SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

MARCH 15, 2008 PAGES 161-176 VOL. 173, NO. 11

sharper view of brain at work

latest stats from the early universe

shooting down blood pressure

alligators use lungs swimmingly

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acid test

CHANGING OCEANS CHALLENGE MARINE LIFE

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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Cover The pink polyps (species in the South China Sea viewed close-up) of corals are likely to have an increasingly hard time constructing a reef as rising carbon emissions change ocean chemistry. (iStockphoto) Page 170

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

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

MathTrek Mathematicians say that spoil proofing elections would take a change in voting procedures.

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

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

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

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

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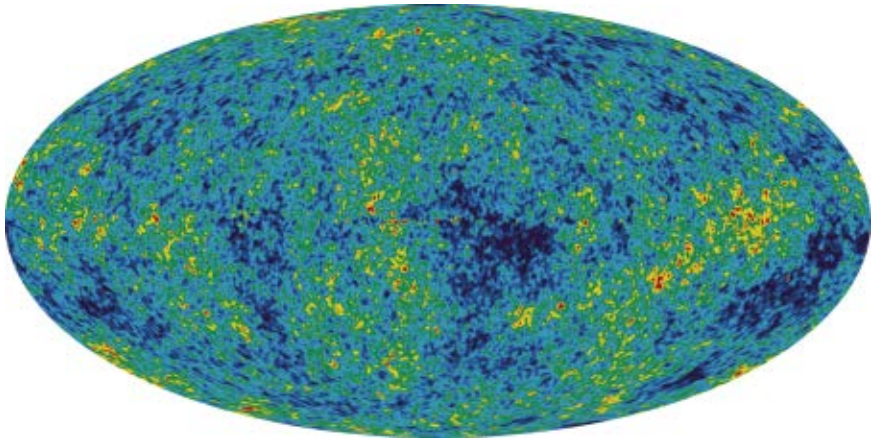
State of the Universe

Microwave glow powers cosmic insights



WMAP SCIENCE TEAM

MICRO MAP Temperature fluctuations (red denotes hottest, blue coldest) in the remnant radiation from the Big Bang reveal density variations that were seeds of galaxies. A scheduled launch of the Planck mission will hone the resolution of this WMAP picture.

New observations of the oldest light in the universe have enabled astronomers to determine the age of the cosmos with unprecedented precision, infer the existence of a vast sea of neutrinos, and better gauge the start and duration of the long-ago era when the first stars switched on.

The findings come from an analysis of 5 years of observations of the cosmic microwave background—the radiation left over from the Big Bang—using NASA's Wilkinson Microwave Anisotropy Probe (WMAP).

The glow was generated at the birth of the universe, but WMAP sees the radiation as it appeared when the universe was about 380,000 years old. That's when the cosmos became cool enough for electrons and ions to combine into neutral atoms, releasing the radiation these charged particles had trapped. A snapshot of the early universe, the radiation is riddled with regions slightly hotter or colder than average—markings of the primordial lumps that grew into galaxies and galaxy clusters. The microwave background also carries the fingerprints of what it has encountered during its multibillion-year journey to Earth.

By using WMAP to measure the size of the hot and cold spots as they appear on the sky today, along with knowledge of their size when the radiation was first released, researchers have pegged the age of the universe to 13.73 billion years, give or take 0.12 billion.

According to theory, immediately after the Big Bang, positrons and electrons collided and annihilated, producing both photons and vast numbers of nearly massless elementary particles called neutrinos. The neutrinos would have slightly smoothed out variations in the microwave background. For the first time, WMAP data reveal just such a smoothing. "Had we not seen this, it would have implied that that was something missing in our understanding of the first second after the Big Bang," says WMAP scientist David Spergel of Princeton University.

He and his colleagues unveiled their findings last week in online articles.

The team also more accurately determined when the first stars were born. Soon after those stars turned on, they emitted enough ultraviolet light to reionize the universe, stripping atoms of their electrons. These electrons created a thin fog that scattered the microwave background radiation and polarized it. WMAP measurements indicate that the first stars began to shine when the universe was no older than 430 million years. Combined with ground-based surveys of ancient quasars, the findings also indicate that reionization was an extended process, lasting for half a billion years.

Universal Stats

Age of the universe	13.73 billion years
Universe contents	
Dark matter	23.3 percent
Ordinary matter	4.6 percent
Dark energy	72.1 percent
Maximum age when stars began reionizing universe	430 million years

That provides a guide for future telescopes—such as Hubble's proposed successor, the James Webb Space Telescope—as to "when in time they need to begin looking for the first stars," says Spergel.

The results provide "another milestone in precision cosmology," comments theorist Max Tegmark of the Massachusetts Institute of Technology. Though the findings mostly confirm previous results based on 3 years of WMAP data (*SN: 3/18/06, p. 163*), the added precision is critical for testing models for the origin of the universe and the formation of galaxies, says Nick Gnedin of the Fermi National Accelerator Laboratory in Batavia, Ill. —RON COWEN

Roll Up Your Sleeve

Hypertension vaccine passes early test

A new vaccine lowers blood pressure in hypertensive people, a study shows. The finding breaks ground in a field dominated by drug therapy.

Surges in blood pressure make physical exertion possible, but chronically elevated pressure spells trouble. Scientists have entertained the idea of immunizing people against high blood pressure for decades, but it hasn't been easy. The only other vaccine to reach the testing stage in people failed to reduce blood pressure.

A vaccine may augment or offer an alternative to blood pressure medications, known to cause side effects.

Several compounds orchestrate blood pressure changes, including a small protein called angiotensin. When cleaved by an enzyme, angiotensin signals blood vessels to constrict, increasing pressure.

Researchers created the new vaccine by binding angiotensin to a harmless fragment of a virus. The protein "is then recognized by the immune system as a virus," says study coauthor Martin Bachmann, an immunologist at Cytos Biotechnology in Schlieren, Switzerland. The immune system makes antibodies against angiotensin and pulls it out of circulation.

Bachmann and his colleagues gave 48 people with mild-to-moderate high blood pressure three injections of the vaccine over 12 weeks. Some received higher doses than others. Another 24 volunteers received sham injections. All patients used devices that monitored their blood pressure regularly day and night.

Two weeks after the last shot, those getting a higher dose of vaccine averaged systolic

(top number) blood pressure that was 9 points less than those getting the placebo shots, the researchers report in the March 8 *Lancet*. The diastolic (bottom number) reading dropped only 4 points, a difference that could reflect chance.

However, compared with the sham-injection group, participants getting the higher vaccine dose had reductions of 25 points for the systolic reading and 13 points for the diastolic during early morning, when their risk of stroke is highest.

The antibodies circulate in the body for 17 weeks, less time than most vaccines.

The biggest problem doctors face in treating hypertension is patients' failure to take their pills, says Sheila Gardiner, a cardiovascular physiologist at the University of Nottingham, England. The vaccine approach might offer convenience, she says. "It's definitely better than taking pills day after day."

And though the blood pressure decrease may seem small, Gardiner says, even 5 points in the diastolic reading decreases the risk of heart failure and stroke by one-third.

It remains unclear whether the vaccine could engender a reaction against one's own tissues, says Ola Samuelsson, a nephrologist at Sahlgrenska University Hospital in Göteborg, Sweden. He expects pharmaceutical companies to conduct long-term tests that might answer that question.

The vaccine doesn't appear to be 100 percent effective, he says, and that's just as well. Some angiotensin in circulation would allow blood pressure to crank up in case of trauma. —NATHAN SEPPA

Common Age

Worms, yeast, and people share genes for aging

Genetic changes that slow aging in roundworms also keep the lowly baker's yeast from going rapidly over the hill, new research shows. Humans have many of these same genes, and drugs targeting them might eventually turn back our own biological clocks.

Aging shouldn't be an evolved trait, with common genes shared by distant species, many scientists once reasoned. Most animals pass on their DNA long before aging takes its toll. And throughout much of life's history, animals were likelier to die from starving or being eaten than from growing old, says biologist Brian Kennedy, who led the study.

