

SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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gigantoraptor discovery
genetic clue to breast cancer
a plant knows its siblings
tipping point for mars ocean

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A fluorescence micrograph showing a dense network of neurons. The neurons are stained with green and red dyes, highlighting their complex branching structures against a dark background. The green neurons are more prominent in the upper half, while the red neurons are more numerous in the lower half.

neuron nurseries

NEWBORN BRAIN CELLS MAY TREAT DISEASE

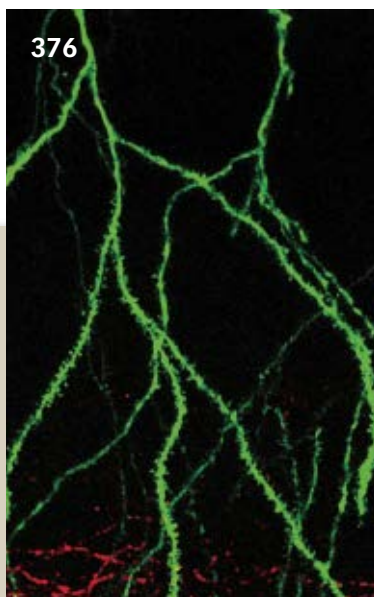
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Cover Newborn neurons (green) grow toward an established brain network (red) in a mouse. Adult mammals constantly generate new neurons, a recent finding that bucks decades of dogma. Drug companies hope to harness the phenomenon to treat a range of brain disorders. (Nicolas Toni, Salk Institute for Biological Studies) **Page 376**

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LETTERS editors@sciencenews.org

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Big and Birdlike

Chinese dinosaur was 3.5 meters tall

Paleontologists have unearthed the remains of an immense, fast-growing dinosaur whose body proportions don't match those predicted by the evolutionary trends that characterize its more diminutive kin.

The creature, one of a group of birdlike dinosaurs called oviraptors, strolled semi-arid river valleys of what is now northern China about 70 million years ago. Aptly given the genus name *Gigantoraptor*, it stood 3.5 meters tall at its shoulder, measured about 8 m long, and probably tipped the scales at about 1.4 metric tons. Other oviraptors weighed no more than 40 kilograms, says Xing Xu of the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing.

Xu and his colleagues recovered most of the creature's limb and tail bones as well as partial remains of its lower jaw and spinal column. When the researchers excavated the first of the creature's enormous bones in April 2005, says Xu, "we first thought it might be from a sauropod," one of the colossal, long-necked dinosaurs that lived in the region at the same time. "Then we thought it might be from a tyrannosaur," he notes.

Characteristics of a variety of bones excavated later indicated that the creature was a bizarre new species, which the team describes in the June 14 *Nature*.

Although the fossils didn't preserve any hints of feathers, Xu speculates that the creature might nevertheless have sported some because many of its smaller relatives did.

The number and spacing of growth rings in one of the creature's leg bones suggest that the dinosaur was about 11 years old when it died. A large number of microstructures produced by a certain kind of mature bone cell indicate that this *Gigantoraptor* was a young adult, says Xu. However, the wide spacing of the last four growth rings recorded in the dense, outermost layer of the bone hints that the creature was still



THAT'S SOME DRUMSTICK In this artist's reconstruction, two 3.5-meter-tall, 1.4-metric-ton *Gigantoraptors* tower over other small, feathered dinosaurs.

growing at the time of its demise, he notes.

Gigantoraptors grew much faster and reached adulthood more quickly than did tyrannosaurs, says Thomas R. Holtz Jr., a vertebrate paleontologist at the University of Maryland at College Park. "There was an incentive [for such a creature] to get big really soon" as a defense against predators such as tyrannosaurs, whose remains have been found in the same sediments, he notes.

The length and proportions of *Gigantoraptor's* leg bones hint at another of the dinosaur's survival skills—its running speed—says Holtz. It "would have been among the fastest dinosaurs of its body size," he speculates.

Among most dinosaurs in the lineage that includes birds, a large body size typically correlates with anatomical features that are less birdlike—including short, stout limbs with relatively short lower-leg bones. *Gigantoraptor* is a big exception to that evolutionary pattern, "so it's really a surprising discovery," says Xu.

"This is one weird dinosaur," agrees Holtz. —S. PERKINS

Breast Cancer Lead

Overactive gene is linked to disease

Researchers have discovered a new breast cancer gene that's overly active in 30 to 40 percent of women with the disease. The high percentage makes the malfunctioning of this gene, called *I-kappa-B kinase epsilon* (*IKBKE*), one of the most widespread genetic traits among breast cancer patients, says William C. Hahn, coleader of the research team at the Broad Institute in Cambridge, Mass.

Most cancer-related mutations are present in less than 10 percent of women with breast cancer, and only a few important ones characterize as much as 30 percent of that population.

The discovery gives drug companies a significant new target for breast cancer drugs. In addition, the study proved the value of a novel way for scientists to screen any kind of tumor for key cancer-causing mutations.

IKBKE is normally active only in immune system cells, where it helps trigger a response to invading viruses. It has no known function in healthy breast cells, but if a DNA mutation causes the gene to become active, it may signal a cell to proliferate out of control.

The team used a three-step screening process to find the gene. First, the scientists injected each of 354 candidate enzymes into normal, cultured breast cells to see which enzymes would induce cancer. Five of them did so. Then the group checked whether the genes that make those five enzymes were overly active in cells taken from tumors in 30 breast cancer patients. Of the genes, only *IKBKE* showed elevated activity, and this occurred in 30 percent of the patients' cancers. The researchers then studied tumors from 200 other breast cancer patients and found the enzyme produced by *IKBKE* in 40 percent of the samples.

In the third step, Hahn's team blocked the gene with a snippet of interfering RNA. With *IKBKE* blocked, the cancerous cells slowly withered and died, indicating that the cells depended on it for survival.

"I actually think [the new study] is a pretty big deal," says Gordon Mills of the M.D. Anderson Cancer Center in Houston. "I doubt that there are many more [breast cancer] genes of this magnitude to be found."

The cancerous cells contained a mutation that produced 5 to 10 extra copies of

IKBKE, but it remains unclear exactly how that mutation happens or what puts a person at risk of it. “We can say they’re amplified or mutated, but we really can’t say why,” Hahn explains.

Developing a drug to target *IKBKE* should be possible, Hahn says, because the enzyme that it produces is a so-called kinase. “Drug companies have a lot of experience at making drugs that can inhibit this class of kinases,” he says. —P. BARRY

Easy There, Bro

A plant can spot and favor close kin

A little beach plant can recognize other plants that grew from its own mother’s seeds, according to experiments on root growth.

Sibling sea rocket plants don’t compete with each other as fiercely as unrelated plants do, reports Susan A. Dudley of McMaster University in Hamilton, Ontario.

Plenty of research in animals has found differences in responses to relatives versus non-kin. Determining what relationships plants can recognize has been murkier. Flowers of many species can tell their own pollen from that of another plant. Root systems grow differently depending on such factors as whether they bump into themselves or the roots of a neighbor, or even whether that neighbor comes from the local community or a far-flung one. And exper-

iments comparing the abundance of seeds produced by plant clusters have in some cases found differences between clumps of kin and clumps of strangers.

To set up a direct test of kin recognition, Dudley and Amanda File of McMaster worked with Great Lakes sea rocket (*Cakile edentula*). This shin-high member of the mustard family thrives on the sandy margins of lakes and along the Atlantic shore.

Dudley and File collected seeds from the beach and planted them in groups of kin or non-kin. The researchers put sets of four seeds either in one container or in a cluster of four smaller containers that held the same total volume of a sand mixture.

When the seedlings reached a phase of vigorous root growth, 8 weeks after planting, the researchers painstakingly washed away the soil and dried and weighed the root masses. They found that unrelated plants growing together allocated about 15 percent more resources to root growth than did plants grouped with their siblings. Plants in single containers that prevented root contact didn’t make that extra allocation, regardless of whether their neighbors were strangers, the researchers report online and in an upcoming *Biology Letters*.

Greater root growth works as a form of competition as plants grab at soil nutrients and water, says Dudley. “It’s like toddlers with cookies.”

The effort put into grabby roots might explain why another lab found clumps of unrelated sea rocket plants less successful at producing seeds than all-kin clumps were, says Dudley. The intense competition among strangers could have drained resources from the non-kin clumps, she speculates.

Ariel Novoplansky of Ben-Gurion University of the Negev in Midreshet Sede-Boker, Israel, who studies self-recognition in plants, says that he’d like to know how Dudley’s plants would have done at

producing seeds. Also, finding the mechanism of this kin recognition “is of utmost importance,” he says.

Ragan Callaway of the University of Montana in Missoula has studied root interactions among desert plants. He praises the “really straightforward, simple” design of the new experiment and says it adds to a growing appreciation among scientists of the complexity of plant interactions. “Plant communities are not just a bunch of populations in the same place,” he says. —S. MILLIUS

Improbability Drive

Focus on rare actions speeds chemical simulations

In *The Hitchhiker’s Guide to the Galaxy*, the book by Douglas Adams, a machine made interstellar travel possible by nudging nature toward extremely improbable, but not impossible, events. A new computer-simulation technique promises to calculate chemical-reaction rates 20 times as fast as before by focusing on chains of events that—on the timescales of molecular motion—are very rare but important.

