such as the indispensable remote control for a television set. Gold explains, using cartoons, how his career trajectories—as an artist, a designer, a scientist, and an engineer—took him toward fields that create stuff in different ways but that nevertheless follow one of seven basic patterns of innovation. Pattern one covers innovations bred of necessity, such as the polio vaccine. Pattern two, by contrast, covers innovations sparked by visionary genius—for example, the photocopy machine. Gold examines how industries are moving from mass-market production to production of goods tailored to consumer specifications. Finally, he looks at the morality of creating and acquiring more stuff. ***MIT Press, 2007, 111 p., b&w images, hardcover, $22.00.***

APOLLO'S FIRE: A Day on Earth in Nature and Imagination

MICHAEL SIMS

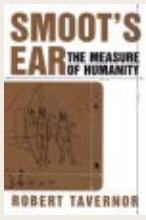
Whether portrayed as a winged chariot blazing across the sky or a smiling golden presence, the sun has always been a source of fascination. Before humans understood the science behind the passage of days, this reliable marker was the subject of myth and legend. Sims follows the passage of the sun on a typical day, blending history, physics, and astronomy. He explores research into the sun's composition and the nature of sunlight, describes the emergence of scientific understanding of the passage of time, and even recounts the invention of the sundial. The account also covers the biological rhythms that correspond with sunlight—rhythms that dictate the sleep-wake cycles and feeding patterns of various organisms. Finally, the author focuses on the vast darkness that envelops Earth after the sun sets, chronicling people's fascination with stars and the notion that Earth hangs in a great void. ***Viking, 2007, 296 p., hardcover, $24.95***.



SMOOT'S EAR: The Measure of Humanity

ROBERT TAVERNOR

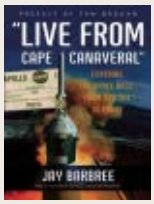
In 1958, Oliver Smoot was a freshman at the Massachusetts Institute of Technology, when, in a fraternity-initiation prank, his body was used to measure the length of the Harvard Bridge. The resulting indicator, designated as a smoot, is still used as a point of reference. Tavernor, a professor of architecture and urban design, uses this example to illustrate how, despite science and industry's best efforts to standardize artificial units of measurement, the process of measuring is still entwined with the way people view their worlds. Measurements, Tavernor proposes, have a symbolic value that is rooted in human history and expressed in science and art. He details how the idealized human body was used to set measurement standards in Ancient Rome, the emergence of the meter, and the antimetric movement. ***Yale, 2007, 249 p., b&w photos, hardcover, $25.00.***



"LIVE FROM CAPE CANAVERAL": Covering the Space Race, From Sputnik to Today

JAY BARBREE

The only reporter to cover every mission flown by astronauts, NBC's Barbree has a unique perspective on the people involved in some of the United States' space milestones. Here he gives a firsthand account of his experiences covering the Cape Canaveral beat over the past 50 years. He recounts the tension that existed as the United States and the Soviet Union vied to be first to send a human into space. He provides portraits of Alan Shepard, the first American in space, and of John Glenn, who led the Mercury mission that made first U.S.-manned orbital flight. He offers a detailed review of the Apollo I tragedy, describes the never-to-be forgotten experience of transmitting the lunar landing live on the radio in 1969, and provides a sobering account of the Challenger disaster. A pilot himself, Barbree became friendly with the astronauts, who allowed him unprecedented access to their lives. ***Smithsonian/HarperCollins, 2007, 321 p., color and b&w photos, hardcover, $26.95***.



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LETTERS

Questioning the surge

"The Power of Induction" (*SN: 7/21/07, p. 40*) was written as if this was a newly discovered technology. I have been using an electric shaver with induction recharging for years.

MIKE YORK, PHOENIX, ARIZ.

The ability to project electrical power some distance suggests a possible method to detonate or disable improvised explosive devices.

JOSEF HEIT, WEBSTER, N.Y.

Several readers pointed out that wireless induction already powers various devices, such as cochlear implants. However, Aristeidis Karalis of the Massachusetts Institute of Technology (MIT) responds that, to the authors' knowledge, all previous applications used induction at distances not substantially larger than the size of coils involved. Second, the MIT invention could in principle shut down the electronics of a bomb detonator, but at no greater a distance than a few meters. —D. CASTELVECCHI

Weighty opinions

People don't need another reason to shun fat people ("Weighting for Friends: Obesity spreads in social networks," *SN: 7/28/07, p. 51*). This group represents the last scapegoat for righteous discrimination in our image-obsessed society. There are myriad reasons a person becomes obese. Friendship is not one of them.

SHAWN DEHNE, LITTLETON, COLO.

As such studies progress, it will be interesting to learn if the opposite—weight loss—is also influenced by social networks. And if not, why not.

VICTORIA D. MCCOY, DRAKE, COLO.

Credit due?

I was surprised to find no mention in "Antidepressants trim suicide tries" (*SN: 7/28/07, p. 61*) of the possibility that the decline in suicide attempts might be owed merely to the hope generated by beginning a treatment, rather than the treatment itself. I have known depression sufferers to be nearly euphoric after starting a new treatment.

KAREN AIKEN, SAN FRANCISCO, CALIF.

Correction *"Barely Alive: Ancient bacteria survive in the slow lane" (SN: 9/1/07, p. 131) misspelled the last name of researcher Russell Vreeland of West Chester (Pa.) University.*

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