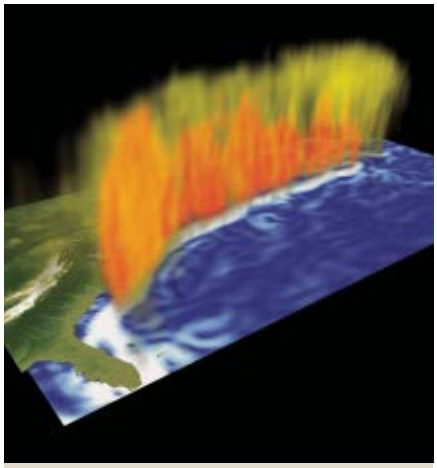
But recent research on aging in yeast, flies, and worms has turned up a smattering of genes that lengthen life span when removed. More than 1 billion years of evolution separates yeast and roundworms.

Kennedy and his colleague Matt Kaeberlein, both of the University of Washington in Seattle, scoured journal articles for genes tied to long life in the roundworm *Caenorhabditis elegans*—a popular animal used to study aging. The researchers identified 276 worm genes that enhance longevity when deactivated, then tested to see if deleting them might slow aging in yeast as well.

Kennedy and Kaeberlein's team found 25 aging-related genes shared by yeast and worms; 22 of these genes had not previously been linked to life span in yeast. Humans have 15 of the genes, the team reports in the April *Genome Research*.

A surprisingly high number of the genes are involved in cells' response to nutrients, Kennedy says. Cutting calories can boost life span in nearly every organism, from yeast to Labrador retrievers. "The things that govern aging are really closely linked to the amount of nutrients in the environment," he says. In times of feast, organisms grow fast, live hard, and die early. With less grub around, an animal might focus on protecting its cells from the damage that spurs aging, he says.

Nutrition explains why yeast, worms, and people have the same aging genes, agrees Pankaj Kapahi of the Buck Institute in Novato, Calif. Studying less complex organisms offers a quick way to home in on genes involved in aging—and possible treatments. "A lot of people don't think yeast aging has anything to do with human aging," he says. "This really dispels that belief." —EWEN CALLAWAY



Weather maker

The North Atlantic's Gulf Stream affects the overlying atmosphere more strongly than previously suspected. Surface waters of the 100-kilometer-wide current (white, with Florida bottom left) can be significantly warmer than those nearby, says Shoshiro Minobe, a climate scientist at Hokkaido University in Sapporo, Japan. High-resolution satellite images reveal that the atmosphere over the Gulf Stream hosts thunderstorms and stronger convection more often than the surrounding ocean, Minobe's team reports in the March 13 *Nature*. The team's model suggests that the curtain of rising air over the current (orange depicts upward wind velocities as high as 40 centimeters per second, yellow shows slower speeds) reaches 8-km altitudes and may influence weather in Europe. —SID PERKINS

Gator Aids

Gators squish lungs around to dive and roll

Alligators turn out to have an unappreciated power organ for maneuvering underwater: their lungs.

Four sets of muscles in the lower part of the gator torso clench during particular phases of diving and rolling, says T.J. Uriona of the University of Utah in Salt Lake City. These moves squeeze the lungs around in the body cavity, changing buoyancy and tipping the animal's body this way and that.

"The big picture is that lungs are probably more than just breathing machines," Uriona says.

Gators use an unusual variety of muscular gadgetry to operate their lungs. For example, a big muscle connects their liver to bones at the base of the torso. This liver piston pulls down viscera and helps draw air into the chest. When the muscle relaxes, the organs rise again, helping press air out of the lungs. Yet when researchers sever this muscle, young alligators still breathe, moving and growing seemingly as well as intact animals, Uriona says.

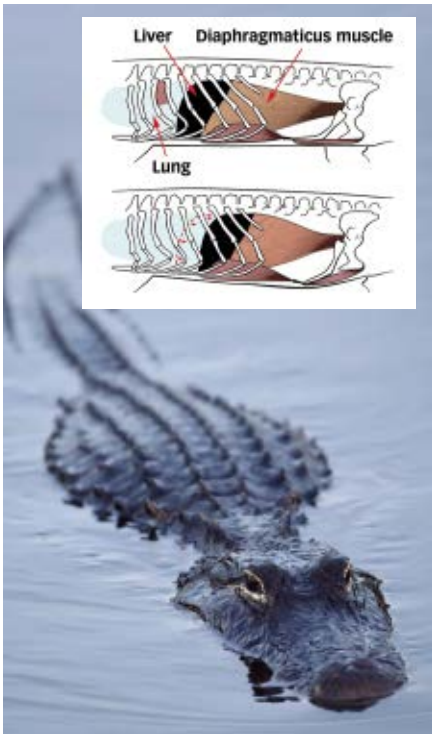
To look for other functions of these supposed respiratory muscles, Uriona and Utah colleague C.G. Farmer implanted electrodes in the muscles of five young alligators. When the animals dived underwater, the electrodes showed four muscle groups tensing during the downward swoop. The motions pull the lungs back toward the tail, seeming to incline the animal downward, Uriona says.

To test the idea, the researchers duct-taped lead shot to the animals' tails. When the weighted animals swooped, the muscles worked harder. Weighting animals' noses, to make a downward dive easier, prompted less muscle activity.

For rolling animals, only one side of the big muscles fired, squeezing the lungs to buoy the upward side.

Buoyancy control could have been the

F. ARAKI AND S. KAWAHARA/ESC JAMSTEC



AIR BAGS An alligator contracts and expands muscles around its lungs to breathe (inset) and move underwater. When the large muscle contracts (inset, bottom), it pulls the liver toward the tail, helping the lungs inflate or shift position to tilt the body for diving.

first underwater function for these muscles, with respiratory assistance coming later, the researchers suggest online in the current *Journal of Experimental Biology*.

"This is very cool," says biomechanicist Frank Fish of West Chester University in Pennsylvania. The discovery fits into his work on alligator death rolls, in which the animal grabs prey and spins on its long axis. In spite of sensational tales of alligators drowning prey with rolls, Fish says he thinks gators mostly use the move to rip a swallowable chunk of meat off a carcass. Fish's high-speed films reveal that a rolling gator kinks up its tail but doesn't paddle with its legs during the roll. "It's like a figure skater tucking in the arms to spin faster," he says. Lung squeezing could help keep a gator rolling.

Now that Uriona knows what to look for, he says, he is finding similar respiratory muscle moves in snapping turtles and African clawed frogs. —SUSAN MILIUS

Small Wonders

Tiny islanders elevate 'hobbit' debate

Randy Newman once jokingly sang that "short people got no reason to live." But he never met the extinct, half-sized humans found in the South Pacific that, long after their deaths, have now entered a heated scientific debate. The debate began over a previous set of fossils found in Indonesia and hailed by their discoverers as a new species of scaled-down human ancestors.

A team led by paleoanthropologist Lee R. Berger of the University of the Witwatersrand in Johannesburg, South Africa, found thousands of human bones in two caves in Palau, Micronesia, in 2006 and 2007. These remains belonged to people who stood roughly 1 meter tall, Berger's group estimates. Radiocarbon measurements indicate that Palau's diminutive denizens lived between 2,900 and 1,400 years ago.

Archaeological evidence already suggested that Palau's initial settlers arrived 3,000 years ago or slightly earlier.

No one disputes that the Palau fossils are *Homo sapiens*, but there is plenty of debate over whether this designation fits the Indonesian finds. The new fossils do exhibit many, but not all, of the unusual skeletal traits reported for *Homo floresiensis* individuals—commonly referred to as hobbits—that once lived on the Indonesian island of Flores. Palau lies about 1,200 kilometers northeast of Flores.

Palau and Flores fossils share comparably small statures, large teeth oriented at unusual angles, reduced chins, and small faces. Preliminary estimates based on cranial and facial fragments suggest that brain sizes of the Palau individuals fell at or just below the bottom of the normal range of modern human brain sizes. Hobbit brains were chimpanzee-sized.