Computational chemistry uses computers as virtual test tubes. For example, by calculating chemical-reaction rates through simulations based on theory, scientists can predict the performance of potential new catalysts before trying to synthesize them, or they can shed light on phenomena such as the misfolding of proteins that’s believed to cause Alzheimer’s and other diseases.

Molecules move on timescales of femtoseconds, or millionths of a billionth of a second, says Titus van Erp of the Catholic University in Leuven, Belgium. The majority of these fleeting motions don’t lead to interesting events, such as molecules hooking up or breaking apart. “It’s like a movie that consists of hours and hours of boring parts,” van Erp says. “An interesting scene lasts a split second, and then it’s over.”

Simulating the entire movie would require a computer to track the motions and states of dissolved molecules as well as surrounding water molecules. The complexity of that task would overwhelm even the world’s most powerful computers.

Scientists have optimized algorithms to ignore the boring parts and to follow only promising action, such as when water molecules align in a way that facilitates a reaction between two dissolved molecules. On the femtosecond scale, such events are rare, but they’re bound to happen if one waits millions or billions of femtoseconds.

But even chains of events that start out



BEACH CROWD When the Great Lakes sea rocket (*Cakile edentula* var. *lacustris*) sprouts in a cluster of close relatives, it competes at root level less vigorously than it would among strangers.

promisingly often come to dead ends. Water molecules may begin aligning into a favorable configuration only to disperse. Following such dead ends can waste large amounts of computing time.

In van Erp's new approach, the computer begins with a random selection of initial molecular arrangements and follows their development in parallel. When one or more of those scenarios produces a favorable outcome—for example, if the molecules that are supposed to react move significantly closer—the simulation starts over. It throws away the uninteresting scenarios and begins again with several variations of the interesting ones.

Crucially, the algorithm keeps track of what fraction of scenarios it throws away at each stage. That enables it to estimate the reaction rate by calculating what proportion of initial states would end with the molecules reacting.

Van Erp says that his method can reduce the waste of computing time by at least an order of magnitude. He successfully simulated the breakdown of DNA 20 times as fast as existing algorithms can. He reports that feat in an upcoming issue of *Physical Review Letters*.

"It's a very nice piece of work," says Juan de Pablo of the University of Wisconsin-Madison. He adds that calculating reaction rates using simulations has been a challenge for decades and that speeding simulations by an order of magnitude is an important step. —D. CASTELVECCHI

Vaccine Harvest

Cholera fighter could be easy to swallow

By genetically modifying rice plants, scientists have created an edible vaccine that triggers an immune reaction capable of neutralizing cholera toxin, tests in mice show. But the researchers stress that the altered rice wouldn't be sold in stores, grown openly, or be eaten as food. Rather, they envision rice-powder capsules or pills that would deliver the vaccine.

The bacterium *Vibrio cholerae* spreads through contaminated drinking water. In the body, the microbe attaches to intestinal tissues and releases its toxin, which causes severe diarrhea. The ensuing dehydration can be fatal.

To fashion the new vaccine, immunologist Hiroshi Kiyono of the University of Tokyo and his colleagues engineered rice plants to make grains that contain a harmless fragment of the cholera toxin. Over 12 weeks, mice received six doses of this rice in a powdered, uncooked form mixed with water. Other mice got normal rice powder.

The animals getting the vaccine fended off a subsequent oral dose of full-strength cholera toxin, while mice that had received regular rice powder experienced severe diarrhea, the researchers report in an upcoming *Proceedings of the National Academy of Sciences*. Further tests showed that the vaccine induced antibody production in cells lining the intestines, the front line of defense in a cholera infection.

Because the new vaccine could be taken orally, health workers wouldn't need syringes to vaccinate a person, Kiyono says. That would cut costs, avoid accidental needle sticks, and eliminate syringe-disposal problems that accompany current injectable vaccines.

Moreover, the rice containing the vaccine remained unchanged after storage at room temperature for up to 18 months, the researchers report. Tablets or capsules made from such rice would be equally stable, Kiyono predicts. In developing countries, keep-



GLOBAL SCOURGE Countries shown in red reported cholera cases in 2004.

ing vaccine vials in cold storage is expensive and unreliable because of frequent power outages.

The experimental vaccine has other features that make it appealing, says microbiologist Andrew Camilli of the Howard Hughes Medical Institute and Tufts University School of Medicine in Boston. Tests by Kiyono's group show that the toxin fragment resists degradation by harsh stomach acids. And a slightly altered form of this vaccine might prevent diarrhea caused by *Escherichia coli* because that microbe's toxin is similar to cholera's, Camilli says.

However, he notes that the Japanese researchers tested the new vaccine by exposing mice to cholera toxin but not to live *V. cholerae*, which would have more closely replicated actual infection.

Microbiologist James B. Kaper of the University of Maryland in Baltimore says that the composition of the vaccine might limit its potency. "This vaccine would give antitoxin immunity [which] could help contribute to protection by combination vaccines," he says. "But there's no evidence in humans that antitoxin immunity alone would protect" against cholera infection.

Another oral cholera vaccine being tested

in people uses killed bacterial cells to engender immunity (*SN: 12/4/04, p. 366*). That vaccine has shown mixed results in tests in South America, Mozambique, and Vietnam.

Kiyono acknowledges that the genetically modified rice would need to be grown in conditions that keep it separate from normal crops. —N. SEPPA

Shifting Ocean

Tipsy Mars may explain undulating shoreline

By proposing that the Red Planet was tipped halfway over on its side several billion years ago, astronomers this week provide a new perspective on—and new support for—the long-standing notion that Mars once held a vast ocean.

Viking-spacecraft images of the northern lowlands of Mars, taken in the 1980s, showed what appeared to be two ancient shorelines, each several thousand kilometers long. The features resembled those found along coasts on Earth. Researchers suggested that the shorelines enclosed a basin that covered one-third of the planet and was filled with water a few billion years ago.

But in the late 1990s, measurements by the Mars Global Surveyor spacecraft showed that the shorelines weren't all at the same altitude. That surprised researchers, who had assumed that shorelines ought to be level. Some scientists began to doubt whether the Red Planet ever had an ocean.

In the June 14 *Nature*, Taylor Perron of Harvard University and his colleagues suggest a way out of the dilemma. In their model, undulating shorelines are a consequence of a phenomenon that astronomers call true polar wander, in which Mars' axis of rotation slowly drifts in direction. Some 2 to 3 billion years ago, Perron and his team propose, the planet's axis, and therefore its poles, lay 50° away from their current positions. That's a movement of 3,000 kilometers along the surface.

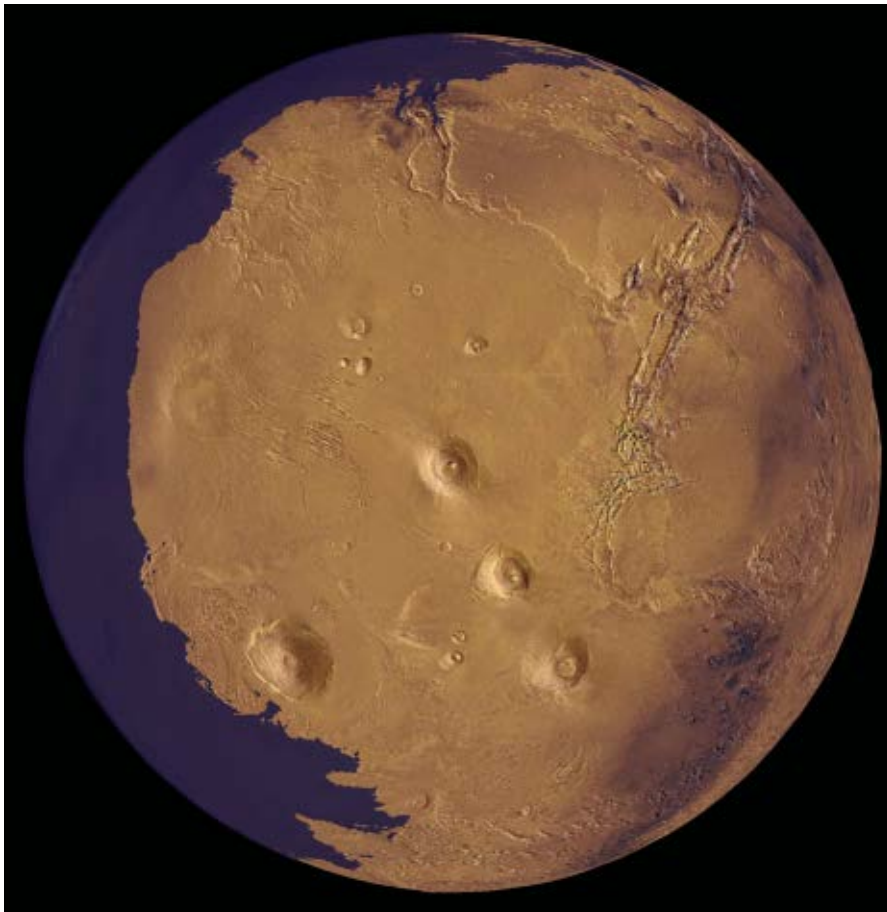
A spinning object tends to flatten at its poles as mass bulges around its equator. As the spin axis drifts, this equatorial bulge also migrates. Perron and his colleagues invoke that effect to explain why the Martian shorelines today have uneven elevations. As Mars' spin axis wanders, the solid surface of the planet would deform and the water level in the ocean would also vary. The shape of Mars' stiff outer shell wouldn't change nearly as much as the ocean's surface and shoreline. The height of the ocean could change by as much as a few kilometers, Perron explains.

