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SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

pyramids and particles
stem cells fix sickle cells
photons find prime factors
memory champ chimp

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KEEPING GERMS OUT OF FIELDS

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DECEMBER 8, 2007 VOL. 172, NO. 23

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Cover Last year's spinach-borne food poisoning outbreak has led to dramatic—and some would say environmentally unfriendly—changes in farm practices. The produce industry's new self-regulation aims to keep germ-harboring wildlife and livestock from tainting fields. (iStockphoto) Page 362

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SCIENCE NEWS is printed in the United States on process chlorinefree paper containing 90% recycled fiber with 30% postconsumer waste.

Science News (ISSN 0036-8423) is published weekly on Saturday, except the last week in December, for $54.50 for 1 year or $98.00 for 2 years (foreign postage is $18.00 additional per year) by Science Service, 1719 N Street, N.W., Washington, DC 20036. Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.

POSTMASTER Send address changes to **Science News**, P.O. Box 1925, Marion, OH 43306. Two to four weeks' notice is required. Old and new addresses, including zip codes, must be provided.

Printed in U.S.A. on recycled paper.

EDITORIAL, BUSINESS, AND ADVERTISING OFFICES 1719 N St. N.W., Washington, D.C. 20036 202-785-2255; scinews@sciencenews.org.
LETTERS editors@sciencenews.org

SUBSCRIPTION DEPARTMENT P.O. Box 1925, Marion, OH 43306. For new subscriptions and customer service, call 1-800-552-4412.

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Sickle Save

Skin cells fix anemia in mice

Using a new technique to turn skin cells into stem cells, scientists have corrected sickle cell anemia in mice. The advance provides proof of principle that stem cells made without embryos can treat disease, at least in lab animals, says Rudolf Jaenisch, the biologist who led the work at the Whitehead Institute for Biomedical Research in Cambridge, Mass.

Jaenisch and his team caution, however, that the technique is not yet suitable for use in humans because it may cause tumors.

Still, Jaenisch says that embryofree stem cells now "have the same potential for therapy as embryonic stem cells, without the ethical and practical issues." Embryonic stem cells are difficult to obtain, and some people oppose such research because it destroys discarded embryos.

In the new work, the scientists turned skin cells into embryonic-like cells. Researchers at Kyoto University in Japan first developed the technique in mice and published the protocol last year. Last month, two teams repeated the feat with human cells (*SN: 11/24/07, p. 323*). All of these protocols deploy viruses carrying four master genes that turn back the clock on skin cells, making them look and act embryonic. Researchers call these new cells induced pluripotent stem (iPS) cells because they can form any tissue in the body.

The Whitehead researchers obtained mice engineered to carry a defective version of the human hemoglobin gene. That flaw distorts red blood cells into the characteristic sickle shape. To fix the flaw, the researchers induced skin cells plucked from the tails of the mice to become iPS cells, and corrected the genetic defect.

Next, the Whitehead team prodded the corrected cells into becoming blood stem cells, which can produce red and white blood cells. The team used a recipe originally developed for embryonic stem cells and found that it also made iPS cells grow into blood stem cells, the researchers report Dec. 6 online in *Science*.

"We wanted to compare the embryonic stem cells versus the iPS cells," says Whitehead researcher Jacob Hanna. "They behaved similarly."

Finally, the researchers performed a procedure akin to a bone marrow transplant. They transfused a million of the corrected blood stem cells into each of three mice whose bone marrow—which harbored the mice's original defective blood stem cells—had been obliterated by radiation. The corrected blood stem cells soon began producing healthy red blood cells. Because the same animal was both donor and recipient, the infused cells were not rejected, as commonly occurs in human bone marrow transplants.

After this treatment, the formerly lethargic mice made swift recoveries. "The improvement was profound," says Hanna. "There was a clear sign of reduction of destruction of red blood cells, which is actually the main problem in sickle cell anemia."

Mark Walters, a bone marrow transplant specialist at Children's Hospital and Research Center in Oakland, Calif., says the procedure surmounts the biggest obstacle in performing such transplants in children—finding a genetically matched donor. Worldwide, only 300 to 400 children with sickle cell anemia have received bone marrow transplants because matched siblings are rare. "But the results are outstanding, with a cure rate between 85 and 90 percent," Walters says.

Before the procedure can advance to human trials, though, researchers must find a more benign way to make iPS cells, because the viruses currently used can trigger cancer. "We'd have to have some information that these are not preleukemic or premalignant cells, that they're safe in the long term," says Walters. —B. VASTAG

Chimp Champ

Ape aces memory test, outscores people

OK, humanity: time to pull up our socks. In a test of rapid number recollection, college students were resoundingly outperformed by a young chimpanzee.

At Kyoto University in Japan, students and chimps saw an array of five of the numerals 1 through 9 flash onto a computer screen for just 650 milliseconds. When the numerals simultaneously turned into white squares, the subjects had to touch the squares in numerical order. The students managed to choose the squares in the correct order around 80 percent of the time, as did Ayumu, a young chimp, says Kyoto's Tetsuro Matsuzawa.

The researchers then shortened the viewing time to 430 ms and finally to just 210 ms, which isn't even enough time for a person's eye to scan across a screen. For the briefest exposures, the students got the sequence right only 40 percent of the time, but Ayumu still managed nearly 80 percent accuracy.

"The memory aspect is really surprising," says Elizabeth Brannon of Duke University in Durham, N.C.

Matsuzawa suggests that Ayumu's prowess comes from something akin to photographic memory in humans. The power to retain extreme detail from a quick glimpse shows up occasionally in young children but fades with age. Youth seems to be an advantage for chimps too, Matsuzawa and Sana Inoue say in the Dec. 4 *Current Biology*.

The researchers worked with three pairs of mother-child chimps. Ayumu's mother, Ai, had starred in earlier research papers when she learned to associate sets of objects with the appropriate numerals.

FLYING FINGER **A chimp learned the sequence of numbers 1 to 9 and then wowed researchers with skill at a memory test.**

AP/WIDEWORLD

Researchers trained all the chimps to tap numerals from 1 to 9 in order, then switched to tests in which numerals popped up briefly on the screen and then turned into white squares. Because the exposure times are so brief, the test challenges perception as well as memory, says comparative psychologist Herbert Roitblat of Ventura, Calif.

On average, the three young chimps outperformed their mothers, the researchers say. Even Ai, despite her skill in using numbers as symbols, proved less accurate than her son. Brannon says she'll be interested to see whether Ayumu loses his edge as he ages.

"The test says absolutely zero about chimpanzees and numerosity," comments Brannon, who studies number skills in nonhuman primates. She predicts that the test could have substituted other shapes for the numerals in the test. "It's really about memory," she says.

"It is a terrific animal-human comparison of the cognitive ability to remember the locations of an ordered sequence," says Anthony A. Wright of the University of Texas Health Science Center in Houston.

"Chimpanzees may have a perceptual

advantage that is slowed down in humans, whose knowledge of counting may interfere," says Sally Boysen of the Ohio State University in Columbus.

However, Matsuzawa's results don't mean that people will always lose to chimps, Brannon says. Ayumu might be an exceptional chimp, and some exceptional people, including children, might be able to keep up with him.

Overall, the scores for people and chimps greatly overlapped. To Brannon, this convergence suggests a basic likeness in the two species' memory mechanisms. "I would argue that this is showing a major qualitative similarity rather than a major difference," she says.