Precise brain-size estimates for the Palau finds await the painstaking removal of hardened sediment from inside relatively complete skulls.

The new finds, described online March 11 in *PLoS ONE*, don't rule out separate species status for *H. floresiensis*. However, "the Palau fossils support at least the possibility that the Flores finds are simply an island-adapted population of *H. sapiens*, perhaps with some individuals expressing congenital abnormalities," Berger says.

Other scientists argue that a partial Flores skeleton represents a pygmy *H. sapiens* with unusual traits that resulted from a genetic growth disorder, such as microcephaly (*SN: 11/18/06, p. 330*).

Peter J. Obendorf of RMIT University in Melbourne, Australia, and his colleagues agree. The Flores skeleton shows evidence of a nonfunctioning thyroid gland, probably because of prenatal nutritional deficiencies, Obendorf's group suggests in a paper published online March 5 in *Proceedings of the Royal Society B: Biological Sciences*. This condition, known as cretinism, leads to short stature and reduced brain size.

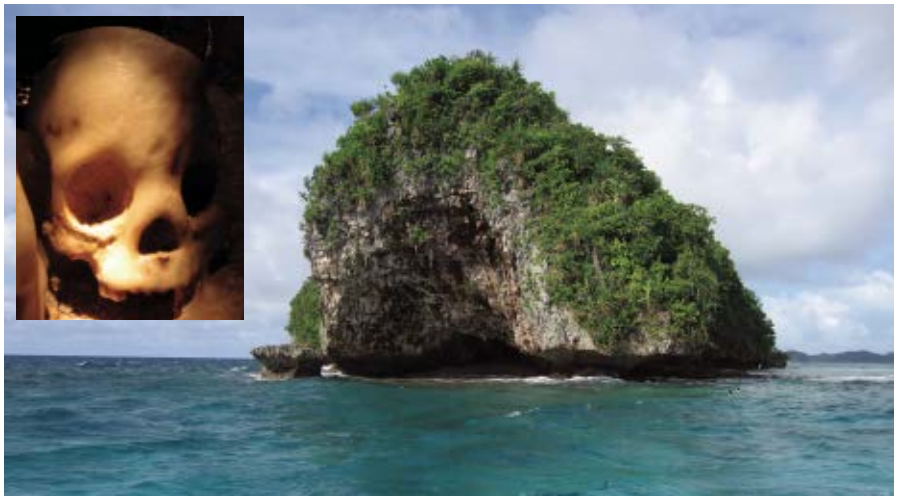
Obendorf's hypothesis "makes me wonder what a cretin or a microcephalic would look like in the Palau sample," Berger says. "It might not be identical to the hobbit skeleton, but perhaps it would look a lot like it."

No way, responds anatomist William L. Jungers of Stony Brook University School of Medicine in New York, a leading proponent of hobbits as a separate species.

H. floresiensis displays a unique body design marked by unusual limb proportions, apelike brain size, and primitive jaw, wrist, and shoulder anatomy, Jungers says.

Moreover, pygmies currently living in the Philippines and elsewhere are as small as or smaller than the "fragmentary, unassociated skeletons" from Palau, and they don't qualify as hobbits, he adds.

No one expects the hobbit debate to cool off anytime soon, remarks anthropologist Robert B. Eckhardt of Pennsylvania State University in University Park. Still, Eckhardt says the Palau discoveries support his argument that the Flores skeleton comes from a pygmy *H. floresiensis* with a growth disorder. —BRUCE BOWER



ISLE BE BACK This South Pacific cave has yielded bones of extinct, meter-tall people, including a skull filled with hardened sediment (inset), that have fueled debate over so-called hobbit fossils from Indonesia.

ISTOCKPHOTO; INSET: FARMER, D. CARRIER, S. NORCROSS; BERGER/UNIV. WITWATERSRAND

Dual Role

Painkiller may affect brain

A class of drugs being developed to stop pain could also obstruct memory formation. The new painkillers aim to block molecules that respond to burning sensations, like those delivered by chili peppers, camphor, and heat from a fire. Those molecules, found on sensory nerve endings, are known as TRPV1 receptors. Blocking those receptors could help with everything from migraines to dental agony.

But TRPV1 blockers could also affect the brain, researchers report in *Neuron* this week. TRPV1 receptors are also found in the hippocampus, a brain region critical for learning and forming habits.

Researchers led by Julie Kauer at Brown University in Providence, R.I., found that, in rats, manipulating TRPV1 receptors in the hippocampus interferes with the strength of signaling at synapses, the junctions between neurons. When TRPV1 is artificially activated, the signals between neurons weaken, the researchers found. If TRPV1 is blocked, the signals between neurons remain strong. Proper patterns of synapse strengthening and weakening—the process known as synaptic plasticity—are essential for learning and memory.

"It's kind of a miracle that no one's found TRPV1 [receptors] in plasticity before," Kauer says.

The researchers also found that the TRPV1 receptor could be activated by the antiobesity drug rimonabant (sold in Europe as Acomplia).

Rimonabant was developed to block cannabinoid receptors, known to trigger the classic cannabis munchies. Studies have shown that rimonabant reduces weight and also waist circumference, but the U.S. FDA rejected the drug last year because of reports about depression and suicide in some patients.

Kauer wonders whether TRPV1 is responsible for such side effects, although she notes that people would need high doses of the drug to block TRPV1 receptors in the brain.

Raj Padwal of the University of Alberta Hospital in Canada thinks that Kauer's study won't do much to sway the FDA. "This study quantifies mechanisms of risk, but not the degree of risk," says Padwal.

More disconcerting, says Kauer, are painkiller drugs that have been specifically designed to hit TRPV1 receptors. Pain-wise, rodents immune to burning sensations indicate that the drugs are doing their job. But Kauer worries that subtle psychological and cognitive effects might go unnoticed in the rodents.

On the positive side, TRPV1's dual role opens possible avenues for novel therapies for cognitive disorders such as epilepsy, Kauer says. —AMY MAXMEN

Tomorrow's Stars

Intel Science Talent Search honors high achievers

As is fitting for a member of the MySpace generation, Shivani Sud has the individual in mind. She developed a model for assessing a person's genetic profile, first to determine individual risk for recurrence of colon cancer and then to tailor a treatment regime. Sud's research won her the top prize Tuesday in the Intel Science Talent Search: a $100,000 scholarship from the Intel Foundation. The 17-year-old from Durham, N.C., received her award at a black-tie gala in Washington, D.C., honoring the Talent Search finalists.

Second place and a $75,000 scholarship went to Graham Van Schaik, 17, of Columbia, S.C. Inspired by working in his grandmother's garden, Van Schaik investigated the persistence of pyrethroids, a class of pesticides, on tomatoes. He also designed two experiments tracking effects of the pesticides on breast cancer cells and nerve cells.

Brian McCarthy, 18, of Hillsboro, Ore., created several thin polymer films that respond to light, materials that could become part of a cheaper alternative to silicon-based solar cells. His chemistry project won him third place and a $50,000 scholarship.

This year's 40 finalists, hailing from 19 states and 35 high schools, were winnowed from more than 1,600 entrants.

Society for Science & the Public (formerly Science Service), which publishes *Science News*, has administered the competition since its inception in 1942.

"The Intel Science Talent Search 2008 finalists personify what drives American ingenuity," says Elizabeth Marincola, president of Society for Science & the Public. "Society for Science & the Public is proud to join with Intel in congratulating Shivani Sud and all of this year's finalists. We are inspired by their dedication to science, and are encouraged by what the quality and depth of their work foretells for our continued innovation and economic prosperity."

Fourth place went to Katherine Banks, 17, of Brooklyn, N.Y., for a mathematical proof for the number of lattice points inside polygons with nine vertices. Eric Delgado, 18, of Bayonne, N.J., won fifth place for developing a strategy to disable a pump that bacteria use to flush antibiotics out of their cells. Sixth place went to David Rosengarten, 18, of Great Neck, N.Y., for his model of galactic rotation in the fifth dimension. Each of these students won a $25,000 scholarship.