"The results could help to resolve some long-standing, uncertain aspects of the interpretation of a former ocean in the northern lowlands of Mars," says planetary scientist Jim Head of Brown University in

Providence, R.I. “This hypothesis makes a number of predictions, such as the formation of an ocean in tropical regions, not high latitudes, that can be further tested during present and future exploration of Mars.”

The team proposes that the 2.5-km variation in one of the shorelines arose when the rotation axis of Mars was pointed 50° away from its current position. Changes in the other shoreline, which has height variations of about 0.7 km, occurred somewhat later, when the axis was tipped by 10°.

That still leaves open the question of why the rotation axis would move in the first place. A large shift in mass, like a volcanic eruption, could cause such a movement. Perron even suggests that the formation of an ocean on Mars could itself have triggered polar wander. Some scientists have proposed that the upwelling of hot material in Earth’s mantle caused our planet to tip completely on its side some 800 million years ago. —R. COWEN



RED PLANET, BLUE OCEAN Mars as it might have appeared more than 2 billion years ago. Researchers propose that an ocean then filled a lowland basin occupying the north polar region, which was tipped significantly from its modern position.

Borderline Aid

Psychotherapy soothes personality ailment

Borderline personality disorder, a psychiatric condition marked by volatile relationships and stormy emotions, has the reputation of being tough to treat. A new study, however, indicates that any of three types of psychotherapy stimulates substantial improvement in people with this disorder.

Psychotherapy that centers on emotional themes arising in the interaction between patient and therapist, known as transference-focused therapy, stimulates the most change in people with borderline personality disorder, according to a team led by psychologist John F. Clarkin of New York Hospital–Cornell Medical Center in White Plains, N.Y.

Dialectical behavior therapy, a currently popular brand of psychotherapy that teaches patients how to control and alter their emotional reactions, also produced good responses, as did supportive psychotherapy that provides basic advice on dealing with daily challenges.

“Contrary to earlier belief in [psychiatry], borderline patients respond to struc-

tured treatments of various orientations with symptom improvement,” Clarkin says. “We now must explore the mechanisms of treatment effects.” The new report is in the June *American Journal of Psychiatry*.

Borderline personality disorder afflicts an estimated 1.3 percent of U.S. adults. Symptoms include intense fear of abandonment, frequent displays of anger, unstable and intense personal relationships, impulsive acts, feelings of emptiness, suicidal threats or acts, and self-mutilation.

Clarkin’s group randomly assigned each of 90 outpatients diagnosed with borderline personality disorder, most of them women, to one of the three psychotherapies. For 1 year, each participant attended one or two weekly sessions with a seasoned therapist.

Overall, patients in each group displayed notable 1-year improvements on measures of depression, anxiety, social adjustment, and overall ability to function in daily life. No one fully recovered from borderline personality disorder, though.

Other measures of success varied across treatments. For example, only transference-focused and dialectical behavior therapy yielded declines in suicide threats and attempts, while only transference-focused and supportive therapy reduced anger and impulsiveness.

Moreover, only transference-focused therapy led to fewer instances of verbal and physical assaults on others and increased patients’ ability to reflect on their own motivations and those of others. Clarkin and his colleagues developed the transference-focused approach, which draws on psychoanalytic concepts (*SN*: 6/9/07, p. 363).

Psychiatrist Glen O. Gabbard of Baylor College of Medicine in Houston calls the work “a landmark study.” Research with larger groups of patients must confirm that transference-focused therapy sparks broader improvement than the other forms of psychotherapy do, Gabbard says.

Other recent findings question whether transference-focused therapy is the best available treatment for borderline personality disorder. An example is a study, published in the June 2006 *Archives of General Psychiatry*, directed by psychologist Arnaud Arntz of the University of Maastricht in the Netherlands.

Arntz and his coworkers studied 88 patients randomly assigned to transference-focused therapy or to schema-focused therapy, which addresses feelings related to past traumatic experiences as well as the patient’s current relationship with the therapist.

After 3 years of twice-weekly sessions, patients in both groups displayed fewer symptoms of borderline personality disorder and reported quality-of-life improvements. Schema-focused therapy yielded bigger changes than transference-focused therapy did, the researchers say. —B. BOWER

PERRON, U.C.; BERKELEY

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The Last Supper, by Leonardo da Vinci, c. 1495-98

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James A. Gray Professor and Chair of the Department of Religious Studies at The University of North Carolina at Chapel Hill. He has won several teaching awards, including the Bowman and Gordon Gray Award for Excellence in Teaching. Professor Ehrman has written or edited 17 books, including the recent bestseller *Misquoting Jesus*.

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BRAIN GAIN

Constant sprouting of neurons attracts scientists, drugmakers

BY BRIAN VASTAG

In the late 1990s, Fred Gage wanted to find a way to see if people, like birds and rodents, continue to produce new brain cells throughout life—a controversial idea at the time. Hearing that Swedish oncologists were injecting cancer patients with a dye that marks rapidly dividing cancer cells, he wondered whether the technique would also highlight newborn neurons in the brain.

When the patients died, Gage, a neuroscientist at the Salk Institute for Biological Studies in La Jolla, Calif., obtained thin slices of their brains. After examining just five of these samples, he knew he was right: The cancer patients had been making new neurons, a process dubbed neurogenesis.

“This was pretty remarkable, because most of these patients were relatively old, and all of them were very sick,” says Elizabeth Gould, a Princeton University neuroscientist who was the first to report neurogenesis in adult primates. “It was a major turning point.”

Gage’s work helped overturn a decades-old doctrine of neuroscience—that we’re stuck with the brains we’re born with. Instead, it turns out that, like skin, bone, and muscle, the brain—or at least certain structures within it—constantly renews itself.

The research explosion that followed Gage’s discovery generated an expansive list of promoters and inhibitors of neurogenesis. Exercise, estrogen, antidepressants, marijuanalike compounds, stimulating environments, and high social status, along with strokes and other injuries, all rev up production of new brain cells. Aging, stress, sleep deprivation, barren environments, and methylphenidate (Ritalin) damp it down.

As scientists begin to grasp the role of newborn neurons in memory, thought, and regulation of body functions, pharmaceutical companies are leaping toward human trials of drugs that boost neurogenesis. Animal studies suggest that such drugs may provide novel treatments for depression and anxiety, Parkinson’s disease, Alzheimer’s disease, stroke, and even overeating and obesity.

LOST BEGINNINGS Studies of neurogenesis date to the 1960s and 1970s, when scientists at the Massachusetts Institute of Technology (MIT) and Boston University found newborn neurons in

certain areas of the brains of adult rats and cats. But in the days before online search engines, this early work faded into obscurity.

“When I was in graduate school in the 1980s, we weren’t taught about adult neurogenesis at all,” says Gould, explaining that researchers had long known that the process existed in youngsters. “I think it was just a classic example of findings and scientists being before their time.”

Renewed attention to adult neurogenesis sprang from two unexpected discoveries. First, Fernando Nottebohm, at Rockefeller University in New York, published sensational reports of fast-growing

brain regions in canaries. The more the birds sang, the more neurons they seemed to sprout, Nottebohm and his colleagues detailed in several seminal papers in the early 1980s.

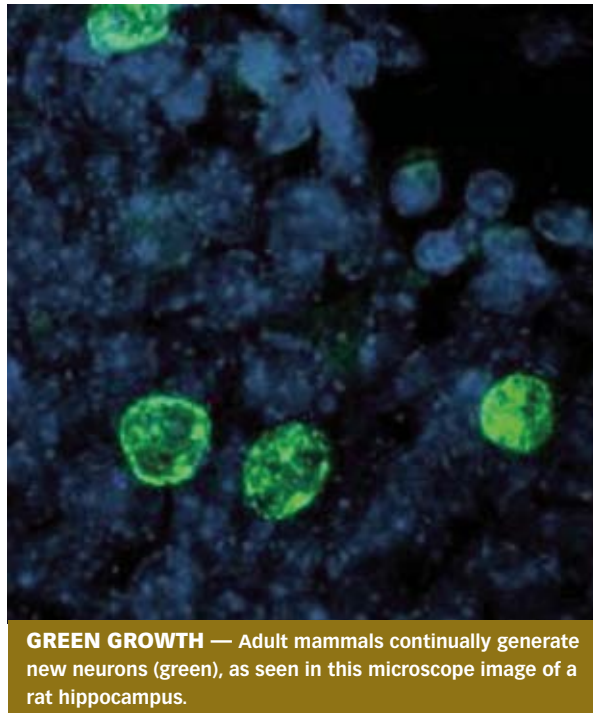
While the work generated widespread interest, most neuroscientists, ignorant of the earlier mammal studies, decided that the phenomenon was a peculiarity of songbirds.

