SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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Cover As voters and election officials grapple with new technologies, such as these touch-screen voting machines in Cook County, Ill., scientists are uncovering evidence of flaws in some of the latest gadgetry and seeking ways to improve voting systems. (Getty Images) Page 298

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Worthless Waters

By midcentury, seas' value may be drained

The biological riches of the oceans will be spent within decades if current trends continue. A global analysis of marine ecology predicts that wild seafood will effectively disappear by midcentury.

"People have fished for as long as we've dwelled on the planet," says study leader Boris Worm. "Within our lifetime, it's going to be over."

Worm, a marine biologist at Dalhousie University in Halifax, Nova Scotia, and an international team of scientists examined data from dozens of localized studies of changes in marine biodiversity. In aggregate, the studies offer a panoramic view of how ecosystems respond to species depletion. The researchers also considered whether species have recovered in places where people discontinued fishing.

In one data set after another, the researchers found that each loss of biodiversity—for example, the disappearances of gray whales, dolphins, and salmon from the North Sea, or the collapse of cod populations in Massachusetts Bay—increased the likelihood of subsequent losses and cut the odds of ecological recovery.

Possible countermeasures to fish declines include setting off new areas as marine reserves and altering management of unsustainable fisheries and destructive coastal activities. Marine reserves and fisheries closures increase species diversity by an average of 23 percent, Worm and his team find.

The researchers report their findings in the Nov. 3 *Science*.

Projected into the future, the trends suggest that by 2048, catches of all marine organisms will fall to less than 10 percent of their historic highs.

Worm says that he came up with that estimate by crunching data on his laptop computer as he proctored a student examination at his university. He was stunned. Disbelieving his computer, he redid the math by hand and confirmed the result.

"Those students I was overseeing ... they'll see the end of seafood," says Worm.

The year 2048, he says, offers "a very tangible deadline of when we're going to hit the bottom of the barrel."

"My guess is it will happen sooner than that," says Elliott A. Norse, president of the Marine Conservation Biology Institute in Bellevue, Wash. By relying on simple extrapolation, the new study has underestimated the immediacy of the threat, he says. It doesn't account for China's exploding demand for seafood, for example, or for the impact of climate change on oceans.

The new study is still impressive, Norse says, because it "carefully quantifies and confirms what a lot of smart people ... have been saying for a long time."

The oceans provide valuable "ecosystem services" other than food, says Jane Lubchenco, a marine ecologist at Oregon State University in Corvallis. These include recycling sewage into usable nutrients and fostering marine ecotourism. Moreover, coral reefs, mangroves, and other features of healthy oceans and coasts protect people from tsunamis and hurricanes.

"Loss of species diversity is detrimental to [those] human interests," Lubchenco says.

Despite the bleak new finding, says Norse, "there is an uplifting message here: If we exercise restraint ... and start treating our Earth as if our lives depend on it, we're going to be OK. It is not 2048 or 2040. We still have some time." —B. HARDER

A. GUR

CODE ORANGE People will soon extract the final drops of biological value from the oceans. A study predicts that wild seafood will drop off the menu by 2048.

A Swarm of Umbrellas vs. Global Warming

Astronomer thinks small to save Earth

Some wives ask their husbands to take out the garbage. Roger Angel's wife asked him to get rid of global warming.

Prompted by her plea, Angel, an astronomer and acclaimed telescope-mirror designer at the University of Arizona in Tucson, began pursuing a space-based solution.

In the plan he came up with, a trillion miniature spacecraft, each about a gram in mass and carrying a half-meter-diameter sunshade, would shield Earth.

This cloud of sun-orbiting flyers, about 1.5 million kilometers from Earth and stretching over a distance of about 100,000 km, would act as a mostly transparent umbrella for the entire planet.

The cloud would reduce by 1.8 percent the amount of sunlight reaching Earth, and that shading would significantly cut global warming, Angel calculates. He describes his ambitious plan, which he says could be deployed in about 25 years at a cost of several trillion dollars, in an upcoming *Proceedings of the National Academy of Sciences*.

Previous schemes to reduce the sunlight reaching Earth had required far heavier craft with larger shades. Such vehicles

would have to be built in space from lunar material or asteroids.

In contrast, Angel's proposed flyers, which include shades made of transparent film and riddled with holes, can be built and assembled on Earth, he asserts.

Rather than requiring rocket fuel, which could further contribute to global warming, the flyers would be accelerated into space by a large magnetic field applied along 2,000-m-long tracks. With each such launch sending out 800,000 flyers, the project would require 20 million launches over a decade.

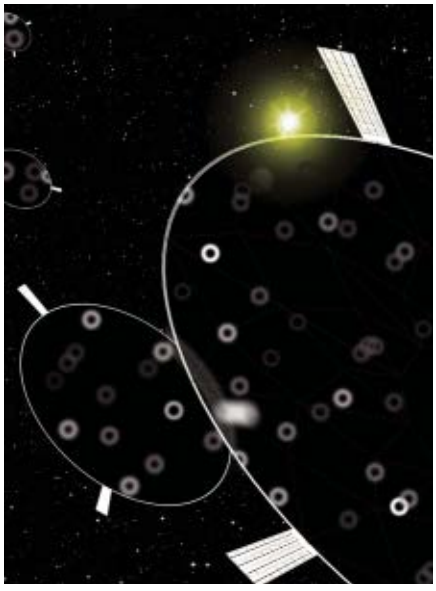
The flyers would rely on ion propulsion to reach their destination—a position between the sun and Earth in which the craft would take the same amount of time to orbit the sun as Earth does. They would then maintain a fixed position relative to Earth and shade it for about 50 years.

The flyers would need to continuously modify their trajectories. The pressure of sunlight on a trio of tiltable solar reflectors, embedded with electronics, would automatically redirect each craft, keeping the cloud intact or dispersing it as needed.

Several scientists say that there are less-expensive and easier ways to reduce global warming. Aluminized Mylar stretched across the ground or white paint covering large areas to reflect visible light from Earth into space "would be vastly cheaper," says astronomer Webster Cash of the University of Colorado at Boulder.

"It makes much more economic sense to find ways to address the climate problem directly by reducing the pollution that causes it," says climatologist James Hansen, director of NASA's Goddard Institute for Space Studies in New York City.

No word has come yet on what Angel's wife thinks. —R. COWEN



COOLING CONCEPT Miniature flyers made of transparent film would deflect sunlight from Earth. Three solar-reflecting tabs on each flyer direct its course. This illustration shows background starlight blurred into doughnuts by the film.

ANGEL, T. CONNORS/UNIV. ARIZONA

Helping Hands

Brief rehab method aids arm activity after stroke

Stroke survivors who have difficulty using an arm or a hand experience lasting mobility gains after completing an unusual 2-week rehabilitation program, a new study finds.

Constraint-induced movement therapy (CIMT) exercises a weakened limb repetitively while restraining the better-functioning limb with either a sling or a mitt for much of the day.

Among patients who had had strokes within the previous 3 to 9 months, 2 weeks of clinician-supervised CIMT produced more mobility in their stroke-weakened arms over the ensuing year than standard rehabilitation approaches did, reports a team led by neuroscientist Steven L. Wolf of Emory University School of Medicine in Atlanta. Wolf and his coworkers present their findings in the Nov. 1 *Journal of the American Medical Association*.

"CIMT should be considered as a valuable form of rehabilitation for stroke patients who have lost arm function," Wolf says. He estimates that as many as 30 percent of stroke survivors can benefit from this intervention.

In the United States each year, about 566,000 people experience arm or hand impairments due to stroke-related brain damage. For most, these mobility difficulties last at least 3 months.

The researchers randomly assigned 222 stroke patients, recruited from seven hospitals across the country, to receive either CIMT or standard care, which ranged from no treatment to various occupational and physical therapies.

Over 2 weeks, each CIMT participant wore a mitt on his or her less-affected hand for most waking hours. On each weekday, the person received up to 6 hours of training in using the stroke-impaired hand and arm to perform basic tasks, such as writing and eating.

Wolf's team evaluated each patient immediately after the assigned treatment, and again 4, 8, and 12 months later. During those assessments, patients performed tasks designed to measure arm and hand dexterity and described how well and how often they used their impaired limbs in daily activities. Of the initial participants, 169 completed 12-month evaluations.