Seventh through 10th place winners each won a $20,000 scholarship. They are:

Xiaomeng (Jessica) Zeng, 18, of Iowa City, Iowa, who found a positive relation between government and private funding of public libraries.

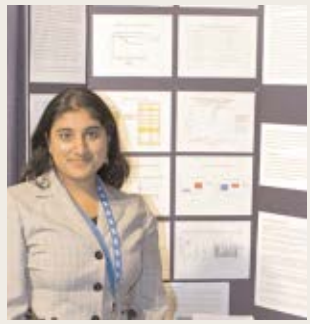
Philip Mocz, 18, of Mililani, Hawaii, who created a statistical algorithm for discovering hidden patterns of nearby stars.

Alexis Mychajliw, 16, of Port Washington, N.Y., who found that female dragonflies and damselflies prefer meadows, while males tend to hang out in wetlands, suggesting that both habitats are crucial.

Evan Mirts, 18, of Jefferson City, Mo., who used a scanning ion-conductance microscope to investigate light-induced changes in spinach chloroplasts. Traditional methods for studying chloroplasts often destroy the sample.

Each of the remaining 30 finalists won a $5,000 scholarship and a laptop computer.

"These 40 students show what American youth can do when they are encouraged to study math and science," says Intel Chairman Craig Barrett. "In this presidential year, their stories should send a strong message that this critical foundation for innovation must be supported." —RACHEL EHRENBERG



TO EACH HER OWN **For research that brings a tailored approach to colon cancer treatment, Shivani Sud won the talent search's top prize.**

S. NORCROSS

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Next-generation MRI scans offer a sharper picture of the brain's inner workings

BY EWEN CALLAWAY

The test subject lies on his back, legs stretching from the tunnel-shaped brain scanner. Flat-screen computer monitors fill the cramped control room for the MRI machine. The subject watches one screen, where phrases flash, such as "Jesus is the son of God," "God puts good and evil everywhere," and so on.

"We're doing a study on religion in the brain," says the technician at the National Institutes of Health (NIH) in Bethesda, Md.

Another monitor reveals a black-and-white cross section of the subject's brain. The picture refreshes every few seconds. The image is mostly a blur, but some smears appear brighter, others darker. It's the brain on religion.

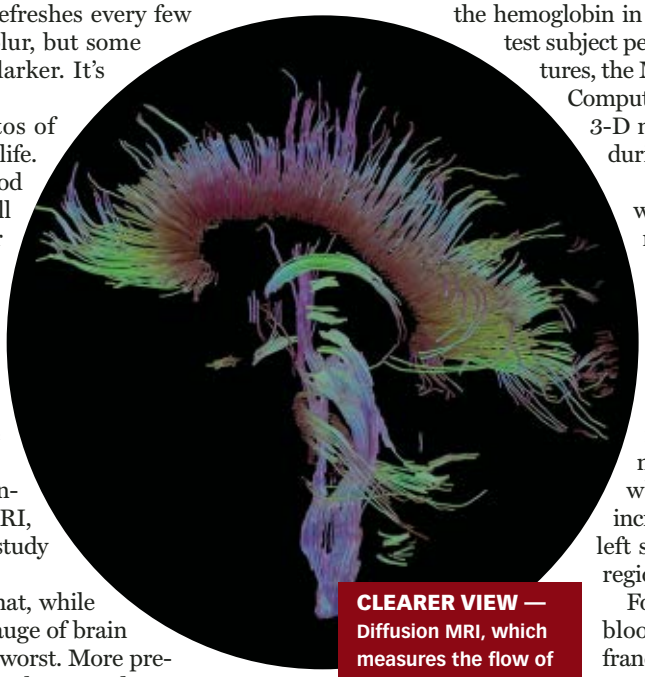
The scanner isn't taking photos of brain cells contemplating the afterlife. Instead, the snapshots capture blood flowing to the cells. Scientists call this measurement BOLD—short for blood-oxygen level-dependent. More blood equals more thought, the theory goes. Combined with traditional MRI (magnetic resonance imaging), the technique has revolutionized neuroscience, providing tantalizing glimpses into the biology of cognition.

Scientists call this method of scanning a brain at work functional MRI, or fMRI. Today, nearly every fMRI study relies on blood flow.

However, many scientists say that, while useful, blood flow is an indirect gauge of brain activity at best, and misleading at worst. More precise measures of the mind will offer clearer and more complete pictures of human and animal brains at work.

"Using BOLD to study how the brain works is a little bit like feeling different parts of a computer—feeling how hot they are—and trying to understand how it works based on that," says Alan Jasanoff, a neuroscientist at the Massachusetts Institute of Technology and a leading proponent of the budding field of bloodless MRI. He studies chemicals that brighten the magnetic signal revealed by an MRI scanner. Other researchers hope to tap the minuscule electric currents that flow through neurons, while still others hunt for subtler physiologic changes.

Although still in its infancy—and flush with ideas but short on results—bloodless MRI will someday usher in a sea change in our understanding of the brain, its proponents say. The new techniques could provide more detailed maps of brains, illuminate the connections between distant regions of the brain, and diagnose diseases like Alzheimer's.



CLEARER VIEW — Diffusion MRI, which measures the flow of water molecules, can reveal connections between the brain's left and right halves.

T. SCHULTZ/MPI INFORMATIK IN SAARBRÜCKEN, GERMANY

LEAKY PIPES Early efforts to map the human brain were as invasive as they were primitive. In the 19th century, scientists linked form to function by dissecting the brains of deceased patients. Surgery offered another window into the mind, as physicians prodded brains. Gentler techniques, such as electroencephalography (EEG) and positron emission tomography (PET) emerged, but suffer other shortcomings. PET releases radiation that is potentially dangerous, and EEG only picks up superficial waves.

Functional MRI seemed like the perfect solution. It is noninvasive and measures brain activity via blood flow with the same machine that diagnoses a badly sprained ankle. The scanner generates an enormous magnetic field tuned to physiologic signals—the hemoglobin in blood, for instance. Then, while a test subject performs a task, such as viewing pictures, the MRI scanner records brain activity. Computers translate the whole affair into a 3-D map, indicating which areas lit up during the task and which dimmed.

Invented in the early 1990s, fMRI was slow to catch on. But the technique eventually became a blockbuster among neuroscientists, says the NIH's Peter Bandettini, an early pioneer who has undergone thousands of scans himself.

In an early experiment, Bandettini alternately tapped his left and right fingers while lying in the scanner. A movie captured the effect: A white smudge, where blood flow increases, jumps between the right and left sides of his motor cortex, a brain region responsible for movement.

For all its usefulness, fMRI measures blood flow, not electricity, the lingua franca of neurons. "The first time I went to an MRI meeting I felt like an electrician in a plumbers' convention," says Nikos Logothetis of the Max Planck Institute for Biological Cybernetics in Tübingen, Germany.

Another common gripe against BOLD is the lag between electrical brain activity and blood flow, Jasanoff says. Tap a finger, and neurons in the motor cortex pulse. Blood soon flows through capillaries to the cells in the motor cortex, but the BOLD signal peaks when blood courses through bigger vessels and subsides several seconds after the initial finger tap. This delay means that when several regions of the brain light up in succession, the BOLD signal might mask the order of activation.

"If you think about what you do with your brain, you would agree that 5 seconds is actually an infinity," Jasanoff says. Imagine driving a car with a 5-second lag between seeing a curve and turning the steering wheel.