As to why researchers pit humans against other species, Roitblat says comparisons with close and distant relatives offer a way to infer the evolutionary path of human capacities. "Are we intelligent because we have language or do we have language because we are intelligent?" Roitblat asks. —S. MILIUS

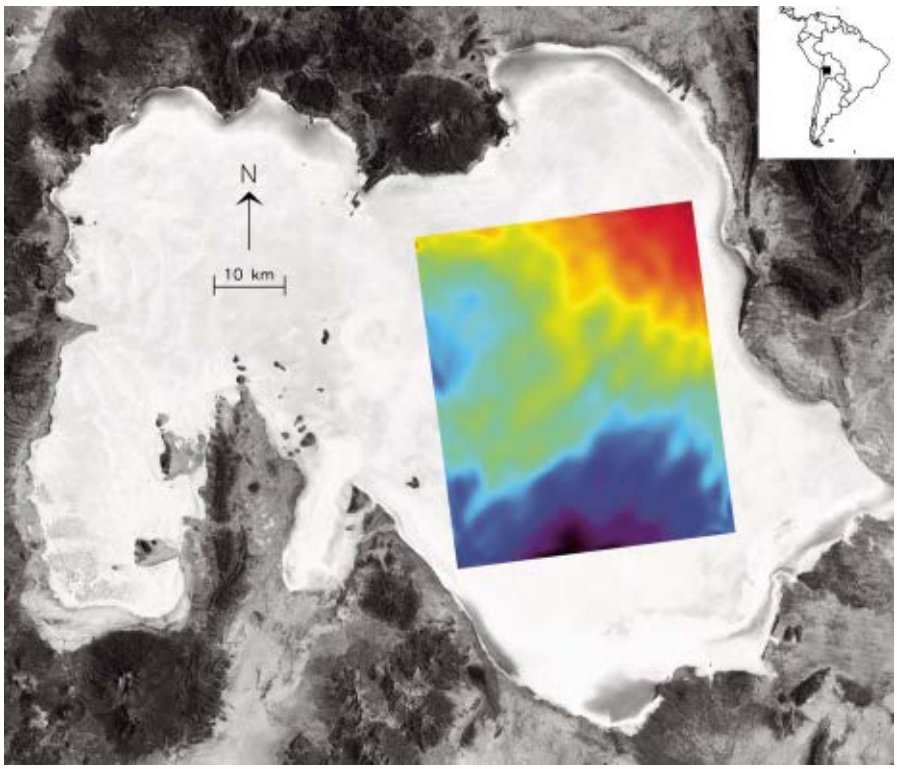
The Salt Flat That Isn't Flat

World's largest playa sports ridges, valleys

People have long known that the world isn't flat. Now, an innovative field survey of the world's largest salt flat—a New Jersey–size playa high in the Andes—reveals that the barren expanse unexpectedly has minuscule variations in topography.

Previous field surveys of southwestern Bolivia's Salar de Uyuni hadn't detected any variations in elevation, says Adrian A. Borsa, a geophysicist at the Scripps Institution of Oceanography in La Jolla, Calif. "On topographical maps, the entire region lies in between contour lines," he notes. Even data gathered during the Shuttle Radar Topography Mission in 2002 (*SN: 2/23/02, p. 126*) weren't accurate enough to discern the subtle ridges and valleys of the 9,000-square-kilometer region.

Scientists have used the large, ostensibly flat area as a target when calibrating altitude-measuring instruments on Earth-orbiting satellites. In fact, Borsa and his colleagues conducted their survey to obtain accurate altitude measurements that could be used to calibrate the laser altimeter on board ICESat, an Earth-orbiting craft designed to monitor ice sheets (*SN: 12/24&31/05, p. 418*).



NOT FLAT AFTER ALL A field survey of Bolivia's Salar de Uyuni, the world's largest salt flat, found a broad ridge (green area running southwest to northeast) flanked by shallow depressions (dark-blue areas). Red denotes higher terrain in the northeastern part of the playa.

The researchers surveyed a 45-by-54-km portion of the playa in September 2002 by crisscrossing its surface in SUVs with Global Positioning System receivers and antennas strapped to their roof racks. Driving back and forth along roughly east-west and north-south paths spaced about 2.25 km apart, the scientists collected GPS data every 100 meters or so, says team member Helen A. Fricker, a geophysicist at Scripps.

The team hadn't originally expected to detect any variations in the topography of the Salar de Uyuni, says Borsa. However, their equipment proved so sensitive that the researchers could even tell that their SUVs rode about 5 millimeters higher off the ground at the end of the day, with empty gas tanks, than they did in the morning.

Analyzing the survey results, the team detected a broad ridge, highest at its ends, running from southwest to northeast. The playa's highest and lowest points lay more than 50 km apart, and their difference in elevation measured just 77 centimeters, Fricker says. The team reports its findings online and in an upcoming *Geophysical Journal International*.

"These findings are pushing the GPS technology to its limits," says Mauri McSaveney, a geomorphologist with GNS Science in Lower Hutt, New Zealand.

The salt flat's highs and lows roughly correspond to peaks and troughs in the local gravity field, says Borsa. That agreement suggests how the Salar de Uyuni maintains its topography, he notes. The rains that briefly flood the playa each year dissolve its surface layer of salt, flow across the ground in response to the local gravity field, and then leave the salt in place when they evaporate. If it weren't for variations in the strength of the local gravity field—and the curvature of Earth's surface—the salt flat would be truly flat.

Results of the newly reported fieldwork cut in half the estimated uncertainty in ICESat's altitude data, says James Abshire, a remote-sensing scientist at NASA's Goddard Space Flight Center in Greenbelt, Md. As a result, researchers are now better able to detect thinning of ice sheets and glaciers. Scientists can also more easily discern the rise and fall of the surfaces of ice sheets due to the flow of water into and out of subglacial lakes (*SN: 3/3/07, p. 142*), he notes. —S. PERKINS

15 = 3 x 5

Photons do their first quantum math

Two teams of physicists have independ- ently confirmed that 15 equals 3 times 5—an arduous task considering that they've done it by manipulating the quantum states of photons. The results are a step toward

BORSA ET AL.

optical quantum computers, which could do some calculations exponentially faster than ordinary computers can and crack the encryption codes that protect data traveling over the Internet.

Multiplying two whole numbers is easy, but the inverse operation generally isn't: Identifying when a number is the product of other whole numbers becomes exponentially more complex as the numbers get bigger, quickly overwhelming even the fastest supercomputers.

This is good for privacy. When Web-based programs request sensitive data over the Internet, they ask the sender's Web browser to encrypt the data using a number, called the public key, that is the product of two prime numbers. Decrypting the data requires identifying those two prime numbers, which only the legitimate recipient knows. Anyone wishing to steal the data would have to break the public key into its prime factors.

In 1994, mathematician Peter Shor, now at the Massachusetts Institute of Technology (MIT), theoretically demonstrated that a computer based on the principles of quantum mechanics could quickly find the prime factors of public keys.

A quantum computer would represent information as quantum states of some physical system, such as the magnetic alignments of atoms or the polarization directions of photons. Shor's algorithm exploits the ability of such systems to exist simultaneously in multiple states. The quantum computer could in essence try dividing a number by all possible factors at the same time. Only states corresponding to the true factors—those that give zero as remainder—would have any probability of actually being measured.

In 2001, researchers ran a simplified version of Shor's algorithm using magnetic orientations of the atomic nuclei in fluorocarbon molecules (*SN: 1/12/02, p. 31*). Using just seven atoms to encode bits of information, the molecules' magnetic states revealed the prime factors, 3 and 5, of the number 15.

Now two teams—one led by Jian-Wei Pan of the University of Science and Technology of China in Hefei, and the other by Andrew White of the University of Queensland in Brisbane, Australia—have performed the same feat using photons.

Photons don't interact much with things around them, explains Pan's colleague Daniel Browne of Oxford University in England. That facilitates keeping the photons in multiple states, in which the photons are polarized horizontally and vertically at the same time.

Both teams pointed lasers at special crystals to create pairs of photons that occupied different combinations of polarization states. Interference between the wave patterns corresponding to the photons then performed the logic operations that yielded the factors of 15. Both results will appear in *Physical Review Letters*.

Seth Lloyd of MIT says the results are a "necessary step" toward photon-based quantum computers. But, he adds, "it's a judgment call that they demonstrated the internal nugget of quantumness in Shor's algorithm," because the teams were able to implement the algorithm only in a drastically simplified form.