Mobility in the affected arm and hand improved for both groups. However, the CIMT participants displayed substantially greater advances immediately after treatment than the standard-care group did, the scientists say. Mobility advantages for the CIMT group over the other participants increased steadily during the next year.

Study coauthor Edward Taub of the University of Alabama in Birmingham had previously directed brain-imaging studies in small groups of stroke patients and in monkeys with experimentally severed arm nerves. The findings indicated that CIMT stimulates brain reorganization that fosters arm rehabilitation. In the 1980s, animal rights activists succeeded in halting Taub's work with monkeys.

STATS

566,000

Yearly number of U.S. stroke patients who lose arm or hand mobility

The new investigation underscores the value of the initial monkey research, says neurologist John R. Marler of the National Institute of Neurological Disorders and Stroke in Bethesda, Md. Wolf's study "shows that it's possible to harness the remarkable plasticity in the brain to improve the lives of stroke patients," Marler remarks. —B. BOWER

Dribble Quibble

Experiments find that new basketball gets slick

A dispute in professional basketball about a new ball has bounced its way into a physics lab. A study launched last month at the University of Texas at Arlington compares a controversial plastic ball introduced in preseason games this summer by the National Basketball Association (NBA) with the previous standard—a leather-covered ball. The official basketball season, the first in which the new ball will be used, began this week.

So far, the Texas experiments indicate that the new ball bounces less elastically, veers more when it bounces, and becomes more slippery when damp than does the official leather ball of the past 35 years.

Many NBA players have griped about the new ball since teams began using it.

"The most significant finding is the slickness of the ball," says University of Texas physicist James L. Horwitz. He, physicist Kaushik De, and their colleagues gauged friction for both new and old balls

by sliding each along sheets of silicon. That material's coefficient of friction is approximately that of the human palm, the scientists say.

The plastic balls, when dry, resisted sliding much more strongly than their leather counterparts did. Yet a single drop of a commercial eyewash, chosen to simulate sweat, slashed the plastic ball's coefficient of friction by 55 percent, the scientists claim. In contrast, leather balls gradually increased their friction coefficients when wetted—to a maximum of about 130 percent of the figure for a dry leather ball.

"When the balls are dry, the synthetic ball is easier to grip, and when they're wet, the leather one is much easier to grip," Horwitz says. The scientists also found that leather balls absorb moisture about eight times as fast as the plastic balls do.

M. SOSEBEE/UNIV. TEXAS ARLINGTON

AIR BALL A plastic basketball that's now the official ball of the National Basketball Association undergoes wind tunnel testing.

Spalding, the Springfield, Mass., manufacturer of both the new and old balls, claims that its tests throughout the design process produced different results. "The new composite [plastic] balls' coefficient of friction outperformed the leather balls' coefficient of friction in both wet and dry conditions," says mechanical engineer Ron Laliberty, Spalding's director of new-product development.

John J. Fontanella, a former college basketball player and now a physicist at the United States Naval Academy in Annapolis, Md., calls the Texas work "impressive."

"The NBA should stick with the leather basketball for another year," he advises. That would give the manufacturer time to develop a better plastic cover material. A new book by Fontanella on basketball physics comes out this month.

The Texas researchers are doing their study—for free—at the behest of Mark Cuban, owner of the Dallas Mavericks, an NBA team. He posted the preliminary test results online on Oct. 27 (*http://www.blogmaverick.com/2006/10/27/nba-balls/*).

In response to the findings, Cuban says that remedial steps are needed. These include frequent ball changes during games and perhaps a redesign of the cover once the current season ends. —P. WEISS

L'Chaim

Wine compound lengthens mouse lives

A chemical famous as a constituent of red wine appears to increase the life spans and boost the well-being of mice that haven't followed the healthiest of lifestyles, according to new research. The finding marks the first time that the compound, known as resveratrol, has shown life-lengthening benefits in a mammal.

In 2003, David Sinclair of Harvard Medical School in Boston and his colleagues reported that yeast dosed with resveratrol lived 60 percent longer than yeast that didn't receive the compound. Since then, his team and other researchers have discovered that this molecule can increase life span to varying extents in other organisms, including worms, flies, and fish.

Some studies have suggested that resveratrol works by activating the same genes that are turned on when an animal eats a severely limited number of calories, a method that's been shown to lengthen the lives of several types of organisms, including mammals.

To see whether feeding resveratrol to mammals would extend their lives, Sinclair and his colleagues provided daily doses of the compound to middle-aged mice being fed an extremely unhealthy diet. Fat contributed a whopping 60 percent of the calories in their chow. The researchers compared these animals with other middle-aged mice that received no resveratrol while eating either the high fat diet or a standard diet of healthy mouse chow.

The mice on the standard diet remained slim, and both groups on the high-fat diet quickly packed on the grams. However, while high fat–diet rodents not fed resveratrol soon died from obesity-related diseases, such as diabetes and heart disease, obese mice in the resveratrol-fed group remained as healthy as those on the standard diet.

Some mice are still living, so the researchers haven't yet calculated how much the compound extended life span. However, Sinclair notes, the team estimates about a 15 percent boost in life span, bringing the resveratrol-supplemented animals' lives in line with those of animals on the healthy diet.

As animals in each group died, pathologists examined their hearts and livers. The organs from the mice that had received resveratrol looked healthier than those of the other groups, the researchers say. Moreover, while the obese animals that weren't fed resveratrol quickly lost motor skills as they aged, those fed the supplement continued to perform just as well as the slim mice did.

"The mice fed resveratrol have not been just living longer. They are also living more active, better lives," says Sinclair. He and his team report the results online Nov. 1 for an upcoming *Nature*.

Another researcher of aging, Peter Rabinovitch of the University of Washington in Seattle, notes that adjusted for the size differences, the amount of resveratrol fed to these mice far surpasses what a person would get from imbibing red wine. "It's something like 300 glasses of red wine a day, which is beyond life threatening," he says.

However, researchers may eventually develop a drug that works even better than the natural molecule, he says, so a pill could confer life- and health-extending benefits. —C. BROWNLEE

QUOTE

"The mice … are also living more active, better lives."
DAVID SINCLAIR, Harvard Medical School

Flow West, Young River

Ancient Amazon ran opposite today's route

The forerunner of the mighty Amazon ran from east to west, a new analysis of rocks laid down by that ancient river suggests.

About one-fifth of all the fresh water that reaches the world's oceans today does so via the Amazon. That river now flows eastward from the Andes for more than 6,000 kilometers, notes Russell W. Mapes, a geologist at the University of North Carolina at Chapel Hill. But that wasn't always the case, Mapes and his colleagues reported last week in Philadelphia at a meeting of the Geological Society of America.

The evidence for the river's flow reversal lies within rocks deposited as sediment by the proto-Amazon when dinosaurs still roamed Earth. The researchers looked at several mineral samples collected near Santarém, Brazil, about 650 km from where the Amazon flows into the Atlantic Ocean, and from a site near Manaus, another 600 km or so upstream.

Although the river laid down the material in those rocks about 85 million years ago, those rocks contain crystals called zircons that solidified about 2.1 billion years ago. The region's only source of rocks of that age lies in northeastern South America, from which the zircon would have had to travel westward to reach its current location, says Mapes.

The configurations of ripples preserved in the rocks at Santarém and Manaus bolster the notion that the ancient river flowed in that direction, he adds.

About 167 million years ago, the great southern continent called Gondwana began to break apart. As part of that process, eastern South America became a highland, the researchers speculate. Because the Andes didn't yet exist, the upheaval made South America tilt toward the west, and rivers ran in that direction.

Other scientists have used the age of zircons in the sandstones of Utah to show that North America once hosted a continent-crossing river system that flowed from east to west (*SN: 8/30/03, p. 131*). Many of those crystals had eroded from the Appalachians when those mountains were young, says Mapes. He notes, "The results of that study inspired us to do our [Amazon] research."

"It's neat to see that zircon analysis is proving things that previously you could only suspect," says Paul K. Link, a geologist at Idaho State University in Pocatello.