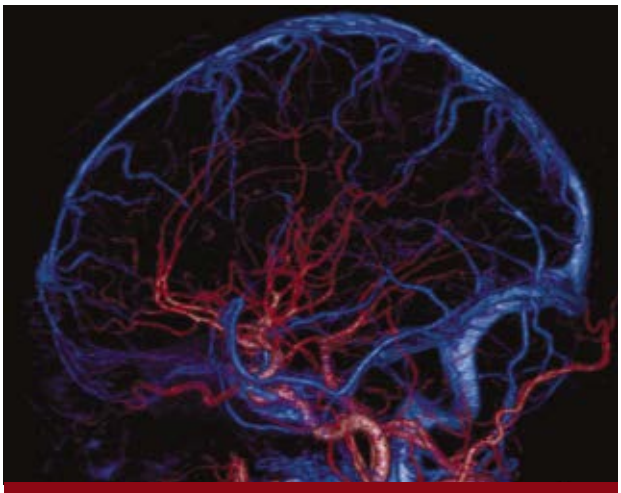
The spacing of blood vessels creates another problem with linking blood flow to brain activity. Because vessels form a loose net around tightly packed neurons, researchers have trouble distinguishing signals from brain cells that are less than a millimeter apart.

Perhaps an even bigger drawback of BOLD may be when it lies. Some brain cells, called inhibitory neurons, actually dampen brain activity by squelching other neurons. Yet they generate the same BOLD signal as other neurons.

SEARCH FOR A SIGNAL In 2006, French neuroscientist Denis Le Bihan and colleagues in Japan published results that continue to reverberate through the small world of brain imaging. Le Bihan's MRI scanners were tuned to detect water molecules as they moved across the membrane that surrounds brain cells, a technique called diffusion MRI. By scanning the brains of six subjects gazing at a flickering dartboard, his team found a brain signal that peaked a few seconds before blood flow could be detected.

Previous research had suggested that neurons swell ever so slightly when they become active. Le Bihan, director of the Federative Institute of Research on Functional Neuroimaging in Saclay, France, thinks his diffusion MRI experiments captured this swelling.

Yet no one has repeated his results. Some claim that the signal may have been caused by changes in blood flow, not water diffusion. "The result may have been an artifact or one of billions of scientific results that seems to be here one day and gone the next," Jasanoff says.



GO WITH THE FLOW — Conventional fMRI tracks changes in blood flow in the brain's dense network of blood vessels.

JOHNS HOPKINS UNIV.

Despite skepticism, Le Bihan is determined to prove his results weren't a fluke. He recently compared diffusion MRI with a technique that gauges brain activity with infrared lasers. The diffusion signal beat out the laser's measurements, he says.

Less controversially, neuroscientists use diffusion MRI not to track activity but to map physical connections between distant regions of the brain. In 2007, a Dutch team studied people who perceive words as colors, one form of a condition called synesthesia. Scans with diffusion MRI suggested that the synesthete brains boast extra connections between a region involved in word and color processing and one linked to consciousness.

Though water diffusion may prove to be a better proxy for brain activity than is blood flow, diffusion MRI remains a circuitous measure. For an even closer pulse on the brain, some scientists are trying to tap into the native tongue of neurons—electricity.

Every time a neuron fires, electrically charged molecules flood in and out of the cell, producing a tiny electrical current. An MRI scanner could likely detect the magnetic field created by the current, says Bandettini.

To test the idea, his team put a petri dish of neurons under a powerful MRI scanner. The cell culture produced a faint signal that disappeared when the researchers added a chemical that blocks the cells from firing. Though the results showed it was feasible to measure the electric fields of neurons, the technological leap from a soup of cells to a human brain isn't trivial. "It will take some sort of breakthrough for it to work," Bandettini says.

Another way of doing bloodless MRI is to tweak the magnetic properties of brain cells with chemicals called contrast agents, says Jasanoff. Most of the chemicals have to be injected directly into the brain, and some are toxic, undercutting their usefulness. However, they reveal measures of brain activity—such as changes in pH or calcium levels—that are more substantive than blood flow.

A better contrast agent might be ferritin, a protein complex that sops up free iron, toxic to cells. But ferritin's natural levels are too low for MRI to pick up. To solve that problem, researchers at Carnegie Mellon University in Pittsburgh infected mouse brain cells with a virus that inserts extra copies of the ferritin genes into the cells. In the future, scientists may sew other genes to the ones for ferritin, creating an MRI signal to match most any cellular chore.

Such tools, though unavailable for human research now, are already making a difference in animal research, says Daniel Turnbull, a neuroscientist at New York University. Using a manganese contrast agent that's sensitive to brain activity, Turnbull found that mice rewire their brains after hearing a monotonous tone for a day.

While chemicals like manganese probably won't fly in humans because of toxicity, researchers haven't written them off completely. Turnbull's lab is working on a molecular sensor to detect plaques associated with Alzheimer's disease. And in 2006, Swedish researchers labeled a nontoxic body breakdown product, pyruvate, with a short-lived magnetic signature. The researchers injected the tagged pyruvate into rats and pigs, and picked up its signal with MRI.

BOLD MOVES Despite such glimmers of progress, many say measuring blood flow is still the best way to see brains—and will be for some time. By carefully timing fMRI tasks, researchers can detect responses within milliseconds, Bandettini says.

Neuroscientists have also devised new ways to apply conventional brain imaging. Real-time fMRI, where scientists get a live readout of a subject's brain, may help treat chronic pain. In one experiment, researchers scanned the brains of pain sufferers and told them what their brains were doing at any instant. Eventually, the patients learned to command a region of the brain linked to pain and even get some relief. Although they sound far-out, mind reading and lie detection may soon become possible with fMRI. On March 5, scientists reported that they deduced the pictures subjects viewed by analyzing the BOLD signal from a region of their brain called the visual cortex (see story on page 173).

"I think it's much more fruitful to work on BOLD than to completely start over," Bandettini says.

Other researchers are more optimistic about the prospects for bloodless MRI, eyeing a potentially huge payoff. Today, fMRI does a decent job of identifying regions of the brain associated with particular thoughts or activities, but the network between these regions is largely unmapped, says Allen Song, a neuroscientist at Duke University in Durham, N.C.

"If I pinch you, you feel pain. That's well understood," he says. "But from that pain you remember the event. We don't really have a good handle on what causes all that." Filling in such missing links is reason enough to pursue new ways of seeing the brain, however speculative, Song says. He is working on a way to image the brain by measuring charged molecules flooding out of active nerve cells.

BOLD continues to be the workhorse of brain imaging, including the NIH efforts to find the seat of religious belief. Jordan Grafman, the neuroscientist leading the study, suspects that the religious messages will light up the prefrontal cortex. Neuroscientists think this region is responsible for many of the cognitive differences between humans and their primate cousins. Yet until scientists perfect new, more direct ways of capturing the human brain at work, researchers may be seeing the effect of religion on blood, not on the brain. ■

THE NEXT OCEAN

Humanity's extra CO_2 could brew a new kind of sea

BY SUSAN MILIUS

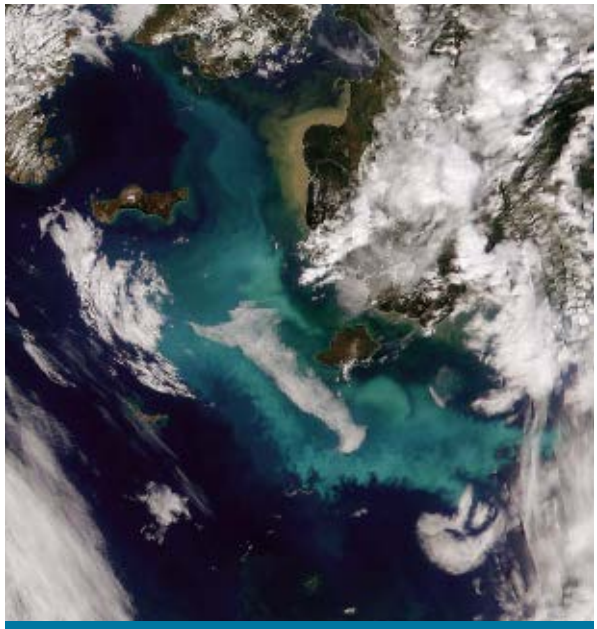
Terrie Klinger is starting to wonder about the future of kelp sex. It's a delicate business in the best of times, and the 21st century is putting marine life to the acid test.