"It wasn't the full demonstration; we're years away from that yet," White says. But

Angiogenesis Factors

Tracking down the suspects in blood vessel growth near tumors

Cancerous growths rely on a surrounding tangle of blood vessels to support their reckless expansion, and scientists have spent decades hunting for the compounds that promote the development of such vessels. Although tumors are known to generate proteins that do the job, researchers have recently implicated bone marrow cells in the process too.

A new study in mice finds that a protein called Bv8 promotes vessel growth around tumors both directly and by inducing certain marrow cells to migrate out of bone and help tumors form a vessel network. Neutralizing Bv8, or preventing cells from making it, curbs such proliferation, scientists at Genentech in South San Francisco report in the Dec. 6 *Nature*.

The notion of thwarting angiogenesis to shut off a tumor's supply of nutrients has dazzled scientists ever since researchers suggested the approach 20 years ago. Since then, scientists have tested dozens of compounds in hopes of neutralizing pivotal factors in angiogenesis.

"Now Bv8 is another target," says Shahin Rafii, a hematology-oncologist at the Howard Hughes Medical Institute and Weill-Cornell Medical College in New York City. "Blocking its activity could abrogate the growth of certain tumors."

Bv8 joins two other proteins clearly implicated in angiogenesis that scientists are seeking to neutralize.

In a raft of experiments, Genentech biochemist Napoleone Ferrara and his team identified a signaling protein that tumors release. They established that this signaler induces certain immature immune cells in the bone marrow to overproduce Bv8. These changes also prompted the marrow cells to venture out of the bone and produce Bv8 elsewhere, including tumor sites, the researchers found.

In tests on mice with cancer, the researchers found that excess Bv8 in tumors increased nearby vessel growth. Bv8 apparently triggers cells lining blood vessels to replicate, Ferrara says.

Treating tumors with antibodies to Bv8 suppressed vessel growth. Anti-Bv8 treatment also kept the marrow cells cooped up in the bone, where they couldn't promote vessel-cell replication.

The Bv8 findings bolster the concept that certain bone marrow cells can contribute to cancer by aiding angiogenesis. That notion met with much skepticism only 10 years ago, Rafii says. "This is exciting. The whole concept that a tumor is a self-sufficient entity is being challenged now."

The migration of marrow cells out of the bone to a tumor represents "a form of inflammation," says immunologist Kyle C. McKenna of the University of Pittsburgh School of Medicine. Many studies have linked inflammation with cancer, in part because nascent immune cells often show up near tumors. The presence of immature immune cells may limit mature immune cells from properly attacking cancer, he says.

The new study shows that Bv8 "is clearly involved in promoting this inflammatory microenvironment around a tumor," McKenna says.

Earlier work had established that nascent immune cells, when in contact with tumors, secrete a protein called matrix metallopeptidase-9 that facilitates new vessel growth, says P. Charles Lin, a vascular biologist at Vanderbilt University Medical Center, in Nashville. Tumors have multiple systems by which they promote angiogenesis, and a reliable therapy would need to address all of them. The Bv8 finding offers a specific protein to target as part of such an all-encompassing strategy, Lin says.

Not all marrow cells boost vessel growth. Some curb it, Rafii says. "We're finding that there is a subset of these cells that contribute to tumor angiogenesis." —N. SEPPA

both White and Browne say their results suggest that photon techniques could lead to computers that can find factors of large numbers and potentially have other applications that are beyond the capacity of current computers, such as simulating the quantum behavior of large molecules. For now, our credit card numbers may still be safe. —D. CASTELVECCHI

Perchlorate Pump

Molecule draws contaminant into breast milk

A molecular pump designed to transport iodine also concentrates the pollutant perchlorate in breast milk, scientists have shown. The result is higher levels of the chemical in breast milk than in other parts of the body, with implications for the amount of perchlorate that pregnant and lactating women can safely ingest.

For the past decade, scientists have debated the health effects of perchlorate, which leaches into groundwater around explosives manufacturing plants. The contaminant was found in some states' drinking water in the mid-1990s. Since then, perchlorate has also turned up in produce grown with contaminated water, and scientists and policy makers have reached no consensus on what levels of the chemical are safe in humans.

Scientists knew that iodine deficiency can cause developmental problems for a nursing newborn. The new results show how perchlorate blocks iodine's movement into organs like the thyroid, lactating breast, salivary glands, and stomach by interfering with a molecular pumping system known as the Na+/I- symporter (NIS). NIS normally raises iodine levels in those organs to more than 40 times the concentrations in the bloodstream.

Ordinarily NIS occupies a cell membrane and simultaneously transports two positively charged sodium ions and one negatively charged iodine, establishing a charge difference across the membrane. But when Nancy Carrasco of the Albert Einstein College of Medicine in New York City and her colleagues exposed cells with NIS to both perchlorate and iodine, no charge difference developed, suggesting that the perchlorate blocked NIS from pumping any ions at all.

But the NIS, it turns out, was pumping the perchlorate instead of the iodine, the team reported in the online *Proceedings of the National Academy of Sciences*.

When the researchers arranged cells with NIS on a filter between two compartments, and put iodine and sodium in the contraption, NIS moved the ions across the filter, concentrating iodine on one side.

When they added perchlorate, though, the iodine stayed put. For about an hour, NIS pumped only perchlorate across the filter. It was only after all the perchlorate had been removed that NIS started pumping iodine again.

"NIS is actually moving perchlorate first, but once that's depleted it still can move the iodine," says Carrasco. "This confirms that NIS has a higher affinity for perchlorate than iodine."

For a lactating mother, this means that perchlorate does double damage, making breast milk not only iodine deficient but also full of perchlorate, which further depletes the baby of iodine.

To explain why their first results, based on charge, had been misleading, the researchers watched radioactively labeled versions of a molecule similar to perchlorate interact with NIS. They realized that when NIS transports a negatively charged perchlorate ion across a membrane, only one positive sodium accompanies it—instead of the two that NIS transports through with iodine.

Purnendu Dasgupta of the University of Texas at Arlington, who in 2005 was the first to note the presence of perchlorate in breast milk, is not surprised by the results.

"The relatively large concentrations of perchlorate in mothers' milk have suggested, even before this study, that perchlorate is actively transported," he says. "This is the first study that unequivocally shows it."

Dasgupta says this molecular proof heightens his concern that pregnant women need more iodine than most currently get, arguing that this would combat the nearly unavoidable levels of perchlorate that people unknowingly ingest.

"If in this country, people would spend half as much time worrying about iodine nutrition than about perchlorate, we would be much better off," he says. —S. WILLIAMS

UIUC, JPL/NASA

A sunlike star's early development

This infrared portrait of an embryonic sunlike star reveals an early, crucial step in the process of planet formation. According to most theories, the spinning cloud of gas and dust from which a star arises should begin to flatten as a planet-forming disk of material takes shape. At the same time, twin jets of gas should shoot out perpendicular to the forming disk. The Spitzer Space Telescope image of this developing, dust-shrouded star, called L1157, provides the first clear evidence that an envelope has begun to flatten, Leslie Looney of the University of Illinois at Urbana-Champaign and her colleagues assert in the Dec. 1 *Astrophysical Journal Letters*. Residing about 800 light-years from Earth, the star is only a few thousand years old and may reveal what our own sun looked like at its birth 4.5 billion years ago. The red haze is dust, and white parts of the jets are the hottest regions. —R. COWEN

THIS HOLIDAY

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MUONS MEET THE MAYA

Physicists explore subatomic particle strategy for revealing archaeological secrets

BY BETSY MASON

At its most glamorous, the life of an experimental high-energy physicist consists of smashing obscure subatomic particles with futuristic-sounding names into each other to uncover truths about the universe—using science's biggest, most expensive toys in exciting locations such as Switzerland or Illinois. But it takes a decade or two to plan and build multibillion-dollar atom smashers. While waiting, what's a thrill-seeking physicist to do?

