


SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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mesopotamian metropolis
prozac speeds neuron growth
whales drink in sounds
pot linked to gum disease

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the body's decline

AGING STEM CELLS, AGING SELVES

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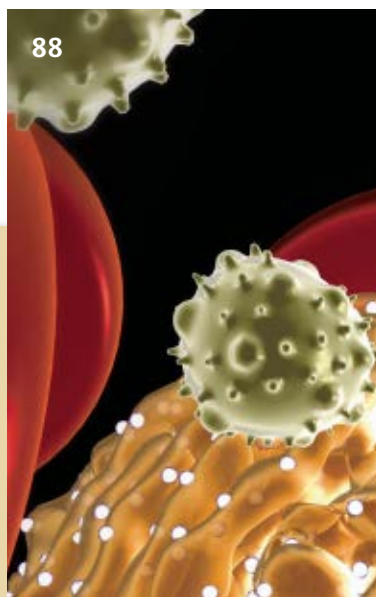
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Cover An adult blood stem cell floats amid red blood cells in this stylized illustration. Red blood cells represent one of the many specialized cell types replenished by these stem cells. Scientists are revealing a more complex picture of the relationship between adult stem cells and the aging process. (Corbis) Page 88

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Growing Up to Prozac

Drug makes new neurons mature faster

Peter Pan won't be pleased to hear the latest theory about how Prozac works. A new study shows that the antidepressant stimulates growth of neurons in the hippocampus and speeds the young brain cells toward maturity. The maturation process could be the mechanism by which the drug relieves depression.

Fluoxetine, the drug commonly known as Prozac, has been used to treat depression since the 1980s. Prozac and other SSRIs (selective serotonin reuptake inhibitors) block the ability of the neurons to take up serotonin, thereby raising levels of the active neurotransmitter in the brain. When people with depression begin taking such drugs, serotonin levels in the brain increase rapidly, but it often takes 2 to 4 weeks before they begin to feel better.

The new study, published Feb. 6 in the *Journal of Neuroscience*, suggests that the lag is due to the time it takes for serotonin to stimulate new neurons to grow, mature, and integrate into brain circuits.

René Hen, a neuroscientist at Columbia University, and his colleagues tested the long-term effects of Prozac treatment on a specially bred strain of nervous mice.

Inside the brains of mice treated with Prozac, the researchers found many more newborn neurons in the dentate gyrus of the hippocampus, a part of the brain involved in learning and memory.

Not only did the Prozac-treated mice have more young neurons than untreated mice, but their neurons had more branch-like extensions, called dendrites, than did neurons from untreated mice. Those branches are important for making connections with other neurons and wiring cells into the larger network of the brain.

The researchers gave the mice a behavioral test to see whether having more newly mature neurons was important for changing how the brain works. For the test, the mice don't get any food for a day. Then researchers place the mice in unfamiliar cages with food pellets in the middle of the box. The mice usually cower in the corner, but after about 2 weeks with Prozac treatment the rodents approach the food. Neither untreated mice nor Prozac-treated mice whose hippocampi have been irradiated with X rays to prevent new neuron formation seek out the food. The result indicates that the birth and maturation of neurons in the hippocampus is important for Prozac to do its job, Hen says.

But it may not be the only way the antidepressant works, he says.

"We still don't know, of all the effects Prozac has on young neurons, which ones are important," Hen says.

It also isn't clear exactly how the hippocampus figures into depression, says Randy Blakely, a neuroscientist from Vanderbilt University in Nashville, Tenn. The brain region may be peripherally involved in regulating mood through connected areas, such as the amygdala, which helps process emotions.

Antidepressants may trigger changes in the hippocampus that relieve symptoms of depression but may not target the underlying cause of the illness, Blakely says. Still, learning how antidepressants work gives clues to how the

brain is wired and what goes wrong in mental illness, he says.

"We need these leads to understand the

cellular and circuit changes that occur with chronic drug administration to learn what the entire system is doing," Blakely says. —TINA HESMAN SAEY

Finding Fault

Trace of old subduction zone found in Italy

A 200-kilometer-long, 500-meter-thick layer of rocks now lying high in the mountains of Italy is recognized as the remains of an erosive subduction zone that was active under the sea millions of years ago, scientists say. The first-of-its-kind discovery provides new clues about ancient seismic activity along this interface between tectonic plates, and also insight into what may be happening along many quake-prone subduction zones today.

When a tectonic plate made of ocean crust and one formed of relatively light continental rocks collide, the continental plate typically overrides the oceanic plate, forcing it back down into Earth's mantle. When friction between the moving plates locks them in place, immense stresses build up along these subduction zones—stresses that can, when released, trigger great earthquakes and devastating tsunamis (*SN: 1/8/05, p. 19*).

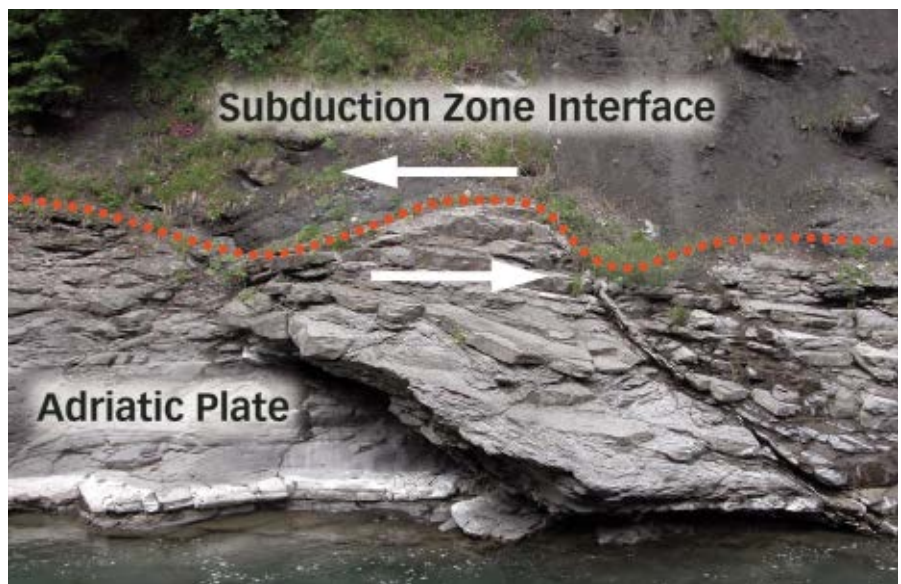
About half of the world's subduction zones, which typically lie in deep water far offshore, are considered erosive margins, where the ocean-crust plate is scouring the front edge of the overriding continental plate, says Francesca Remitti, a geologist at the University of Modena and Reggio Emilia in Italy. That action destroys evi-

QUOTE



We still don't know, of all the effects Prozac has on young neurons, which ones are important."

RENÉ HEN, Columbia University



ANCIENT SCRAPE Now preserved high in the mountains of Italy, the Adriatic tectonic plate was subducting beneath the European plate millions of years ago. The dotted orange line depicts the boundary between the Adriatic plate and the material trapped in the subduction zone; arrows indicate ancient plate motions. The European plate lies above the area pictured.

dence of the processes that occur at such tectonic interfaces, so the team's geologic find, in the Apennines of north central Italy, is especially rare.

Why and how portions of a subduction zone could end up being preserved in a mountainous region “are wonderful questions that jump out of this paper,” says Stephen T. Johnston, a geologist at the University of Victoria in Canada.

Today, those rocks sit between 1 and 1.5 km above sea level. About 12 million years ago, however, the rocks lay about 3 or 4 km beneath the seafloor, where the edge of the Adriatic tectonic plate was subducting beneath the European plate. Eventually, this mountain-building collision lifted the subduction zone out of the sea and preserved it, Remitti and her colleagues suggest in the Feb. 7 *Nature*.