The site at Santarém probably sat about 500 km from the source of the proto-Amazon, says Mapes. However, because he and his colleagues haven't yet analyzed samples obtained farther west than Manaus, they can't tell how long or how large that ancient river was. —S. PERKINS

Rejuvenating Observatory

Green light given for space telescope repairs

After 3 years of uncertainty following the Columbia disaster, NASA this week gave the go-ahead for a shuttle mission to carry astronauts to refurbish the 16-year-old Hubble Space Telescope and to install new detectors that would vastly improve its capabilities.

"This is fantastic news," says Matt Mountain, director of the Space Telescope Science Institute in Baltimore. "We're getting a completely new telescope."

The shuttle flight, scheduled for mid-2008, would endow Hubble with the most sensitive ultraviolet spectrograph ever flown. The device is designed to trace the distribution of galaxies and intergalactic gas. The crew would also install an infrared camera to record galaxies even more distant than the ones Hubble can now image.

HUBBLE HURRAH Astronauts will repair parts and install new instruments on the Hubble Space Telescope during a newly announced mission, scheduled for 2008.

The crew would also revitalize the system for pointing the telescope, replace all six gyroscopes, and attempt to repair an imaging spectrograph that stopped working in 2004. NASA estimates that the $900 million mission would add 5 years to Hubble's life, extending it until 2013.

NASA Administrator Michael Griffin approved the flight, the fifth such mission to repair Hubble. Because of safety concerns about the shuttle, a second, rescue shuttle will be on the launch pad during the 2008 mission. —R. COWEN

Abated Breath

Serotonin problems may contribute to SIDS

Babies who die of sudden infant death syndrome usually appear to thrive right up to their last moments. It often seems as if the babies simply forgot to breathe.

Even autopsies have failed to reveal abnormalities associated with SIDS. However, a new study has found brain stem anomalies that may be at fault. They undermine the action of the chemical serotonin, which is critical to respiration, the researchers conclude.

Because the brain stem controls automatic functions such as breathing, problems within that structure have been considered culprits in SIDS. Previous studies found that babies who died of SIDS had fewer serotonin receptors in their brain stems than other babies did. The new study bolsters that finding and reports other abnormalities in the use of serotonin, notes David S. Paterson of Children's Hospital Boston.

In the new study, Paterson, Hannah C. Kinney, also of Children's Hospital, and their colleagues compared the brains of 31 infants who died of SIDS with those of 10 infants who had died suddenly of other causes. The scientists found that the babies who died of SIDS had as few as half as many serotonin receptors as the others did.

Surprisingly, the team also found that the neurons that produce serotonin were 30 percent to 50 percent more abundant in the babies that died of SIDS than in the other infants. Furthermore, in the babies that died of SIDS, each cell on average had fewer of the structures that recycle serotonin.

"There's no doubt to us that there is a problem with the serotonin system," Paterson says. He and his colleagues report the findings in the Nov. 1 *Journal of the American Medical Association.*

Today, researchers can detect such abnormalities only after an infant has died, but further work may lead to methods to determine which babies are at high risk of SIDS and, ultimately, to treatments for preventing it. Currently, doctors recommend preventive measures for all babies, including putting babies to sleep on their backs to ease breathing.

"This study makes it clear that infants who die with SIDS have many anomalies with serotonin function," says Jack L. Feldman of the University of California, Los Angeles. He cautions, however, that other brain-chemical systems have not been thoroughly studied and may play equally strong roles.

Ralph E. Fregosi of the University of Arizona in Tucson admires the new work but says that the significance of the reported anomalies isn't clear. The physical changes that the team found don't necessarily imply that those parts of the brain were working badly. "There's this hole in their beautiful anatomical data related to the function of the system," he says. —J. REHMEYER

NASA

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THE CANCER OF DORIAN GRAY

Is growing old an inescapable cost of averting malignancy?

BY BEN HARDER

Dorian Gray, the everlasting dandy of Oscar Wilde's novel, halted aging. Rather than his body growing old, his portrait suffered the insults of time. In recent years, biologists have created real-life Dorian Grays: mice that don't show certain signs of age. But in both the story and the lab, there were trade-offs. By remaining young, the fictional Dorian Gray became self-destructive. In the scientific plotline, the specially bred mice develop cancer and die young.

Scientists create such mice by inserting mutations in one of two important tumor-suppressing genes that mice and people share. The result has revealed a deep link between cancer and aging. Cancer depends on over-enthusiastic cell replication, whereas replication typically dwindles during aging. In a sense, according to the new findings, growing old is the flip side of fending off cancer.

"Aging itself may be part of the body's anticancer machinery," says Viktor Janzen, a hematologist-oncologist at the University of Tübingen in Germany. The trick in using that information against cancer or aging will be to uncouple one effect from the other.

In the nearer term, scientists may find new ways to minimize the side effects associated with chemotherapy and radiation exposure. In one strategy with that objective, they plan to temporarily neutralize one of the recently studied genes that controls cell replication.

The other gene in the studies may also have a near-term use. From measures of its activity, doctors might gauge a person's physiological age. That assessment of vitality might tell physicians how aggressively to test or treat a person's various ailments, says oncologist and cancer geneticist Norman Sharpless of the University of North Carolina in Chapel Hill.

A DUAL ROLE Recent experiments on one cancer-suppressing protein revealed that it's a "double-edged sword," says biologist Judith Campisi of the Lawrence Berkeley (Calif.) National Laboratory. "We thought p16 was an unequivocal good guy, but this protein can also shut down the proliferation of good cells."

Sharpless and his team created two strains of mice for use in several experiments. The strains differ in their production of the protein p16, also called $p16^{INK4a}$. The substance suppresses replication of cancerous cells. One of Sharpless' mouse strains has a mutation that inactivates the gene for p16, while the other has an extra bit of DNA that enhances the gene's activity.

Scientists had previously noted that p16 becomes more abundant with age in some types of mammalian tissue. The new experiments, reported in three papers in the Sept. 28 *Nature*, establish that p16 contributes directly to the age-related process called regenerative senescence, which gradually erodes cells' capacity to replicate.

Mammals and other long-lived organisms must continually replace cells in their tissues as existing ones wear out. "Declining proliferation is a cause of mammalian aging," says Sharpless.

In one new study, he and his colleagues examined how p16 affects the proliferation of insulin-producing islet cells, which reside in the pancreas. A shortage of islet cells is a cause of diabetes.

In normal mice, old age correlates with elevated p16 concentrations and reduced islet-cell proliferation. Mice engineered to have excess p16 have little islet-cell proliferation, even during youth, the researchers found. By contrast, in the p16-deficient strain, cell proliferation remains at a youthful level of activity into maturity.

Though the p16-deficient animals excelled at islet-cell replacement, they were prone to developing cancer. Their premature deaths made it difficult for the researchers to assess whether extra cell proliferation offered any benefit to the animals. So, they exposed the protein-deficient animals, as well as some normal mice, to a drug that kills islet cells.

> "We are not optimized for longevity and cancer suppression. We are just sort of a half-hearted compromise."
>
> — GERARD EVAN, UNIVERSITY OF CALIFORNIA, SAN FRANCISCO

The toxin caused mature, genetically normal mice to develop diabetes and die. In the p16-deficient strain, mature mice were more likely to recover.

In another set of experiments, Sean Morrison of the University of Michigan in Ann Arbor and his collaborators, including Sharpless, showed that p16 can reduce regenerative capacity in the mouse brain. For example, as mice aged, those that lacked p16 had smaller declines in neuron production in the olfactory bulb, which processes odors, than normal mice did.

A third study examined p16's effects on blood-producing stem cells in bone marrow. The research team was led by David Scadden of the Harvard Stem Cell Institute and included Sharpless and Janzen.

Transplants of bone marrow cells can reinstate blood-cell production in people who have leukemia. In general, the marrow's regenerative capacity declines with the donor's age, Janzen says.

The researchers repeatedly transplanted marrow cells from one mouse to another, waiting a few weeks between transplants to see whether the cells would proliferate in their new hosts. Among aged mice, mutants that had low p16 concentrations despite their age contributed stem cells that proliferated more readily than did those in mice with a normal gene for p16. It's as if the p16-defficient mice had marrow that was still young, Janzen says.

It makes sense that a single protein can have effects that both fight cancer and preserve cell regeneration, says neuroscientist Heidi Scrable of the University of Virginia School of Medicine in Charlottesville. Rapid cycles of cell division and growth are hallmarks of tumors, and sluggish cycles are characteristic of aged tissues.