How about using some of the perfectly good, and completely free, subatomic particles that rain down on Earth from space every day to peek inside something really big and mysterious, like, say, a Mayan pyramid? That's exactly what physicist Roy Schwitters of the University of Texas at Austin is preparing to do.

High-energy particles known as muons, which are born of cosmic radiation, have ideal features for creating images of very large or dense objects. Muons easily handle situations that hinder other imaging techniques. Ground-penetrating radar, for instance, can reach only 30 meters below the surface under ideal conditions. And seismic reflection, another method, doesn't fare well in a complex medium. With muons, all you need is a way to capture them and analyze their trajectories.

Besides probing pyramids in Belize and Mexico, physicists are applying the muon method to studying active volcanoes and detecting nuclear materials. The concept sounds out of this world, but it's really quite simple. When cosmic rays hit the Earth's atmosphere, collisions with the nuclei of air atoms spawn subatomic particles called pions that quickly decay into muons that continue along the same path. Many of the muons survive long enough to penetrate the Earth's surface. Because of their high energy, the particles can easily pass through great volumes of rock or metal or whatever else they encounter. However, they are deflected from their path by atoms in the material, and the denser the material, the greater the deflection.

Schwitters wants to exploit this deflection to see if there are any rooms or chambers inside a Mayan pyramid in Belize, he told science journalists in Spokane, Wash., at a recent meeting sponsored by the Council for the Advancement of Science Writing. His team is building several muon detectors that would be buried in shallow holes around the base of the pyramid to create an image of what's inside by measuring the trajectories of the muons that pass through it.

"What you see is very much like an X ray," he says. "If you see a spot with more muons, it means there's a space there. If you see fewer muons, it means there's something extra-dense there."

Schwitters won't be the first to marry physics and archaeology in this way. In 1967, Nobel prize–winning physicist Luis Alvarez of the University of California, Berkeley placed a muon detector in a chamber beneath the pyramid of Khafra in Egypt to see if it was hiding any burial chambers like those discovered in the larger pyramid of Khufu. He found none, but the experiment showed that the method worked.

FROM PHYSICS TO ARCHAEOLOGY As the director of the Superconducting Supercollider laboratory in Texas until 1993, when Congress gave the project the axe, Schwitters is no stranger to waiting for the next big thing. And he has always been intrigued by the possibility of applying the tools of the high-energy physics trade elsewhere, so a chance conversation with one of Alvarez' former colleagues, combined with a little spare time, got Schwitters wondering what other enigmatic ancient structures were waiting to be probed.

Archaeologist Fred Valdez, director of the Mesoamerican Archaeological Research Laboratory at UT Austin, had the answer: an enormous pyramid in the third-largest Mayan city in Belize. The city is in an area in northwestern Belize known as La Milpa, which was home to one of the densest populations of Maya from as early as 1000 B.C. until around A.D. 850. The area was packed with four large cities, each with 20,000 or more residents, that were only around 8 to 12 kilometers apart with 60 or more towns, villages, and hamlets in between. Valdez believes there is much to be learned from the society that existed there.

> "If you see a spot with more muons, it means there's a space there."
>
> — ROY SCHWITTERS, UNIVERSITY OF TEXAS AT AUSTIN

"The amazing part is how close how many of these large cities are to each other," he said. "The Maya were clearly expert at adapting to their environment and exploiting their environment, clearly making better use of things than we are today, just to support the populations that were there."

Because there isn't a chamber below the La Milpa pyramid, Schwitters plans to harness muons with four or five smaller detectors spaced around the structure to get a three-dimensional view inside. Each detector will be a cylinder wrapped with strips of polystyrene, which emits light when hit by a muon. The bursts of light as each particle passes through both sides of the detector will be recorded by photo detectors at the end of the cylinder and used to reconstruct the muon trajectories.

Dense matter will deflect muons away from their paths, so fewer muons will hit the detectors from that area while more particles will pass through empty spaces to reach the detectors. A computer program will translate the information into an image that can be read like a CT scan or an X ray with bright spots indicating voids and dark areas correlating to more dense matter. Because muons hit the Earth at the rate of about 1 per square centimeter per minute, it will take several months to get a good image of the guts of the pyramid. Schwitters hopes he'll be able to resolve chambers as small as a cubic meter.

20/20 HINDSIGHT Knowing exactly where to dig to find potential tombs or other chambers could save precious time when dealing with very large structures like the pyramid in Belize. It could also save artifacts that need special treatment, sometimes within hours, to keep them from deteriorating from exposure. Dust in a tomb that is normally trampled during excavation could contain valuable information about diseases that affected the Maya, or about the plants and herbs they used.

"Ideally, the results would give us a look into the building without having to do the destructive process of excavation," Valdez said.

He envisions being able to drill a small auger hole into a chamber and send a fiber-optic camera down to take a look. That way he can study the chambers exactly as they were left, and the appropriate experts and equipment can be on hand to deal with the contents as they are exposed by coating them with resin, immersing them in water, or sealing them in an airtight case.

"That's tremendous information," he said. "It's almost like 20/20 hindsight."

With funding from Sandia National Laboratory in Albuquerque, N.M., and support from UT and National Instruments, Schwitters' team has already built and successfully tested one detector at UT that weighs in around a ton, at 4.5 m long with a 1.5 m diameter. The detectors that will go to Belize will be much smaller, around the size of water heaters and weighing about 200 pounds. Depending on funding, the detectors could be ready for showtime in 2009.

SUBATOMIC ARCHAEOLOGY — Physicists plan to use muons generated by cosmic rays to probe the interior of the Pyramid of the Sun at Teotihuacán.

Another team of scientists may be just months away from using muons to image the Pyramid of the Sun in Teotihuacán, Mexico, in a quest to learn why the pyramid was built. And if burial chambers such as those found in the nearby Pyramid of the Moon are discovered, they could reveal whether the society was ruled by a single person or a government of several leaders.

Led by physicist Arturo Menchaca-Rocha of the National Autonomous University of Mexico, the team is currently working out some kinks in its detector having to do with wires cracking from temperature changes. Once that hurdle is cleared, which will likely be sometime after January, their single detector will be placed in a tunnel discovered under the pyramid in 1971, much like Alvarez' experiment in Egypt.

"We are quite delayed," Menchaca-Rocha said in an e-mail from a meeting in Veracruz. "But the pyramid has been sitting there for 2,000 years, so it can wait for us to be perfectly happy about the detector."

NUCLEAR SECURITY In the meantime, physicists at Los Alamos National Laboratory in New Mexico are looking to muons to help detect special nuclear materials such as plutonium and uranium at the country's borders. Current nuclear-detection capability relies on identifying the gamma-ray radiation emitted by the materials, but that doesn't always work.

"If someone wants to bring in nuclear material to build a bomb, they need to shield it with something dense like lead to stop the gamma rays," says Los Alamos physicist Chris Morris.

So Morris is working on a detector that would use muons to root out both nuclear materials and shielding. Lead is dense enough to perturb a muon's path, and it is even easier to spot the muon fingerprint of things like plutonium and uranium because their high density and big atomic charge scatter the particles more than anything else.

Los Alamos lab has partnered with Decision Sciences Corporation of San Diego to build a prototype four-sided muon detector that resembles a carport before the end of the year. Vehicles would drive into the device like entering a car wash and wait while detectors on all four sides of the tunnel record muon trajectories. A single muon would be recorded by multiple detectors, revealing any changes in its path.

"It measures the track of every muon going through the vehicle," Morris says. "In 20 seconds you can detect whether or not they have a chunk of metal that's 4 inches by 4 inches by 4 inches. If you went a little longer, you can see something smaller."