In many places, the rocks are crisscrossed by thin veins of calcite. Those veins, along with other characteristics of the rocks, indicate that seismic activity along the ancient subduction zone occurred at depths of 4 km and greater, says Remitti. That's surprising, she notes, because modern subduction zones don't exhibit seismic activity above depths of 5 km or so.

Although many research teams have used seismic waves to construct CT-scan-like images of these zones, those provide only inferences about the processes taking place along such tectonic interfaces, says Remitti. Several groups of geologists, including Harold J. Tobin of the University of Wisconsin–Madison, are now mounting ocean-drilling expeditions to obtain rock samples from active subduction zones.

Remitti and her team “have a big advantage in having samples of an actual subduction zone to study in real detail,” says Tobin. The big challenge, he notes, will be discriminating processes that occurred while the rocks were forming from those that modified the rocks after they were lifted from the sea millions of years ago. —SID PERKINS

Whales Drink Sounds

Hearing may use an ancient path

Whales may receive sounds through the throat in addition to taking them in through the jaw, a new study finds. Understanding



DEEP LISTENER The Cuvier's beaked whale prefers water more than 1,000 meters deep and mostly eats squid, detected by echolocation. New work has uncovered a sound pathway in this rarely seen toothed whale that may be shared by all whales.

where sound enters the head of the Cuvier's beaked whale could point to the original acoustic pathway for all whales and provide insight into how sonar affects the animals.

The Cuvier's beaked whale is one of roughly 80 species of toothed whales, along with pilot whales, dolphins, orcas, sperm whales and others. Toothed whales are deep divers that hunt for food using echolocation—they emit sounds that bounce off objects and return to the whale, giving a “picture” of the prey's shape, size, and whereabouts.

Previous experiments and anatomical studies had found that sounds entered a toothed whale's head through a structure known as the acoustic window, an area of the lower jaw that's very thin on the outside with a large pad of fat on the inside. Sounds were thought to vibrate the thin layer of bone and then travel through the fat to the ear.

Ted Cranford of San Diego State University in California explored the “jaw hearing” idea further with CT scanners. Using scans of two Cuvier's beaked whales that had died and washed up on the beach, Cranford and his colleagues created a computer model of a whale's head. The team incorporated the head's exact geometry and all of its physical properties, such as bone and tissue density. The researchers then fed mathematical “sounds” into the model and watched how the sounds traveled.

To Cranford's surprise, sound seemed to be traveling under the jaw, not through the acoustic window. The sound waves then went through the throat, and passed through a hole in the back of the jaw to the fat by the ear.

After repeating the modeling runs and looking again at the anatomy of other whales, Cranford realized that this path—from throat to ear—might also be used by other whales, even baleen whales, the non-toothed whales that do not use echolocation. Jaw hearing may have evolved in the toothed whale lineage to provide an advantage under certain circumstances, he says. The throat pathway might actually be very old, he adds—possibly the original acoustic pathway for all whales.

“Using the throat area as a wave guide does make a lot of sense,” says Michael Moore of the Woods Hole Oceanographic Institution in Massachusetts, who was not part of the study.

The study, from the March *Bioinspiration and Biomimetics*, could add insight into the observed relationship between whale strandings and sonar testing. Now other species need to be examined, says Moore, to learn whether all whales can “see” the same way with their ears. —RACHEL EHRENBERG

Tots Who Tote

Babies show neural signs of budding number sense

A 3-month-old baby can't help you with your taxes, but nonetheless possesses a brain-based grasp of numbers, a new study indicates.

Previous studies suggested that, by 4½ months, infants detect changes in the number of items in a set. Some researchers regard this feat as evidence for an early number sense. Others attribute it to babies' tendency to notice novel events or to other nonnumerical cues. The new study is the first to connect infant number sense with brain activity.

By 3 months of age, infants already display distinct neural pathways for distinguishing the number of objects that they see as well as for identifying objects, say neuroscientist Véronique Izard of Harvard University and her colleagues. These pathways correspond to a pair of neural networks also found in adults.

A “where-and-how” network primarily monitors an object's location, size, and potential uses, while a “what” network handles its identification.

“Our findings show that infants as young as 3 months are able to process numbers and to identify objects thanks to specific neural systems,” Izard says. Her team presents its findings in the February *PLoS Biology*.

Izard's group studied 36 infants, all 3

months old. Each youngster wore a cap with sensors that recorded electrical activity from the brain's surface.

While being held by a parent, babies watched a series of images on a computer screen. Most screens depicted the same object, such as a cartoon character, shown in arrays of the same number. Occasionally, an image showed either a new object or a different number of previously seen objects.

The infants' brain surfaces displayed distinctive electrical responses within a fraction of a second after number and object changes.

The researchers then used a computer model to estimate neural sources of the infants' electrical responses.

As has been reported for adults and children, brain areas along the top of the left temporal lobe responded vigorously in the infants' brains as they observed object changes, accessing the "what" network.

Number changes elicit responses primarily from the "what-and-how" network, which functions in the lower part of the brain. But in the infants, this activity was focused in right-brain areas. Other studies indicate that left-brain contributors to this network appear during childhood and strengthen by adulthood.

The new study also counters thinking that infant awareness of changes in objects and numbers merely reflects a tendency for novel events to grab a baby's attention, Izard maintains, because the networks triggered in the study lie largely outside of brain regions involved in attention.

Intriguingly, infants showed comparable neural responses to changes in both small (four or fewer) and large numbers of items. Psychologists have theorized that small-number detection relies on a system for tracking a few individual objects, whereas large-number detection depends on a system for estimating the magnitude of a group of items.

"These are interesting findings," comments psychologist Susan C. Levine of the University of Chicago. A common neural pathway for small and large numbers in infants suggests that the magnitude-estimation system operates for all numbers, although a separate small-number system must also exist, Levine proposes. —BRUCE BOWER

Pot Downer

Marijuana users risk gum disease

It's a bummer, man.

Young adults who regularly smoke marijuana face an increased risk of severe gum disease, scientists report. The study is the first to link pot smoking to a health danger that's more commonly associated with tobacco.

The findings arise from a long-term study of people born in the 1970s in Dunedin, New Zealand. Researchers there have monitored this group regularly, conducting periodic interviews about lifestyle and health

and collecting data from medical exams. For this study, the scientists analyzed 903 people and noted the results from four dental checkups done between the ages of 18 and 32. These revealed any signs of periodontitis, an inflammation in which the inner layer of the gums and bone pull away from the teeth, ultimately loosening them. The researchers counted the number of spots in which gums had receded in each person and noted the severity of these detachments.

Meanwhile, the scientists assessed participants' use of marijuana, also called cannabis. One-fifth of the people had smoked it about once a week in the years preceding two of the dental exams, while nearly half had smoked pot less often and 32 percent had never used it.