P16 is "like a rheostat," Scrable says. "If you turn it down, you have decreased tumor suppression, but the replicative life span is extended."

Researchers continue to document the link between p16 and aging. For example, European researchers found that p16 was more than twice as abundant in skin cells from people 21 to 70 years old—and approximately seven times as abundant in cells from people over 70—as it was in cells of children and teenagers. In the October *Aging Cell*, researchers led by Meinhard Wlaschek of the University of Ulm in Germany conclude that "$p16^{INK4a}$ is a true and robust biomarker" of cellular aging.

According to Sharpless, "The most immediate clinical application [of the findings] is that someone could measure the p16 level of a patient and tell [his or her] biological age." Doctors could use such a "biomarker of age," he says, to identify patients who are most or least likely to benefit from tests such as colonoscopy and treatments such as chemotherapy.

Scientists are also thinking about drugs that they might derive from p16, though they're wary of the protein's opposing effects. "A drug that will keep the tumor-suppressor part of p16 active and turn it off in the stem cells [could potentially] preserve stem cell function without the risk of cancer," suggests Campisi.

Such a medication might "rescue the regenerative capacity" of old or damaged tissues, Janzen adds.

That may be wishful theorizing. "I think what we're going to show is there is an inextricable link between cancer and aging," Sharpless says.

DIVISIBLE FUNCTIONS While the two major functions of p16 may be inescapably intertwined, new research suggests that scientists might tease apart the dueling effects of another potent antitumor protein, p53.

Recent studies have linked p53 to regenerative senescence and aging. For example, a 2002 study found that although mice that generate excess p53 have low incidences of cancer, they have short life spans (*SN: 1/19/02, p. 47*).

Newer research raises the possibility that manipulating p53 might minimize the side effects of chemotherapy and radiation and permit doctors to administer more-potent treatments. "When we deliver heavy-duty chemotherapy, we could suppress p53 transiently so that toxicity is not so high," Campisi suggests.

Radiation and chemotherapy cause DNA damage, killing cancer cells but also potentially making other cells become cancerous. P53 guards against that hazard both by triggering cells that have been moderately damaged to stop multiplying and by prompting severely damaged cells to kill themselves. These effects contribute to the toxicity associated with chemotherapy and radiation.

In one study, cancer biologist Gerard Evan of the University of California, San Francisco and his colleagues treated mice with strong gamma rays. The mice had been engineered so that researchers could turn p53 production on and off at will.

In some of the animals, the scientists suppressed p53 throughout the study. In other animals, they turned it on for just 6 days either before or after the radiation.

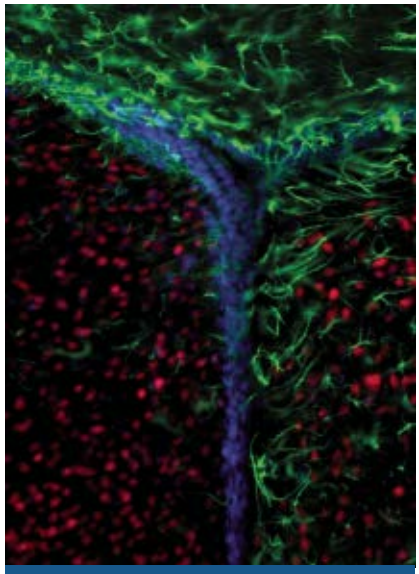
As the scientists expected, the animals that produced no p53 after receiving radiation developed lethal cancers. Mice in which p53 production occurred just before radiation exposure—so that they had high concentrations of the protein when they were irradiated—had severe side effects from the treatment, but the other mice didn't.

Having high concentration of p53 at the time of radiation exposure "makes the mice very sick," Sharpless says, but surprisingly, it "doesn't suppress cancer much." Scientists had assumed that the body's short-term, pathological reaction would protect the animals against later cancers.

Furthermore, in Evan's experiment, restoring p53 production after radiation exposure protected most mice from the gamma rays' immediate toxicity and against later cancer. The protein accomplished the trick by killing radiation-damaged cells days after the gamma-ray exposure, an activity that p16 doesn't share. Inhibition of cells' normal cycle of division and growth, which both proteins can affect, leads to the side effects but plays a negligible role in preventing cancer, Evan's team concludes in the Sept. 14 *Nature*.

A separate study in the same issue of *Nature* supports Evan's finding. Researchers led by Manuel Serrano of the Spanish National Cancer Research Center in Madrid tested a strain of mice that has an extra copy of the gene that makes p53. They found that the protein's anticancer effects depend primarily on biochemical reactions that are unrelated to the protein's response to DNA damage.

The idea of dialing down p53 in a person undergoing cancer treatment is appealing, says Anton Berns of the Netherlands Cancer Institute in Amsterdam. "If you could take away the toxic effects that p53 has on normal tissues, that might let you use a higher dose of radiation or [anticancer] drugs," he says.



DIVIDE AND CANCER — A slice of brain tissue from an adult mouse reveals neurons (red), astrocytes (green), and cell nuclei (blue), all of which regenerate less quickly with age, as a tumor-suppressing protein becomes more abundant.

MORRISON/HOWARD HUGHES MEDICAL INST., UNIV. MICHIGAN

REVISING EVOLUTION Evan suggests that p53's role in side effects and its lifesaving actions are linked not by an immutable law of biology but by coincidence. "We surmise that an evolutionary accident ... has cobbled together two things that don't need to be together," he says.

On a cellular level, the toxic side effects of radiation resemble the effects of aging, Evan and Sharpless note. "P53 is involved in pathological response to chemotherapy, radiation, and perhaps aging as well," Evan posits.

"We are not optimized for longevity and cancer suppression. We are just sort of a halfhearted compromise," Evan says. "It might be possible to manipulate our rather substandard evolutionary dowry ... to retain all the benefits of tumor suppression and yet dispense with all the downsides of having p53."

Conversely, researchers propose that rather than decreasing p53, they might increase the protein in a person to suppress tumors without compromising health in other ways.

"I have faith that we will find ways to ... suppress cancer to a large degree without causing accelerated aging," Campisi says. In fact, when Serrano's team recently increased p53 activity in mice, the scientists saw successful suppression of tumors but none of the cellular signs of aging.

"While those mice don't seem to live longer, at least they're not aging faster," Campisi comments. Several groups are working on a way to control p53 activity in people. In the September *Nature Chemical Biology*, molecular geneticist Andrei Gudkov of the Cleveland Clinic in Ohio and his colleagues describe a molecule that in mice temporarily inhibits the protein and in people might prevent radiation-related side effects.

The same sort of p53-blocking compound, taken over months or years with intermittent breaks, might combat aging. Sharpless proposes, "Maybe once a month, you'd activate p53 for a few days and wipe out all your incipient cancers."

Would that put the ravages of time on hold, finally satisfying Dorian Gray? "It's going to be real hard to manipulate aging," Scrable says. "But we'll see. Scientists are clever." ■

BALLOT ROULETTE

Computer scientists and mathematicians look for better ways to vote

BY PETER WEISS

Two months ago, in primaries for governor and congressional and state legislative seats in Maryland, many trips to the polls became painful experiences. At hundreds of precincts in Montgomery County, for instance, new touch-screen voting machines sat useless for lack of plastic authorization cards needed to operate them. In many polling places, electronic poll books with lists of eligible voters froze or mistakenly claimed that new arrivals had already cast their ballots.

Maryland governor Robert L. Ehrlich Jr. has called for a return to paper ballots and is urging voters statewide to cast paper absentee ballots for next week's general election to avoid the computerized machines in polling places.

In Illinois in March, hundreds of precincts in Cook County reported difficulties with their electronic-voting systems. Snafus with electronic systems have also plagued contests this year in Iowa and Arkansas, not to mention the 2004 election, in which problems with electronic machines occurred in Ohio, North Carolina, Florida, and other states.

The technologies that underlie the U.S. voting system have undergone a huge change in the past 6 years. According to the Washington, D.C.–based Election Data Services, a company that tracks voting-machine trends, the percentage of citizens using computerized-voting machines has climbed from roughly 12 percent in 2000 to an expected 38 percent in this Tuesday's election.

Although the machines have gotten a bad rap, human foibles contributed to the recent problems, and the electronic systems are in some ways an improvement over older technology. But whether they are the best option remains to be seen, and the search for the most practical and secure voting technology goes on.