Then Gould, who at the time was working with Bruce McEwen at Rockefeller, revived the idea of neurogenesis in adult mammals. The two were studying the rat hippocampus, a seahorse-shaped part of the brain crucial to memory formation. Removing a rat’s adrenal gland led to massive neuron death in its hippocampus. But in an unexpected twist, the total number of neurons in the hippocampus appeared stable.

Gould and McEwen thought that as some neurons died, others were born.

“It was really an accident in a way,” Gould says of the discovery. “We had this puzzling result that didn’t square with something else we were seeing.” So Gould hit the stacks and dug deep into musty neuroanatomy journals. There, she discovered the MIT and Boston work from earlier decades. Springboarding from those studies, Gould and McEwen reported in 1992 that spikes in stress hormones decreased neurogenesis in rats. Gould then won a professorship in the psychology department at Princeton, launching her career as a pioneering neurogenesis researcher.

OF MICE AND MARMOSETS Meanwhile, Nottebohm continued his work in birds. His team captured wild chickadees, injected them with a radioactive dye that marks dividing cells, and released some of them into the wild. The researchers kept the rest captive. After 6 or more weeks, the team recaptured some of the released birds.



GREEN GROWTH — Adult mammals continually generate new neurons (green), as seen in this microscope image of a rat hippocampus.

The birds that had spent their time flying free had more new neurons in the hippocampus than the birds kept captive did. But Nottebohm didn't know what factor led to the increase in neuron production.

Follow-up work in Gage's lab found that mice living in cages with running wheels—which all rodents will spin for hours every night—made more new neurons than did rodents in identical cages without wheels.

Exercise—whether by wing or foot—spurred neurogenesis, it seemed (*SN*: 2/25/06, p. 122).

Gould then delved deeper into the stress-neurogenesis connection. She and her team set up a colony of marmosets, which are petite primates with funky hairdos. They tested the effects of social stress on neurogenesis by placing marmosets that were unfamiliar with each other in the same cage. Sure enough, the stressed marmosets produced fewer new neurons than did marmosets left on their own. Gage reported similar findings in mice.

In the past 5 years, piles of scientific papers have continued to identify other factors that affect neurogenesis. A bigger picture formed: Nonstressful stimulation and exercise, as well as certain hormones, growth factors, and drugs, speed the birth of neurons, while stress, aging, and sleep deprivation slow the process. Taken together, the recent studies indicate that neurogenesis is “not a genetically preprogrammed process where cells are born and give rise to new neurons at a sort of regular clip,” says Gage. “Instead, there's this concept that [new neurons] are regulated by experience.”

As interest in the field grew, a more basic question came into focus: What does it mean?

“The most central point in the field is what the cells are good for,” says Hongjun Song, a neurogenesis researcher at Johns Hopkins School of Medicine in Baltimore. “We know that all mammals have the new cells. So why do we need them? If we don't have them, what's going to happen?”

THE WHAT AND THE WHERE It turns out that what new neurons do depends on where they end up. Many arise from a reservoir of brain stem cells near the ventricles, the fluid-filled openings in the middle of the brain. Most then migrate to the olfactory bulb on the underside of the brain, where they presumably help in odor detection.

Some researchers say that they've found small stashes of brain stem cells and modest neurogenesis throughout the brain. But those results remain controversial. Only in the ventricles and the hippocampus, especially in a substructure called the dentate gyrus, are researchers confident that brain stem cells regularly spin off new neurons. Given the hippocampus' key role in memory, scientists zeroed in on it from the beginning.

At first, neurogenesis researchers thought that new neurons might simply replace old, dying ones. “But the view is changing,” says Song, “because it's almost impossible for the young cells to make exactly the same connections as the cells [that die]. What we've found, and what other people have found, is that the young cells seem to be different than the old cells. ... The young cells are very plastic, they're very flexible.”

Like babies exploring the world, young neurons in the dentate gyrus spend their first weeks absorbing information that programs them for the rest of their existence, according to a theory Gage and others are developing. If the nascent cells are starved of stim-

ulation, they wither and die. “It seems that something is coded in those [new] cells during that critical period,” says Gage. He says he thinks that this ability makes new information more prominent. Consensus is building that “the new neurons are doing something important for learning,” says Gould. In rodents, for instance, neurogenesis appears crucial for spatial memory, needed in tasks such as remembering how to navigate a maze.

HARNESSING NEW NEURONS Even as researchers uncover how the brain generates new cells and how these cells knit themselves into the brain's networks, companies are already testing compounds for their ability to stimulate neurogenesis.

“If we have new neurons, can we use them to remake [brain] circuitry and to cure disease?” asks Song.

Drugmakers' interest grew in 2000, when a team at Yale University reported that antidepressants such as fluoxetine (Prozac) increased neurogenesis in the hippocampi of rats. The finding helped explain how the drugs work. While antidepressants boost neurotransmitter levels immediately, patients don't feel better for several weeks, which puzzled psychiatrists. But because new neurons don't mature in the hippocampus until several weeks after the start of drug therapy, the Yale team speculated that they may have stumbled on the real way antidepressants work.

A series of follow-up experiments by René Hen and colleagues at Columbia University buttressed the theory. The team treated mice with antidepressants but inhibited neurogenesis by zapping the animals' brains with X rays. Minus neurogenesis, the animals didn't

respond to the drugs.

“[T]hat's what got us convinced that neurogenesis had something to do with the mechanism of action of antidepressants,” says Hen.

Recent work in monkeys lends further support to the idea. In a paper published in the May 2 *Journal of Neuroscience*, a team led by Tarique Perera of Columbia University found that electroconvulsive shock therapy, a last-resort treatment for depression in people, boosts neurogenesis in adult monkeys. The study is the first to show that depression treatment increases neurogenesis in primates.

Researchers are now exploring whether boosting neurogenesis in brain areas other than the hippocampus might benefit patients with Alzheimer's, Parkinson's, and other diseases. “There is increasing evidence that there are dormant [brain stem cells] in different parts of the brain, and with proper stimuli these quiescent cells can be woken up [to] start producing neurons,” Hen says. Whether this will help patients remains unknown.

A Swedish company, NeuroNova, plans to test the idea in people late this year. Using an undisclosed growth factor, the company hopes to induce neurogenesis and other brain changes to restore function in patients with Parkinson's disease. The growth factor will be delivered via a tube directly into the brains of 10 to 20 patients with advanced Parkinson's, says Anders Haegerstrand, NeuroNova's chief scientific officer. “We've done experiments [in animals] where we see an increase in dopamine cells”—a type of neuron—“in the substantia nigra,” he says, referring to the brain structure that degenerates in Parkinson's patients.

But there's a danger. Stimulating too much neurogenesis willy-nilly can cause seizures, says Phyllis Wise, who studies animal models of stroke at the University of Washington in Seattle. In

(continued on page 380)



PLUCKY PRIMATE— A marmoset prepares to leap in a playground filled with ladders and food for foraging. Elizabeth Gould of Princeton University studies the effects of enriched environments such as this one on the brains of mammals.

WILDFIRE, WALLEYES, AND WINE

Latest predictions for life in North America's changing climate

BY SUSAN MILIUS

Considering how much trouble two people have deciding what movie to see, the most remarkable thing about a new set of global-climate predictions may be that it exists at all. More than one hundred nations belong to the Intergovernmental Panel on Climate Change (IPCC), and for the panel to speak, the representatives of all those nations have to agree.

Over the course of this year, the panel will issue a comprehensive report on the state of science concerning climate change, updating the panel's 2001 analysis. The new report, the IPCC's fourth, divides climate science into three areas: the physical processes, their effects, and what people could do about it. Three working groups of hundreds of scientists specializing in the relevant topics have been laboring for 5 years to draft the technical chapters for the epic document.

In April, the panel convened in Brussels to weigh the results from the working group on Impacts, Adaptation and Vulnerability, which considers how global warming has affected people and ecosystems and what is yet to come. The 451 scientists who created the technical chapters had squeezed them down to 1,572 pages. In Brussels, the national representatives had a week to agree on a summary—22 pages, in the end—that they could all accept.

"They [went] over it sentence by sentence," explains one of the working group scientists, Chris Field of the Carnegie Institution in Stanford, Calif. Four days of debate stretched into wrangles that lasted throughout the final night, and IPCC Chair Rajendra Pachauri of the Energy Research Institute in New Delhi, India, confided at the concluding press conference that he was wearing the same clothes he'd put on the morning before.

Yet the parties finally agreed on a summary and accepted the report. It includes more details about regional effects than any IPCC report has had so far. In North

America, as in the rest of the world, the panel says, climate change already shows effects. On the politically explosive topic of agriculture, the panel notes predictions of rising yields for some crops, such as grains in middle latitudes. But the report warns of "major challenges" for crops growing near the warm end of their ranges.

The report also highlights concerns over the availability of water for all uses, and over the greater likelihood of damage from sporadic but huge natural disasters. The world is woefully underprepared for the effects of climate change, says the IPCC. One of the biggest themes to emerge from the report is an urgent need to think about adapting to the risks that are already upon us.