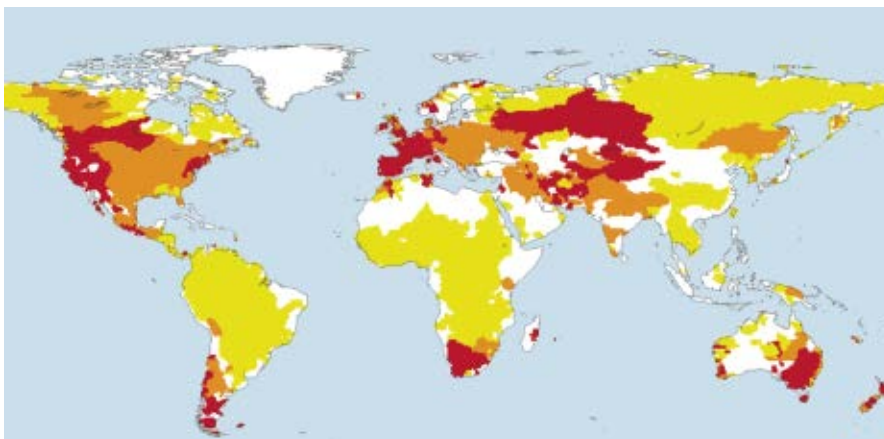
By the time they reached age 32, the heaviest cannabis users were three to five times as likely as the nonusers to have an area of severe gum detachment, the researchers report in the Feb. 6 *Journal of the American Medical Association*. Heavy users were also twice as likely to have incurred some of their periodontal damage between the ages of 26 and 32. Occasional pot smoking increased the risk somewhat less, says study coauthor W. Murray Thomson, a dentist at the University of Otago in Dunedin. The researchers accounted for tobacco use, socioeconomic status, frequency of dental services, and tooth plaque.

In a separate analysis, the team looked only at people who had never smoked tobacco. Those using only cannabis had dramatically more gum disease than non-smokers.

Gum tissues are soft but tough, designed to cling to the jawbones and teeth and hold everything in place. They also take a lot of abuse. Not only is the mouth a front line against invading pathogens, but gums often get nicked and cut from hard foods, says Scott Tomar, a dentist and epidemiologist at the University of Florida in Gainesville. For these reasons, gum health is a two-pronged affair: Invading pathogens must be cleared from the site by the immune system, and injured tissue must be repaired fast and often.

"Periodontitis is pretty widely thought to be a bacterial disease," Tomar says. At the same time, chemicals in smoke also engender inflammation, which impairs the body's ability to fight off bacterial infections and repair tissue.

While dentists routinely counsel patients against the periodontal risks of cigarette smoking, cannabis is a touchy subject, Tomar says. "You're asking about an illegal behavior, so it does raise some discomfort among clinicians. On the other hand, here we have what may be a substantial risk for relatively young people," he says. "It does have some very real clinical implications." —NATHAN SEPPA



Spread of nonnative fish mirrors human commerce

The percentage of foreign fish in rivers is strongly linked to nearby economic activity, according to a new study of 1,055 river basins worldwide. Nonnative plants and animals can outcompete local species and damage ecosystems, sometimes to the point of collapse. Freshwater fish can't readily move from one river basin to another on their own, so the distribution of invasive fish ought to reflect human influence, says lead researcher Sébastien Brosse of the Laboratory of Evolution and Biological Diversity in Toulouse, France. Local measures of economic activity, such as gross domestic product, account for about 70 percent of the distribution of foreign fish, supporting the idea that human activity is largely to blame, Brosse's team reports in the February *PLoS Biology*. Red indicates greater than 25 percent invasive fish; orange, 5 to 25 percent; and yellow, less than 5 percent. —PATRICK BARRY

Wish List

FY '09 budget proposal ups physical sciences

On Feb. 4, President Bush announced his proposed research and development (R&D) spending blueprint for 2009. It echoed his embattled plan from last year.

Federal support for R&D, totaling \$146.9 billion, would pump up funds for physical sciences but not for biomedical research. Last year, Congress overrode those priorities, and analysts predict a similar fight this year.

The President's request includes \$5.2 billion in research funds for the National Science Foundation (NSF), a 13.3 percent increase over fiscal year (FY) '08, and \$4.72 billion for the Department of Energy's (DOE) Office of Science, a 16 percent increase (percent changes have been adjusted to account for a 2 percent rate of inflation estimated for the current fiscal year).

Such boosts would be on pace to match the administration's goal, stated 2 years ago, of doubling R&D funding in the physical sciences within 10 years to maintain the nation's competitive edge. They also mirror administration statements about reining in biomedical-research spending.

The administration's agenda "has been fairly consistent," says Kei Koizumi, director of the R&D Budget and Policy Program at the American Association for the Advancement of Science in Washington, D.C. Indeed, with many parts of the overall federal budget slated for big cuts, Koizumi says, science is faring surprisingly well.

In the past 2 years, Congress did not fund the President's requested increases for physical sciences, which would have largely come at the expense of biomedical research.

Last year, in particular, science funding was caught in a stand-off between the administration and Congress. Under threat of a presidential veto, and trying to conclude the budget process before the holiday recess, Congress had to find places to cut, and boosts for physical sciences shriveled.

The 2009 proposal is encouraging for particle physicists. "In my best hopes, that's what I wanted to see," says Pier Oddone, director of the Fermi National Accelerator Laboratory in Batavia, Ill., home to the world's most powerful particle accelerator.

Fermilab and the Stanford (Calif.) Linear

Accelerator Center—both funded by DOE's Office of Science—were badly hurt in the FY '08 budget war. Because of a \$93-million cut in federal funding for particle-physics programs, announced in December, both laboratories scheduled layoffs and took other emergency measures. For instance, at Fermilab "we are all taking 10 percent of our time off without pay," Oddone says.

Oddone warns that if Congress does not restore the lost funding, the damage to U.S. particle physics could become irreversible.

The new budget proposal would restore funding for an international nuclear-fusion project and reinstate some of the President's priorities, such as nanotechnology, information technology, and cyber security.

The proposed budgetary gains would be largely offset by pinching back elsewhere, notably at the National Institutes of Health (NIH), the second-largest federal R&D spender. The President would hold NIH's funding flat—with not even an increase to cover inflation.

John Marburger, the President's science adviser, showed little sympathy for NIH. "Everybody wants to see NIH become more efficient," he told reporters.

"It is disturbing that the President proposes once again to flat-line funding for the NIH," said Robert Berdahl of the Association of American Universities in Washington, D.C., in a statement. "If approved, this will mean that, over 6 years' time [FY '04 through '09], NIH's purchasing power ... has been cut by one-seventh."

The Department of Agriculture's R&D programs have been targeted for a major hit. For instance, the \$1 billion proposed for

the Agricultural Research Service programs would be a 9 percent drop from FY '08.

NASA's total science budget would increase by 0.9 percent, with some internal redistribution reflecting the agency's ongoing shift away from the space shuttle program and toward the President's stated goal of establishing a human base on the moon. Accordingly, lunar-science investments would more than double, to \$105 million.

Some new Earth missions would also receive funding, including a satellite to map soil moisture and a satellite to measure ice-sheet mass as well as cloud and aerosol heights. However, other programs in astrophysics, for instance, would drop to \$1.16 billion in 2009—a loss of roughly 15 percent.

The Department of Commerce, parent agency for the National Oceanic and Atmospheric Administration and the National Institute of Standards and Technology, received a 1.9-percent boost in R&D funding. About \$74 million would restore a program to deploy climate sensors on satellites, and about \$5.3 million would go to enhancing hurricane forecasting.

Toting up the winners and losers, overall inflation-adjusted R&D spending in the President's budget would top this year's appropriated funds by just 0.7 percent.

Bush's latest and last budget proposal could spark another spending fight, according to analysts. "I don't see any incentives for this President to compromise," says Koizumi. He and others suspect Congress might hold off approving the FY '09 federal budget far beyond Oct. 1, the beginning of the fiscal year—hoping for a more favorable moment with the winner of November's presidential election. —SW STAFF

Federal R&D Budget (in millions of dollars)*

| AGENCY OR DEPARTMENT | FY 2007 SPENT | FY 2008 ALLOCATED | FY 2009 PROPOSED | PERCENT CHANGE [†] 2008-2009 |
|----------------------|----------------|-------------------|------------------|---------------------------------------|
| Defense | 78,329 | 80,192 | 80,494 | -1.6 |
| NIH | 28,880 | 29,307 | 29,307 | -2.0 |
| NASA | 9,952 | 10,436 | 10,737 | 0.9 |
| Energy | 8,522 | 9,739 | 10,558 | 6.3 |
| NSF | 4,479 | 4,500 | 5,201 | 13.3 |
| Homeland Security | 1,246 | 1,143 | 3,287 | 181.9 |
| Agriculture | 2,275 | 2,309 | 1,952 | -17.1 |
| Commerce | 1,080 | 1,113 | 1,157 | 1.9 |
| Interior | 604 | 676 | 617 | -10.5 |
| EPA | 606 | 557 | 550 | -3.2 |
| Other | 3,099 | 3,091 | 3,103 | -1.6 |
| Total | 139,072 | 143,063 | 146,963 | 0.7 |

*Adapted from Office of Management and Budget documents; figures reflect rounding.

