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SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

virgin eggs beget stem cells

songbirds as avian-flu carriers

blood test bests pap smear

dark matter particle disappears

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settling in

HUMAN PATHOGENS ON VEGETABLES

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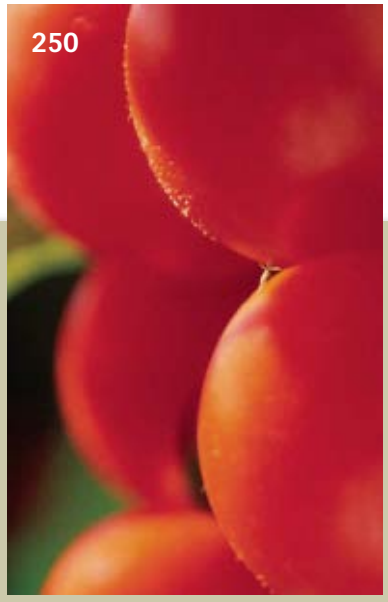

Features

This Week

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Of Note

Departments

Cover Outbreaks of food poisoning caused by vegetables carrying salmonella and other bacteria are on the rise. These pathogens don't merely contaminate vegetables, biologists are finding, but colonize plants using some of the same mechanisms they employ to infect animals. (Corbis) Page 250

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

Food for Thought High-temperature cooking can imbue meats with a chemical that acts like a hormone.

MathTrek A study of the way skin and bedsheets wrinkle has won this year's Ig Nobel prize in physics.

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Better Than Pap

Blood test detects cervical cancer

For more than 50 years, doctors have used Papanicolaou tests—better known as Pap smears—to screen women for cervical cancer. But researchers now report that a newer test, based on a blood sample, gives a more accurate diagnosis.

In a Pap smear, cells scraped from the cervix are analyzed under a microscope for physical abnormalities. Blood tests developed in the past decade, however, can detect the presence of human papillomavirus (HPV). This sexually transmitted disease is the primary cause of cervical cancer.

In two studies in the Oct. 18 *New England Journal of Medicine*, researchers report that HPV tests caught many more cases of cervical cancer than Pap smears did.

"When something is visible in the microscope, that's when the Pap test is positive. But the HPV test can go far before that and give us a window of safety," explains Eduardo Franco of McGill University in Montreal, who led a study of more than 10,000 Canadian women.

Participants in the study got both a Pap smear and an HPV test. Women with abnormal results in either test, along with a random sampling of those with normal results, had cervical biopsies, a surefire way of diagnosing cancer. Franco's team found that the HPV tests detected almost 95 percent of the cancers, whereas the Pap smear caught only 55 percent.

Franco adds, though, that the Pap test still serves a purpose. It's far less likely to give a false negative, he says: If you can see something wrong on the Pap smear, it's almost as good as a diagnosis by biopsy.

"So it makes more sense to do the Pap test when the HPV one [has shown up] positive," says Franco.

The second study, led by Joakim Dillner of Lund University in Malmö, Sweden, included more than 12,000 Swedish women. It showed that giving a woman both tests rather than a Pap smear alone increased the chance of early cancer detection.

Gynecologic oncologist Carolyn Runowicz of the University of Connecticut Health Center in Farmington says that more research is needed, however, before any policy change. The two studies, she points out, compare HPV tests with a kind of Pap smear that isn't widely used in the United States. In conventional Pap smears, cell samples are held between glass microscope slides. The cells tend to clump, making them hard to examine under a microscope. In the United States, 85 percent of smears are now done using a liquid that spreads the cells into a single layer.

"It's exciting to think about molecular screening," says Runowicz, "but we're just not there yet." —S. WILLIAMS

STATS

74%

Decline in U.S. cervical cancer deaths between 1955 and 1992 after introduction of Pap smears

Going Coastal

Sea cave yields ancient signs of modern behavior

At Pinnacle Point on South Africa's southern coast, a cave perched above the sea has provided scientists with evidence of a set of surprisingly complex behaviors practiced by Stone Age people about 164,000 years ago, near the evolutionary dawn of *Homo sapiens*. Our species emerged an estimated 200,000 years ago.

A team led by anthropologist Curtis W. Marean of Arizona State University in Tempe found three critical clues in the cave that point to modern-human behavior: the remains of mussels and other shellfish, 57 pieces of reddish pigment probably used for body coloring or other symbolic acts, and more than 1,800 stone implements, including small, expertly crafted blades.

Ancient Africans took up coastal living between 195,000 and 130,000 years ago, when a relatively cold, dry climate inland reduced the number of edible plants and animals, Marean and his coworkers propose in the Oct. 18 *Nature*. Shellfish harvested from exposed, rocky shores and from tidal pools offered a stable food source that allowed populations to grow and become less nomadic, in Marean's view.

Symbolic behavior as a form of social expression could then have flourished, he suggests.

Using modern hunter-gatherer societies as a guide, Marean suspects that coastal living involved a shift from male-dominated big game hunting to female-led foraging for plants and shellfish. "If shellfish were important, it means that women were a key component of that new economy and may have held substantial economic power," he says.

The earliest previous evidence for shellfish eating and seaside living by modern humans came from a 125,000-year-old East African site.

Pinnacle Point artifacts lay in soil dated by a technique that indicates when sediment was last exposed to light.

Many shellfish remains came from brown mussels, giant periwinkles, and limpets.

Double-edged stone blades appeared in

MOSSEL BAY ARCHAEOLOGY PROJECT

ANCIENT VIEW **The ocean recedes beneath the mouth of a South African cave where researchers found the earliest known evidence of modern-human behavior, including a chunk of pigment (inset).**

a variety of sizes, including some no more than 10 millimeters wide. Miniature blades could be attached to the end of a stick to form a spear or be lined up like barbs. Comparably small stone blades characterize much younger African sites, beginning about 70,000 years ago.

Pigment chunks included about a dozen that had been ground or scraped. Some also display intentional incisions.

The new discoveries bolster the proposition that modern-human behavior developed gradually, starting perhaps 285,000 years ago, remark anthropologists Sally McBrearty of the University of Connecticut in Storrs and Chris Stringer of the Natural History Museum in London in an accompanying editorial. The earliest evidence of red-pigment use comes from that time, prior to the evolution of anatomically modern humans.

An opposing view holds that a transition to modern-human behavior occurred rapidly around 45,000 years ago.

Complex, symbolic behavior developed differently from one geographic region to another, comments anthropologist Christopher Henshilwood of the University of the Witwatersrand in Johannesburg. Henshilwood has uncovered 70,000-year-old shell beads and pigment pieces in South Africa's Blombos Cave.

Marean's finds at Pinnacle Point suggest that an ancient reliance on seafood "may have been one critical factor in the expansion of *Homo sapiens* out of Africa and along coastal routes to the east," Henshilwood says. —B. BOWER

Beware the Starlings

Common birds can carry avian influenza

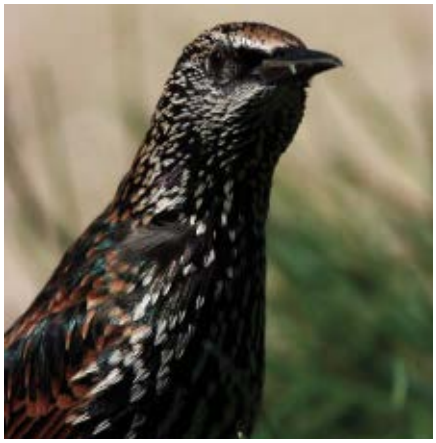
Starlings, introduced into North America from Europe in the 19th century, have become a widespread nuisance. And they just got more annoying: It turns out they're good at carrying bird flu.

During the past two winters, common songbirds in Hong Kong "have been dropping dead out of the sky," says Robert Webster, an infectious-diseases specialist at St. Jude Children's Research Hospital in Memphis, Tenn. Some of those birds died from avian influenza. Webster and his colleagues wanted to know what role the birds might play in spreading the virus.

In a laboratory study, the scientists found that captured starlings infected with four strains of avian influenza breathed and defecated large amounts of virus. One uninfected starling picked up the bug from its cage mates—the first reported case of starling-to-starling transmission.

If highly pathogenic avian influenza ever arrives in North America—and there's no evidence that it has—the experiment shows that the near-ubiquitous birds could serve as a reservoir for the disease, Webster and his colleagues report in the November *Emerging Infectious Diseases*.

"It's the little songbirds like starlings that form the bridge, if you will, between waterfowl and poultry and people," says Walter Boyce, executive director of the Wildlife Health Center at the University of California, Davis. At watering holes, for instance, songbirds often mingle with waterfowl, which later might mingle with poultry.



THREAT FROM THE AIR Some common songbirds, like this European starling, could act as carriers of avian flu.

In other experiments, Webster's team found that house sparrows and common pigeons did not spread the virus to others of their species. Sparrows dispersed large amounts of virus, but died 4 to 6 days after infection, making them poor long-term carriers. Infected pigeons showed no signs of illness and breathed and defecated only small amounts of virus, indicating that they, too, would provide a poor bird-flu reservoir.