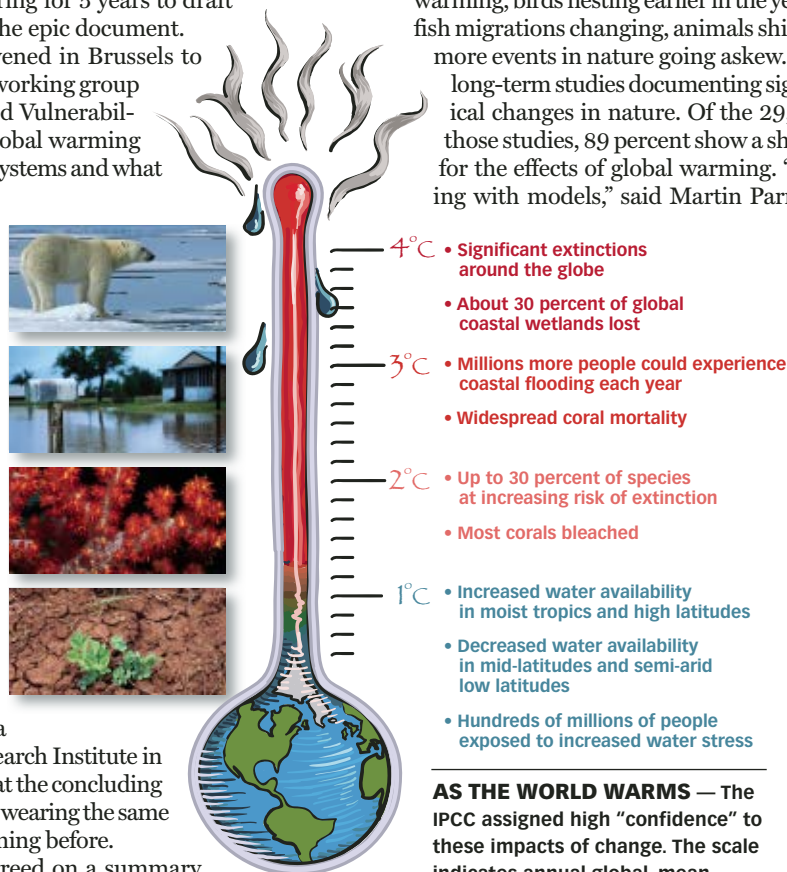
SO FAR Climate change isn't just about the future anymore. The summary begins by emphasizing a flood of new evidence documenting the effects that climate change has already produced.

That's evidence "from all continents and most oceans," says the summary. Numerous studies show glaciers melting, permafrost warming, birds nesting earlier in the year, leafbuds popping sooner, fish migrations changing, animals shifting their ranges, and many more events in nature going askew. The summary highlights 75 long-term studies documenting significant biological and physical changes in nature. Of the 29,000 sets of observations in those studies, 89 percent show a shift in the direction predicted for the effects of global warming. "We're no longer hand-waving with models," said Martin Parry of the United Kingdom's

Department for Environment, Food and Rural Affairs, cochair of the IPCC impacts group, as he unveiled the consensus summary.

"There are some good examples from North America now," says Linda Mortsch of Environment Canada in Waterloo, Ontario. She and Field worked as coordinating authors for the technical chapter on climate impacts in North America. This chapter is now getting its final editing, with release currently scheduled for this summer. But Mortsch and Field are already talking about its contents.

Like the summary, the North American chapter starts with what's already happened. For example,



AS THE WORLD WARMS — The IPCC assigned high "confidence" to these impacts of change. The scale indicates annual global-mean temperature change from the 1980-1999 mean.

daily observations from satellites starting in 1981 show that spring has been turning Canada and the continental United States green earlier and earlier. By 2000, the region was greening up 10 to 14 days earlier than it had 19 years before then.

Ground-level data, meanwhile, show that lilacs advanced their first blooms by about a week between 1959 and 1993. Honey-suckle in the western United States has started blooming 3.8 days earlier per decade, while in the northeastern United States, apples and grapes have been opening their leaves about 2 days earlier per decade.

Animals furnish many more such examples. Fifteen out of 23 butterfly species in lowland California are taking off for their first flight of spring an average of 24 days earlier than they did 31 years ago. In northern Canada, red foxes have pushed north, driving back Arctic foxes.

CROP FUTURES Having established that changes are already under way, the IPCC impacts group went on to consider what will probably happen if people don't curb greenhouse-gas emissions. Debate has burned especially hot over agriculture. Seizing on predictions that crop yields will rise, at least under certain scenarios, some political factions and business interests have touted the benefits of climate change.

It's probably not going to be that simple. In North America, the IPCC says, "moderate change in the early decades of the century is projected to increase aggregate yields of rain-fed agriculture by 5 to 20 percent but with important variability among regions." But the summary warns that results will vary by region, especially for crops that depend on fought-over water supplies.

That mixed message is for mid-and-higher latitudes only. The summary says that nearer the equator, rises of even 1° to 2°C are expected to decrease crop productivity.

Within North America, climate change will push different crops in different directions. For the early decades of this century, most studies predict that warming will boost yields of major cereal crops, such as corn, rice, soybeans, and wheat, some 5 to 20 percent. On the other hand, a study of 12 crops in California hasn't shown a consistent trend one way or the other, says Field. He and Carnegie Institution colleagues David Lobell and Kimberly Cahill have shown that temperature rises can explain some improvements in yield among the state's orange groves. Avocado yields, on the other hand, have trended downward.

The IPCC report likewise refers to a complex story in the wine grapes of California, citing work by Ramakrishna Nemani of the University of Montana in Missoula and his colleagues. During the period from 1951 to 1997, the average annual temperature in the Napa-Sonoma region rose a modest 1.13°C. Most of that change came from warmer nights and earlier spring warming. Those tweaks lengthened the growing season by 65 frost-free days. The humidity increased, too, and the summer temperatures turned milder and more grape friendly. Thus far, the researchers conclude, warming trends in the coastal region have brought good fortune to premium-wine vineyards.

Further warming may not be so kind. Some grapes already grow under optimal conditions, and more climate change will probably undermine their performance. For example, bringing just a little more humidity to the California coast raises the risk for grapevine diseases. Growers are already fighting an intensifying wave of

Pierce's disease, a bacterial vine killer spread by the glassy-winged sharpshooter, a highly mobile insect typically killed by frost.

Field sums up the situation by saying that many tree and vine crops may not fare as well as the big cereal crops will. Grain farmers can choose from a range of varieties, and the plants' short life span, just a season from seed to harvest, allows flexibility in tailoring crops to changing climate. But grapes and other woody plants can take years to yield, so growers can't rip them out and replace them in one season. And these crops rarely come in alternative varieties that would better tolerate changed conditions. "I'm more worried about our iconic crops, like maple sugar or California wine," says Field.



BURNING UP — During the past 30 years, the western United States' wildfire season has lengthened by 78 days, according to research cited in the latest international report on the impacts of climate change. This water drop is on a fire this March in Los Angeles.

DRINKING PROBLEMS The future of crops in North America depends in large part on the future of water, and that's worrisome, says the IPCC report. Across the region, farmers, developers, shippers, conservationists, and others already wrangle over water. Climate change and drying regions will put these antagonists' interests into even sharper conflict.

Picking highlights from all climate-change impacts on North America, the IPCC panel chose to comment first on water supplies in the continent's western mountains. With "very high confidence," says the report, scientists predict that warming will decrease the snowpack blanketing the mountains in the winter, increase the flooding in winter and spring as precipitation shifts from snow to rain, and reduce the water flows out of the mountains in the summer.

For land and people sustained by water from these mountains, the report predicts shrinking snowpacks "exacerbating competition for over-allocated water resources." Taking the Columbia River as a case study, the report cites studies predicting that

water flows will swell in winter and spring but dwindle in summer and fall. At the same time, a rising population is dependent on the river's water. Current projections for Portland, Ore., say that by the 2040s, population growth alone will raise the city's thirst for the Columbia's water by 20.8 million cubic meters per year. On top of that, a 2°C temperature rise translates into an extra 5.7 million m³ a year of water use by residents, while shrinking the supply by some 4.9 million m³ a year.

Changes in river flow could stymie well-intentioned efforts to solve environmental problems, warns Mortsch. Energy planners call for switching to more hydropower to reduce carbon emissions, but that energy source will dwindle if river flows weaken. Lower water flow also means less dilution of pollutants. Research at the Bay of Quinte in Lake Ontario suggests that a drop in flow could increase a river's average phosphorus concentration 25 to 35 percent.

Water temperatures will rise, too, with repercussions for fish that need cool water. The report notes that Lake Ontario is both warming and falling in volume, changes that have already shrunk the habitat for the lake's cherished walleye. Brook trout in Canada will also suffer as water warms, and they may disappear from half of their current habitats by the year 2050, according to work by Cindy Chu of the Great Lakes Laboratory for Fisheries and Aquatic Sciences in Ontario and her colleagues.

And don't ignore frozen water. The IPCC report notes that natural snowpacks will shrink but that snowmaking could cushion the shock for the ski industry in western North America. The \$27-billion-per-year snowmobiling industry, however, remains at the mercy of natural flakes.