VOLCANIC INSIGHT But the real strength of muon imaging is tackling very large structures, such as volcanoes, that defy other methods. Scientists led by Hiroyuki Tanaka of the University of Tokyo installed a single muon detector 1 kilometer from the summit of Mount Asama on the main island of Japan. By measuring muons traveling nearly horizontally through the volcano, the detector successfully imaged a lava mound that was created a few hundred meters below the crater floor during a 2004 eruption and a conduit below it.

"The cosmic-ray muon imaging technique has much higher resolving power than conventional geophysical techniques, with resolutions up to several meters allowing it to see smaller objects and greater detail in volcanoes," Tanaka wrote in a report on the results of the Mount Asama study in the Nov. 15 *Earth and Planetary Science Letters*.

Tanaka's team has also used muon detection to image a lava dome that has been smoking since 1945 on the flank of Usu volcano in Hokkaido, Japan. Both of Tanaka's current studies involved single detectors. But adding more detectors would give a three-dimensional view and help untangle the effect of higher-density materials on the muons from that of a longer distance traveled through somewhat less-dense material.

"This technique might provide a way to forecast a volcanic eruption by monitoring changes in the density of the magma channel inside the summit region of a volcano," Tanaka writes in a study on the lava dome in the Nov. 16 *Geophysical Research Letters*.

Even more promising is a real-time digital muon camera that Tanaka is working on that could capture real-time images of an active volcano. He hopes to have one installed with a view of Mt. Asama from 1.5 km away by May 2008, and a second one sometime thereafter that could provide a 3-D picture of Asama's next eruption.

"With this device, I think that the technique would be more practical for use in forecasting eruptions," he wrote in an e-mail from Japan.

Schwitters envisions other geologic studies that could benefit from muon detection, such as gauging the size and location of underground aquifers or assessing the stability of the geology around nuclear-waste depositories. But for now he is content to focus on the pyramids buried under dirt, trees, and vines in the forest in Belize.

"There is good reason to believe they contain rooms and chambers that have not been disturbed since the Maya left, and that's what makes them so exciting," he says. ■

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LETTUCE LIABILITY

Programs to keep salads germfree raise wildlife and conservation concerns

BY JANET RALOFF

Little more than a year ago, supermarkets from coast to coast stripped fresh spinach from produce aisles as a food-poisoning outbreak swept the nation. From mid-August through September 2006, virulent bacterial infections sickened at least 204 spinach consumers. Five died and 30 others suffered acute kidney failure.

Among more than 3,500 genetically unique strains of *Escherichia coli* O157:H7, microbiologists ultimately linked all of those spinach poisonings to a single strain. Uncertainty over where that germ entered the salad-supply chain prompted the biggest food recall in history, with multimillion dollar losses. Eventually, federal and state government scientists traced the national outbreak to a single California farm.

Now, as insurance companies have begun paying out huge settlements to victims and their families, food-handling practices by one California farm, the company that processed the spinach, and the conglomerate that helped market and distribute the greens have all come under scrutiny for their potential liability.

Although the rate of disease outbreaks may not be increasing, large-scale food distribution has helped increase the ability to track an infection back to its source, making sellers a growing target for lawsuits.

The outbreak of one germ on one farm managed to shake up California's entire $14.6 billion-a-year produce industry, which supplies roughly two-thirds of U.S. salad greens. Within a month, that industry began creating a new program to strengthen what it perceived to be a particularly vulnerable link in the supply chain: the farm. The resulting Leafy Greens Marketing Agreement rolled out on July 23.

Some 118 shippers, processors, and distributors, representing virtually all California-grown greens, have signed on to the agreement. Farms that sell salad greens to any of those companies must adopt dozens of new food-safety rules. Because livestock and wildlife serve as reservoirs of *E. coli* and other harmful bacteria, most of the rules focus on keeping animals and animal wastes away from crop fields.

Some rules limit how close farmers may plant crops to grazing livestock, composting manure, surface waters, and non-crop vegetation. Others require frequent germ testing of irrigation water and strict sanitation practices for farmworkers and tools.

While no one argues against improved germ control, conservation agencies and environmental groups say that the new Leafy Greens rules are triggering changes that will erode hard-won gains in protecting wildlife and its habitat. For example, the rules encourage some growers to eliminate erosion-controlling hedgerows that might harbor disease-carrying animals and to keep out deer by erecting tall fencing that may block wildlife-migration corridors.

Judith Redmond, a co-owner of the certified-organic Full Belly Farm near Sacramento, Calif., told *Science News* that the Leafy Greens rules threaten to put farming at odds with environmental goals. For the past 2 decades, she says, "a vanguard of farmers has been trying to figure out how to farm with nature [and] be good environmental stewards."

GREEN RULES — Leafy Greens initiatives impose new rules on growers of most U.S. salad greens, often conflicting with conservation goals.

REDMOND

Although participation in the new initiative is ostensibly voluntary, "the marketplace is such that if you don't sign on, no one's going to buy your product," says Joe Pezzini, a vice president of Ocean Mist Farms in Castroville, Calif., and chairman of the Leafy Greens advisory board. Even the Canadian Food Inspection Agency recently announced that it will allow importation of California salad greens only from handlers that have signed on to the Leafy Greens program.

California farmers now face a tough choice: Adopt costly, environmentally damaging changes in order to sell to members of the Leafy Greens agreement or risk losing a major market share.

And the issue is already starting to spread to other states. On Oct. 2, Arizona's food industry adopted a similar Leafy Greens program. Two days later, the U.S. Department of Agriculture proposed establishing a national program modeled on California companies' Leafy Greens initiative.

AUDIT BRIGADES Even before the 2006 spinach recall, companies that grow and market lettuce and other leafy produce had developed safety guidelines such as the repeated rinsing of leaves, frequent disinfection of hands and tools that touch the greens, and tracking of batches of greens so that the source of an outbreak can be quarantined. Yet such measures didn't prevent last year's outbreak from sickening people in at least 26 states.

"Because of all that happened with the spinach outbreak, for

the first time the industry was ready to say: 'We need a set of mandatory standards,'" Pezzini recalls.

With the Leafy Greens agreement, what were formerly guidelines for good farm practices have suddenly become rules. USDA-trained inspectors now audit farms to enforce the industry's new self-regulation. Perceived violations can result in would-be buyers rejecting all or part of a harvest.

Most affected farmers were already used to scrutiny by outside auditors, observes Melanie Beretti of the Monterey County (Calif.) Resource Conservation District in Salinas. Every company that moves or markets farm commodities can inspect its growers' agricultural practices, she says.

"If you're a grower selling to three different shippers and two different [food] processors—and each of them sells to a couple different retailers—you might have a dozen individuals come out to conduct food-safety audits of your farm," she explains.

However, in the interests of improving food safety, inspections have become increasingly stringent and interpretations of what constitutes good practices vary among individual auditors, Beretti says.

SLUG IT OUT — Leaf-loving slugs can not only harbor *E. coli* but also shed it in feces.

SPROSTON

ANIMAL UNFRIENDLY Under the new Leafy Greens rules, more than 400 feet must separate the edges of fields from livestock waste and composting manure. Livestock may not graze within 30 feet of a field and untreated manure must be stored at least 200 feet from wells and no less than 100 feet from surface waters providing irrigation. During the growing season, farmers must test irrigation water monthly for *E. coli* and other pathogens and share lab findings with auditors. Growers must also keep a 2-year record listing any possible field intrusion by pigs, deer, cattle, goats, sheep, and other possible *E. coli* carriers.

Many companies that have signed the Leafy Greens agreement ask growers not only to follow these rules but also to exceed them dramatically. For example, the rules recommend installing fences where deer or pigs frequently pass through fields, but some auditors have begun telling farmers that they need to install tall chain-link fences even where deer intrusion is rare, notes Full Belly Farm's Redmond.

This summer, the Monterey Resource Conservation District surveyed some 200 farms in and around the Salinas Valley and California's central coast, where most of California's leafy greens are grown. The results, says Beretti, show "it's not just that growers feel they're caught between the conflicting demands of food safety and the environment; we have statistically defensible evidence that many really are caught in the middle."