Boyce says that the study "adds another piece of the puzzle. [But] there is not strong evidence these [common songbirds] are going to be an important source of virus for the other animals they're in contact with."

Since 1996, outbreaks of the H5N1 avian-influenza virus in Asia, Europe, and Africa have led to the culling of millions of poultry. Experts think that ducks and other waterfowl serve as the natural reservoir of H5N1, which is genetically distinct from the influenza viruses that circulate in the United States each winter.

Health authorities recorded the first human case of avian influenza in 1997, and 202 people have since died from the virus.

The high fatality rate of H5N1—61 percent of the confirmed human cases have resulted in death—worries public health officials. They're concerned that the virus might mutate into a form that can spread from person to person, sparking a pandemic. —B. VASTAG

Regulating Muscle Decline

Small molecules linked to degenerative diseases

Deteriorating muscles in people with diseases such as muscular dystrophy have abnormal amounts of important gene-regulating molecules called microRNAs, new research shows.

These microRNAs—snippets of the molecule that copies genetic information from DNA—help regulate the working of cells by silencing as many as hundreds of genes each. Scientists knew that microRNAs play important roles in healthy muscle cells, but the new study is the first comprehensive survey of microRNA activity in these muscle-wasting diseases.

Scientists led by Louis M. Kunkel of Children's Hospital in Boston measured the activity of several hundred microRNAs in samples of muscle tissue taken from 88 patients with either Duchenne muscular dystrophy or one of nine similar diseases. The researchers found 185 microRNAs that had either elevated or reduced activities in the diseased tissue when compared with healthy muscles.

"These microRNAs are influencing overall gene expression and the progression of the diseases," Kunkel says. By looking at a subset of 18 microRNAs, Kunkel's team could identify the disease affecting a particular sample with greater than 90 percent accuracy, the scientists report online and in the Oct. 23 *Proceedings of the National Academy of Sciences*. "There are unique microRNA-activity profiles specific to each of the diseases," Kunkel says.

To understand the functional roles played by the affected microRNAs, the scientists checked their list against a database of known types. Of the 145 microRNAs that were listed in the database, about 60 percent regulate genes in muscle cells.

Of the remaining microRNAs, 11 are active in cells of the immune system. While the various forms of muscular dystrophy are primarily caused by inherited mutations in genes that produce muscle proteins, the immune system sometimes contributes to the diseases by attacking muscle cells.

"This research is going to make our view

ISTOCKPHOTO

of these diseases more realistic," comments Francisco H. Andrade of the University of Kentucky Medical Center in Lexington, who has studied microRNAs in mice with a muscular dystrophylike condition. "We'll have a better sense of how complex the response of the tissue to the genetic defect is," he says.

John J. McCarthy, a colleague of Andrade's at the University of Kentucky, points out that while this research shows that certain microRNAs become more or less active in the diseases studied, it does not demonstrate which of those changes are essential for producing the diseases' symptoms. Future experiments should test whether altering the amounts of these microRNAs affects disease-related genes in ways that improve muscle function, McCarthy says.

If so, the microRNAs identified by Kunkel's team could eventually provide targets for new drugs that mitigate the diseases' effects, Andrade says. Drugs that can enhance or reduce microRNA activity are still years away, but developing such drugs is a burgeoning area of research.

"Maybe we couldn't correct the inherited genetic defect, but maybe we could alter the course of the disease," McCarthy says. Profiling microRNA activity could also give doctors a new way to diagnose which form of muscular dystrophy a patient has. —P. BARRY

Axion Gone

New tests find no sign of anomalous particle

Last year, physicists reported seeing tantalizing experimental traces of the axion, a hypothetical subatomic particle that's been mentioned as a possible constituent of cosmic dark matter. But the axion was showing up where theory said it shouldn't be. It now looks as if it wasn't there after all.

The axion sprang from an attempt to explain certain differences between the strong and weak nuclear forces. Cosmologists seized on the axion because its properties made it a plausible component of dark matter, the unseen material that far outweighs ordinary matter in the universe.

In 2000, Giovanni Cantatore and his colleagues at the Italian National Institute of Nuclear Physics in Legnaro were investigating the behavior of photons by shining a laser beam through a strong magnetic field. They noticed that the light's polarization shifted slightly after it went through the field—not the effect they were looking for.

The team posited that the polarization shift could have resulted from the magnetic field converting some of the beam's photons into axions, which would then fly off undetected. But the shift the researchers saw, while tiny, was much larger than physicists had thought possible. If such an effect occurred in the cores of stars, for example, axion emission would siphon energy away, reducing stellar lifetimes far below their actual values.

Cantatore and his colleagues reluctantly decided to publish their data last year, after numerous fruitless efforts to find a flaw in their experiments. "We thought it was our duty to report our results," Cantatore says.

After the announcement, at least five labs around the world began experiments to settle the issue. They looked for a different effect, known as photon regeneration, or, in Zenlike fashion, as "light shining through a wall." Researchers shoot a laser beam through a magnetic field toward a metal plate. The metal wall blocks photons, but any axions created in the field would pass through. On the other side of the wall lies a second magnetic field that would convert some of the axions back into photons, making it appear that some photons had passed through.

A team at the École Polytechnique in Palaiseau, France, reports the first results of such an experiment in an upcoming *Physical Review Letters*. "No regenerated photons were observed," says team member Cécile Robilliard, of the Université Paul Sabatier in Toulouse, France. "This allows us to exclude the Italian results with 99.9 percent confidence," she says.

Meanwhile, Cantatore and his colleagues have performed a new round of observations after taking their machine apart and rebuilding it almost from scratch. The polarization shift finally went away. The team posted a retraction of its earlier results online last June.

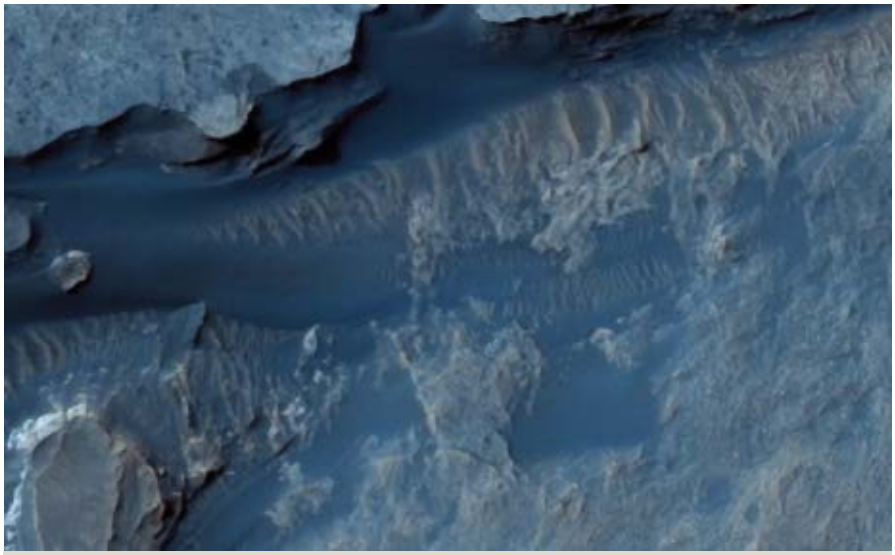
Cantatore says that a number of small effects could have combined to create the fake signal. For example, magnetic field lines might have leaked out of the magnet and helped shift the polarization.

Helen Quinn, a theorist at the Stanford Linear Accelerator Center in Menlo Park, Calif., who helped propose the axion in the 1970s, says that other experimental approaches might still find axions in the future. —D. CASTELVECCHI

Bad Acid

Ocean's pH drop threatens snail defense

A predicted worldwide fall in ocean alkalinity could have subtle effects on a small shoreline snail, shutting down one of its best defenses against crab predators, researchers say.



UNIV. ARIZ., JPL/NASA

Portrait of a Martian crater

Swept by wind and apparently sculpted by water, this area within the Red Planet's 140-kilometer-wide Gale crater was imaged by the Mars Reconnaissance Orbiter's HiRISE camera. Revealing features only a half-meter wide, the image depicts part of the floor of the crater (top), which may once have held a lake, as well as an overlying mound of layered terrain (center and bottom) that probably includes volcanic ash as well as sediments deposited by water. Each of the layers "provides an important record of Martian geological history," says Alfred McEwen of the University of Arizona in Tucson. A smoother section of the crater floor, adjacent to this area, includes a possible landing site for the Mars Science Laboratory, a sophisticated rover set to arrive in 2010. The HiRISE images of Gale and of some 30 other possible landing sites will help planetary scientists narrow the choices. —R. COWEN

The surface waters of the world's oceans are slightly alkaline. As human activity continues to add carbon dioxide to the atmosphere, however, increasing amounts of the greenhouse gas dissolve in the oceans, pushing seawater toward acidity.