BIG BAD BLIPS One of the big changes in thinking that the new IPCC report captures, says Field, is “an increased appreciation” of extreme events. It’s not enough to talk about climate change in terms of upticks and downturns in average conditions, he says: “Hurricane Katrina occurred halfway through our writing.” Much of the impact from climate change will come not from average conditions but from disasters that exact sudden and huge tolls on people, property, and ecosystems.

Field clarifies that he’s not laying the blame for Katrina or any other specific coastal storm on global warming. Still, these calamities show vividly how much damage extreme events can bring.

A warming climate means dry horrors as well as wet ones. For example, “it’s clear that risks from wildfires are sharply rising and very, very sensitive to climate change,” says Field.

As the climate warms, summer lingers and gives potential wildfire fuel an extra toasting, the new report says. It notes calculations that the wildfire season in the western United States during the past 30 years has expanded some 78 days. Substantial fires—those that scorch more than 1,000 hectares—have gone from burning an average of nearly 8 days to burning for 37 days. Between 1987 and 2003, fires burned nearly seven times the area of western-U.S. forests as they did from 1970 to 1986.

Even if the world doesn’t burst into flames, heat still kills. “It’s

really striking how many people die of heat-related causes,” says Field. The European heat wave of 2003 killed tens of thousands of people, and North America is far from immune to such disasters. The new report cites estimates that by the end of the century, the frequency of heat waves in Chicago will have increased by 25

percent. Los Angeles’ current dozen-or-so typical heat wave days will grow as to as many as 95 a year.

The emphasis on disasters raises another big point, says Field. “Doing something” about climate change has typically meant reducing carbon emissions. That’s vital, but it’s not enough, he says. Disasters are already on the way, and preparations for them—what the new report lumps into the term *adaptation*—have been spotty and weak.

“People look at their portfolio of protection, and they say, ‘Well we have reasonable building codes, and we have reasonable distribution of insurance,’” says Field. That kind of thinking, he warns, relies on preparations for disasters past, and won’t necessarily address disasters of the future. He also predicts that insur-

ance will become less consoling as people face the magnitude of impending risks. “Until disaster strikes, you feel like insurance is a good way to protect yourself. After it strikes, you say, ‘You know, a stronger levee would have been a good idea.’”

The main problem, though, is to get people thinking about what to do, he says. “As we look at the history of adaptation in North America, in some ways, the biggest risk is complacency.” ■



EARLY BLOOMERS — Climate change has already left fingerprints on North American plants. For example, lilacs advanced their first blooms 1.8 days a decade between 1959 and 1993.

(continued from page 377)

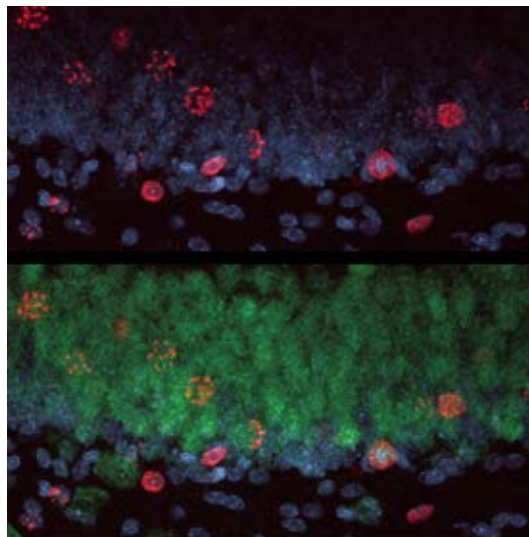
animal models of epilepsy, seizures induce rapid growth of new neurons, which in turn seem to feed further seizures. “Not all neurogenesis is necessarily good,” says Wise. “It has to be controlled.”

Another company, Brain Cells Inc., founded by Gage, Hen, and other scientists, is planning a clinical trial of a new antidepressant later this year. The company’s scientists discovered the compound with a test that screens for neurogenesis. “Many, many big pharmaceutical companies, as well as small start-ups, have identified this [test] as something they can use” to find new brain drugs, says Gage.

In addition to depression and Parkinson’s disease, animal research suggests that enhancing neurogenesis may have some value in treating Alzheimer’s disease and even obesity. One mouse study published in 2005 found that treating fat rodents with a brain-growth factor spawned new neurons in the hypothalamus, which serves, among other functions, as an appetite regulator. Treated animals lost substantial weight.

The trouble with human studies, according to Hen, is that no one knows exactly what brain changes contribute to observed outcomes. Neurogenesis may be just one process among many that allow the brain to adapt. Antidepressants may indeed drive neurogenesis, but a host of other brain changes, such as denser connections among neurons, could also help explain how the drugs work. In her

experiments with marmosets, Gould keenly monitors this synaptogenesis as well as neurogenesis, because she’s interested in how social interactions change the brain as a whole. And because human brains can’t be readily sliced and stained to reveal new neurons, “we really need some good imaging techniques,” Hen says.



SEA OF GREEN — New neurons (red) integrate an existing network of mature neurons (green), as seen in this microscope image from a rat hippocampus.

A paper published in the March 27 *Proceedings of the National Academy of Sciences* brings that wish a step closer. The study, led by Scott Small of Columbia University, found that, in mice that exercised, increased blood flow in the brain indicated neurogenesis. Using magnetic resonance imaging scans, the team then saw the same increased hippocampus blood flow in people who exercised. “We’re relying on inference to say that what we’re seeing probably reflects neurogenesis in humans, but there’s no way to know with certainty,” Small says.

Says Gould: “A good imaging technique would do wonders for the whole field.”

In the meantime, Gould and her colleagues are basking in the glow that comes from overturning scientific dogma. “When we had our first abstract at the Society of Neuroscience meeting in the early 1990s, there was no session for us,” says Gould. “Now I see session after session of just adult neurogenesis. It’s really amazing. There’s a lot of data pouring in.” ■

BEHAVIOR

Mental letdown for antipsychotic meds

Antipsychotic medications spur surprisingly little improvement in the mental prowess of people with chronic schizophrenia, a national investigation finds. Patients who were prescribed any of several new antipsychotic drugs, often touted as effective at boosting thinking skills in people with schizophrenia, displayed only modest increases in mental agility during the first 6 months of treatment.

The drugs' effects were no better than the effects of an older antipsychotic substance, according to a team led by psychologist Richard S.E. Keefe of Duke University Medical Center in Durham, N.C.

After 18 months, patients receiving the older drug actually showed slightly more improvement on a battery of learning, memory, attention, and reasoning tests than did patients getting the newer antipsychotics, the scientists report in the June *Archives of General Psychiatry*.

The study's volunteers, ages 18 to 65, had been taking antipsychotic drugs for schizophrenia at clinical sites throughout the country. Participants randomly received the old drug—perphenazine—or one of the new ones—olanzapine, quetiapine, risperidone, and ziprasidone.

Testing of mental skills occurred before the study began and after 2 months of drug treatment for 817 patients, after 6 months for 523 patients, and after 18 months for 303 patients. —B.B.

FOOD & NUTRITION

Nutrients linked to brain lesions

Physicians, nutritionists, and health magazines advocate increased consumption of calcium and vitamin D. Together, the nutrients build strong bones, while vitamin D offers a bevy of benefits on its own—from fighting cancer to improving people's gums. The aging brain may not share in those benefits, however.

In a new study, greater consumption of either nutrient correlated with more and bigger brain lesions in elderly volunteers.

"I'm talking about damage that you can see in white matter or gray matter of the brain," explains study leader Martha E. Payne of Duke University in Durham, N.C. "We think these lesions are due to a lack of oxygen to [affected] areas," she reported May 1 at the Experimental Biology meeting in Washington, D.C.

As part of a long-term study on late-life depression, Payne's group administered dietary questionnaires to 232 people and did magnetic resonance scans of their brains. Most participants were over 70 years old but didn't necessarily have depression.

Everyone had lesions, which typically develop with age. However, after accounting for factors associated with a greater risk of lesions, such as high blood pressure, the researchers found that the degree of damage generally tracked the elderly people's intakes of calcium and vitamin D.

The damage occurred in regions "important in mood regulation," Payne says.

Payne cautions that it's too early to conclude that either nutrient actually causes brain lesions. —J.R.

BIOMEDICINE

Right combination of malaria drugs?

Children in Uganda recover from malaria faster when taking an herb-based combination therapy than when given standard drugs, solidifying the herbal drugs as frontline treatments for malaria in Africa.

Artemisinin is made from the leaves of the Chinese wormwood shrub (*SN: 2/7/04, p. 94*), and the drugs artesunate and artemether are derivatives known to kill the parasites that cause malaria.

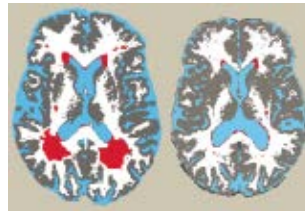
Researchers monitored the health of 601 children for up to 19 months. During that time, 329 came down with malaria caused by the protozoan *Plasmodium falciparum*. The scientists randomly assigned some of these kids to get one of the artemisinin derivatives in combination with longer-acting drugs. Others received pills combining sulfadoxine and pyrimethamine, an old, inexpensive therapy still used extensively in Africa (*SN: 11/11/06, p. 307*).