"Five to 10 years ago, computer scientists weren't paying attention" to the technology used in voting, notes computer scientist David A. Wagner of the University of California, Berkeley.

However, newly aware of the stakes, risks, and intellectual challenges associated with voting equipment, computer scientists and mathematicians specializing in encryption are now avidly taking part in the search for dependable and inviolable voting technology. These researchers are investigating existing systems, devising ways to improve them, and inventing entirely new approaches.

"In the long term, the goal is to … make a voting system that's more reliable and secure than what we have now or have ever had. I think that's a very feasible goal," says computer-security specialist Edward W. Felten of Princeton University.

OPEN SESAME The technological transformation now under way in polling places has its roots back in 2000. That's when the close and pivotal presidential vote in Florida focused national attention on voting-system flaws. Those flaws included technological ones, such as confusing ballot layouts and balky punch-card ballots (remember "butterfly ballots" and "hanging chads") that made many voters' intentions uncertain.

Identifying the 2000 election debacle as partly a technology failure, Congress in 2002 passed the Help America Vote Act (HAVA), which pledged $3.9 billion to the states for modern voting equipment, voter education, and other election reforms. Under HAVA, many electoral districts across the country have purchased electronic-voting machines to replace punch-card equipment and mechanical voting machines. The electronic machines typically either scan a paper ballot that was marked by hand or record voters' selections made by means of buttons, a dial, or a touch screen.

The latter class of devices, known as direct-recording-electronic (DRE) machines, is the newer of the two electronic approaches and the one that's attracted the most criticism for reliability problems. But operational breakdowns aren't the only cause for concern. Several analyses dating back to 2003 have identified security vulnerabilities in DREs that could allow an attacker to secretly alter vote tallies or disrupt polling. Because the machines weren't designed to produce a paper record of votes, many voting activists have fretted that a recount after a security breach would be impossible. In the past 3 years, however, more than 20 states have adopted rules requiring that DREs print a record of each person's vote.

> "Five to 10 years ago, computer scientists weren't paying attention" to the technology used in voting.
>
> — DAVID A. WAGNER, UNIVERSITY OF CALIFORNIA, BERKLEY

Except for their voting software and a few other modifications, DREs differ little from everyday personal computers. Researchers familiar with the vulnerabilities of ordinary computers say they've found insecure aspects of touch-screen voting machines made by Diebold Election Systems of Allen, Texas. The company's DREs will be the most widely used electronic machines in this Tuesday's contests. Investigators have uncovered evidence, for instance, of inadequate protections of vote tallies and other data, opportunities for tampering with authorization cards or other features of the system, and easy-to-defeat physical barriers, such as locks and cladding that covers critical hardware.

A 2003 security analysis of DREs made by the top four vendors—Diebold, Election Systems and Software, Hart InterCivic, and Sequoia Voting Systems—found security flaws in all the machines reviewed. Compuware Corp. of Detroit conducted that study for Ohio.

In one of the most recent studies of Diebold machines, a team of Princeton University computer security experts installed a computer program that boosts the tally of one candidate at the expense

of his or her opponents. The researchers introduced the vote-stealing software into a machine in their lab by means of a memory card that polling officials routinely insert and remove during their duties. Because poll workers using the Diebold machines monitor only the total number of people voting—which the tampering doesn't alter—the monkey business could go undetected, Felten says.

In the same study, Felten, Ariel J. Feldman, and J. Alex Halderman, all of Princeton, made a computer virus that can reside on the memory card, install itself along with the vote-stealing software in whatever machine the card is inserted into, and then later infect any new, uninfected memory card that gets plugged in. "Because cards are transferred between machines during vote counting and administrative activities, the infected population will grow over time," the team reports in a preprint, made available on the Internet (*http://itpolicy.princeton.edu/voting/*).

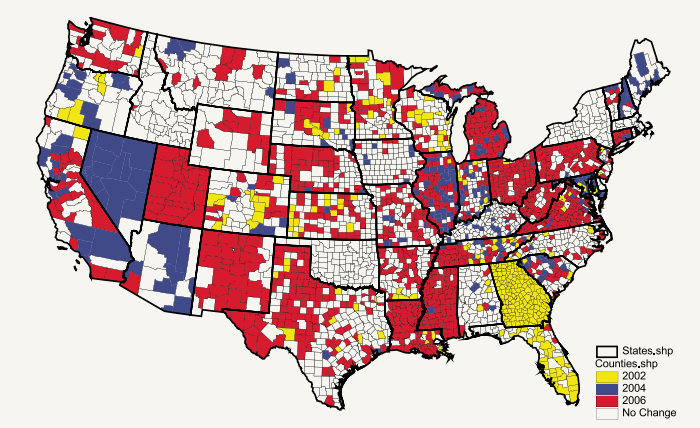
While the possibility of a voting machine virus had been hypothesized by other researchers, the new study shows that the threat is real, comments computer scientist Douglas W. Jones of the University of Iowa in Iowa City. "It's a demonstration that needed doing," he adds.

The Princeton findings—and those of previous analyses of Diebold machines—may have implications for other brands of DREs, Felten says. "Similar products designed against similar engineering problems tend to fail in similar ways," he says.

Fortunately, there's no firm evidence so far that hackers or other miscreants have exploited the vulnerabilities that computer scientists have identified.

Representatives of Diebold, one of the vendors most under fire for security weaknesses, contend that the company has tightened security of its machines in response to earlier findings. However, director of marketing Mark Radke dismisses the new Princeton report as "unrealistic and inaccurate." Additional protections given the machines by election districts, but downplayed in the report—such as physically sealing card slots and election officials' keeping an eye on machines—would prevent the kind of tampering described in the study, he contends.

Diebold also points to a 2005 academic study indicating that DREs, compared with older methods, substantially reduce numbers of spoiled ballots that can't be counted (*vote.caltech.edu/media/documents/wps/ vtp_wp25.pdf*).



FLECKS OF FLUX — Change in voting technology has swept the United States since 2000, albeit unevenly. Counties shown in yellow switched to new voting equipment in 2002, blue in 2004, and red in 2006. Counties in white have not changed.

BRAINSTORMS While some researchers probe for flaws in specific voting machines, others are tinkering with ways to make electronic voting work better.

At a voting-technology meeting in Vancouver, British Columbia in August, a research team including Wagner suggested a way to reduce the complexity of the programs used in touch-screen devices. These simpler computer-based voting systems would be more reliable and easier to scrutinize for tampering than those used today, Wagner says.

In conventional DREs, the computer tailors the ballot on its screen to each voter according to, say, that person's party affiliation in a primary or to special needs such as a foreign language.

In the new proposal, Wagner and his colleagues suggest a different procedure in which election officials mock up in advance all the possible ballot screens, including where a voter's finger will need to touch to register a choice. On Election Day, the computerized voting machine simply displays the screens and records voters' responses.

"The trick is, we do all the heavy lifting before the election," Wagner says.

The team's prototype user interface required a mere 293 lines of programming instructions. By contrast, the Diebold AccuVote TS machine contains some 14,000 lines of user-interface code, although that software includes an audio interface for visually impaired voters and other functions not present in the prototype, acknowledge Wagner, Ka-Ping Yee, and Marti Hearst, all of the University of California, Berkeley, and Steven M. Bellovin of Columbia University.

Thinking outside the box of the electronic-voting machine itself, another team at the Vancouver meeting proposed a simple way to boost security of an election district's central computers.

Election administrators typically upload tallies from those computers to the Web for the public to see, notes Iowa's Jones. That practice may open them to attack from computer hackers prowling cyberspace. "If [attackers] infiltrated your system and put in software that can be switched on and off somehow, [incoming] messages as simple as 1 bit are a threat," Jones notes.

With just $20 worth of electronic parts, Jones and Tom C. Bowersox, an Iowa computer science undergraduate, created a device that halts any such incoming messages, allowing data to flow only from the secure election computers to the outside.

Their invention is a takeoff on a one-way valve called a data diode, which typically keeps data from flowing out of a secure computing system.

"Security [of computer systems] is complicated, and usually you wait until you get burned," says Jones. "I don't want to get burned on democracy."