The common periwinkle (*Littorina littorea*) normally grows a thicker shell when living among predators, says Simon Rundle of the University of Plymouth in England. In lab tests, he and his Plymouth colleagues found that a big increase in seawater acidity had little effect on periwinkles' shells—except when a predatory crab was lurking. In acidified seawater, shells of threatened periwinkles failed to thicken, the scientists report online and in an upcoming *Biology Letters*.

"The big take-home message is that effects of ocean acidification can extend beyond the direct effects," says Rundle.

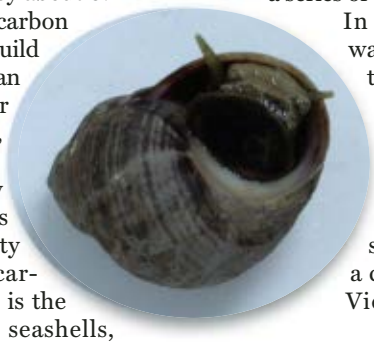
The oceans' surface-water pH now averages 8.2, says Scott Doney of the Woods Hole (Mass.) Oceanographic Institution. (A pH of 7 marks the line between acidity and alkalinity.) A variety of evidence suggests that ocean water has become more acid since the start of the Industrial Revolution, sinking in pH by about 0.1 unit. If atmospheric carbon dioxide continues to build up at current rates, ocean pH could drop another 0.3 to 0.4 unit by 2100, modelers predict.

As the acidity increases, sea creatures have greater difficulty producing calcium carbonate. This mineral is the stuff of coral reefs, seashells, shields on plankton, and even the teeth of sea urchins.

So far, most research on changes in ocean chemistry has focused on individual species, according to Doney. Rundle says the periwinkle work aims to explore interactions among species.

The common periwinkle creeps along much of Europe's coastlines. They often fall prey to common shore crabs (*Carcinus maenas*), which grab them "like ice cream cones," says Rundle. The frailest periwinkles get crushed and eaten.

Rundle and his colleagues grew more than 100 periwinkles in tanks. For half the snails, the team bubbled extra carbon dioxide through the water to mimic an acidic ocean with a pH of 6.45. That's much lower than predicted levels for this century, but Rundle says it provided a starting point for a series of experiments.



CRUSH THIS
Common periwinkles grow extrathick shells when crabs are nearby, unless the water becomes too acidic.

RUNDLE

In tanks with normal seawater and a crab at the bottom, the periwinkle shells thickened by an average of 0.05 millimeter—a substantial fraction of their total thickness. In the acidified tanks, however, shells didn't thicken when a crab was present.

Victoria Fabry, a biological oceanographer at California State University, San Marcos, says that she welcomes the new research because it goes beyond earlier studies of calcification and "shows that there's a link most likely with survival of the organism."

One of Rundle's collaborators, John Spicer, says that studies of crabs are already under way. Will lower ocean pH bring them periwinkle feasts? Not necessarily, he cautions, since calcium dynamics could affect predators as well. "Maybe the crabs will have weaker claws." —S. MILIUS

Looking for Biomarkers

Protein signature may warn of impending Alzheimer's disease

Amounts of certain proteins in the blood could tip off doctors to nascent Alzheimer's disease in people who don't yet show clear symptoms of the illness, researchers report.

The beginnings of Alzheimer's resemble the occasional forgetfulness and slight cognitive loss that come with normal aging, making the disease difficult to diagnose at a point when treatment might be most helpful. Tony Wyss-Coray of Stanford University and his colleagues reasoned that the quantities of certain proteins that carry information between cells might provide a diagnostic marker of Alzheimer's disease. Earlier research had suggested that protein markers could aid Alzheimer's diagnosis, but those analyses required tapping into spinal fluid—an invasive procedure (*SN: 2/18/06, p. 102*). Now, Wyss-Coray and his team have designed a protein test that requires only a blood sample.

To narrow the search, the team focused on 120 known signaling proteins. When the researchers measured concentrations of these proteins in Alzheimer's patients and healthy people, they detected 18 proteins that turned up in inordinately high or low concentrations in the Alzheimer's patients.

The scientists then checked amounts of these 18 proteins in blood samples obtained several years earlier from 47 people who had mild cognitive impairments at that time. In the interim, 22 of those people had gone on to develop Alzheimer's disease.

The telltale signature of the 18 proteins showed up in 20 of the 22 people with Alzheimer's but not in eight patients who had developed other forms of dementia. Of 17 people who still had only mild cognitive impairment up to 6 years after the blood samples were taken, the Alzheimer's-linked protein signature ominously appeared in seven.

The findings will appear in the November *Nature Medicine*.

"This is the first study I know of that looks at a blood-based test" for Alzheimer's, says Kelvin H. Lee, a biochemical engineer at the Delaware Biotechnology Institute in Newark, Del.

"The lack of precise biomarkers for neurodegenerative diseases such as Parkinson's or Alzheimer's is really the critical obstacle in the development of disease-modifying drugs," says neurologist Clemens R. Scherzer of Harvard Medical School in Boston. Biomarkers that identify people with early Alzheimer's would enable drug researchers to target the most appropriate individuals when testing new drugs, he says.

Currently, no medications can reverse the brain damage and cognitive losses caused by Alzheimer's, but some can slow the progression of symptoms (*SN: 2/18/06, p. 110*). If further research shows that protein signatures can provide accurate diagnoses, "it will be much easier to detect Alzheimer's disease earlier and treat it to stop the damage from happening," says Eric M. Blaylock, a neuroscientist at the University of Kentucky in Lexington.

Ultimately, Lee says, doctors might need to combine blood, spinal-fluid, brain-imaging, and psychological tests to get an accurate early diagnosis of Alzheimer's. —N. SEPPA

Are You Sensing You're Getting Older or Are Your Senses Getting Old?

Get Smarter: Learn How Your Brain Uses Your Senses as You Age

Why do we react to the world the way we do, not only in consistent ways—turning our heads toward a tap on the shoulder or toward a sudden movement in our peripheral vision, for example—but in individual ways as well?

What causes us to gasp in alarm at a sharp sound that our spouse barely notices? Why do children react with disgust when asked to try their parents' favorite food? How did your adventurous younger self grow into an adult whose stomach churns at even the thought of a roller coaster ride?

The answer is that each of us—or even a more recent model of ourselves—isn't reacting to the same world at all.

Although the physical world we occupy may be identical, the reality we each experience—the perceptions created when our brains combine input from our senses with past encounters with those same inputs—is very different. And this is true not only from one person to another but within individuals as well. Our sensory systems can be altered over time, their acuity changing in response to aging, injury, life experiences, evolving personalities, or other factors.

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About Your Professor

Professor Francis B. Colavita is an Emeritus Associate Professor of Psychology at the University of Pittsburgh. He received his B.A. in Experimental Psychology from the University of Maryland and his Ph.D. in Physiological Psychology from the University of Indiana. He is the recipient of five teaching awards, including the prestigious Chancellor's Distinguished Teaching Award, the highest award for teaching excellence bestowed by the University of Pittsburgh.

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STEM CELLS FROM VIRGIN EGGS

Nonviable embryos could answer ethical concerns

BY PATRICK BARRY

Last winter, two female Komodo dragons at separate zoos in England gave their keepers big surprises. With no contact from any male, each of the giant lizards laid a clutch of viable eggs, some of which hatched healthy young (*SN: 12/23/06, p. 403*). The events made the news because they were the first known examples of the species reproducing by the asexual process of parthenogenesis, or virgin birth.

Without fertilization by sperm, the animals' eggs had begun dividing. In these surprising cases, the process continued and cute little komodo dragons emerged. Viable young can also result from parthenogenesis in various species of reptiles, plants, insects, fish, and birds.

Mammals normally can't reproduce by parthenogenesis, but that very fact is making the process interesting in a different way: It suggests a possible solution to the moral issues surrounding embryonic stem cell research. Even if an unfertilized human egg is tricked into beginning to grow, most scientists say that it will lack the capacity to produce a viable pregnancy. Yet the entity could contain stem cells with the ability to develop into nerve cells, heart cells, or any other kind of cell in the body.

Stem cells hold tremendous potential for medicine and basic biological research. But acquiring these primordial cells usually involves extracting them from an embryo that has developed into a blastocyst, a hollow sphere of about 100 cells. The extraction generally destroys the blastocyst, so opponents of embryonic stem cell research say that it also destroys a potential human life.

But what if an embryo never had the potential to develop into a human being? Because parthenogenesis can't lead to a live birth in people, some researchers argue that an early embryo created by parthenogenesis is merely a ball of cells. Removing embryonic stem cells from such a ball doesn't pose an ethical dilemma, they say. "It's a morally unproblematic way" of getting stem cells, says Michael West, chief scientific officer for Advanced Cell Technology of Alameda, Calif.

Recent years have seen swift progress in parthenogenesis. In 1994, Nicholas D. Allen and his colleagues at the Babraham Institute in Cambridge, England, succeeded in creating parthenogentic stem cells from unfertilized mouse eggs. In 2002, Jose Cibelli of Advanced Cell Technology and his colleagues created them from egg cells taken from macaque monkeys.