Only 7 percent of children getting the artemether combination failed to recover within a month, compared with 17 percent of those getting the artesunate combination

and 26 percent receiving the sulfadoxine-pyrimethamine pills, Philip J. Rosenthal of the University of California, San Francisco and his colleagues report in the May 23/30 *Journal of the American Medical Association*. In light of earlier results, the researchers are confident that the artemisinins are the greater contributors to the combinations' success.

Unlike the case for chloroquine and most other antimalarials, "there's probably no resistance to the artemisinins in Africa," Rosenthal says. "We used chloroquine for 50 years. ...

Now, we're clearly settling in with the artemisinin combination therapies as our new answer." —N.S.



SPOTTED Red zones highlight brain lesions—notable in scan at left and minimal in scan on right—imaged in magnetic resonance scans during a study of diet and the brain.

ENVIRONMENT

Age and gender affect soot's toxic impact

From second to second, blood vessels must alternately constrict and dilate to regulate blood flow. That ability can diminish markedly in rodent vessels exposed to an oily constituent of diesel soot, researchers report.

The team took arteries from rats' thighs and exposed them to the soot chemical phenanthraquinone.

Vessels came from female rats that were 6, 14, and 24 months old—comparable to girls approaching puberty, women in their reproductive years, and women over 65 years of age. Half of each age group of animals had undergone ovary-removal surgery, lowering their production of sex hormones and simulating that of postmenopausal women. Vessels of male rats 6 and 24 months old were also tested.

The soot agent rendered vessels from 24-month-old males and from all females without ovaries unable to dilate, says study leader Timothy R. Nurkiewicz of the West Virginia University School of Medicine in Morgantown. In 6-month-old males and 14-month-old females with ovaries, phenanthraquinone reduced dilation by 65 percent. Only the youngest females showed no vessel impairment from the chemical.

Such findings reinforce the need to consider age and gender when evaluating the toxicity of pollutants, says Nurkiewicz. He presented the findings May 1 at the Experimental Biology meeting in Washington, D.C. —J.R.

American Geophysical Union
Acapulco, Mexico
May 22 – 25

CLIMATE

Dust Bowl affected midwestern climate

During the 1930s, immense clouds of dust wafting over the Great Plains blocked so much sunlight that temperatures there were significantly lower than normal during summer months, a new analysis suggests.

From 1930 to 1938, an extended drought transformed the central United States into the Dust Bowl of popular legend. That dry spell, like many others that have struck the United States, occurred during a lengthy La Niña, when sea-surface temperatures in the central Pacific were cooler than normal (*SN*: 8/10/02, p. 85).

Travis A. O'Brien, a climatologist at the University of California, Santa Cruz, and his colleagues used a computer model to estimate the effect of airborne dust on the midwestern climate. To create the appropriate weather patterns in their simulations, the researchers forced their model to follow the sea-surface temperatures recorded throughout 1988, when a strong La Niña occurred and a major drought struck 40 percent of the United States. One simulation allowed dust to lift off the parched ground if winds were strong enough. In another simulation, dust stayed on the ground, regardless of wind speed, says O'Brien.

When dust went airborne, it kept at least 15 percent of the sunlight during June, July, and August from reaching the ground throughout a swath of land stretching from northern Texas to North Dakota.

Those dust clouds substantially cooled the underlying landscape, the researchers found. Across large areas of Oklahoma and Kansas, the average temperature at Earth's surface during the summer months was more than 1°C lower during the dusty simulation than in the dustfree scenario. —S.P.

EARTH SCIENCE

Darker days during Arctic summer

Satellite observations of Earth indicate that Arctic regions reflected less sunlight into space in the summer of 2006 than in other recent years. That change could contribute to the warming of Earth's climate.

Sensors on board NASA's Terra satellite have been observing Earth's surface since May 2000, says Roger Davies, a climate physicist at the University of Auckland in

New Zealand. By analyzing those data in 36-day sets, Davies has identified seasonal trends in the planet's albedo, the percentage of sunlight that it reflects into space.

Between 2000 and 2005, the albedo during any given season remained about the same, says Davies. In May and June of 2006, however, albedo fell significantly in comparison with the same months in previous years. In particular, regions north of 55°N—approximately the latitude of Copenhagen and the southern part of the Alaskan Panhandle—had darkened enough to decrease Earth's average albedo from 31 percent to 30 percent.

One small mystery: Sea ice coverage during the Arctic summer has dramatically decreased throughout the past decade, but changes in albedo didn't show up until last year. It's possible, Davies says, that the effect of replacing large areas of white sea ice with dark, open water was masked by clouds before 2006—an issue that he is now researching. —S.P.

BIOLOGY

How sea turtle hatchlings know where to crawl

Field tests suggest that newly hatched sea turtles need a variety of senses, not just sight, to find their way to the ocean.

The female black sea turtle (*Chelonia agassizi*) buries her eggs in sand 100 meters or so from the shoreline. As soon as the hatchlings emerge, they head for the water. Most previous studies of how these young creatures find their way into the surf have focused on the role of visual cues such as moonlight, says Gabriel Gutiérrez-Ospina, a neurobiologist at the National Autonomous University of Mexico in Mexico City. However, the results of his group's experiments now suggest that other senses help the turtles set off in the right direction.

The 15 turtles in the experiment's control group, which were allowed to crawl across the beach unhindered, made the 120-m trip in an average of just over 15 minutes, says Gutiérrez-Ospina. During the nighttime experiments, researchers set bright lights along the paths of another 15 turtles. Apparently attracted to the lights, the hatchlings veered off course, and none reached the ocean within 20 minutes. Likewise, hatchlings whose eyes were covered with patches or whose nostrils were

temporarily plugged with dental wax didn't make it to the sea in that time, says Gutiérrez-Ospina.

Twelve of 15 hatchlings with weak magnets glued atop their heads made it to the sea within 20 minutes. However, no turtle adorned with a magnet strong enough to mask Earth's magnetic field reached the surf within the same period.

The team's results suggest that hatchling turtles rely primarily on sight to reach the sea but also use their sense of smell and their ability to discern Earth's magnetic field, says Gutiérrez-Ospina. The findings also suggest that those supplementary senses don't ensure successful navigation when visual clues are absent or distracting, the researchers note. —S.P.

CLIMATE

Trouble for forests of the northern U.S. Rockies?

Climate change expected to occur in the coming decades may cause forests in northern stretches of the U.S. Rockies to stop absorbing carbon dioxide and even to release some to the atmosphere, exacerbating the planet's warming.

Trees pull carbon dioxide from the air as they grow. Much of the carbon from that gas is stored in wood and foliage, but some ends up in material littering the forest floor and in the underlying soil. From there, it can make its way back into general circulation, says Céline Boisvenue, an ecologist at the University of Montana in Missoula.

She and her colleague Steven W. Running used computer models to estimate how three climate-change scenarios might affect carbon storage at forest sites in Idaho, western Montana, and northwestern Wyoming.

The good news: By 2089, the growing season in the forests will be at least 3 weeks longer than it was in 1950. The bad news: Over that same period, higher temperatures will cause the trees to suffer water stress—slowing or stopping their growth—for an additional 8 weeks each year. Even under a climate scenario with higher precipitation than at present, trees will have insufficient water for 54 more days each year in 2089 than they did in 1950.

By the year 2020, under a scenario with reduced precipitation, dieback of trees and decomposition of leaf litter at three of the six studied sites will cause the forests to emit more carbon dioxide than they absorb. By the year 2070, the forests at five of those sites will be net producers of carbon, says Boisvenue. —S.P.

Books

A selection of new and notable books of scientific interest

THE SILENT DEEP: The Discovery, Ecology, and Conservation of the Deep Sea

TONY KOSLOW

The deep ocean was once thought to be a lifeless abyss. Within the past 50 years, however, improved exploration techniques have revealed, at depths below 200 meters, a habitat that's teeming with life. Koslow chronicles the history of deep-ocean exploration, from a late-19th-century expedition to present-day, high-tech exploration of deep trenches.

He explores the question of how so many species reside in a place that would seem hostile to living things. He also explains the science of tectonic movement and of hydrothermal vents. Finally, Koslow analyzes the human impact on the deep sea. Its remoteness and vastness once made it seem the perfect dumping site for sewage, toxic chemicals, and even nuclear waste. However, such pollutants are building up in the deep water and in the animals that live there. He ends his book with proposals for protecting this vast, intriguing ecosystem. *Univ. Chicago Press, 2007, 270 p., color plates and b&w illus., hardcover, \$35.00.*

GUANXI (The Art of Relationships)

ROBERT BUDERI AND GREGORY T. HUANG

As U.S. companies feel more and more competitive pressure from enterprises in countries such as China and India, many people worry about the U.S. economy. However, Redmond, Wash.-based computer-software-giant Microsoft has found a way to tap into Chinese talent while remaining at the forefront of information technology. Buderer is a research fellow at the Massachusetts Institute of Technology's Center for

International Studies, and Huang is a science and technology writer. They describe Microsoft's 1998-founded, Beijing-based lab called Microsoft Research Asia and recount how its wealth of top young Chinese minds has produced many of Microsoft's latest achievements. Microsoft founder Bill Gates set about recruiting employees for this new lab by offering them the opportunity to work on cutting-edge technology while remaining in their native country. So far, Microsoft has invested \$100 million and hired 400 of China's best and brightest computer scientists. *Simon & Schuster, 2007, 306 p., b&w plates, paperback, \$16.00.*

THE BIRDS OF COSTA RICA: A Field Guide

RICHARD GARRIGUES AND ROBERT DEAN

For the nature lover fortunate enough to vacation in Costa Rica—and for all lovers of beautiful birds—comes this up-to-date, comprehensive field guide to more than 820 native and migrant birds to be found in that country. From the distinctive pink spoonbill

to the colorful trogons and toucans, Costa Rica is home to a remarkably diverse population of birds. Garrigues, a birding guide in Costa Rica, and Dean, an illustrator, provide information for both experienced and novice birders alike. Each page of this compact book is devoted to a different species, listing basic behavioral information and important physical features. Colorful corresponding images highlight plumage differences among juvenile, male, and female birds.