Klinger, of the University of Washington in Seattle, studies the winged and bull kelps that stretch rubbery garlands up from the seafloor off the nearby Pacific coast. These kelp fronds do no luring, touching, fusing of cells or other sexy stuff. Fronds just break out in chocolate-colored patches.

The patches release spores that swim off to settle on a surface and start the next generation. The new little kelps don't look as if they belong to the same species, or even the same family, as their parents. The little ones just grow into strings of cells, but these are about sex.

"Those of us who have spent far too long looking at this can tell the males from the females," says Klinger. The subtly female-shaped filaments form eggs and release kelp pheromones to call in the male filaments' sperm.

Sex filaments have kept kelp species going for millennia, but Klinger says she wants to know what's happening now that carbon emissions are changing seawater chemistry. The intricate reproductive cycle of kelp is an example of a delicate system that can experience big effects from seemingly small changes in ocean chemistry.



MATTERS OF SCALE — A phytoplankton bloom (lighter turquoise waters) in the Bering Sea offshore of the Aleutian Islands is visible in this July 1998 satellite image. Relatively small changes in ocean chemistry may have big effects on such small creatures.

SEA-VIEWING WIDE FIELD-OF-VIEW SENSOR (SEAWIFS)/NASA/GSFC, GEOEYE

This chemistry is already shifting, powered by the increased concentration of carbon dioxide in the atmosphere from human activity. Not all the carbon dioxide from burning fossil fuels stays in the air. The oceans have absorbed about half of the CO_2 released from burning fossil fuels since the beginning of the industrial age, says Richard Feely of the National Oceanic and Atmospheric Administration in Seattle. The ocean takes in about 22 million tons of CO_2 a day, he says.

The influx causes what scientists call ocean acidification. It's a term of convenience. The ocean isn't acid now, nor do Feely and other ocean chemists expect that seawater will become acid in the foreseeable future. However, the extra CO_2 is driving the oceans closer to the acidic side of the pH scale. By the end of this century, Feely says, the upper 100 meters or so of ocean water will be more acidic than at any time during the past 20 million years.

Klinger is just one of the biologists trying to figure out what a shift in seawater chemistry will do to seaweed, corals, fish, and other marine life. The filaments of both bull and winged kelps grow noticeably slower in acidic seawater, she reported last week at the 2008 Ocean Sciences Meeting in Orlando, Fla.

Biologists are discussing what the chemistry change will do to marine creatures: It looks like bad news for calcium users and a new dawn for slimy rocks. It could begin an age of simplification for ocean ecosystems. Either way, there's a rising consensus that, by changing the oceans' chemistry and biology, burning fossil fuels is essentially making new oceans.

SEA CHANGE Researchers say the oceans of today already register a chemical change, though it may sound deceptively small at first.

Feely now rates the upper layer of seawater on average at 8.10 on the pH scale. That scale goes from 14 to 0 and describes the increasing concentration of hydrogen ions. Plain water, defined as neutral, ranks as 7, and lower numbers indicate increasingly strong acids and larger numbers of hydrogen ions. Since the beginning of the industrial age, Feely says, the seawater pH has slipped about 0.11 of a pH unit.

That's a considerable change, says a 2005 report on ocean acidification from the United Kingdom's Royal Society. The pH scale works logarithmically, so 7 means 10 times more ions than 8. The industrial age has increased the concentration of hydrogen ions by roughly a third.

The pH change from this century could be even bigger. The business-as-usual scenario for carbon emissions will drive the pH of the ocean surface waters down another 0.3 to 0.4 units by the end of the century, says Feely.

That's still not acidic, though. To push the ocean pH below 7, models predict that people would have to burn all of the fossil-fuel carbon on the planet plus a good deal of methane hydrates, he says.

Still, describing the process as ocean acidification isn't wrong. Seawater is acidifying in the sense of creeping toward the acid zone on the scale. Even if the ocean isn't turning into lemon juice, biologists predict that smaller dips in pH could do big things to marine life. It's a peril humans easily fail to appreciate. We can bathe in milk (pH 6.7) or chug orange juice (pH 3 or 4) and call ourselves refreshed. Thanks to fancy protective coatings, such as skin, and robust physiological mechanisms,

a milk-soaked juice drinker's blood still hovers around pH 7.35 to 7.45. But our bodies don't have to build coral reefs.

Marine species from corals to snails to floating dots of life called coccolithophores create structures of calcium carbonate. A CO_2 boost makes this job harder.

A key ingredient in making calcium carbonate is the carbonate ion, CO_3^{-2}. When it reacts with water, CO_2 forms carbonic acid, H_2CO_3. "It's the same as adding CO_2 to pop to make it fizzy," says Feely. The carbonic acid dissociates, releasing hydrogen ions that react with the carbonate ions in the water—thus making them unavailable to calcifiers such as corals building reefs. Feely says the carbonate concentration in the warmer waters where corals live today has already decreased 16 percent since the preindustrial era.

NOT-OK CORAL The future of corals depends on just how much CO_2 ends up in the atmosphere, says Ove Hoegh-Guldberg of the University of Queensland in St. Lucia, Australia. During a conversation in Boston last month at the annual meeting of the American Association for the Advancement of Science, he refers to his most recent paper. In the Dec. 14 *Science*, he and 16 other scientists summarize their predictions of three possible futures for corals.

Hoegh-Guldberg flips to a triptych of photographs of coral reefs. In the first, multicolored fish swim over a mosaic of nubby tan and brown corals crowding against each other, the classic postcard of a diverse reef. The scene represents a world where humanity freezes carbon emissions now. The CO_2 in the air stabilizes at its current concentration of 380 parts per million (ppm). Some changes for ocean ecosystems are already inevitable, but for most of the world's current reefs, corals will remain the dominant species.

The second image represents the world with atmospheric CO_2 concentrations bumped up to between 450 and 500 ppm. Swaths of ocean once hospitable to reefs become so starved of carbonate that more and more corals in the upper 100 meters or so of water can no longer add to their skeletons. The colorful fish have dwindled as the crumbling reef no longer offers them habitats. Big, shaggy species of macroalgae muscle in over the diminished corals, making it ever more difficult for coral larvae to find a home.

The last image, for the 500-plus ppm world, shows a murky slope of eroding rubble. It doesn't actually have an old tire in it, but that's the mood. As Hoegh-Guldberg puts it, "You've got slimy rocks."

This ocean could be real by the end of the century. Even one of the more optimistic scenarios from the Intergovernmental Panel on Climate Change puts the atmospheric concentration of CO_2 at 550 ppm in the year 2100.

ADDING HEAT Increased CO_2 also means the corals will have to contend with temperature increases. Depending on the coral species and the place, 3 to 4 weeks of temperatures a degree or two Celsius above current summer peaks can turn a reef into a spooky white sculpture of itself. This bleaching comes from the breakdown of the partnership between warm-water, soft-bodied corals and their colorful live-in algae, or zooxanthellae. They photosynthesize, and the host corals take a share of the lunch. Sometimes the partners get together again after a bleaching break-up, but prolonged absence of zooxanthellae kills a shallow-water coral.

Studies of zooxanthellae during the past decade have revealed unsuspected variety in the alga's capacity to endure heat. Corals primarily colonized with a variant called the D strain withstand heat better than others, according to Ray Berkelmans of the Australian Institute of Marine Science in Townsville. Researchers including Andrew Baker of the University of Miami in Florida are working to develop reef-saving therapies that swap out fragile zooxanthellae strains for heat-savvy ones.

The strategy doesn't brighten Hoegh-Guldberg's view of coral futures if carbon emissions keep soaring. Heat waves have bleached corals widely in recent years, but Hoegh-Guldberg hasn't seen the zooxanthellae adapting naturally. "Everyone's had enough time to show magical adaptation of corals," he says.