In the June *Cloning Stem Cells*, a team of Russian scientists working for Walkersville, Md.–based Lifeline Cell Technology announced the first deliberate creation of parthenogenetic stem cells from human eggs. The same milestone had been achieved accidentally by now-discredited Korean researcher Woo Suk Hwang in 2004, but Hwang claimed that he had created stem cells through cloning rather than parthenogenesis (*SN: 8/4/07, p. 69*).

But creating human parthenogenetic stem cells is just the first step toward the possibility of using them in medical therapies. The abnormal genetic makeup of these cells—with duplicated DNA from the woman whose egg is used—poses significant scientific hurdles.

Even if scientists can overcome these obstacles, could both women and men benefit from therapies using parthenogenetic cells? Doctors could use an egg from a woman with, say, Parkinson's disease to produce stem cells that the woman's body wouldn't reject, since the cells would share her genetic makeup. But that's not possible for a man, since parthenogenesis can't start with sperm.

INFERTILE GROUND It's a strange relic of evolution that human egg cells can undergo parthenogenesis at all.

Animals capable of reproducing by parthenogenesis store an extra set of chromosomes in a pouch called a polar body, in case a sperm doesn't show up and deliver its DNA. Although people can't naturally reproduce this way, a woman's egg also retains an extra set of chromosomes in a polar body until fertilization.

Scientists can jolt the egg into reclaiming the DNA in the polar body. The cell may then begin to develop without being fertilized.

Once the egg has developed into a blastocyst, scientists can extract stem cells to use for research or for stem cell therapies. These cells, however, are far from normal because of abnormalities in a process called imprinting, which normally turns off certain genes in mammals. Chromosomes inherited from the mother will have one pattern of imprinted genes, and the paternal chromosomes will have another. Many imprinted genes are involved in fetal development, so mammal embryos need both patterns in order to develop normally.

Abnormal imprinting is what prevents a mammalian egg activated by parthenogenesis from developing much beyond the blastocyst stage. In such an egg, both members of each pair of chromosomes would have maternal imprinting, resulting in an abnormal pattern of turned-off genes.

When used medically, however, stem cells created via parthenogenesis wouldn't need to go through the complex baby-building process. Scientists could steer the cells directly into becoming adult heart-muscle cells to treat a heart attack victim or into nerve cells for a person with Parkinson's disease. The cells wouldn't need to use their fetal-development genes, explains George Q. Daley of Children's Hospital Boston.

Although parthenogenetic stem cells aren't exactly normal, "maybe many cell types would be normal enough to be clinically useful," West says. Indeed, some evidence points in this direction. The year after Cibelli's group created parthenogenetic stem cells from macaque eggs, the team steered these cells into becoming working nerve, heart, and fat cells. "The cells seemed very normal," reports West, who was on the team. "You couldn't tell any difference."

More recently, researchers at the University of Pennsylvania in Philadelphia replaced mice's bone marrow with blood-forming

cells derived from parthenogenetic stem cells. Despite the abnormal imprinting, the cells established new bone marrow that functioned normally for at least 4 months, Kenneth J. McLaughlin and his colleagues reported in the Feb. 15 *Genes and Development*.

A MOTHER'S TOUCH While experiments have shown that abnormal imprinting might not be a deal breaker, more research is needed to address concerns raised by parthenogenetic cells' other genetic abnormality: the fact that both members of each pair of chromosomes are inherited from one parent.

A cell whose paired chromosomes are identical is called homozygous. "A lot of bad things can happen if the cell line is homozygous," says Jeanne F. Loring, a stem cell researcher at the Burnham Institute for Medical Research in La Jolla, Calif. For example, having different paternal and maternal versions of many cancer-related genes prevents either set of genes from having too much influence on whether a cell becomes cancerous. If a gene-copying error results in a cell with two identical copies of the gene, it can upset this balance and lead the cell toward becoming a malignant growth.

In the real world, however, imperfections in egg creation prevent the chromosome pairs from being perfectly identical. In fact, the parthenogenetic stem cells made accidentally by Hwang are only about 40 percent homozygous, Daley and his colleagues report in the September *Cell Stem Cell*. For the other 60 percent of the genome, corresponding pairs of chromosomes differ from each other as much as they would if they had been inherited from two parents.

The reason for this odd fact lies in how an egg is formed. A cell that will become an egg begins with pairs of each chromosome, one from the woman's mother and one from her father. First, that cell duplicates these chromosomes, resulting in two maternal and two paternal copies. Then, the chromosomes line up across the center of the cell in preparation for the cell to divide. There, the ends of tube-shaped bundles of maternal DNA can mingle, intertwine, and even swap pieces with the paternal copies.

When the cell divides in half, the somewhat altered chromosomes of each pair part ways. One of these chromosomes—perhaps the maternal one—ends up in the cell that splits again to become the egg and polar body. Because this chromosome had been duplicated at the outset, the egg and polar body each end up with a copy of the maternal chromosome. But because of the random swapping with the paternal DNA, these chromosomes won't be identical. As a result, in parthenogenetic stem cells, the two chromosomes in any given pair will differ from each other wherever those swaps occurred, thus reducing the cells' homozygosity.

Scientists might be able to control the lingering cancer risk from homozygosity by simply checking whether any newly created stem cells have matching copies of known cancer-related genes. Doctors could discard any cells that pose too much of a risk. "In all such techniques you need quality control," says West.

For certain genes, homozygosity might actually be a good thing, because it could extend the benefits of parthenogenetic stem cells to men and postmenopausal women who no longer ovulate. The main reason for using a person's own cells to make stem cells for medical therapies is to prevent the person's immune system from rejecting the implanted tissues. As with organ transplants, however, a close match is often good enough. Finding such a match would be easier with parthenogenetic stem cells than with normal cells. That's because normal cells have two versions of a set of genes called the major histocompatibility complex, which determines whether the cells would be accepted or rejected, whereas the stem cells would often have two identical sets. This greatly reduces the number of possible combinations of these genes, making it easier to find an acceptable match.

"You could find a credible match, maybe not a perfect match, for a lot of people," Daley says.

SELF-STARTER — A woman's eggs keep a spare set of chromosomes inside a small pouch called a polar body (arrow) until a sperm delivers the paternal set. Scientists can spur the egg to reclaim these extra chromosomes and begin growing without having been fertilized.

E. POLAK DE FRIED, FERTILITY AND STERILITY/ELSEVIER

UNCERTAIN FUTURE Some people and institutions staunchly opposed to making embryonic stem cells by other means remain open to the possibility of making them by parthenogenesis. The Roman Catholic Church, for example, has taken a firm stance against stem cell research that destroys embryos made by cloning and by in vitro fertilization. However, it has adopted a wait-and-see approach to parthenogenetic stem cells, says Tadeusz Pacholczyk, a neurologist and priest at the National Catholic Bioethics Center in Philadelphia.

The Catholic Church probably won't issue an official decision until scientific research establishes whether such blastocysts are impotent balls of cells or viable human embryos that happen to be defective, Pacholczyk says. "Until we have really clear and convincing evidence whether parthenogenesis makes a true human embryo, the church is not going to step into these waters."

Kevin FitzGerald, a Jesuit priest and geneticist at Georgetown University in Washington, D.C., agrees that the moral issue revolves around gaining a better understanding of what is produced when scientists cause a human egg to undergo parthenogenesis. "Since you don't naturally get parthenogenetic offspring in mammals, if you get some sort of [spontaneous] parthenogenetic growth, then yeah, that's not an embryo," FitzGerald says. "But if you induce it yourself, what are you creating?" The laboratory techniques that scientists use to trigger parthenogenesis affect egg cells in ways that are still poorly understood. While natural parthenogenesis doesn't produce viable embryos in mammals, more research is needed to show whether artificially activated eggs might sometimes be viable.

When President George W. Bush vetoed a bill in June that would have allowed federal funding for research on newly created embryonic stem cells, he specifically mentioned parthenogenesis as a method that should not receive federal money. However, the president's Council on Bioethics has given a conditional nod to parthenogenesis as a possible ethical work-around. In a 2005 report, the council wrote that the blastocyst-like ball of cells created by parthenogenesis "is assumed by most commentators to lack entirely the potential for development as a human being, and is therefore, arguably, not really an embryo."

The council stopped short of recommending the technique, saying that more evidence is needed to show that such a ball of cells can't sometimes develop like an embryo.