[†]Adjusted for 2.0 percent expected rate of inflation.

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FAULTY FOUNTAINS OF YOUTH

Adult stem cells may contribute to aging

BY PATRICK BARRY

Skin sags. Hair grays. Organs don't work quite like they used to. A gradual wearing out and running down of the body's tissues seems an inherent part of growing older. Rejuvenation of skin, muscles, and other body parts naturally declines with the passing years.

Scientifically speaking, however, this observation is much less self-evident. Some cells in a person's body can resist the tide of aging. Consider the reproductive cells a person carries that will become the cells of newborn children who have 80-plus years of life to look forward to. Generation after generation, these reproductive cells form an unbroken line stretching for millennia.

The reason that an otherwise healthy person grows old and dies remains a mystery. Scientists have suggested several suspects for why people's bodies wear out with age, including accumulated damage to DNA, free radicals, and the shortening of telomeres—the caps on the ends of chromosomes. While each of these factors may play a part, biologists acknowledge that their understanding of aging is incomplete.

Enter stem cells. Scientists have long known that people have small reservoirs of stem cells in some of their tissues, such as bone marrow. These stem cells are distinct from those found in newly fertilized embryos—the more controversial embryonic stem cells. The embryonic type can become any type of cell in the body.

Adult stem cells, in contrast, can normally generate new cells only for the tissue in which they're found: blood cells for blood, intestinal cells for the intestines. As old cells in these tissues are damaged or wear out, nearby stem cells can manufacture new ones to take their place. At the same time, the stem cells produce more copies of themselves, maintaining a seemingly indefinite pool of cells capable of churning out a stream of replacement cells.

Until recently, most scientists thought that adult stem cells existed only in tissues that need to constantly replace their cells, such as skin, blood, and the lining of the intestine. But over the past few years, researchers have found stem cells in many, perhaps most, of the body's organs and tissues. Even the brain, which scientists once thought never replaced its nerve cells during adulthood, is now known to have stem cells that make new nerve cells throughout life (*SN*: 6/16/07, p. 376).

With the realization that so much of the body contains self-renewing stem cells, scientists began wondering whether changes in these stem cells over time might contribute to aging.

Imagine that, as a person ages, these fountains of cellular youth might start to run dry. As the supply of fresh cells dwindles, tissues would gradually decline and show signs of age. "That was the initial model" of how stem cells could be involved in aging, says Norman E. Sharpless, a stem cell expert at the University of North Carolina in Chapel Hill. And some data support this idea.

Graying of hair, for example, could be caused by a decline in melanocyte stem cells that accompanies aging, as observed by Emi K. Nishimura and her colleagues at Dana-Farber Cancer Institute in Boston. Melanocytes make the hair pigment melanin, so depleting these stem cells eventually causes loss of hair color, the team reported in *Science* in 2005.

Elderly people also have diminished resistance to disease because

their immune systems make fewer of the disease-fighting white blood cells known as lymphocytes. In mice, bone marrow stem cells produce fewer lymphocytes as the mice get older, Derrick J. Rossi, now at Harvard Stem Cell Institute in Cambridge, reported in 2005 in the *Proceedings of the National Academy of Sciences*.

Yet evidence is mounting that the connection between adult stem cells

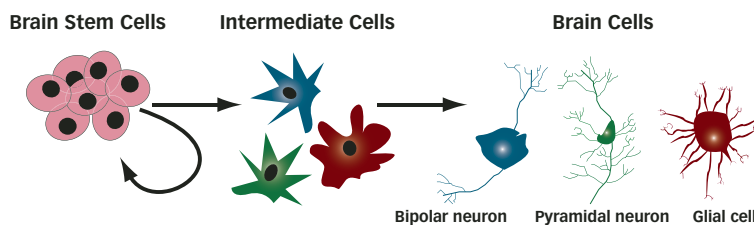
and aging is more complex. Some kinds of stem cell actually grow *more* abundant with age. And just as stem cells affect aging, the aging body affects stem cells.

TINKERING WITH TIME To untangle these effects, scientists led by Thomas A. Rando of Stanford University surgically joined pairs of mice like reconnected Siamese twins. The team linked the animals' circulatory systems so that blood from each member of a pair flowed through both mice. One mouse in each pair was old; the other was young.

Scientists knew that the ability of muscle stem cells (also called satellite cells) to repair damaged muscles declines substantially with age. Rando's team wanted to find out whether such declines should be attributed to changes in the satellite cells themselves or to changes in the cells' environment as the animals aged.

"There clearly is an effect of aging on stem cells," Rando says. "But I think the other question is ... are those changes reversible or irreversible?"

Amazingly, the blood of the young mice completely restored



CELL FACTORY — When adult brain stem cells (left) divide, they can produce another stem cell (looping arrow) as well as intermediate progenitor cells (center). Those progenitor cells can develop into the specialized cell types found in the brain, including the three shown here (right).

the tissue-healing powers of the satellite cells in the older mice, Rando's team reported in 2005 in *Nature*. Exposure to the young blood reactivated a system of proteins inside the cells called the Notch signaling pathway, which is crucial for triggering the cells' muscle-repair functions. Notch signaling in satellite cells normally declines in old age, but Rando's experiment showed that this decline is a response to changes in the blood, not the result of an inherent wearing out of the satellite cells themselves.

This influence of the cells' environment is possible because all cells receive signals—including hormones and other messenger proteins—from their surroundings, and these signals allow the cells to behave appropriately for their context. So a change in these external messengers in aging mice could diminish the satellite cells' muscle-repair activity.

Stem cells' surroundings also wield an influence in fruit fly testes. Changes in the stem cell-harboring niche inside the testes contribute to a decline in the number of sperm-making stem cells with age, according to research by D. Leanne Jones of the Salk Institute for Biological Studies in La Jolla, Calif., and her colleagues. As the flies grew old, the niche produced less of a protein that activates a gene in the stem cells called *unpaired*, which triggers self-renewal of the cells, the team reported in the Oct. 11, 2007 *Cell Stem Cell*.

"We definitely see changes in the environment long before we start to see" signs of intrinsic aging, Jones says. In mice testes as well, "there seems to be evidence for the environment aging instead of the stem cells themselves."

In other cases, though, stem cell aging seems independent of context. Blood-forming stem cells from bone marrow age in an unusual way. When scientists transplant blood stem cells from an old mouse into a young mouse, allow the young mouse to grow old, and then repeat the process for several generations, the stem cells lose none of their ability to make copies of themselves. In fact, in some mouse strains, blood stem cells become even more numerous with age.

But that's not necessarily a good thing. While old age doesn't appear to affect blood stem cells' power of self-renewal, it does gum up their ability to make specialized offspring cells. Ideally, each time a stem cell divides, one of the daughter cells would remain a stem cell, and the other would continue dividing to produce a fresh crop of specialized cells to replenish the tissue. That way, the stem cell's lineage always contains only one stem cell at a time to replace the original, keeping the total number of stem cells constant.

For that number to increase, daughter cells must sometimes both become stem cells, decreasing production of tissue-replenishing cells.