FROM THE CRYPT Taking another, very different, approach to modern election problems, a small cadre of scientists has been researching novel balloting schemes that rely primarily on clever math. In the past couple years, several teams have devised ways to combine the high-level formulas of cryptography with paper ballots.

Unlike voting systems in use today, these schemes would give voters a way to check that their votes were recorded as marked. They would also provide observers—such as political parties and voting-advocacy groups—a means to test the accuracy of the vote tallying as it takes place, all without violating voter privacy, says computer scientist Ben Adida of Harvard University.

He and Ronald L. Rivest of the Massachusetts Institute of Technology (MIT) recently devised one such cryptographic voting approach, called Scratch & Vote. Adida presented the new scheme at an Oct. 30 conference called "Workshop on Privacy in the Electronic Society."

Scratch & Vote and some new cryptographic approaches like it use a perforated ballot with voting boxes on one half and candidates' names—printed in varying order from ballot to ballot—on the other. After marking a ballot, each voter detaches and shreds the portion with the printed candidate names. The voter then feeds the marked portion, which includes an encrypted version of the names and their order, through an optical scanner to record the vote in the election system. That portion, which the

ELECTION DATA SERVICES

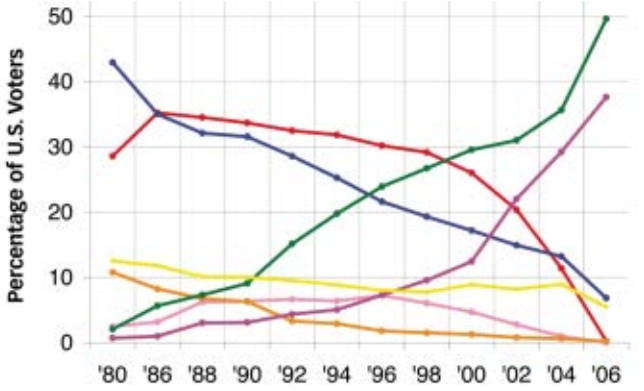
voter keeps as a paper receipt, doesn't reveal the voter's choices but does provide an indelible record of the voter's ballot.

A major issue for cryptographic schemes is that the encrypted information must truly represent the order of selections on a given ballot, Adida notes. That's where the scratch part of his and Rivest's scheme comes in. Each ballot has a scratch foil like that of a lottery ticket, which voters can scrape away to verify that the codes are correct.

After voting, citizens can also look on the election district's Web site and confirm that their ballots were scanned. Moreover, because all the encrypted votes are posted on the Web with no violation of their secrecy, outsiders have a way to independently perform tallies on the encrypted data, Adida explains.

Because the cryptographic systems are so transparent, they "achieve a class of verification that's really far superior to current systems," he says.

Another new cryptographic scheme, called Punchscan, uses scannable ballots with two separable layers that are marked by voters with ink daubers like those used in bingo games. Unlike Scratch & Vote, a Punchscan election would allow voters to keep either layer of the ballot while destroying the other. But neither half on its own includes enough information to reveal a voter's choices. Punchscan's inventors, who include independent cryptography consultant David Chaum, have created an interactive tutorial on the Web about the method (*http://punchscan.org/learnmore.php*).



OUT WITH THE OLD — Voting by punch cards (red line) and levers (blue line) has dropped sharply in recent years. In the meantime, the use of optical scanners (green line) and computerized devices (magenta line) such as touch screens has soared.

Computer scientists Stefan Popoveniuc and Ben Hosp, both of George Washington University in Washington, D.C., also posted a preprint of a scientific paper explaining the system on Sept. 3 on the same Web site.

Although most cryptographic schemes have remained within the small community of cryptography specialists, a Bellevue, Wash.–based company called VoteHere has developed a commercial device that connects to conventional voting machines such as DREs and prints encrypted vote receipts.

Still, cryptography remains out of the mainstream of voting technologies. That may change, however, given a recent push by cryptographers to redesign their systems and bring them to public attention.

If the effort succeeds, it would be in keeping with a broader trend since 2000 toward a sounder scientific foundation for voting technology.

Today, the California Institute of Technology and MIT run a joint institute devoted to voting technology. Other universities participate in ACCURATE, a research collaboration on the topic. For the past 2 years, the National Institute of Standards and Technology has been developing voting-technology guidelines and is now preparing a program to certify testing laboratories for voting equipment.

Although most voters may never decide how to vote by a process anyone might describe as scientific, the means by which votes are cast and counted may be heading in that direction. ■

ELECTION DATA SERVICES

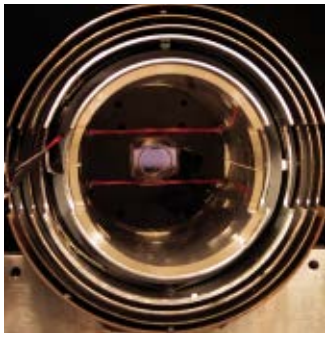
OF NOTE

PHYSICS

First teleportation between light and matter

Atoms tend to stay put, but light is always on the move. Physicists would like to exploit those qualities to make information-processing devices in which atoms store information and light shuttles it around (*SN: 4/3/99, p. 220*). In a step toward that goal, researchers have transmitted quantum states between atoms and light.

Such a transfer of properties is called teleportation. "This is the first case of successful teleportation between objects of a different nature"—namely, photons of energy and atoms of matter, says study coauthor Ignacio Cirac of the Max Planck Institute for Quantum Optics in Garching, Germany.



NIELS BOHR INSTITUTE

TELEPORTATION CHAMBER
During experiments conducted when this chamber was closed, quantum states leaped from a laser pulse to a cloud of cesium atoms like the pink one shown trapped in a glass tube.

In experiments since 1998, numerous teams of physicists have demonstrated teleportation of quantum states between objects of the same kind (*SN: 6/19/04, p. 387*). For instance, researchers have transferred the orientation of one photon's electromagnetic field—the light particle's polarization—to another photon.

In the new experiment, Cirac, Eugene S. Polzik of the Niels Bohr Institute in Copenhagen, and their colleagues teleported traits of a dim laser pulse, including the strength of its electromagnetic field, onto a cloud of 1 trillion cesium atoms.

To do so, the researchers first created a quantum-information bridge between a different, brilliant laser pulse and the atom cloud. That connection formed when the scientists fired the bright pulse through the cloud, causing the photons' polarizations to become correlated with the cloud's spin, another quantum trait.

In the language of quantum physics, the brilliant pulse and the atom cloud became "entangled." When objects are entangled, changes to the quantum state of one immediately affect the other, no matter how distant it is.

Once the researchers had achieved entanglement of the photons and atoms, they mixed the bright and dim pulses. A few further manipulations triggered the desired light-to-matter transfer of the quantum states, the scientists report in the Oct. 5 *Nature*. —P.W.

CHEMISTRY

Unnatural success

Chemists report the first synthesis of a promising antibiotic that other researchers recently discovered in nature. With the recipe in hand, scientists can pursue modifications that might make the compound more effective.

Earlier this year, a team from Merck Research Laboratories announced the discovery of platensimycin, a small molecule produced by the bacterium *Streptomyces platensis* (*SN: 5/20/06, p. 307*). Platensimycin killed certain drug-resistant pathogens by disrupting their synthesis of fatty acids.

After seeing that "exciting report," K. C. Nicolaou of Scripps Research Institute in La Jolla, Calif., says, he and his colleagues devised a strategy to synthesize the compound. The 16–step lab process builds the compound's two halves separately and then joins them.

The researchers describe their work in the Oct. 27 *Angewandte Chemie International Edition*.

Nicolaou's group is now working to improve the synthesis strategy and to modify the antibiotic. For instance, the Merck team had found that mice required a continuous infusion of the drug, an indication that the drug might break down too quickly to be effective in people. Nicolaou says that his team will try to develop longer-lasting forms of the compound. —A.C.

PLANETARY SCIENCE

Jovian storm grows stormier

Jupiter's Little Red Spot has become as strong as its big brother. The highest wind speeds in the smaller, more recent storm have reached 640 kilometers per hour, the same as those of the planet's long-observed Great Red Spot. Amy Simon-Miller of NASA's Goddard Space Flight Center in Greenbelt, Md., and her colleagues base their assessment on measurements that they took last April with the Hubble Space Telescope (*SN: 5/13/06, p. 293*). The researchers describe their findings in an upcoming *Icarus*.