So if further research makes it clear that artificially induced parthenogenesis can't produce a viable human embryo, the technique might find acceptance among political and religious leaders who have thus far rejected other kinds of embryonic stem cell research. In its report, the president's council concluded, "Those who are convinced that parthenogenetic embryos have no chance of development beyond the blastocyst stage are likely to have few ethical objections." ■

NOT JUST HITCHHIKERS

Human pathogens make homes on plants

BY SUSAN MILIUS

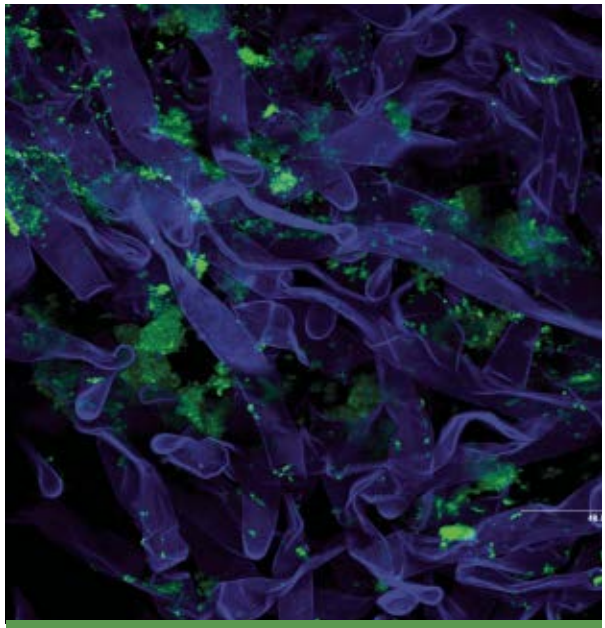
Jeri Barak's tomato plants have a weird disease breaking out on them. Not the biggest surprise, perhaps, since she's a bona fide U.S. Department of Agriculture plant pathologist. But what's afflicting Barak's tomatoes isn't some everyday farm ailment—their leaves are colonized with *Salmonella enterica*, more famous as an animal pathogen. This bacterium leads to about 600 deaths in people each year, along with 40,000 reported cases of illness.

It's the species that everyone's supposed to guard against when handling raw meat, eating undercooked eggs, or petting baby turtles. Barak, however, has started studying this animal pathogen's role on plants. And she's not talking about bacteria just passively smearing plants like streaks of dirt.

Evidence has been growing that high-profile human pathogens, such as salmonella strains and the deadly *Escherichia coli* O157:H7, actively colonize plants. In doing so, the pathogens follow variations on their attack tactics for animals. They grow structures to glue themselves in place. They build defensive shields and fortresses. They set up housekeeping. Barak doesn't go so far as to say that salmonella and *E. coli* make plants sick, but these human pathogens are definitely up to something on plants.

Understanding what human-disease organisms do when they go plantside could suggest new ways to combat foodborne illnesses, says Barak. Produce is increasingly often the culprit behind disease outbreaks, and cases such as the 3 people killed and more than 200 sickened in 2006 from eating tainted fresh spinach have dramatized that food safety begins with the food, not its handlers.

The people-plant-pathogen interplay inspired a special symposium at last July's annual meeting of the American Phytopathological Society in San Diego. Some pathogen species literally do cause diseases in both plants and people (*see sidebar*). Other microbes typically don't hurt plants as much as they hurt people. Still, plant pathologists say that discovering how these microbes set up housekeeping on plants could lead to new ways to stop them. Barak, of the USDA in Albany, Calif., told her colleagues at the meeting that although plant pathologists had for decades deferred to human-disease specialists in the study of these pathogens, "now we need to take back salmonella."



BUT WE WASHED — Alfalfa sprouts (ghostly blue ribbons) rinsed with sterile water still show the green spots indicating the presence of *E. coli* O157:H7 that has been engineered to fluoresce under laser illumination.

BARAK, A. LIANG

PLANT LIFE Just what salmonella and *E. coli* are up to on plants didn't get much attention until recently. "It wasn't until people started getting sick from fresh produce that [we] started looking at how pathogens do this," says Barak.

According to statistics from the Centers for Disease Control and Prevention (CDC) in Atlanta, only 0.6 percent of disease outbreaks from food in the 1970s could be traced to fresh produce. In the 1990s, however, produce accounted for 12 percent of outbreaks, and since a 1998 revision of surveillance criteria, the percentage has edged up to 14.

Many factors have contributed to the rise in killer fruits and vegetables. People today eat almost a third more fresh produce than they did in the 1970s. And today's produce comes from an international and industrialized system in which it often travels farther than the people who eat it. Outbreak-tracing techniques have improved too.

The increase in outbreaks inspired new research on produce safety and led to disturbing findings. Even a few years ago, Barak says, microbiologists had assumed that human pathogens were merely passengers on plants, and so could be dealt with by soap and water. But in test after test early in this decade, none of the available washes and sanitizers could clean produce completely. The persistence of bacteria prompted researchers to wonder whether pathogens were making more than merely casual contacts with plants.

Tests showed that pathogens, either passively or actively, could infiltrate tissues far beyond the reach of surface washes. For example, Red Delicious apples dunked in water containing *E. coli* O157:H7 in a lab test ended up with the bacteria inside the core even though the fruit hadn't been cut. The bacteria in this experiment carried a gene that made them fluoresce green, and the glow showed the bacteria near the seeds, Larry Beuchat of the University of Georgia in Griffin and his colleagues reported in 2000.

Other experiments have shown *E. coli* seeping into uncut, unpeeled oranges through the little break in the skin where the fruit parts from its stem. Mangos and tomatoes likewise are vulnerable to salmonella through their stem scars.

Even pathogens that didn't lurk deep in tissues proved virtually indelible. By 2002, at least four studies had confirmed that neither chlorine treatment nor a good, brisk scrubbing dislodged *E. coli* from lettuce. Current research is addressing this challenge (*SN: 12/16/06, p. 394*), but the failure of most washing systems has clued researchers in to a secret of *E. coli* contamination: The bacterium gets a grip on plants and hangs on.

Studies of other pathogens similarly came to the conclusion that pathogens actively colonize plants. Maria Brandl, also of USDA's Albany lab, followed up on a 1999 salmonellosis outbreak in California by testing a bacterial strain of *S. enterica* called serovar Thompson, which had been isolated from a patient. After inoculating chopped cilantro leaves and even some salsa with the strain, Brandl reported that the bacterium grew quickly to high concentrations in both foods.

Brandl and her USDA colleague Robert Mandrell then took their test to live plants. They inoculated growing cilantro leaves with a pathogenic salmonella strain as well as with two bacterial species common on plants. All three microbes grew and colonized the leaves. The salmonella strain didn't flourish as abundantly as the specialized plant bacteria, but it did establish a presence on the leaf.

When the researchers stressed the bacteria by keeping the leaves dry, the salmonella population shrank but rebounded when Brandl rehumidified the plants. The salmonella strain responsible for the 1999 poisonings was a perfectly plausible leaf colonizer, Brandl and Mandrell reported in 2002.

Ordinary diseases of the plants, which are otherwise harmless to people, may help the human pathogens make themselves at home. Growing in a test tube, *E. coli* O157:H7 doesn't reliably make a protective biofilm. But when researchers added the *E. coli* to test tubes along with a regular plant bacterial pest, *Erwinia chrysanthemi*, the human pathogens readily joined the biofilm of the plant pathogen.

Barak is now working on a study with whole plants. She and her colleagues are finding that salmonella grows more abundantly if a plant is already infected by *Xanthomonas campestris* pathovar *vesicatoria*, which causes bacterial spot disease on peppers and tomatoes.

SURVIVOR To tease out the genetic mechanisms behind salmonella's ability to make itself at home on a plant, Barak and her colleagues worked their way through a set of experimentally created mutants of a strain called serovar Newport. The researchers found mutants that couldn't attach themselves to alfalfa sprouts, a common source of disease outbreaks. Analyzing the genetic defects in these bacteria gave Barak a clue as to what genes the bacteria use when confronting a leaf. "It was ironic," says Barak, that 13 out of 20 of these mutants had disruptions in genes that had never been characterized in years of previous work on how salmonella infects animals.

That discovery implies that the bacteria cope with plants by using some of the same genes that power pathogenic attacks on animals—for example, a gene for strands of protein nicknamed Tafi, which attach the bacterial cell to a surface. Tafi have attracted attention from Alzheimer's researchers trying to understand how protein deposits build up outside cells in failing brain tissue.

But as Barak's work shows, salmonella cells apparently also have devices specifically for making solid attachments to plant surfaces. The latest paper from this project, in the September *Molecular Plant-Microbe Interactions*, details two such fasteners. The molecular gadgets help the microbes hold on to each other as well as to plant tissue. The interconnected bacterial cells form a solid biofilm, which offers protection to its members from external hazards.

Such capacity for living on a plant doesn't surprise Barak. "I think colonizing plants may be vital for salmonella to live out their life cycle," she says. Any such animal pathogen has to survive occa-

Same Pathogens Hit People and Plants

Some bacteria can cross the line

The average gardener doesn't worry about giving the petunias a cold or catching a rash from the blemished leaves of a rose. There's a species barrier, for heaven's sake. But that barrier may not stand as tall and strong as we think. Biologists have already found a few pathogens that can make both people and plants sick.

One of the most famous cases began in the 1950s, when plant pathologist Walter Burkholder of Cornell University announced that he'd found the culprit causing a disease of onions called sour skin. When a wound opens at the neck of the onion, the bulb's outer layers darken and turn mushy. Burkholder showed that the cause was a bacterium that now bears his name, one of the nine closely related lineages within what's called the *Burkholderia cepacia* complex (BCC).