For instance, 7 percent of farmers had removed ponds in response to demands from auditors. Although the Leafy Greens rules don't require pond removal, some auditors have said that ponds could harbor disease-causing amphibians and waterfowl.

In addition, 32 percent of surveyed growers were instructed by auditors to remove non-crop vegetation, such as hedgerows. At auditors' request, half of surveyed growers said they had surrounded fields with deep, bare-ground buffers, 40 percent had installed fencing to keep out wildlife, 40 percent had installed wildlife traps, and at least 50 percent had installed poison bait stations to kill rodents.

Where feces or other signs of wildlife appear, Leafy Greens rules instruct farmers not to harvest crops within a radius of at least 5 feet. "I had one farmer tell me that for one company he grows for, if there's been evidence of wildlife intrusion, he must draw a 20-foot radius around that spot; everything inside it is nonharvestable," Beretti says.

Trevor Suslow, a plant pathologist at the University of California, Davis, has heard similar anecdotes. When an auditor is visiting a field and finds a single frog or hoofprint, that inspector may "reject 10 acres of product," he says.

Hoofprints, in particular, have become a hot-button issue, since wild pigs were found carrying the germ responsible for the 2006 spinach outbreak. Of 40 pigs examined, colons of two hosted last year's outbreak strain of *E. coli*, notes Andrew G. Gordus of the California Department of Fish and Game in Fresno. Five of 47 samples of feral-pig scat also carried that version of *E. coli*.

On rare occasions, wild-goose feces are known to host *E. coli* O157:H7. Of approximately 1,000 samples tested, however, "only one was positive," says Gordus.

Suspicions that deer might also host the germ prompted Gordus' team, together with colleagues from UC–Davis and the federal government, to launch a study in August inspecting colons from deer caught during the local 6-week hunting season. Hunters in the Salinas region brought in colons from only 27—too few to be statistically significant, but none carried *E. coli*.

IMMUNE TO FENCES Even unreasonably high safety standards aren't foolproof. The Leafy Greens rules focus on efforts to curb field intrusions by livestock, large wildlife, and their wastes, but new research indicates that germs may be spread by animals that could move under, over, or through any fencing. Furthermore, *E. coli* and other food-poisoning germs may colonize field crops even without animal transmission (*SN: 10/20/07, p. 250*).

Last year, slugs in a Scottish pasture were found harboring the same strain of *E. coli* O157:H7 that nearby infected sheep were excreting. The incidence was low. Of 33 batches of slugs, each containing 15 animals, only one batch tested positive, Emma L. Sproston and her colleagues at the University of Aberdeen reported in the January 2006 *Applied and Environmental Microbiology*.

To confirm the findings, Sproston placed slugs on a piece of moist paper seeded with a nontoxic form of *E. coli* and allowed the animals to slime their way across its surface. Afterward, the slugs hosted *E. coli* for 2 weeks. Once excreted, the germs remained alive in the slugs' feces for another 3 weeks.

Sproston says, "I've also found a few slugs carrying *Campylobacter*," food-poisoning bacteria normally associated with chickens (*SN: 8/7/04, p. 85*).

It seems reasonable, she concludes, that germs "could end up in your salad" if slugs passed through feces from infected livestock or wild animals and then crawled onto lettuce. Alternatively, she notes, a bird might dine on an infected slug and spread ingested germs onto field crops via its droppings.

Sproston's latest studies of a farm with cattle and sheep indicate flies, too, can host and presumably transmit *E. coli*.

Even American bullfrogs can be carriers. In one experiment, scientists put *E. coli* O157:H7 into the mouths of two dozen bullfrog tadpoles shortly before they were due to metamorphose, then

left them to mature in stagnant water. More than half showed evidence of infection lasting at least 2 weeks, reported Debra L. Miller of the University of Georgia in Tifton, and her colleagues in the June *Applied and Environmental Microbiology*.

Because the dose administered to these frogs was large, Miller says, "the only thing we know for sure is that if they ingest [the *E. coli*], it can stay alive in them long enough to come out the other end." If this happens in the wild, her team argues, frogs might hop between ponds and contaminate water used for irrigation or for drinking by other animals.

NO ANIMALS — In Salinas, Calif., farmers must keep fields free of animals—or risk salad crops becoming unmarketable.

FARMERS' LIABILITY When a product causes illness, U.S. law renders businesses strictly liable, which means they're responsible even if they were unaware that their goods were tainted. For farmers, however, a different standard applies, explains attorney Jeffrey Gilles, who advises Salinas Valley farmers and food processors on food-safety issues. Traditionally, farmers have become liable for selling tainted products only if they exhibited negligence.

In recent years, however, companies that buy crops have increasingly been writing contracts that require a farmer to indemnify them for any financial hit that may result from the grower passing along tainted food.

In hopes of catching any tainted foods early, processors are starting to require frequent spot checks for bacterial contamination of crops in the field, immediately after harvest, and at every step into and through a food-packing facility, says Gilles.

As Salinas Valley companies gradually adopt such measures, Gilles expects that by next spring's harvest "virtually 100 percent of the processors will require this ... and eventually that every processor in California will." The goal is to identify contamination before it enters the retail market, so that any tainted goods can be culled from the supply chain long before they can reach consumers.

The discouraging news, says University of California's Suslow, is that this new field testing "is showing that the extent of contamination in fields—although low—is unfortunately higher than we ever could have known." Neither farmers nor food processors are sharing hard numbers publicly, but they are routinely turning up "a low, but certainly detectable, level of pathogens," he says.

"Since we're never going to have zero risk" of crop contamination, Beretti says, the industry, including growers, must embrace science to identify what bacterial quantities are dangerous and then learn to surgically rout them. And this must be accomplished, she argues, by neither "sacrificing food safety for the environment nor compromising the environment for food safety." ■

OF NOTE

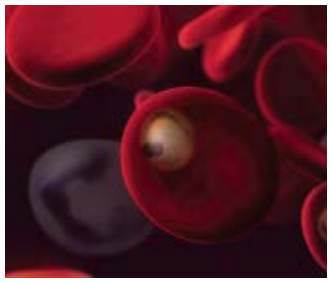
INFECTIOUS DISEASES

Malaria's new guises

The complicated life cycle of the malaria parasite has just taken another swerve. Scientists have observed *Plasmodium falciparum* enjoying three distinct lifestyles in the blood of infected children. Two of these three states have never been seen before, and one of those two appears to cause an unusually severe illness.

The findings highlight new targets for future antimalaria drugs, says the Massachusetts Institute of Technology's Aviv Regev, a computational biologist involved in the study.

For the research, scientists developed a new technique to isolate messenger RNA from the parasite as it infects red blood cells. This messenger RNA paints a profile showing which of the parasite's 6,000 genes are switched on, and to what degree. The researchers found three distinct genetic profiles in parasites from 43 infected children in Senegal.



RING CYCLE The malaria parasite (yellow-white ovals) infects red blood cells (big red discs) during the "ring" stage of its complicated life cycle. Researchers have found the parasite lives in one of three distinct ways during the ring stage.

One genetic profile resembled an active-growth state also seen during lab studies of *P. falciparum*. But the other two profiles were new. In one, the parasite appears to be starving. In the other, it's stressed out.

The 17 patients whose parasites were in the stressed state suffered worse symptoms than the others. "They had a higher fever, they had the disease for longer, and they had a higher load of parasites in their blood," says Regev. The study appears online in *Nature*. —B.V.

SCIENCE AND SOCIETY

Divorce is not ecofriendly

Divorce often takes a devastating emotional toll on families, and it has significant impacts on the environment as well, a new study suggests.

When couples split and form additional households, it dramatically boosts the consumption of water, land, energy, and other resources. In many parts of the world, such resources are becoming severely limited, says Jianguo Liu, an ecologist at Michigan State University in East Lansing.