The increased intensity of Red Jr. might have contributed to its color change, the team says. The storm was originally white but by early 2006 had taken on a ruddy hue. About the diameter of Earth, the Jovian hurricane arose 6 years ago from the successive mergers of three storms first spied in the 1930s. Observations of these storms by the Voyager 1 and 2 spacecraft in 1979, as well as the Galileo craft nearly 20 years later, revealed that the top wind speeds had held steady at about 460 km/hour.

Hubble is the only telescope sharp enough to measure wind speeds on Jupiter. However, astronomers won't use the telescope to make new measurements until early next year, when the planet moves farther from the sun's glare, Simon-Miller says. —R.C.

ASTRONOMY

Galactic spider

Mighty galaxies from little galaxies grow. That's the standard scenario for galaxy formation, and now astronomers have caught on-camera evidence of the process. A Hubble Space Telescope image has revealed the assembly of a large galaxy from dozens of smaller ones in the early universe.

Hubble zoomed in on the radio-emitting galaxy MRC 1138-262, which George Miley of Leiden Observatory in the Netherlands and his colleagues have now nicknamed "the spiderweb," for its complexity and clumpiness. The picture shows the small galaxies bunching together within the larger one, capturing an event that dates from just 3 billion years after the Big Bang.

The arrangement supports the bottom-up model, which holds that galaxies and galaxy clusters assemble from smaller building blocks. The MRC 1138-262 finding, which Miley's team describes in the Oct. 10 *Astrophysical Journal Letters*, also corroborates the idea that distant radio-emitting galaxies formed the giant galaxies seen at the centers of clusters in the cosmos today.

The data "show that mergers are likely a very important process in the formation of massive galaxies," comments Christopher Conselice of the University of Nottingham in England. "It also tells us when this process occurs." —R.C.

ADDICTION

Nicotine during rat youth primes brain for harder drugs

The addictive ingredient in those cigarettes in the schoolyard could prep the brain for reliance on illicit drugs, say researchers working with adolescent rats.

Previous studies have suggested that teenagers who smoke cigarettes are more likely to progress to drugs such as marijuana or cocaine than are teens who never smoke. However, researchers haven't directly tested whether cigarettes themselves might be responsible for this effect.

To investigate, Susan McQuown of the University of California, Irvine and her colleagues gave some 1-month-old rats multiple low-dose nicotine injections over 4 days. The amount of nicotine was the rat equivalent of a person smoking 4 cigarettes a day. Other rats received injections of saline.

The researchers then placed each animal in a box with several holes, one of which delivered a dose of cocaine when the rat poked its nose inside.

McQuown and her team discovered dramatic differences in how quickly the two groups picked up the cocaine habit. Within the first day in the box, half the rats that received nicotine were frequently self-administering cocaine. In contrast, only 20 percent of the animals that received saline took up the drug immediately.

Trying an identical experiment with sugar pellets instead of cocaine, the researchers saw no difference between the nicotine and saline groups. In a separate experiment with adult rats, animals that received nicotine were no more likely to take up cocaine than were adult rats that received saline.

These results suggest that nicotine "might change the wiring of the brain during adolescence," heightening the response to other addictive drugs, says McQuown. She and her colleagues plan to test whether the effects of receiving nicotine in youth persist into adulthood. —C.B.

BIOMEDICINE

Pain follows cycle

The rise and fall of estrogen during a female's menstrual cycle may change her perception of pain, according to an experiment on rats.

Studies have shown that women tend to report more-intense and longer-lasting pain than men do, but the reason for this difference hasn't been clear. Nicole Amador of the City University of New York and her colleagues suspected that female-sex hormones could make women more sensitive to pain.

To test their hypothesis, the researchers tracked the estrous cycle in adult female rats. It's analogous to a woman's menstrual cycle. On the same day, regardless of what part of the cycle the animals were experiencing, the scientists injected one of each animal's hind paws with a chemical that causes painful inflammation. Each rat was then monitored for an hour for signs of pain.

Amador and her colleagues found that the animals' responses differed depending on what phase of the estrous cycle they were in. Pain perception was consistently high in animals in the half of the cycle when estrogen concentrations were low. Pain seemed to be less intense to animals in the high-estrogen part of the cycle, which precedes ovulation.

The results suggest that estrogen might relieve pain, says Amador. She adds that if these results extend to people, doctors may eventually want to take women's menstrual phases into account when determining dosages for analgesic drugs. —C.B.

HEALTH

Insulin can protect diabetic brains

Staying on top of diabetes treatments may prevent some of the brain atrophy and cognitive deficits that typically accompany this disease, say researchers studying mice.

Previous research in people had shown that diabetes, whether diagnosed in youth or adulthood, can lead to learning and memory problems. Recently, some scientists demonstrated that the brains of diabetic patients gradually shrink and develop abnormalities in white matter, factors that may be responsible for cognitive deficits.

It's unknown whether these problems are inevitable consequences of diabetes or whether consistently treating the disease with insulin can prevent them, says Cory Toth of the University of Calgary in Canada. He and his colleagues looked into this question by testing mice with a form of diabetes.

Several weeks after the animals' disease was well established, the researchers started training those mice and non-diabetic ones to complete a variety of cognitive tasks—for example, to locate a platform in a pool of water or to find a treat hidden in a maze. Two weeks after these training sessions began, the researchers started giving some of the diabetic animals daily doses of insulin. Other diabetic mice received saline instead.

Several months after the training ceased, the saline-treated diabetic mice could no longer complete the cognitive tasks. But the insulin-treated animals and the healthy mice continued to perform well. When the scientists examined the diabetic animals' brains, they found that insulin appeared to have slowed the brain atrophy associated with the disease.

If future studies find that these results are relevant to people, Toth says, this information could give diabetic patients an additional reason to keep their disease under control. —C.B.

DEVELOPMENT

Mom's caffeine harms pups' brain cells

Rats born to mothers who drank caffeinated beverages throughout their pregnancies had abnormal brain-cell function, researchers report.

Experts already recommend that pregnant women limit their caffeine to 300 milligrams per day—about the amount in three cups of coffee. Although this moderate consumption is considered safe, Deborah Soellner and Joseph Núñez of Michigan State University in East Lansing wondered whether it could still have significant effects on youngsters' brains.

The researchers provided some pregnant rats with free access to caffeinated water. On average, the animals consumed 3 to 4 mg of caffeine daily, the equivalent of the recommended limit for pregnant women. Other pregnant rats received only plain water.

When the pups were born, the researchers took samples of cells from each baby's hypothalamus. Soellner and Núñez tested the cells' responses to various chemicals that brain cells use to communicate, such as the neurotransmitters gamma-aminobutyric acid and glutamate.

The scientists found that cells from the caffeine-exposed and caffeinefree pups behaved differently. The response in the caffeine-exposed pups was heightened for certain neurotransmitters but dampened for others. Since some of these signaling chemicals affect brain development, the researchers suggest that caffeine during pregnancy may affect children's later brain function.

"Maybe human studies on caffeine consumption during pregnancy should be reevaluated," Núñez says. —C.B.