Despite the onion issue, these organisms proved remarkably useful. Certain strains were developed to clean herbicides or other pollutants out of groundwater and soil. BCC strains suppressed the growth of other microbes and thus helped control some agricultural diseases. The Environmental Protection Agency registered at least two products based on these strains.

But in the 1980s, doctors linked these versatile bacteria to severe lung infections in people with cystic fibrosis. The thick mucus that builds up in these people's lungs renders them vulnerable to respiratory infections, and some BCC strains can be deadly there.

By 2003, methods for identifying bacterial strains had improved enough for researchers to say that a BCC strain collected from rotting onions during the 1940s was the same one isolated from a person with cystic fibrosis. The EPA is not approving BCC products these days.

A lesser-known case concerns *Serratia marcescens*, a bacterium that people might remember from biology-lab exercises. This supposedly harmless bug grows in red-tinted colonies that serve as conspicuous markers of how easily contamination can spread.

Military research from the middle of the last century also featured this species, says entomologist Jacqueline Fletcher of Oklahoma State University in Stillwater. She studies *S. marcescens* in agricultural settings but says that she's heard Cold War tales of intentional releases of the bacterium among U.S. populations as tests of how biological agents might spread.

That use of the species came to an end when epidemiologists realized that the bacterium was showing up in wounds, and not benignly. *S. marcescens* can attack human tissues, particularly of immunocompromised hospital patients, says Fletcher. It reaches patients from floral arrangements and salads and even intravenous tubes. A recent study documents *S. marcescens* in wounds in survivors of a tornado.

Fletcher got involved with the species when a frustrated colleague asked her to help trace the cause of a disease that could suddenly wilt a field of squash plants. In trying to isolate the pathogen for what's called cucurbit yellow vine disease, "we kept getting this stupid contamination" with *S. marcescens*, says Fletcher.

Eventually, she realized that there was no contaminant. Rather, a colorless strain of the same *S. marcescens* species that infects people was invading and killing the squash. —S.M.

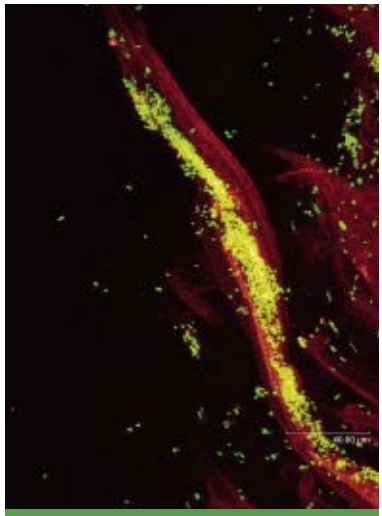
sional periods when it's outside the warm, plush world of an animal host. By comparison, a plant leaf is harsh, with no temperature regulation or protection from drought, deluge, or ultraviolet blast. Landing on a plant "is like *Salmonella* going to the moon," Barak says. So it makes sense that pathogens maintain equipment for emergency landings on plants.

The hardships of life in a crop field have other effects important to people, according to Karyn Meltz Steinberg of Emory University in Atlanta. People who get sick may just be collateral damage in a war between bacteria and their protozoan predators. She and her Emory colleague Bruce Levin have been musing about what benefit *E. coli*, a microbe with hoofed mammals as its natural host, gets from killing people.

The pathogen's toxin might defend the bacteria against grazing protozoa typically encountered outside one of those hoofed hosts, such as in soil. Meltz Steinberg and Levin tested the idea by tracking *E. coli*'s survival with and without the presence of the rapacious, bacteria-hunting species *Tetrahymena pyriformis*. An *E. coli* strain carrying a toxin-making factor outperformed a harmless strain only when stalked by the protozoans, the researchers reported in the Aug. 22 *Proceedings of the Royal Society B*.

Even though life on plants may be a stretch for human pathogens, they can be very hard to kill there. A better strategy, Barak says, is to improve farming practices so as to limit the spread of bacteria to crops. To keep food safe, "we've got to give farmers the tools", she says.

The Albany research program includes efforts to find possible routes of agricultural contamination. Barak's been studying the life of salmonella in soil, where other research has suggested that the bacteria can survive at least for a while. In the lab, she mimicked a farmer discovering a contaminated crop of tomato plants, plowing them into the soil, waiting a week, and then planting new seeds. Even 6 weeks after reseeding, she found salmonella on the second crop.



BAD TIP — Ends of alfalfa sprouts, washed with sterile water, still reveal spots of salmonella dyed to appear yellow.

BARAK, A. BATES

The way in which water is used on farms could also be a problem, according to several labs. For example, the USDA lab in California has recovered *E. coli* O157:H7 from lettuce seedlings days after experimentally irrigating them with tainted water. And when the Beuchat group painted a salmonella solution onto tomato blooms, 2 of the 8 fruits that formed from those flowers carried the pathogen. Farmers don't go around dabbing their crops with dirty paintbrushes, but they have felt free to use untreated water from the farm for spraying pesticide mixes. Barak speculates that someday farmers might have to make sure they use clean drinking water in their sprayers. These and other routes of contamination need investigating, she says.

In the meantime, she offers comfort—with some cautions—to fans of fresh fruits and vegetables. "Flare-ups of food pathogens are rare events," she says. To minimize her own chance of encountering worrisome bacteria, she avoids damaged fruits and vegetables. They leak moist innards of the plant and offer fertile ground for pathogen picnics. And she minimizes store-to-fridge time as much as she can. "I tell people: 'Treat your produce like ice cream.'"

Even with her research on the dark side of salad, she hasn't given up. "Oh, I eat this stuff," she says. "I'm a vegetarian." ■

OF NOTE

TECHNOLOGY

Platinumfree fuel cell

Many obstacles stand in the way of ditching the internal combustion engine in favor of electric motors feeding off hydrogen fuel cells. Such a change would require new infrastructure for the delivery, storage, and distribution of hydrogen, either in a low-temperature, liquid state, or at high pressure, as a room-temperature gas. And standard hydrogen fuel cells are expensive, requiring as much as 100 grams of platinum at a cost of thousands of dollars.

A new type of fuel cell could solve both problems at once. The technology, proposed by engineers at Daihatsu, a unit of Toyota, in Ryuo, Japan, uses a fuel called hydrazine hydrate, instead of hydrogen.

Hydrazine hydrate—a compound of nitrogen, hydrogen, and water—is liquid, which makes it easier to store and deliver than gas. And it contains no carbon, so cars using it would still be environment-friendly. But perhaps the main advantage of the new fuel cell is simply that it's cheaper.

In hydrogen fuel cells, platinum serves as a catalyst membrane that breaks down hydrogen molecules into ions and electrons. The electrons provide the current that powers the car's motor. Platinum is used because it's the only metal catalyst that can survive corrosion by hydrogen ions for any length of time.

But the membrane in the Daihatsu fuel cell has to cope only with more-benign hydroxide ions, allowing engineers to use cheaper catalysts such as cobalt or nickel.

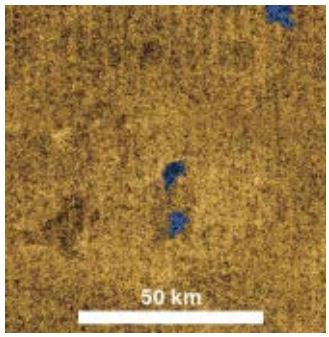
"We believe that this technology has the potential of bringing the cost of a fuel cell vehicle [down to] that of an internal combustion–engine vehicle," says team member Koji Yamada. His team's results appear in the Oct. 22 issue of *Angewandte Chemie*. —D.C.

PLANETARY SCIENCE

Titan: Land of lakes—and drizzle

A newly assembled mosaic of radar images of Saturn's hydrocarbon-shrouded moon Titan, taken over the past 18 months by the Cassini spacecraft, shows what are probably hydrocarbon lakes and seas at the moon's north pole. At least one of the lakes is larger than Lake Superior. In addition, radar images taken by Cassini during an Oct. 2 flyby show evidence of hydrocarbon lakes at the moon's south pole.

Cassini's radar has now studied 60 percent of the north polar region above 60° latitude. Lakes appear to occupy about 14 percent of the scanned area. Planetary scientists have long proposed that lakes could form because of methane and ethane raining down from the moon's atmosphere. Cassini's radar view of a small patch at the south pole shows three lakes, indicating that these features may be just as common there as at the north pole.



LIQUID VIEW Radar image shows what appear to be hydrocarbon lakes (blue) at Titan's south pole.

"All the circumstantial evidence points to the lakes being filled, partially or fully, with liquid, but the radar cannot give us direct positive evidence," notes Jonathan Lunine of the University of Arizona in Tucson. "Confirmation will require difficult, near-infrared observations that might provide a signature of liquid methane or ethane," he says.

In a separate finding, near-infrared studies using two Earth-based telescopes suggest that methane clouds are drizzling the hydrocarbon onto Titan. In an equatorial region called Xanadu, the observations show widespread methane cloud cover at high altitudes and also suggest the presence of drizzle lower in the atmosphere. The clouds and precipitation, which either strike the ground or turn into mist, seem to dissipate by mid-morning, as measured locally.