In the year 2000, nearly 15 percent of U.S. households were headed by divorced people, U.S. Census Bureau data suggest. The separation of families aggravated urban sprawl, boosting the number of households by more than 6 million and increasing the number of rooms to be heated and cooled by almost 36 million, says Liu.

Because the number of people in a household decreases after a divorce, efficiency of resource use drops as well, Liu and his colleague Eunice Yu note in an upcoming *Proceedings of the National Academy of Sciences*. As a result, average per-person costs for electricity and water in a household headed by a divorced person are about 46 percent and 56 percent higher, respectively, than in a married household.

Using survey data gathered in 2005, Liu and Yu estimate that divorce increased water use in the United States that year by more than 627 billion gallons, at a cost of nearly $3.7 billion. Also, the team reports that divorce boosted electricity consumption that year by about 73.5 billion kilowatt-hours—about 2 percent of the nation's electricity use—at a cost of nearly $7 billion. —S.P.

BIOMEDICINE

Diabetes drug shows new potential

A drug currently prescribed for people with type 2 diabetes might also prove useful for individuals who are newly diagnosed with the type 1 form of the disease. Whereas type 2 diabetes typically appears in adulthood, type 1 usually strikes in youth.

In experiments in mice with a disease similar to type 1 diabetes, researchers found that the drug exendin-4 activated idle beta cells in the pancreas. These insulin-making cells are destroyed at the onset of type 1 diabetes in an immune onslaught that ultimately eliminates the body's capacity to make insulin. But the beta cells don't all die at once.

Earlier work suggested that a drug called anti-CD3 monoclonal antibody can reverse type 1 diabetes in mice by thwarting the immune attack before beta cell reserves are depleted. Scientists are currently testing anti-CD3 drugs in people with type 1 diabetes.

Kevan C. Herold, an immunologist at Yale University, reasoned that exendin-4 (exenatide), which helps to regulate insulin manufacture, might complement the effect of the anti-CD3 drug. In the new study, Herold and his colleagues found that mice that had high blood glucose—a sign that their remaining beta cells were making very little insulin—didn't benefit any more from combined therapy than they did from the anti-CD3 alone.

However, some mice in the study had only marginally high blood-glucose readings. In these mice, the combined therapy reversed diabetes more effectively than either drug alone, the scientists report in the November *Endocrinology*. Exendin-4 revived idle beta cells and boosted their insulin production, Herold says.

"There's no reason why you couldn't give this drug to people with type 1 diabetes," Herold says. "You might expect the effect could be quite dramatic if they had good numbers of beta cells to begin with." —N.S.

CANCER

Putting tumors on pause

Precancerous breast cells don't degenerate into full-blown cancer when production of a certain protein is blocked, new research on mice shows.

The protein, called focal adhesion kinase (FAK), could offer a new target for developing drugs that would prevent benign breast tumors from becoming malignant, the researchers say.

FAK allows a cell to "know" about its surroundings by relaying signals from the cell's outer membrane. "It's telling the cell whether it's in a normal environment," explains William J. Muller of McGill University in Montreal. A cell's context within a tissue is part of what determines its behavior, so the signals transmitted by FAK are important for making the cell behave normally.

"Any time you have disruption of the balance of signaling, the cell may not respond to its environment as it should," Muller says. In a cancerous tumor, cells proliferate out of control. Tumor cells contain unusually

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high concentrations of FAK in a majority of breast cancers.

Muller's team reduced the amount of FAK by partially disabling the gene for the protein in mice that were genetically engineered to develop breast cancer. The mice had precancerous growths, but the growths did not progress to a malignant stage, the team reports online and in an upcoming *Proceedings of the National Academy of Sciences*. Metastasis—the spreading of tumor cells to other parts of the body—is usually what makes breast cancer fatal, but only malignant cells can spread.

The scientists are now studying in detail the reasons why high FAK levels cause a cell to become malignant, Muller says. —P.B.

SCIENCE & SOCIETY

Strategies to improve teaching

American students' science and math skills have been losing ground relative to those of their peers in other countries even as the economic importance of analytical skills has continued to climb. A new book from the National Research Council aims to improve science education by building on the results of a recent study of U.S. teaching methods and emerging data on how children learn and retain scientific concepts. *Ready, Set, Science! Putting Research to Work in K–8 Science Classrooms* (National Academies Press, Washington, D.C., 2008) is for parents, teachers, and curriculum designers.

Science textbooks "have often drawn a fairly sharp distinction between scientific content and scientific processes," says the new book, which urges educators instead to marry the presentation of facts with hands-on science experiments.

The National Research Council recommends that schools present fundamental concepts gradually over several years, rather than cramming them in to a few weeks or months. It also suggests focusing on core topics, such as the atomic-molecular theory of matter, evolution, cell theory, and Newtonian laws of force and motion. The book offers examples of classroom projects that let kids assimilate such concepts by testing them out.

"Understanding what it takes to teach and learn science effectively is very different today than it was 20 or 30 years ago," the new book says. It argues that to boost student achievement, schools must recognize and incorporate the new findings about how children learn. —J.R.

NANOTECHNOLOGY

Tractor beam

A simple magnet can go a long way toward eliminating bacteria.

Xuefei Huang and his colleagues at the University of Toledo in Ohio coated nanoparticles of rusty iron with sugary molecules normally found on the membranes of mammalian cells. Different bacteria bind to specific types of such molecules when they attack cells.

The researchers targeted three strains of *Escherichia coli* with nanoparticles coated with each strain's favorite sugars. The particles quickly stuck to the bugs. The researchers applied a magnet, which immediately began pulling the nanoparticles' bacteria in tow. After 45 minutes, the magnet had dragged out 88 percent of the *E. coli*, Huang and his colleagues report in the Nov. 7 *Journal of the American Chemical Society*.

Huang says that the nanoparticles could be designed to quickly detect specific pathogens, including viruses. "If you see a white powder and you suspect it's anthrax, you want to detect it within a few minutes," he notes.

So far, the method detects only microbes that are present in sizable numbers, but Huang says using fluorescent sugar molecules might bring the sensitivity down to single cells. Because the nanoparticles could be cheap to produce, they could also help in decontaminating water supplies, Huang says. —D.C.

PHYSICS

Sharper than expected

A new technique beats the resolution limits of ordinary microscopes in a way that seems to defy conventional optical theory, its discoverers say.

Peter Stark of Harvard Medical School in Boston and his collaborators exposed a photosensitive film to light coming from microscopic holes in a thin silver plate. Ordinarily, those images would record no details smaller than half the wavelength of light, a fact that limits the resolution of optical microscopes to about 200 nanometers. Instead, the researchers' 60-nm-wide holes were in perfect focus.

That's because the team shined light from the holes' rims rather than through the holes, Stark says. The researchers pointed a violet laser straight at the silver plate, where the electric field of the laser's photons interacted with the metal's electrons and formed perturbations called surface plasmons. The plasmons traveled on the silver's surface. At the holes, some of their energy converted back into photons, which then created an image. Stark speculates that these photons were acting like particles rather than waves—a behavior that would be expected only over a longer range of distances. The team's findings appear in the Nov. 27 *Proceedings of the National Academy of Sciences*.

Researchers have circumvented the diffraction limit before. So called near-field probes pick up light within 5 nm from the sample, a range where diffraction effects are negligible, Stark explains. However, that process is very slow, since a probe must scan a sample pixel by pixel.

Stark says the new technique might allow scientists to quickly image living cells or other samples in great detail. He also says that it might lead to less-expensive alternatives to microchip fabrication technologies that use ultraviolet light to etch features that are only a few tens of nanometers wide. —D.C.

BOTANY

Botanists refine family tree for flowering plants

Two research teams have each used the biggest collection yet of flowering-plant genes to map out the floral family tree.

"We got the same answer," says Michael J. Moore of Oberlin College in Ohio. Both family trees show the same basic arrangement of the eight lineages that still bloom today. Five of the eight appear as short branches at the top, a sign that the five more-recent lineages split from each other rapidly. The new analyses calculate that when these lineages split at least 125 million years ago, the divisions took place in less than 5 million years.