Each set of illustrations is accompanied by text listing the species' common name, scientific name, and identifying markings for a birder to look for. Also included is a range map for the species, indications of each bird's size, and a few words about the bird's habits and anatomy. *Cornell, 2007, 387 p., color images, paperback, \$29.95.*

F5: Devastation, Survival, and the Most Violent Tornado Outbreak of the Twentieth Century

MARK LEVINE

On April 3, 1974, nature unleashed a storm of epic proportions that spawned, within a 16-hour period, 148 tornadoes from Michigan to Mississippi. Six of those storms were ranked F5, the highest level of destruction on the tornado-intensity scale, called the Fujita scale. From a broad perspective, magazine writer Levine tells the history of tornado forecasting and thunderstorm research, describes how tornadoes are born and what factors intensify and sustain them, and recounts how Tatsuya Fujita developed a

way to measure the storm's intensities. To humanize his story, the author focuses on the frightful F5 storm that struck in Limestone County, Ala. The cast of characters includes two high school sweethearts, a pastor, a lineman for the electric company, and the county's sheriff. Levine's compelling narrative documents both panic and heroics by these and other townspeople and disaster responders. He follows up with the story of subsequent efforts to restore normalcy to Limestone County. *Miramax Books, 2007, 307 p., hardcover, \$25.95.*

THE RICHNESS OF LIFE: The Essential Stephen Jay Gould

STEVEN ROSE, ED.

The late scientist and Harvard professor Stephen Jay Gould became a household name through the wit and intelligence of his science writing. In this book, Rose has compiled 44 essays from Gould's major books, his prodigious essay series in the magazine *Natural History*, other articles, and speeches. Gould's primary academic focus was evolution, particularly his concept of punctuated equilibrium—now an influential viewpoint among evolutionary theorists. The collection covers this area but also includes autobiographical writings, biographies of other scientists, and Gould's wide-ranging musings. Rose and the book's foreword author, Oliver Sacks, offer this collection as a tribute to a unique wordsmith and scientist. *Norton, 2007, 653 p., b&w illus., hardcover, \$35.00.*

LETTERS

Bigger picture

Reading "Pictures Posing Questions: The next steps in photography could blur reality" (*SN: 4/7/07, p. 216*), I was struck by the similarity between the image that used a cone-shaped mirror and the images you get from gravitational lensing. As the same data are available in both types of images, it ought to be possible to process gravitationally imaged objects in a way to reconstruct their 3-D shapes under certain circumstances.

ROBERT BRAUNSTEIN, RESTON, VA.

Old news

The existence of ancient proteins is no surprise. Evidence of remnants of durable, skeleton-associated proteins such as collagen are not uncommon in the fossil record long before *Tyrannosaurus rex* ("Ancient Extract: *T. rex* fossil yields recognizable protein," *SN: 4/14/07, p. 228*). For example, remains of bivalve ligaments are known from the mid-Ordovician, over 400 million years ago. Other durable but pliable organic materials, such as protist resting cysts, are important parts of the Precambrian fossil record, up to 2 billion years old.

DAVID CAMPBELL, UNIVERSITY OF ALABAMA, TUSCALOOSA, ALA.

House of cars

I was interested to read that running portable generators caused carbon monoxide poisoning, presumably by improper fuel burning ("Even outdoors, generators pose risks," *SN: 4/14/07, p. 237*). A good solution to this problem is to use a generator that is designed for much lower emissions. I use my Toyota Prius as an emergency generator that can power my house! It can deliver 3 kilowatts cleanly, efficiently, and continuously, and many more kilowatts on peaks as needed for starting motors in appliances, the well, and the furnace. As hybrids become more popular and prevalent, getting emergency power from your car will be a lot easier and safer than using the ubiquitous portables.

RICHARD FACTOR, KINNELON, N.J.

Not measuring up

The title of "Wanted: Better Yardsticks" (*SN: 4/21/07, p. 251*) exemplifies the problem. By law, the official and preferred system of measurement for all U.S. activities is SI, or the modern metric system. We too often forget that a gram of prevention is worth three kilograms of cure. Education reform at all levels needs to model and teach SI units.

SCOTT M. KRUSE, FRESNO, CALIF.

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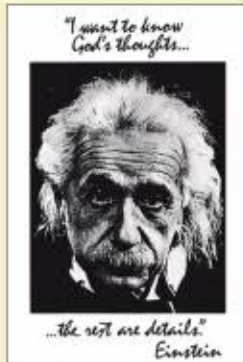
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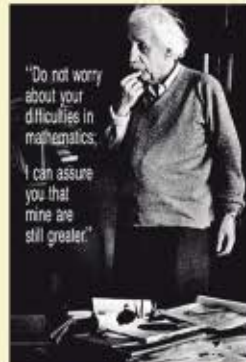


"You Are Here" Poster

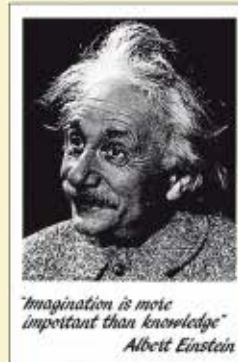
This poster depicts a beautiful galaxy with an inset picture of the earth on it. The wording in the bottom right hand corner is by Carl Sagan, excerpted from a public lecture given on October 13, 1994, at Cornell University. It starts out "Look at that dot." There is a symbol on the galaxy showing where the earth is approximately located in the Milky Way. This poster gives us some perspective of our place in the cosmos. Size: 24" W X 36" L, Laminated, Order #JPT-1348, Cost: \$16.95



Einstein's Gods Thoughts poster
"I want to know God's thoughts... the rest are details." Size: 24" W X 36". Laminated. Order #JPT-1643, \$15.95; 2 for \$30



Einstein's Difficulties in Math poster - "Do not worry about your difficulties in mathematics; I can assure you that mine are greater." Size: 24" W X 36" L. Laminated. Order #JPT-1914, Cost: \$15.95; 2 for \$30



Einstein's - "Imagination is more important than knowledge." Size: 24" W X 36" L. Laminated. Order #JPT-1911, Cost: \$15.95; 2 for \$30 All three Einstein posters Order # JPT-einstein, Cost \$45

Sterling Silver Meteorite Pendant



The meteorite in this pendant is a NWA 869 (North West Africa). It is among the prettiest class of common chondrite meteorites and is a L-5 type chondrite. Size: 1" x 1" Comes with braided silver chain - 20" long, information and authenticity. Order #JPT-1064 \$85.00, Also available in gold, Order#JPT-1165, Cost \$265

Mind Molecules Poster



Mind Molecules Poster

19 mind molecules are represented on this highly informative poster. Entries are: caffeine, nicotine, ethanol (alcohol), ephedrine, heroin, amphetamine, diazepam and many more. Each has a graphic molecular representation with key, information on its action in the body and addiction level. Laminated. Size: 24" W X 36" L; Order #JPT-7770, Cost: \$16.95; 2 for \$30-Order#JPT-7730

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Moon Boxed: Order #JPT-1818
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Size: 3 1/4" X 4 1/4"

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Size: 3 1/4" X 4 1/4"

Sumerian Medical Tablet



Sumerian Medical Tablet

Reproduction of the earliest known prescription written in cuneiform. A detailed booklet comes with the tablet and gives a translation and history. The original was found a Nippur (c. 2100 B.C.). Size: 6" X 3" X about 3/4" thick. Comes with an adjustable walnut wood easel stand. Order # JPT-sumer, Cost: \$69.95

Mesopotamian Legal Tablet



Mesopotamian Legal Tablet

Our other ads featured the Medical Tablet - This is a Legal Tablet, Size 4 1/4" L X 2 1/2" W. Replica, Dates 1860 B.C.E. Comes with information and stand Order # JPT-legal, Cost: \$65; Sumerian Medical Tablet, Order #JPT-legal; Cost: \$65.95



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Libyan desert glass is thought to have been made by the action of an asteroid or comet impacting the sand in the Libyan desert and causing it to vaporize into these beautiful droplets of glass. This unique glass was found as the centerpiece in the breastplate in King Tut's tomb. This glass is only found in the Great Sand Sea of the eastern Sahara desert and with a silica content of 98 percent, is the purest known glass in the world! Comes with information, authenticity, with matching chain and black velvet jewelry box. Each piece is unique. Prices range from \$230-\$520. Order JPT-Libyan. Limited quantity. See different pieces on website.

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