"Widespread and persistent drizzle may be the dominant mechanism for returning methane to the surface from the atmosphere and closing the methane cycle," Máté Ádámkovics of the University of California, Berkeley and his colleagues note in an upcoming *Science*. —R.C.

ASTRONOMY

Motion of two nearby galaxies clouds the picture

Astronomers may have to rewrite the textbooks on the two galaxies closest to the Milky Way. A new analysis confirms previous indications that the Large and Small Magellanic Clouds are not gravitationally bound to our galaxy but are instead speeding by, having come this way just 1 billion to 3 billon years ago.

Visible to the naked eye as bright clouds, the two galaxies are small and irregular. The Large Magellanic Cloud is about 160,000 light-years from the Milky Way and has about one-twentieth the Milky Way's diameter, while the Small Magellanic Cloud, one-200th the Milky Way's size, lies about 200,000 light-years distant.

Earlier this year, Gurtina Besla of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., and her colleagues measured the velocities of the galaxies relative to the Milky Way with unprecedented accuracy. The velocities were unexpectedly high, suggesting that either the two galaxies aren't bound to the Milky Way or that our galaxy is much heavier and exerts a greater gravitational tug than astronomers had estimated (*SN: 1/13/07, p. 19*). Further analysis of those data now shows that the two galaxies are traveling along parabolic orbits, meaning that each is making its first pass by the Milky Way, the team reports in the Oct. 20 *Astrophysical Journal*.

That's a puzzle on several counts, notes Besla. For instance, it's not clear what pulled the Magellanic Stream, a long tail of hydrogen gas, out of the two clouds. Some astronomers had suggested that gravitational interactions between the clouds and the Milky Way created the trail. Alternatively, the trail could have arisen if the two galaxies had rammed into the outskirts of the Milky Way. But the new findings show that the clouds haven't been hanging around the Milky Way long enough for either scenario to have happened. —R.C.

TECHNOLOGY

CD players could serve as cheap lab tools

The average home-entertainment disc player is good for audio and video, but a talented hacker could apparently expand the machine's horizons to include medical diagnoses and chemical tests.

Normally, the devices' lasers scan a CD (compact disc) or DVD (digital video disc) for microscopic bumps that encode sounds

JPL/NASA, USGS

and images. Analytical chemist Angel Maquieira of the Polytechnic University of Valencia in Spain and his colleagues reasoned that the system could be modified to detect certain chemicals in lab samples as well, and would be much cheaper than the $40,000-to-$80,000 portable microarray detectors usually used.

The scientists coated blank CDs with dots containing antibodies mixed with various chemicals. The antibodies were designed to darken if they came into contact with any of three pesticides in the chemical mixes. The team placed these discs in a CD player to which the researchers had added sensors that could detect changes in the intensity of light transmitted through the dots as they were scanned by the player's laser. Normally, CD players detect only the presence or absence of reflected light. A computer hooked up to the player then read whether individual dots had darkened. In the Oct. 15 *Analytical Chemistry*, the team reports that the modified device detected concentrations of pesticides as low as 20 billionths of a gram per liter, a level of sensitivity comparable to that of current lab scanners.

Maquieira says that a converted disc player could run tests in home labs, at doctors' offices, or even outdoors. The device could even help pharmaceutical companies rapidly assess the behavior of potential drugs, since up to 300,000 samples could be crammed onto a single disc. —C.C.

LAB PLAYER Researchers modified this compact disc player to detect small amounts of chemicals in lab samples.

MAQUIEIRA

MATERIALS SCIENCE

Feet of clay, but superstrong

To make clay strong, just add glue.

Nanotechnology promises to deliver materials that will possess, on a large scale, the exceptional mechanical properties of tiny particles such as carbon nanotubes or the mineral grains that constitute clay. But because a chain is only as strong as its weakest link, it's crucial that in materials made of strong building blocks, those blocks stick together robustly.

Nicholas Kotov and his collaborators at the University of Michigan in Ann Arbor have created high-strength films by linking clay particles and polymers. The researchers dissolved clay in water, freeing its component particles—nanometer-thick flakes composed of aluminum, oxygen, and silicon atoms. They let the sheets deposit onto a glass surface, alternating them with layers of the polymer polyvinyl alcohol, "a chemical cousin of the glue that you used at school," as Kotov describes it.

Kotov says that hydrogen bonds, a relatively weak chemical linkage, formed between hydrogen atoms in the polymers and oxygen atoms in the clay. Those links glued the clay layers together, while keeping the structure flexible. Strong covalent bonds formed between the polymers' oxygen atoms and aluminum atoms along the edges of the clay sheets, joining them laterally. The team's results appear in the Oct. 5 *Science*.

Kotov says that clay-based composites could find applications as membranes for separating out mixtures of gases, or could lead to lighter, stronger bulletproof vests. —D.C.

MICROBIOLOGY

Bacteria thrive by freeloading

They say that cheaters never win, but some bacteria appear to do quite well by adopting this strategy.

The guilty party is a mutant form of the bacterium *Pseudomonas aeruginosa*, which can infect people with weakened immune systems and is often the cause of death among people with cystic fibrosis. Because this species is effective only in large numbers, the bacteria wait until they sense chemical messages from many nearby individuals before they begin producing the toxins that cause their virulence—a process called quorum sensing.

Scientists had been puzzled that some bacteria in samples taken from infected people had mutations that caused them to ignore quorum sensing. Losing the ability to detect when the bacterial population reaches critical mass seemed to be a detrimental trait that natural selection would weed out.

Now, Martin Schuster and his colleagues at Oregon State University in Corvallis have shown that these mutants can grow faster than their peers by freeloading on the hard work of their neighbors.

"Some bacteria are taking advantage of others, letting them do the work necessary for survival," Schuster says.

Once quorum has been reached, the normal, cooperating bacteria start to churn out compounds that convert nutrients into forms that the bacteria can use. By not producing those compounds, the cheating bacteria save energy that they can instead devote to growth, Schuster's team reports in the Oct. 2 *Proceedings of the National Academy of Sciences*.

If the cheaters outgrow their peers too much, nutrient supplies for the whole population will suffer. So the mutants also undergo genetic changes that turn their quorum-sensing abilities back on if they become too numerous. —P.B.

NEUROSCIENCE

Emotional memory

Where were you on Sept. 11, 2001? Or when the shuttle Challenger exploded in 1986? Heightened emotions cause experiences to crystallize into lasting and vivid memories. This boost in memory formation is due in part to the stress hormone norepinephrine, but scientists haven't understood how the hormone causes this effect.

Now researchers have uncovered molecular changes triggered by norepinephrine that help nerve cells form new memories.

A team led by Roberto Malinow of Cold Spring Harbor Laboratory in New York traced the hormone's effects to a receptor molecule called glutamate receptor 1 (GluR1) on the surfaces of nerve cells. Through GluR1 and similar receptors, nerve cells can receive signals from their neighbors. Nerves store new memories by increasing the strength of those signals, according to a leading theory.

Norepinephrine, a form of adrenaline, triggers the attachment of a small molecule called a phosphate group to GluR1s before they reach a nerve cell's surface. Adding the phosphate group expedites the movement of GluR1 molecules to the surface, where they're thought to help cells form memories.

"There are likely to be a number of different mechanisms that underlie this effect, but this appears to be a major one," Malinow says.

The team engineered mice to have a mutation in GluR1 that prevents phosphate groups from attaching. Injecting norepinephrine into normal mice improved the animals' ability to learn from experience. But for the mice with impaired GluR1, the hormone made no measurable difference, the researchers report in the Oct. 5 *Cell*.

The research could lead to new drugs for emotion-related memory disorders, Malinow notes. "In post-traumatic stress disorder, where you have too much emotionally charged memory, this [receptor] could provide a molecular target for possible treatments." —P.B.

Books

A selection of new and notable books of scientific interest

QUIRKOLOGY: How We Discover the Big Truths in Small Things

RICHARD WISEMAN

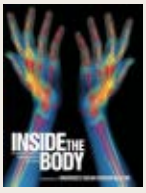
A student of human behavior for decades, Wiseman has discovered interesting facts about lying, decision making, and humor.