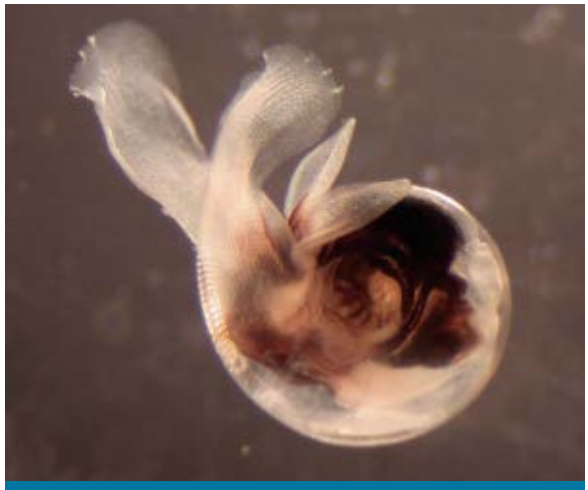
Another hope for adaptation swirls through conversations about coral reefs, but it doesn't cheer Hoegh-Guldberg either. Atmospheric carbon dioxide has spiked and ocean pH has plunged before in Earth's history. So the question arises of whether corals could just do whatever it was they did to survive last time.

"That's crap," says Hoegh-Guldberg. Ancient corals would have had more time than today's to get up to speed on hot, lower-pH life, he says. Again he flips open the *Science* paper and jabs a finger at some data. He and his colleagues used published measurements from air bubbles trapped in ancient ice to calculate rates of change for CO_2 concentrations in the atmosphere. The concentrations have risen more than 1,000 times faster per century during the industrial revolution than during the previous 420,000 years, the team concludes.

Also, Hoegh-Guldberg says he's not convinced that calcifying organisms did manage to laugh off earlier planetary burps of greenhouse gases. During the early Triassic, for example, CO_2 concentrations reached levels five times as high as today's. He notes a gap in the fossil record during this time of evidence for both the reef-building corals and the algae that sculpt carbonate.

Some lineages of today's corals are ancient enough to have survived hot spells with funky ocean chemistry. Yet those lineages that survived may have done so without calcified skeletons. "They essentially became anemones," he says.

That's survival for lineages that can do it, but it's still not a happy ending to Hoegh-Guldberg. Even if all today's corals successfully turned into naked, soft-bodied bits—more magic adaptation perhaps—other reef species would still end up homeless. The intricate crags and crevices of reefs shelter much of the biodiversity of oceans, perhaps a million species. Without complex reef habitats built by corals, it will be a simpler ocean, he says.



CRUNCH — About the size of a peppercorn, a *Limacina helicina* pteropod is a favorite snack of larger creatures. Declining seawater pH could hamper formation of pteropod shells.

HOFMANN

FLOATING HUBCAPS Beings smaller than corals, some of the mere specks of life that drift in the seas as plankton also need calcium carbonate to build.

Microscopic coccolithophores, up until now not exactly famous, have become iconic in the study of ocean pH change, thanks to Ulf Riebesell of the Leibniz Institute of Marine Sciences in Kiel, Germany. The celebrity plankton look like a craft project of hubcaps welded around a giant beach ball. The ornate hubcaps, platelets made of calcium carbonate, enclose a photosynthetic cell.

Springtime blooms of coccolithophores such as *Emiliania huxleyi* can spread over an area the size of Ireland. Light glinting off all the platelets makes milky blue streaks in the sea visible from space.

E. huxleyi doesn't follow the corals' recipe for calcifying struc-

tures. Yet the coccolithophores also fail to grow normally in low-pH seawater, says Riebesell. In experiments simulating such water, he's seen runt cells with flimsy or even deformed platelets.

Growth anomalies are showing up in other marine builder species, such as oysters. And in one of the few studies focusing on larvae, Gretchen Hofmann of the University of California, Santa Barbara, reports difficulties for very young sea urchins. Normal larvae look like alphabet soup "A's." In seawater dosed with extra CO_2, though, the larvae grow "shorter and stubbier," she says.

LOSERS AND WINNERS — More acidic waters could be tough on the tiny coccolithophore *Emiliania huxleyi* (left), which builds a shell of calcium-carbonate platelets; but comfy for nitrogen-fixing cyanobacteria such as *Trichodesmium* (right).

BJÖRN ROST; DAVID CARON/UNIV. SOUTHERN CALIFORNIA

OUTSIDE THE SHELL Much of the first wave of research on the next ocean has focused on the future of calcification. Not that that's silly. Creatures accounting for 46 percent of the annual U.S. seafood catch form some kind of calcified structure, such as clam shells, says Scott Doney of the Woods Hole Oceanographic Institution in Massachusetts. Adding in species that eat the calcifiers, such as pink salmon fattening up at sea on swimming snails called pteropods, would boost the percentage.

Still, water chemistry could affect uncalcified aspects of life for marine species, and research is now branching out into these matters. For example, moving around seems to get more difficult for squid in lower-pH water, according to ongoing research by Brad Seibel of the University of Rhode Island in Kingston, and others. The dip in seawater pH disturbs the oxygen transport in squid blood, and squids get sluggish.

That odd future ocean means good news for some species, particularly among the noncalcifiers, says David Hutchins of the University of Southern California in Los Angeles. Nitrogen-fixing cyanobacteria grow better in experiments that mimic ocean acidification. "They really love the CO_2," he says.

The cyanobacteria's cells, such as those in a *Trichodesmium* species, don't transport CO_2 efficiently from the outside world to their internal energy trapping machinery. A richer mix of the gas outside makes the cells more productive.

Who flourishes and who fades among the plankton in the new ocean matters to bigger creatures. The marine grazers that feed on plankton prefer some kinds and shun others. If the plankton equivalent of broccoli gives way to a brussels sprouts equivalent, grazer populations change too. Preferences work their way up to top predators, including those on dry land about to pick up a fork.

Considering lab and field experiments simulating future oceans, Hutchins speculates that plankton shifts will mean more microbial predators and less fish in the future oceans. "It's not necessarily going to be a world we particularly like," he says.

Whether kelps will like it remains to be seen. Kelp biologist Klinger emphasizes that she's just getting started in answering this question. She puts in a plug for the importance of understanding what will happen to kelp. Much like reefs, clusters of fronds offer complex habitats, with hidey-holes for fish and highways for snails. Also one could argue that a future ocean would be a little less interesting without kelp sex. ■

OF NOTE

PHYSICS

Too speedy for gravity?

Ya got trouble, my friend. Trouble with a capital T and that rhymes with G and that stands for gravity.

A new analysis suggests that when five different spacecraft flew past Earth several years ago, they gained more speed than can be accounted for by Einstein's theory of gravitation.

NASA, JHU APL

MYSTERY KICK When the Near-Earth Asteroid Rendezvous mission (pictured) flew past Earth on Jan. 23, 1998, it received a kick the standard theory of gravity may not explain.

The unexplained gain in speed is tiny, between 1.8 and 13.5 millimeters per second—only about one-millionth the total velocity of the spacecraft examined. But with radar tracking able to clock spacecraft speeds as small as 0.1 mm per second, that excess is enough to warrant further scrutiny, assert John D. Anderson of NASA's Jet Propulsion Laboratory in Pasadena, Calif., and his collaborators in the March 7 *Physical Review Letters*.

The largest speed deviations occurred during the flyby of NASA's Near Earth Asteroid Rendezvous craft. Anderson's team proposes that Earth's rotation is somehow imparting an extra kick to the craft. The kick might be similar to, but much larger than, an effect predicted by Einstein's theory in which rapidly spinning bodies warp surrounding space and drag orbiting objects with them.

A decade ago, Anderson and other researchers reported that the two Pioneer spacecraft seemed to be heading out of the solar system at speeds too high to be explained by the standard theory of gravity, but that claim remains controversial. Anderson says that because the new findings include a multitude of craft in the easier-to-measure near-Earth environment, the results appear to be on firmer footing.