Even when these elderly stem cells do spawn new lines of specialized cells, the process goes awry. Blood stem cells must give rise to a whole family of specialized cells: red blood cells, lymphocytes, monocytes, macrophages, and others. As the stem cells age, something goes wrong in this specialization process, skewing it away from making lymphocytes. So the old-age slump in germ-fighting lymphocytes happens not because the stem cells peter out but because they charge ahead with their specialization machinery slightly broken. In mice, this misbehaving of blood stem cells occurs even when scientists repeatedly transplant the cells into young animals, leading them to conclude that the stem cells themselves become damaged with time.

FIGHTING DEATH WITH AGING In trying to understand how stem cells in various organs deteriorate with age, scientists have run up against the perennial nemesis of cell biology: cancer.

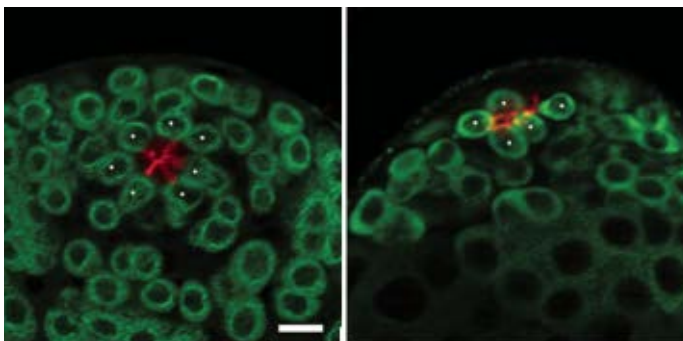
"Having all these cells around that can divide all the time is quite dangerous for an organism," Sharpless says. Cells continually accumulate DNA damage, but copying and segregating the DNA during cell division is particularly hazardous. Every time a cell divides, there's some error of replication.

Most of these mistakes get fixed by repair enzymes, but certain lingering errors in DNA can cause a cell to begin growing and dividing out of control, which is how cancer arises. Cells have elaborate tools for detecting DNA damage early and either fixing it or shutting down the affected cell. Recent data suggest that these mechanisms for thwarting cancer could cause the body to cull some of its own stem cell supplies.

For example, researchers led by Sean J. Morrison of the University of Michigan in Ann Arbor found a link between the decline in nerve stem cells in mouse brains and the potent anticancer gene

p16. This gene causes cells to enter a dormant state called senescence. Mice bred without *p16* retained significantly more of their nerve stem cells into old age than did mice that had the gene, Morrison's team reported in *Nature* in 2006.

The famous tumor-fighting gene *p53* also reins in damaged stem cells in old age. Blocking the activity of *p53* in stem cells restored populations of intestinal stem cells in elderly mice, K. Lenhard Rudolph of Hannover Medical School in Germany and his colleagues reported in the



BREAKDOWN — The niche for sperm-making stem cells in the testes of young fruit flies (left) is well structured and supports seven stem cells (white dots). In an elderly, 50-day-old fruit fly, the niche has fallen into disarray and only five stem cells remain.

January 2007 *Nature Genetics*.

Whether the bodily declines that come with aging are due to the depletion of stem cells depends on which organ is in question—and on which scientist you ask. Most scientists agree that adult stem cells play an important role in aging; the other thing that they seem to agree about is that this role is complicated. "There's still a tremendous amount of debate about even the [blood stem cell] system, which is one of the best-studied systems," Jones says.

In blood and other tissues with high cell turnover, decline of stem cells may make a greater contribution to the signs of aging than it does in tissues with slower cell turnover.

In skin, which constantly produces new cells, a decline in stem cell vigor is expected by some scientists to play a big part in the sagging and poor elasticity of skin that comes with old age. For organs such as the brain and heart, which retain most of their cells throughout adulthood, signs of old age more likely come from traditional mechanisms of aging acting on the organs' mature, specialized cells.

But even this guideline may be too simple. Alzheimer's disease, a form of dementia that commonly occurs in the elderly, is characterized by plaques accumulating in the brain. Young people's brains make the plaque proteins as well, but some data suggest that immune cells called macrophages patrol the brain and clear out budding plaques. Macrophages are continuously being made by—you guessed it—blood stem cells. So even for organs in which cell renewal by stem cells proceeds very slowly, the declines of old age might be caused by the decline of adult stem cells elsewhere in the body.

Some aspects of aging will likely prove unrelated to stem cells, Sharpless says, but these cells now appear far more important for aging than scientists once thought. "I've stopped trying to predict which symptoms of aging are related to [stem cell] proliferation and which are not," Sharpless says. Scientists "used to be so confident about this 10 years ago. Now I'm prepared to be wrong." ■

DAWN OF THE CITY

Excavations prompt a revolution in thinking about the earliest cities

BY BRUCE BOWER



CITY RISING — In northeastern Syria, the earthen mound of Tell Brak ascends above fields where suburbs of the ancient city once stood.

A massive earthen mound rises majestically and rather mysteriously above agricultural fields in northeastern Syria. From a distance, the more than 130-foot-tall protrusion looks like a jagged set of desolate hills. But up close, broken pottery from a time long past litters the mound's surface. The widespread debris vividly testifies to the large number of people, perhaps as many as 10,000, who once congregated on and around this raised ground.

Known as Tell Brak, the mound and its surrounding fields contain the remnants of the world's oldest known city. The word *tell* refers to an ancient Near Eastern settlement consisting of numerous layers of mud-brick construction. Generation after generation of residents cut down, leveled, and replaced each layer with new buildings, eventually creating an enormous mound.

At the city of Brak, the first *tell* layers were built more than 6,000 years ago. At that time, the settlement emerged as an urban center with massive public structures, mass-produced crafts and daily goods, and specially made prestige items for socially elite citizens.

Surprisingly, the evidence for Brak's rise as a major city pre-dates, by as many as 1,000 years, evidence for comparable urban centers hundreds of miles to the south, in what's now southern Iraq. Like those southern cities, Brak lay between the Tigris and Euphrates rivers in the ancient land of Mesopotamia. But scholars have long assumed that southern Mesopotamia's fertile crescent, blessed with rich soil and copious water, represented the

"cradle of civilization." In the traditional scenario, fast-growing southern cities established colonies that led to a civilization of the north. Southern immigrants sought timber, metal, and other resources that were absent in their homeland.

Excavations at Tell Brak and at the nearby remains of a comparably ancient city, Hamoukar, may turn that model on its head. New discoveries indicate that the world's first cities either arose in northern Mesopotamia or developed independently and at roughly the same time in the region's northern and southern sectors. The idea that urbanites radiated out of the south and triggered the construction of major northern settlements now rests on shaky ground.

"As yet, no other large site, indeed no other Near Eastern site, has yielded evidence of early urban growth comparable to that at Tell Brak," says archaeologist Augusta McMahon of the University of Cambridge in England. McMahon directs excavations at the Syrian site.

Researchers have also discovered dramatic signs of ancient warfare at Brak and Hamoukar. Further analysis of these discoveries may illuminate the nature of contacts and conflict between northern and southern Mesopotamians.

"Excavations at Brak and Hamoukar are the biggest thing to happen in Mesopotamian research in a long time," comments archaeologist Guillermo Algaze of the University of California, San Diego.

URBAN SPRAWL Excavations at Tell Brak started modestly enough about 70 years ago. Archaeologist Max Mallowan, husband of author Agatha Christie, led a team that uncovered the ruins of a religious temple. Thousands of small stone idols depicting eyes littered its floor. The investigators dubbed the poorly dated structure the Eye Temple.

MCMAHON/TELL BRAK PROJECT

A husband-and-wife team from Cambridge, David Oates and Joan Oates, initiated a new series of Tell Brak excavations in 1976. At the time, they suspected that the site held remnants of urban development from perhaps as early as 5,000 years ago, when, evidence suggested, the Eye Temple had been built.