Among the behaviors he has investigated in small but ingenious experiments is many people's belief that birth date affects personality. Despite the inaccuracy of horoscopes, many people swear that their astrological signs fairly accurately describe their lives. This is so, the author explains, because horoscope writers make their predictions believable by keeping them general and flattering. Wiseman also examines people's relatively poor ability to recognize a lie, the superstitious worry surrounding the number 13, and the fact that good-looking criminals often get off with lighter prison sentences than their less attractive counterparts do. In his quest to unlock the secrets of what makes a joke funny, Wiseman set up a Web site asking for joke submissions and ratings—and made some interesting and disturbing findings about the darker side of humor. He explains these and other strange aspects of human behavior, revealing just how quirky the human mind is. ***Basic, 2007, 323 p., hardcover, $26.00.***

INSIDE THE BODY: Fantastic Images from Beneath the Skin

SUSAN GREENFIELD

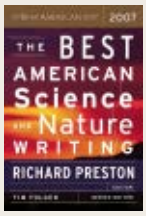
Modern medical technology allows physicians and scientists to see the inner workings of the human body with unprecedented detail. Light micrographs enable scientists to view individual cells and many of the structures within them. Electron microscopes go deeper and give three-dimensional views. Angiograms can produce real-time images of blood vessels. These methods and others are used to create the bold images in this book. Starting at the cellular level, human tissues and organs are magnified thousands of times to reveal hidden and often bizarre structures. Striking images include the fingerlike projections of intestinal cells, flexible but tough tendons within the heart, the spiderlike arms of nerve cells, a sperm and egg at the moment of fertilization, and a simple whole-body X ray. In total, these images reveal the complexity and beauty of the human body. ***Firefly, 2007, 287 p., color images, paperback, $29.95.***



THE BEST AMERICAN SCIENCE AND NATURE WRITING

RICHARD PRESTON, ED.

A newly emerging field called molecular gastronomy is shaking things up in the cultivated culinary world in Paris. Male bighorn sheep may reveal secrets about the evolution of homosexuality. And obtaining a nuclear bomb may not be as difficult as one would hope. These are among the fascinating topics covered in the 28 essays in this informative and eye-opening anthology. Editor Richard Preston, author of such books as *The Hot Zone* and *The Wild Trees*, selected articles that exemplify the best in American science and nature writing for the year 2007. His choices represent the latest and greatest in emerging research and exploration. The essays were culled from such well-respected publications as *National Geographic, The Atlantic Monthly, Scientific American, Discover*, and *The New Yorker*. Authors include Neil DeGrasse Tyson, Paul Bennett, Meredith Small, and others. From the hype surrounding bird flu to the future of video games, readers will find here a diverse collection of cutting-edge science journalism. ***Houghton Mifflin, 2007, 300 p., paperback, $14.00.***



VITAL SIGNS 2007–2008

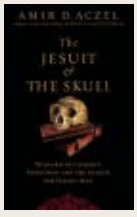
THE WORLDWATCH INSTITUTE

Produced annually by the Worldwatch Institute, the Vital Signs series highlights critical developments affecting the present and future of Planet Earth. This year's guide focuses on 44 trends that are having enormous impact on the world's resources, people, and environment. Some of the trends, such as the rapid consumption of natural resources, climate change, and the continued prevalence of HIV/AIDS, are broad in impact. Others, such as increases in child labor, apply primarily to certain groups. Among the newer findings is a disturbing drop in male reproductive health. Rates of testicular cancer are up, and sperm production is down. The news is not all bad, however. Nuclear-weapons production is on the decline, and the use of alternative fuels is rising. Literacy rates are rising. The book provides a thought-provoking look at the state of the world and the actions needed to sustain it. ***W.W. Norton & Co., 2007, 166 p., b&w photos, paperback, $18.95.***

THE JESUIT AND THE SKULL: Teilhard de Chardin, Evolution, and the Search for Peking Man

AMIR D. ACZEL

As the battle between the proponents of evolution and of intelligent design rages on, Aczel examines the earliest days of the controversy. The 1929 discovery of a skull of *Homo erectus* in a cave in China provided a much-sought link between humanity's ancient ancestor and modern *Homo sapiens*. The fossil, which became known as the Peking Man, could well have produced an internal conflict for Pierre Teilhard de Chardin, one of the paleontologists who discovered the skull, who was a Jesuit priest. Teilhard, however, did not believe that his religious beliefs should preclude the scientific study of human evolution. Aczel covers Teilhard's writings on science and religion, the Catholic Church's attempt to suppress his work, and the disappearance of the Peking Man fossils during the Japanese occupation of China. Finally, Aczel examines the proliferation of the fossil record and what post–Peking Man fossil discoveries can tell us about human origins. ***Riverhead, 2007, 288 p., hardcover, $24.95.***



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LETTERS

Well, read

Margit L. Bleecker appears to have discovered that those who score highly on reading tests also score highly on tests of memory, attention, and concentration ("How reading may protect the brain," *SN: 8/18/07, p. 110*). I don't find that highly surprising.

IVAN MANN, HOOVER, ALA.

How it happened stance

"Alien Pizza, Anyone?" (*SN: 8/18/07, p. 107*) reviews efforts to explain why certain biological molecules tend to be all right-handed (e.g., sugars) or left-handed (e.g., amino acids). An explanation might lie in the evolution of enzymes involved in their synthesis. For example, the fact that some organisms produce predominantly d-alanine could be explained by random mutations for the opposite enzyme rather than a modification of some physical molecular-pairing mechanism.

JOHN E. MORRIS, CORVALLIS, ORE.

Road worries

The research described in "Road Bumps: Why dirt roads develop a washboard surface" (*SN: 8/18/07, p. 102*) draws sound conclusions. However, the context suggests the tests were done at constant speeds. I submit there is yet another cause. It has been my observation that washboarding occurs initially and primarily at areas where there is acceleration, such as coming out of curves and starting up inclines.

DON BUELKE, VICTOR, MONT.

It's unfortunate that researchers don't look for previous studies before duplicating efforts of others. In January 1963, a *Scientific American* article describes the controlled experiments done by Dr. Keith B. Mather, using a powered turntable, which resulted in identical conclusions.

DAVID A. COATS, MINNEAPOLIS, MINN.

The authors do not seem to have any real-world experience driving on dirt roads. I can attest that it is almost solely the materials that make up the road that determine whether or not it will develop washboards. Loose materials create washboard roads. Too much sand and gravel, without the appropriate amount of clay, or glue, and you get washboards.

DAVID T. ALLEN, PAGE, ARIZ.

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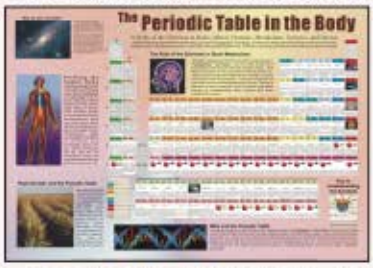
The Periodic Table in the Body, 2007



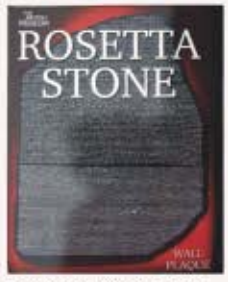
The Periodic Table in the Body - Poster discusses each of the elements on the Periodic Table in relation to how the body uses them. There are five sections to this periodic table poster. One section examines why we are indeed "star stuff" and our chemical ties to the universe; others profile the chemical makeup of the human body, plant growth, DNA, and the role of the elements in brain metabolism. Full color, laminated, 2cd Edition, 28"W X 38"H poster, Copyright 2007.....#JPT-4191.... Cost $28.95, Special: 2 for $50.

Carl Sagan's Cosmic Calendar

Carl Sagan's Cosmic Calendar Poster - This poster graphically portrays Carl Sagan's idea of a Cosmic Year, from the Big Bang - at the stroke of midnight, January 1, to the present. The first eleven months are presented on a concise time line. The month of December appears as a standard calendar grid, which encompasses the whole of human history. It is colorful and intriguing. Size: 24"WX 36" L Comes Laminated, Order # JPT-19447, Cost: $16.95

Egyptian Scribe Replica

Egyptian Scribe Replica - This replica is of a scribe that lived during the reign of Hatshepsut (Dynasty 18). His name was Amenemhat. The scribe comes with information and is cast in resin. Size: 4"D X 4"W X 6"H. Order #JPT-scribe, Cost: $45



Rosetta Stone Wall Plaque - Replica
Size: 12 3/8" X 10 5/8"
JPT-Rosetta, Cost: $85

14K Sunburst with Jade Accent
Gorgeous 14K Sunburst with jade accent measures 1" diameter. Jade accent measures about 3/8" diameter. Comes with gold chain, information and a crushed black velvet jewelry box. Order #JPT-10334, Cost: $325

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The Grand ***World Rock and Gem Collection - New!*** This very attractive oak display case contains 100specimens. It comes with information, *ready for wall hanging*, and is perfect for anyone fascinated by the earth sciences. Size: 20 1/2" L X 14 1/2" W X 2 1/4"D with ***plexiglass slide in groove*** cover. Weighs: 5 lbs. Contains: kimberlite (diamond pipe), anorthosite (crust of the moon), andesite (commonly found on Mars), jade, amethyst, lapis, tephra, fulgurite, meteorite, manganese nodule, and much more! Information sheet discusses igneous, sedimentary, or metamorphic properties. *Just what the teacher wants! Everything you would expect in a world -class collection!* Order#JPT-78131, Cost $265

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New! Mesopotamian *Legal* Tablet Our other ads featured the *Medical Tablet* - This is a Legal Tablet, Size 4 1/4"L X 2 1/2" W, Replica, Dates 1860 B.C.E. Comes with information and stand Order # JPT-legal, Cost: $65; Sumerian Medical Tablet, Order #JPT-sumer; Cost: $69.95

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