Books

A selection of new and notable books of scientific interest

A YEAR IN THE LIFE OF THE UNIVERSE: A Seasonal Guide to Viewing the Cosmos

ROBERT GENDLER

From Earth, the view of the heavens changes from season to season. Gendler's lavishly illustrated guide is intended to help astronomy buffs recognize the most vivid and scientifically interesting sky objects throughout the year. Autumn and spring are best for viewing galaxies, winter is ideal for nebulae, and summer offers the best views of the Milky Way. The author, a physician and photographer whose images routinely appear in *Sky and Telescope* magazine, provides vivid images and abundant facts about more than 120 deep-sky objects. After a short introduction to basic astronomy, Gendler presents cosmic features according to season, beginning with the autumnal equinox and progressing through the solar year. For each object, he provides the name, location in the sky, and a brief paragraph detailing the object's classification and unusual features. ***Voyageur Press, 2006, 160 p., color images, hardcover, $24.95.***

THE COSMIC LANDSCAPE: String Theory and the Illusion of Intelligent Design

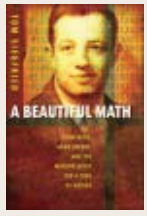
LEONARD SUSSKIND

Widely recognized as the father of string theory, Susskind tackles another idea that's so contentious that it has formed a rift within the physics community and beyond. Susskind's idea, known as the anthropic principle, states that the universe is uniquely structured to allow for the presence of intelligent life. But instead of ascribing this event to the agency of a supreme designer, he credits the universe's structure to an accident of mathematics. Here, Susskind outlines how the laws of physics have created a universe that provides the specific building blocks of life in a structure that's habitable. Finally, he argues that pocket universes, each containing its own set of physical laws and properties, probably exist. ***Little, Brown and Company, 2006, 404 p., b&w illus., hardcover, $24.95.***

A BEAUTIFUL MATH: John Nash, Game Theory, and the Modern Quest for a Code of Nature

TOM SIEGFRIED

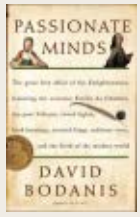
In the1950s, John Nash, a brilliant but mentally ill mathematician, published research on game theory and its real-life applications. Though his ideas caught on slowly, game theory is now an essential tool in fields as varied as economics, anthropology, and neuroscience. According to longtime science writer Siegfried, game theory may hold the key to unifying the life sciences and physical sciences. He details game theory's various applications, beginning with economic theory. The author reviews how game theory can describe behaviors such as altruism and cooperation, how games often have different outcomes depending upon the culture in which they are played, and how game theory can describe networks—from the U.S. power grid to the "six degrees of Kevin Bacon" parlor game. Overall, Siegfried reveals the remarkable flexibility of game theory. ***Joseph Henry Press, 2006, 264 p., hardcover, $27.95.***



PASSIONATE MINDS

DAVID BODANIS

In 18th-century France, the writer Voltaire married the woman who would become his intellectual and emotional soul mate, Émilie du Châtelet. In a time when women weren't formally educated, the 27-year-old du Châtelet displayed a remarkable intellect, expanding and modernizing Newton's ideas about the conservation of energy, the nature of light, and other scientific phenomena. Bodanis mines a wealth of letters, unpublished manuscripts, diaries, and other resources to shed light on this uniquely talented and passionate couple. Voltaire and du Châtelet championed the ideals of the Enlightenment, especially that women should enjoy equal standing with men in society. Du Châtelet's contributions to science were obscured following her death, primarily because many of her male contemporaries were unwilling to accept that such insight came from a woman. Bodanis' book attempts to right this wrong and, in so doing, details the life of a woman ahead of her time. ***Crown, 2006, 373 p., b&w plates, hardcover, $24.95.***



SKIN: A Natural History

NINA G. JABLONSKI

People glean much of what they know about the world through skin—the largest organ in, or perhaps one should say on, the human body: skin. Skin protects people from harmful environmental agents, bacteria, and ultraviolet rays. All the while, human skin remains permeable to some medications and enough sunlight to make vitamin D. The skin sweats to efficiently maintain body temperature. Aside from changing color in response to emotional states, skin comes in a multitude of natural shades, corresponding to the differences in sun exposure at various latitudes and serving, for better or worse, as a way for groups to identify their members. Anthropologist Jablonski delves into the natural history of skin in animals and people and explains its structure and function, its evolution as a nearly hairless body covering in people, and the utility of its pigment melanin. She also examines the role of skin in activities as varied as finding food and bonding socially. Finally, she looks at the prospects for artificial skin. ***Univ. Calif. Press, 2006, 266 p., color plates and b&w photos, hardcover, $24.95.***

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LETTERS

Twisted logic?

I have a question concerning "The Sun's Halo in 3-D" (*SN: 8/19/06, p. 120*). It says, "As the sun rotates, it polar regions make a complete circle in about 34 days, compared with the 25 days required by its equator." I was wondering how it's possible to have two points on a rotating body take different amounts of time to make a complete revolution.

MIKE CRAWFORD, SNOHOMISH, WASH.

The sun is a giant ball of gas, not a solid like a planet. Different points rotate at different rates, in a process called differential rotation. —R. COWEN

Dark secrets

I won't state that "dark matter" hasn't been discovered. However I disagree that empirical evidence for it is demonstrated in this collision ("Enlightened: Dark matter spotted after cosmic crash," *SN: 8/26/06, p. 131*). Other phenomena that could explain the images include excitation of preexisting gases or imaging artifacts. Nowhere in the article does it state that the mass of "dark matter" was actually observed passing unimpeded through the normal matter or other "dark matter."

SHAWN SIMPSON, ORLANDO, FLA.

Shakespeare on the clock

There is a serious limitation to the "print clock" technique ("Mutant Maps," *SN: 8/26/06, p. 136*) that can probably be addressed. The method proposed holds good only for works with small print runs (such as expensive maps), where the damage to the printing surface in successive printings is minor in comparison to deterioration over time. Damage to the printing surface in the same run has already been studied in the case of Shakespeare's early folio texts, and can be significant. If researchers combine the data for two very different physical processes—deterioration owing to pressure on surfaces and repeated use and deterioration over time—the results will gain a great deal of accuracy.

ANTHONY GUNERATNE, JACKSONVILLE, FLA.

Dust bust

I find it interesting that when we didn't find as much deuterium as we expected near the sun, we assumed it's hidden by dust ("Too Much Deuterium?" *SN: 9/9/06, p. 172*). But there didn't seem to be any real proof that it is indeed hidden by the dust. I am not convinced.

ERIC ADAMS, DELRAY BEACH, FLA.

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Deluxe Dinosaur Panorama Poster

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Earthrise over the Moon

Earthrise over the Moon - This poster represents the classic beauty of outer space! Size: 15.75" X 19.75" Comes Laminated, Order #JPT-5515, Cost: $15.95

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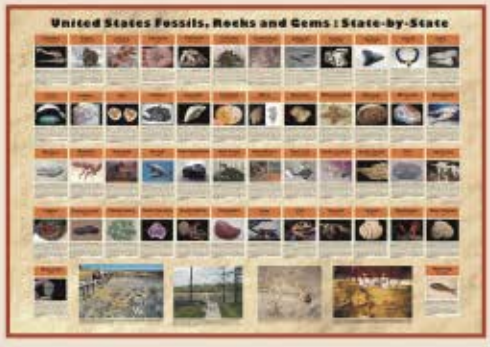
Egyptian Scribe Replica - This replica is of a scribe that lived during the reign of Hatshepsut (Dynasty 18). His name was Amenemhat. The scribe comes with information and is cast in resin. Size: 4"D X 4"W X 6"H. Order #JPT-scribe, Cost: $45

United State Fossils, Rocks and Gems State-by-State Poster - NEW!



United States Fossils, Rocks and Gems; State-by-State Poster - All 50 states shown with information and picture available for each. Features 54 images about state fossils, state gems, state stones / rocks, and minerals. Featured National Parks include: Clayton Lake State Park, New Mexico; Crater of Diamonds State Park, Arkansas; Dinosaur National Monument, Utah; and The Mammoth Site Museum, South Dakota. Information about many other national parks is included. Great in-color pictures with plenty of interesting description. This poster should be in every earth science classroom, national park gift shop, natural history museum, and science center. Size: 26" X 38" Laminated Order#JPT-8012, Cost: $28.95; 2 for $50

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"W X 36" L Comes Laminated, Order # JPT-19447, Cost: $16.95

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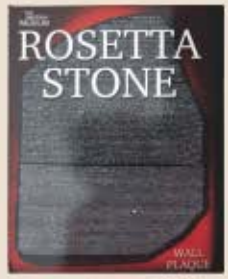
Gorgeous 14K Sunburst with jade accent measures 1" diameter. Jade accent measures about 3/8" diameter. Comes with gold chain, information and a crushed black velvet jewelry box. Order #JPT-10334, Cost: $325



Rosetta Stone Wall Plaque - Replica
Size: 12 3/8" X 10 5/8"
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This exquisite, delicately carved Ivory Rose Pendant is wrapped in 14K gold. Comes with 20" braided gold chain. The pendant comes with certificate of authenticity and its history. It is the perfect gift for Christmas or other special occasions. Rose pendant size 1" diameter, rose earrings size 3/8" diameter. Order #JPT-rose..$185 Order jewelry set - with earrings, pierced ears or clips, #JPT-1733...$360 for the set.

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