But as years of field work accumulated, unexpectedly deep tell levels came to light. By 2006, the investigators realized that they were digging into something special. Sediment from 6,000 years ago or more, when the earliest known southern Mesopotamian cities had not yet been built, started to surrender the remains of huge public buildings.

In the September 2007 *Antiquity*, McMahon, Joan Oates, and their colleagues describe these discoveries. (David Oates is now deceased.)

The oldest structure found so far, dating to about 6,400 years ago, featured a massive entrance framed by two towers and an enormous doorsill made of a single piece of basalt. Excavations revealed parts of two large rooms inside, a group of small rooms near the front, and a pair of guard rooms just outside the entrance. Despite its size, it was likely not a temple, but rather an administrative center, McMahon says. With a central room and several satellite areas, its layout is not that of a standard Mesopotamian temple.

“Whatever its formal functions, this is the earliest Mesopotamian example of a genuinely secular monumental building,” McMahon says.

A second ancient structure, with red mud-brick walls surrounding three floors, housed potters and other artisans. These workers had access to several large, clay ovens inside the building.

Pottery finds include large, open bowls, small bowls with incised craftsman’s marks, and a basic type of mass-produced bowl.

The scientists also uncovered huge piles of raw flint, obsidian, and a variety of colored stones used to make beads and other stone objects. Some areas contained caches of clay spindle whorls situated near the bones of sheep or possibly goats. These finds resulted from wool weaving, according to the investigators.

To their surprise, this building also yielded an unusual obsidian and white marble chalice. A piece of obsidian had been hollowed out to form a drinking vessel and attached with sticky bitumen to a white marble base. This fancy cup contrasts with mass-produced bowls found throughout the building and points to the presence of at least a small number of social elites in ancient Brak, McMahon holds.

Workshop rooms also contained numerous clay stamp seals, including one bearing the impression of a lion and another showing a lion caught in a net. Such seals signified a ruler’s total ownership or control in southern Mesopotamian cities, and probably meant much the same at Brak.

The researchers refer to a third huge structure from roughly 6,000 years ago as “the feasting hall.” It contained several large ovens for grilling or baking huge amounts of meat. The bones of goats and other medium-sized game, as well as pieces of mass-produced plates, littered the floors of adjacent rooms.

Either this building was designed for feasting or it served as a kind of ancient cafeteria for nearby workers and bureaucrats, the scientists speculate.

One of the most intriguing insights at Tell Brak came not from excavations but from an analysis of how pottery fragments accumulated across the entire site, from the city center to adjacent suburbs. Brak’s urban expansion began more than 6,000 years ago in a set of small settlements that now surround the central mound, according to the pottery study (*SN: 9/15/07, p. 174*). As these villages ballooned in size, they expanded inward. Construction of the city center’s massive buildings followed.

In other words, Brak’s urban ascent was not planned and directed by a ruling class that first built an imposing group of core structures, as happened at southern Mesopotamian sites. McMahon’s team argues that decentralized growth characterized the northern city, as inhabitants of nearby settlements interacted to cultivate a metropolis without necessarily planning to do so.

BRAK ATTACK Sometimes archaeologists make major finds serendipitously. In 2006, local residents bulldozed a grain-storage trench along the mound’s border. The shocked farmers dug into a pit crammed with human skeletons, pottery, and animal bones. They had uncovered a mass grave.

Last year, McMahon’s team excavated the area and found two mass graves containing parts of at least 70 bodies.

Radiocarbon measurements and assessments of pottery scattered among the bones place their age at about 5,800 years, a time of intense growth at Brak.

These graves probably held the victims of warfare, McMahon says. The bodies primarily come from young and middle-aged adults who apparently died at the same time. Many individuals lack hands and feet, possibly due to scavenging of the dead by rats and dogs on the battlefield.

Skirmish survivors apparently dumped dead bodies of their comrades, or perhaps of their enemies, into the pits. It wasn’t an entirely haphazard operation, however. In one cavity, a pile of human skulls rises from the skeletal carnage.

Animal bones that held choice pieces of meat were thrown into one burial pit after ancient residents held some sort of ceremonial feast on top of it, McMahon adds.

“It’s a little bit gruesome, but very exciting,” she says. “It’s also frustrating that we don’t yet know anything about normal ways of death at Brak.”

The unearthing of mass burials at Brak follows the 2005 discovery of an ancient war zone at Hamoukar. A major battle destroyed the city around 5,500 years ago, says archaeologist and excavation codirector Clemens Reichel of the University of Chicago.

Reichel’s team noted extensive destruction of a 10-foot-high mud-brick wall that protected Hamoukar. Bombardment by thousands of inch-long clay bullets shot out of slings weakened the wall, which then collapsed in a fire.



BIG DRINK — Tell Brak investigators found this obsidian and white marble chalice in one structure, indicating that the city included socially elite citizens.



ANCIENT ROAR — A large artisans’ workshop at Tell Brak yielded this clay seal depicting a lion, a Mesopotamian symbol of a powerful ruler.

Southerners likely contributed to the attack on Hamoukar, Reichel says. Destruction debris strewn across the site contains

A. MCMAHON/TELL BRAK PROJECT

numerous large pits stocked with southern Mesopotamian pottery. Southerners either led the charge against the northern city or assumed control of it afterward, in Reichel's view.

Investigators have also discovered a site for making obsidian tools on Hamoukar's outskirts, dating to more than 6,000 years ago. The nearly 800-acre site roughly equals the size of Uruk, the largest known southern Mesopotamian city.

Hamoukar residents built this enormous workshop primarily to export tools, Reichel proposes. It sits on an ancient trade route that led to southern Mesopotamia.

"Urbanism in northern Mesopotamia started much earlier than we previously realized and wasn't imposed by the south," Reichel says.

SOUTHERN SECRETS Ironically, new insights into northern Mesopotamian cities gleaned from work at Brak and Hamoukar highlight huge gaps in what researchers know about urban origins in the south.

No archaeological projects have occurred in southern Iraq for nearly 20 years because of political instability and war. Moreover, periodic flooding in that region has covered ancient sites in layers of river sediment.

"I don't believe we're seeing earlier urban development in the north than in the south," Reichel remarks. "We don't know what happened in the south at the time of Brak and Hamoukar."

UCSD's Algaze agrees. He formerly advanced the view that urbanism spread from southern Mesopotamia to the rest of the Near East, but he has changed his mind in light of the new northern discoveries.

Ancient urban centers in the north and south likely developed at roughly the same time, Algaze theorizes. For now, much more data exist for early northern cities, making regional comparisons difficult.

"Tell Brak is an archaeological gold mine," Algaze says. "The picture of Mesopotamian urbanism is now more complex and interesting than ever."

Consider the puzzle of the decline of northern cities such as Brak beginning around 5,000 years ago, accompanied by continued growth of southern settlements. No one knows why urbanism initially reached massive heights in both regions only to wither in the north and flower in the south.

For that matter, it remains a mystery why northern Mesopotamian cities emerged in the first place, Reichel adds.

New hypotheses for when and how Brak transformed into a major city need to be tested in further work, including excavations of additional northern and southern Mesopotamian cities, according to Algaze.

"We need to go back to the drawing board," Algaze remarks, "and rethink how urbanism originated in the Near East." ■



WAR VICTIMS — Excavations on the edge of Tell Brak revealed skeletal remains of people thrown into two burial pits after dying in some sort of battle.

OF NOTE

SCIENCE & SOCIETY

Diabetes drug and conflicts of interest

So much for confidential peer review.