Fast divergences are hard to reconstruct, so botanists have struggled to sort out the relationships among the more-recent lineages. Both of the new trees show the same position for the eudicots, the biggest flowering lineage, which includes many common plants, from buttercups to mustards. It turns out to be the closest branch to the second-largest lineage, the monocots, which include grasses, lilies, and related plants with linear leaves.

To build the tree, Moore and his collaborators at the University of Florida in Gainesville used the 61 genes common to all chloroplasts. The other team, led by Robert K. Jansen at the University of Texas at Austin, used 81 chloroplast genes. Neither team's tree structure is 100 percent certain, cautions Moore.

Both papers appear in the Dec. 4 *Proceedings of the National Academy of Sciences*. —S.M.

Books

A selection of new and notable books of scientific interest

TRYING LEVIATHAN: The Nineteenth-Century New York Court Case That Put the Whale on Trial and Challenged the Order of Nature

D. GRAHAM BURNETT

As readers of *Moby Dick* will recall, early whalers tended to describe their prey as "big fish." But when threatened with a tax on the cetacean's oil as a fish product, whalers and others enthusiastically endorsed the new taxonomists' view that these animals were definitely not fish. Debate over the whale's status ultimately played out dramatically in the 1818 court case, *Maurice v. Judd*. A Princeton historian of science profiles this case, which was set in motion when a New York City fish inspector fined a local merchant who had not submitted three casks of whale oil for inspection and grading. During the trial, whalers, philosophers, attorneys, and others argued anatomy, animal behavior, and scripture. What makes this case so important, the author argues, is that it serves as a vehicle for investigating whales as "problems of knowledge," offers a window on the often contentious world of taxonomy, and reveals how the 19th-century public viewed natural history. For the record, the court decided in favor of science. ***Princeton Univ., 2007, 266 p., b&w illus., hardcover, $29.95.***

CRUISIN' THE FOSSIL FREEWAY

KIRK JOHNSON

This lavishly illustrated travelogue describes the adventures of paleontologist Johnson—the chief curator of the Denver Museum of Nature & Science—and artist Ray Troll as they drive across the American West in pursuit of fossils. Their rollicking trek proved fruitful. "The truth is," Johnson concedes, "I … read road cuts the way you read billboards." Johnson makes geology a sport, and Troll's art is irreverent and sure to bring plenty of smiles. Like when they discovered a fossil resembling cannabis and hops. "[T]hat the last dinosaurs might have been browsing on an extinct missing link between hops and marijuana led to some fertile conversations about the real cause of their extinction," Johnson quips. ***Fulcrum, 2007, 204 p., color illus., paperback, $29.95.***

THE STORY OF MEASUREMENT

ANDREW ROBINSON

It's hard to imagine civilization without measurement. In addition to length, weight, height, and other obvious units, time and language require standards. Current quantification includes concepts inconceivable to the earliest humans—eyeglass prescriptions, time zones, air-quality indexes, radioactivity, IQ, and even the polygraph. In this illustrated compilation marking the march of measurement, the reader gets a page or two on each of these and more. It's a walk through time, appropriately enough. Predictably, there are barometers, microscopes, and Geiger counters. But Robinson also offers the first compass (China, A.D. 1115), the first ordered military rank (Egypt, 2nd millennium B.C.), and the first public clock that struck the hours. Language itself is loaded with measurements, including some colorful plurals. As a result, geese come in gaggles, fish in schools, and chickens in broods. "Man is the measure of all things," said the philosopher Protagoras 2,500 years ago. By then, the science of measurement was already well under way. ***Thames & Hudson, 2007, 224 p., b&w and color illus., hardcover, $34.95.***

THE ENDS OF THE EARTH: An Anthology of the Finest Writing on the Arctic and the Antarctic

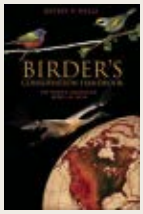
ELIZABETH KOLBERT AND FRANCIS SPUFFORD, EDS.

The polar regions have been imagined as much as explored. This compilation of essays and stories takes the reader into the ice from the earliest days of Western exploration in the 1800s to today's well-financed ventures. The book contains some essential writings, penned by familiar names such as Ernest Shackleton and Roald Amundsen. But story tellers Jack London and Jules Verne lighten the load. In addition to explorers, novelists, and scientists, the reader gets a modern-day report from Nicolas Johnson, representing people at the bottom of the status pyramid in Antarctica—contract workers. Some entries come from unusual places—a West African passing a winter in Greenland, or an Australian surviving a harrowing trek a century ago in Antarctica. This compendium attempts to capture the deprivation, beauty, darkness, wonder, and terrible cold of it all. ***Bloomsbury, 2007, 440 p., hardcover, $29.95.***

BIRDER'S CONSERVATION HANDBOOK: 100 North American Birds at Risk

JEFFERY V. WELLS

Avian ecologist Wells, senior scientist for the International Boreal Conservation Campaign, chose his list of the continent's top 100 troubled birds by paring down an original list of 500. Still, he argues against gloom. New initiatives for saving wetlands or curbing energy benefit birds, and Wells calls for greener living as a vital act of bird conservation. He supports the theme by working through his list in a format that echoes a field guide. Each species gets an account packed with details of what's known about its problems and what conservationists are doing. Unlike the range maps in the usual field guide, Wells doesn't send birds flying into blank space at the Mexican border. Instead, he shows the whole geography of winter and summer homes, with enough shaded blobs oozing over borders to make the point that saving birds will take some global thinking. ***Princeton University Press, 2007, 464 p., b&w illus., paperback, $35.00.***



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LETTERS

Errors of biblical proportions

"Lazarus taxa" is an appropriate name for species that seem to have been resurrected ("Back from the Dead?" *SN: 11/17/07, p. 312*). However, the Lazarus whom Jesus raised from the dead was a householder who lived with his sisters, Mary and Martha, in Bethany (John 11). The beggar named Lazarus appeared in a parable that Jesus told to his followers (Luke 16).

LINDA WICKLUND, LONGMONT, COLO.

"Let There Be Aluminum-42: Experiment creates surprise isotope" (*SN: 10/27/07, p. 260*) indicates that Adam appeared on the fifth day. The actual day of Adam's appearance, according to Genesis, chapter 1, is the sixth day.

NATHAN S. CLEMONS, ETCHISON, MD.

I found your reference to the Christian creation myth offensive. I'll bet it brought the same feeling to anyone else who, like me, has worked to prevent the teaching of "intelligent design" as science. Please stick to the facts.

LEE HELMS, HAZEL PARK, MICH.

The influence of drugs

Two recent articles hit on the same theme. "Bipolar Express: Mental ailment expands rapidly among youth" (*SN: 9/8/07, p. 150*) discussed the recent sharp increase in the diagnosis of bipolar disorder. The summary of the new book *Shyness: How Normal Behavior Became a Sickness* (*SN: 11/17/07, p. 319*) hit much closer to the mark. If you want to know why these diagnoses have increased so markedly, forget medicine. Follow the money. There is a tremendous amount of money to be made prescribing, manufacturing, and distributing drugs.

TOM DUBOIS, GLENS FALLS, N.Y.

Win by losing?

"If You Can Stomach It: Obesity surgery extends life span" (*SN: 8/25/07, p. 115*) states that "those who get the [bariatric] surgery live longer than those who don't." That raises the question whether liposuction to reduce a disproportionately large waistline in a nonobese person would yield medical benefits such as a reduced risk for coronary heart disease.

ANGELA LAMBERTH, INDIAN ISLAND, MAINE

Big yawn

It's not surprising that a study shows that "Too little sleep may fatten kids" (*SN: 11/17/07, p. 318*). Less sleep leads to more snacking leads to weight gain.

IRWIN TYLER, SPRING VALLEY, N.Y.

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