Last May, a controversial paper in the *New England Journal of Medicine* (*NEJM*) reported that a popular diabetes drug—rosiglitazone, sold as Avandia—substantially hikes a user's risk of heart attack (*SN*: 6/23/07, p. 397). But according to an ongoing investigation by the U.S. Senate Committee on Finance, Avandia's maker knew about the study before it was published. The company—Philadelphia-based GlaxoSmithKline—had a leaked copy, courtesy of a scientist that *NEJM* had recruited for a peer review of the paper.

"The man who did this is Dr. Steven Haffner," ranking Finance committee member Sen. Charles E. Grassley (R-Iowa) reported last week, referring to the investigation. Grassley added that Haffner, a physician with the University of Texas Health Science Center (UTHSC) in San Antonio, "confirmed to my investigators that he faxed a draft of the study to GlaxoSmithKline weeks before it was published."

According to a statement issued by William L. Henrich, dean of medicine at UTHSC-San Antonio, the charges have "just come to light on our campus. We are embarking on a complete investigation." He added that if Grassley's charges are confirmed the university expects to take "swift and appropriate action."

Most troubling, Grassley argues, is the reviewer's role. By leaking unpublished data, Haffner "violated practically every tenet of independence and integrity held sacred by the major medical journals," he says.

Calls to Haffner were forwarded to the UTHSC-San Antonio Office of External Affairs.

When Haffner received the UTHSC-San Antonio Presidential Distinguished Scholar Award last year, the university noted that, in terms of federal support, he is among its "highest-funded investigators." He also received some \$75,000 for consulting and speaking fees from GlaxoSmithKline, according to government filings that Grassley's team uncovered. —JANET RALOFF

CHEMISTRY

Chomping on uranium

To a chemist's eye, uranium has always looked dull. Not anymore.

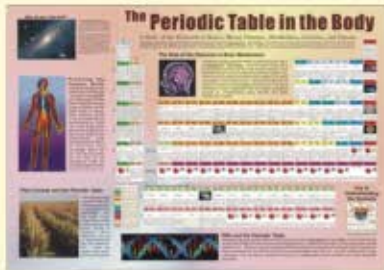
Natural uranium mostly occurs as an oxide. In water, the oxide readily dissolves in the form of a uranyl ion—a positively charged molecule made of one uranium and two oxygen atoms. In this respect, uranium behaves similarly to lighter metals such as molybdenum and tungsten.

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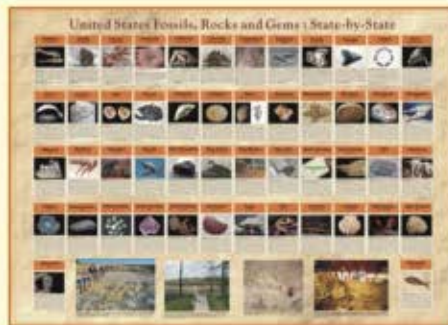


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reactive, uranyl is shy, chemically speaking, and extremely stable. It's harder to clean from toxic spills, for example, because it won't react with or bind to much at all.

Polly Arnold and Jason Love of the University of Edinburgh in Scotland and their collaborators have brought out uranyl's more outgoing side. They have coaxed uranyl to become reactive in an organic liquid by "biting" it with a mouth-shaped molecule. The molecule captures the uranyl in its jaw, Arnold explains, with one of the oxygen atoms sticking up toward the palate—a sort of Pac-Man with a tongue piercing, she says, referring to the 1980s videogame.

Pressed to the molecule's palate, the oxygen is forced to donate electrons to potassium atoms. This transfer throws off uranyl's balance, allowing its other oxygen end—which pierces through Pac-Man's jaw and sticks out the other side—to react with silicon-based compounds dissolved in the solution, the authors report in the Jan. 17 *Nature*.

Directing uranyl's behavior could have other uses. Lighter metal oxides are "famously good" as catalysts, Arnold says. Thanks to uranium's complex structure, new, uranyl-based catalysts might enable novel reactions, such as the cheap conversion of natural gas into liquid fuels that would be easier to transport, Arnold says. —DAVIDE CASTELVECCHI

ENVIRONMENT

Early dioxin exposure hinders sperm later

An explosion at a chemical factory near Seveso, Italy, in 1976 exposed factory workers and local residents to the pollutant dioxin, presenting an opportunity to track how exposure at different ages affects sperm quality.

Now, results from a new study point to a window of vulnerability in reproductive system development when such chemical disruptions may leave a permanent mark. "The timing is very important," says study co-author Larry Needham of the Centers for Disease Control and Prevention (CDC) in Atlanta.

Led by Paolo Mocarelli of the University Milano-Bicocca in Milan, Italy, researchers analyzed levels of dioxin in blood samples taken in 1976 from 135 exposed males. They collected new samples of blood and sperm from these same men, and compared those data to samples from a control group of 184 men.

The researchers found that the sperm in men exposed before age 10 was feeble and depleted. At the same time, the pollutant seemed to stimulate sperm production and motility in men exposed when they were 10 to 17 years old. Both groups had altered levels of reproductive hormones that can affect developing testes. However, sperm appeared normal in men who were exposed as adults.

The results suggest that exposure to dioxin as a child or teenager can permanently alter the reproductive system. The chemical may meddle with the cells that nourish developing sperm, the scientists speculate in the January *Environmental Health Perspectives*.

The findings also hint that chemical exposure may be a factor in the decline of sperm quality recently seen in Western nations, Mocarelli says. —RACHEL EHRENBERG

ARCHAEOLOGY

The Black Death chose its victims selectively

The Black Death, a bacterial epidemic that wiped out more than 1 in 3 Europeans from 1347 to 1351, was not an equal-opportunity destroyer. A new report finds that the disease disproportionately took the lives of physically frail people, rather than indiscriminately killing off individuals regardless of their health.

Sharon DeWitte of the University at Albany, N.Y., and James W. Wood of Pennsylvania State University in University Park examined 490 skeletons from London's East Smithfield cemetery, established in 1348 or 1349 solely to bury Black Death victims. The researchers looked for any of four types of bone damage or deformation that have been linked to infections or poor nutrition early in life.

For comparison, DeWitte and Wood also studied 291 pre-Black Death skeletons from cemeteries of two medieval Danish towns.

The scientists estimated each individual's age at death and used a computer model to calculate the extent to which frailty contributed to death in the two populations.

Physical infirmities greatly raised the risk of dying for Danes unexposed to the Black Death, the scientists report in the Feb. 5 *Proceedings of the National Academy of Sciences*. For instance, Danes with certain lower-leg lesions exhibited more than five times the risk of dying as their peers without such damage did.

Frailty also showed a strong, but less pronounced, link to death among Britons exposed to the epidemic. Individuals who incurred lower-leg damage before exposure to the Black Death were 50 percent more likely to die during the epidemic than were their non-damaged peers.

The new findings challenge assumptions that Black Death cemeteries contain a representative cross-section of the population from that time. —BRUCE BOWER

ARCHAEOLOGY

Zeus' altar drew early visitors

Long after his heyday as the head god of ancient Greece, Zeus has thrown a curveball rather than a lightning bolt at scientists. New excavations of the Sanctuary of Zeus at Greece's Mount Lykaion indicate that religious activity occurred there as early as 5,000 years ago, at least a millennium before the Greeks began to worship Zeus.

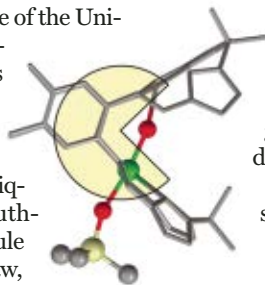
Last year, a team led by David G. Romano of the University of Pennsylvania in Philadelphia excavated 5,000- to 3,200-year-old pottery fragments from the site's

ash altar, a cone of earth situated atop Mount Lykaion's southern peak. Ancient Greeks conducted ceremonies at Zeus' ash altar, but until now evidence of such activity dated to no more than about 2,700 years ago.

Also on the ash altar, Romano's team found a lens-shaped seal of rock and crystal bearing a carved depiction of a bull. This find dates to roughly 3,500 years ago, Romano says. It suggests that an early connection existed between the Minoan island of Crete, where similar bull images originated, and ancient Greece.

It's not clear how people used Mount Lykaion's ash altar

before the emergence of Zeus worship, Romano says. He described the new discoveries at a university-sponsored lecture on Jan. 30. —BRUCE BOWER



PIERCED PAC-MAN

A molecule clamps onto a uranium oxide (green and red in this artist's impression), and hand-wrings it to react with another molecule.



GRIN REAPER New evidence suggests that Black Death victims, such as the woman represented by this skull, often had physical frailties before the epidemic.

Books

A selection of new and notable books of scientific interest

ELIZABETH BLACKBURN AND THE STORY OF TELOMERES: Deciphering the Ends of DNA

CATHERINE BRADY

In 1976, molecular biologist Elizabeth Blackburn discovered telomeres when she noticed a series of

repeated cytosine bases at the tips of chromosomes in a single-celled microbe. The tips protect vital genes from being lopped off each time a cell divides. Though her finding had huge implications for chromosome replication and cell survival, it caused hardly a tremor in the scientific community at the time. A

decade later, Blackburn and biologist Carol Greider identified the enzyme telomerase, which extends cell life by maintaining telomeres. When the enzyme decreases, cells die. Telomerase likewise received scant attention until Blackburn showed it to be reactivated in cancer cells. Almost immediately, the enzyme was heralded as the cure for cancer and age-related disease, and Blackburn had to then downplay the hype about telomerase. Blackburn later made headlines when she was dismissed from President Bush's Bioethics Advisory Council for her views on stem cell policy. In telling Blackburn's story, Brady touches on cell biology; the tension between basic research and biotechnology; science, and policy; and the pressures that women continue to face in male-dominated labs. *MIT Press, 2007, 392 p., b&w photos, hardcover, \$29.95.*

THE LUCIFER EFFECT: Understanding How Good People Turn Evil

PHILIP ZIMBARDO

Psychologist Zimbardo directed the Stanford Prison Experiment, in which college students were randomly assigned to act as either guards or inmates. The study was aborted after just 6 days.

"Inmates" showed severe stress reactions, such as trembling, crying, and screaming in reaction to the sadistic behavior of "guards," whose sole instructions were to keep order and let no one escape. That study, conducted more than 30 years ago, reemerged in light of abuses at Abu Ghraib. As an expert

defense witness at the court-martial of an Abu Ghraib guard, Zimbardo used the results of his study to argue that the U.S. military system had as much to do with prisoner abuse as did the individual perpetrator. His testimony was rejected and the guard sentenced to 8 years in prison. Here, Zimbardo weaves together mounting evidence that good people can abandon their moral scruples (hence the allusion to the angel Lucifer, who was transformed into Satan). By predicting what situations lead to such transformations, he hopes to prevent future atrocities, such as genocide, from occurring again. *Random House, 2007, 551 p., b&w photos, hardcover, \$27.95.*

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THE PHYSICS OF NASCAR: How to Make Steel + Gas + Rubber = Speed

DIANDRA LESLIE-PELECKY

Dedicated to the men and women who work in garages and race shops, this book focuses on the physics that experienced motor heads intrinsically

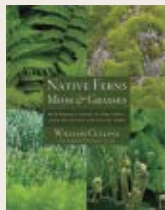


understand regardless of the words they use to explain it. Physicist Leslie-Pelecky was entranced the first time she watched a race car smack against an outside wall and career across the track, taking out other cars before going up in flames. While researching this book, she spoke at length with NASCAR drivers and pit-crew members to learn about the science behind speed. An appreciation of the aerodynamics involved in NASCAR elevates the auto race—a sport that originated when drivers made illegal runs for moonshine during the Prohibition era—to an art. *Dutton, 2008, 286 p., b&w illus., hardcover, \$25.95.*

NATIVE FERNS, MOSS, AND GRASSES

WILLIAM CULLINA

In contrast to their 50-foot-tall predecessors that towered beside the dinosaurs, modern day club-

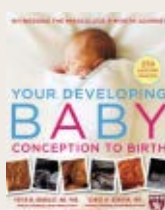


mosses creep along the forest floor from the tropics to the tundra. Gardeners may wish to add these ancient plants, which come in lovely tones of yellow and green, to their yards. Cullina warns, however, that cultivation of clubmoss is difficult; even the fungal micro-organisms they live with must survive transplant. But this author has done it, and describes how. Most other species covered in this encyclopedic book survive more easily. Broom moss, for example, grows on rocks and retains a deep-green color even when dry or frozen. Mosses, ferns, and grasses sophisticate a landscape by sewing together flowers against a lime, chartreuse, or emerald background. *Houghton Mifflin, 2008, 256 p., color photos, hardcover, \$40.00.*

YOUR DEVELOPING BABY: Conception to Birth

PETER M. DOUBILET, CAROL B. BENSON, AND ROANNE WEISMAN

Having answered questions for anxious parents-to-be for decades, radiologists Doubilet and Benson decided to write a book about babies in the womb.



The growth of the fetus' organs, skeletal and digestive systems, brain, and heart is explained alongside ultrasound images and diagrams. The brain, for example, is tracked in a series of 2-D ultrasound images from the second and third trimesters, as it quadruples in length and goes from smooth to bumpy and furrowed. A spectral Doppler ultrasound portrays the flow of blood between mother and baby through the umbilical cord. Writer Weisman collaborated with the doctors to create an accessible and captivating text that guides readers through 9 months of pregnancy. *McGraw Hill, 2008, 185 p., b&w photos and color illus., paperback, \$18.95.*

LETTERS

Small, or just invisible?

"Heavy Find: Weighty neutron stars may rule out exotic core" (*SN: 1/12/08, p. 20*) says that the companion star of the pulsar PSR B1516+02B must be "tiny" because it cannot be seen. Isn't it possible that the companion is made of dark matter? Is there a "wobble" test or other way to discern between a companion that is truly tiny (low mass) and one that is perhaps more massive but not visible? The mass of the companion star seems to bear directly on the conclusion favoring heavy neutron stars.

MAUREEN MCALLISTER, WAYNE, ILL.

The companion to PSR B1516+02B is very likely a white dwarf star, says Paulo Freire of Arecibo Observatory in Puerto Rico. White dwarfs are faint, and become harder to detect as they grow older and cooler. Few companions to millisecond pulsars have ever been directly detected, but those that have are almost all white dwarfs. Freire adds that dark matter seems to clump at galactic scales, and that he is not aware of any theoretical predictions of dark matter able to form small objects like stars. —RON COWEN

Defining 'pristine'

"Prairie Revival: Researchers put restoration to the test" (*SN: 12/15/07, p. 376*) talks of restoring prairies to an earlier state, but if the concepts summarized in Charles C. Mann's book *1491: New Revelations of the Americas Before Columbus* are even within shouting distance of reality, the "native prairie" being pursued by some represents a fleeting moment in time created by the destruction of a civilization and the total collapse of its agricultural support system. The "pristine" environment concept, both in the prairies and in the rainforests, may well be wrong. **LON CROSBY, WEBSTER CITY, IOWA**

Most researchers acknowledge that restoring a prairie to a state free of human intervention is impossible. The prairie landscape itself was created by fire and grazing, processes that Native Americans manipulated. Understanding how that landscape was maintained is an active area of study and re-implementing those processes is a cornerstone of prairie restoration. —LESLIE ALLEN

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