With other, more mundane explanations, such as errors in software tracking, still to be explored, "it's way too early to get excited about this," says Ron Hellings of Montana State University in Bozeman. —RON COWEN

BEHAVIOR

Altruistic twist in market economies

Democratic societies with market economies have a reputation as cauldrons of competition, materialism, and greed. There's another side to that coin, though. These societies also foster cooperation among strangers in order to achieve a common financial goal, say economist Benedikt Herrmann of the University of Nottingham, England, and his colleagues.

In contrast, nondemocratic and other societies without market economies—marked by low civic involvement and distrust of public authorities—promote an ethic of punishing strangers who demand cooperation in a joint economic effort, Herrmann's group reports in the March 7 *Science*.

The researchers studied 273 college students from 15 countries as they played a "public goods" game. Each of four anonymous players could contribute any number of 20 tokens to a public account. That account was then multiplied by 1.6 and divided evenly among the players. This process was repeated 10 times. At that point, volunteers exchanged tokens for money.

After each round, everyone's contributions were revealed and players could punish those who gave too little by taking away three of their tokens. This action cost the punisher one token.

Volunteers from democratic, market-based societies—including the United States, England, and Germany—usually increased their contributions after punishment, thus boosting group earnings. In these societies, people reprimanded for low contributions felt guilty for letting down anonymous partners and thus became more cooperative, the researchers suggest.

Participants from traditional and nondemocratic societies—such as Saudi Arabia, Greece, and Russia—often responded to punishment by taking tokens away from high contributors in ensuing rounds. That led everyone to stop contributing to the public account. Such societies champion personal sacrifice on behalf of family and friends, so punishment by well-intentioned strangers elicited anger followed by revenge, the investigators propose. —BRUCE BOWER

MATERIALS SCIENCE

Cellulose that stiffens and softens

A new material inspired by the skin of sea cucumbers goes from firm to flabby in minutes. The substance could find wide use in medicine—including as brain implants.

Sea cucumbers tense up in seconds by linking the collagen fibers of their skin into a stiff net. Releasing the connections between the fibers causes the echinoderms to go soft.

To make a material with similar properties, polymer scientist Christoph Weder of Case Western Reserve University in Cleveland, Ohio, bonded cellulose "whiskers" to a nanoparticle glue. The whiskers glom on to one another, making the material as stiff as a plastic compact disc case, Weder says. Add water, and the whiskers separate and the material softens. But the nanoparticles remain bonded, holding the material together. When the water evaporates, the cellulose bonds return, making the material stiff again, Weder and colleagues report in the March 7 *Science*.

This property is ideal for making electrodes that zap brain cells into action, a therapy that could treat Parkinson's disease or paralysis, Weder says. To be surgically inserted into the brain, implants need to be rigid. But once in place, the implants might work better if they mimicked the brain's squishy consistency. Weder's colleague Dustin Tyler is already testing the new material in rat brains with results expected by the end of the year. —EWEN CALLAWAY

NEUROSCIENCE

Pick a photo, any photo

The guessing game 20 Questions might be won with a quick scan of an opponent's brain. Researchers have developed a way to measure how the human brain reacts to pictures—and to predict what images people are gazing at.

Though a long way off, the technology could help scientists reconstruct dreams or repressed memories, says Jack Gallant,

a neuroscientist at the University of California, Berkeley, who led the study, published online March 5 in *Nature*.

As a first step, two members of Gallant's team viewed hundreds of black-and-white photos from everyday experience, such as people, animals, and fruits, while a functional magnetic resonance imaging (fMRI) scanner recorded the activity of their brains. By analyzing the activity patterns that the images sparked, the researchers made a model that could predict how the brain might respond to any image.

Next, the same two subjects viewed 120 pictures they had never seen before, while their brains were scanned. Based on the model, Gallant's team predicted how each person's brain would respond to the 120 new images, then matched the brain scans to these predictions. The researchers guessed right 92 percent of the time for one person and 72 percent for the other. When they upped the ante to 1,620 pictures, accuracy dropped considerably. The team read one person's mind half the time and the other subject's mind a third of the time. —EWEN CALLAWAY

BIOMEDICINE

Exercises counteract lazy eye

An innovative set of eye exercises enables people with amblyopia, or lazy eye, to improve their vision, researchers report.

Amblyopia stems from a youthful eye injury, disease, or defect that induces the brain to "give up" on signals from that eye. A patch over the good eye can reprogram the brain before the age of 8. Otherwise, the brain will remain hardwired to disregard input from the weak eye, scientists have thought. That assumption has come under fire in recent years (*SN: 5/14/05, p. 317*).

Using a set of tasks devised by scientists at Beijing Hospital in China, Zhong-Lin Lu of the University of Southern California in Los Angeles and his colleagues tested 31 teenagers and young adults—10 with amblyopia and 21 with normal vision.

In the test, each participant looks at a screen and focuses on alternating black and white undulating waves. Upon hearing cues, amblyopia participants attempt to see the lines with the lazy eye, repeating this visual task 900 times each day. Sometimes the lines are within the person's capability, sometimes just beyond it, says Lu, a neuroscientist. "If they are doing too well and getting it 100 percent right, we reduce the contrast to make it harder for them," he says. The volunteers completed 9 to 12 daily sessions of the exercises.

While vision in the control group improved only slightly, the amblyopia patients gained two to three rows on a standard eye chart, the researchers report in the March 11 *Proceedings of the National Academy of Sciences*.

Lu notes that the vision improvements translated to everyday life and have lasted a year so far. —NATHAN SEPPA

BIOMEDICINE

New technique brings Parkinson's treatment closer

In a step toward using stem cells to treat Parkinson's disease, scientists in South Korea have developed a consistent and efficient way to convert human embryonic stem cells into dopamine-producing nerve cells.

People with Parkinson's disease have lost the natural dopamine-making cells from one brain region, resulting in the disease's characteristic symptoms.

Transplanting the newly made nerve cells into the brains of rats with a Parkinson's-like condition relieved the rats' symptoms, the researchers report in the March 4 *Proceedings of the National Academy of Sciences*.

While scientists have made dopamine-producing neurons from stem cells before, yields were low and inconsistent. The cell clusters also contained immature cells that often developed into tumors.

"Our method generates the highest yield of dopamine cells from human embryonic stem cells ever reported," says lead scientist Dong-Wook Kim of the Stem Cell Research Center in Seoul. The rats treated by Kim's group showed no signs of brain tumors after 14 weeks, presumably because the implanted cell clusters contained a higher proportion of mature neurons and fewer immature cells, the team reports.

In repeated attempts, the resulting cell masses consistently contained about 66 percent dopamine-producing neurons. With previous methods, percentages ranged from 10 to 30 percent and varied from experiment to experiment.

The team combined existing techniques in a novel way. After transforming stem cells into an intermediate type of cell called neural progenitors, the researchers expanded the number of cells by growing them in dishes. The team teased the cells apart and added signaling proteins to finish the conversion to neurons.

"With this protocol, you have a good shot to get enough cells to do this in primates and potentially in humans," comments Kai-Christian Sonntag of the Center for Neuroregeneration Research at Harvard Medical School in Belmont, Mass.

Kim says that his group plans to improve the efficiency even further and to ensure that immature cells will not eventually form tumors. —PATRICK BARRY

BOTANY

City life changes style of weed seeds

Urban living quickly drives a species of little yellow flower to make seeds that end up living with mom, say researchers in France.

A member of the dandelion family, *Crepis sancta* naturally produces two kinds of seeds. Most grow a miniature feather-duster that takes them wafting away on the breeze. The others, with no tuft, just fall off the mother plant to sprout nearby.

G. PRZETAK

URBANITE ***Crepis sancta*** **flowers pop up along urban sidewalks in Europe, where the pressures of city living bring rapid changes in seed formation.**

Pierre-Olivier Cheptou of CNRS in Montpellier, France, and his colleagues studied the seed strategies in the *C. sancta* popping up around the local sidewalk trees. There, nontufted seeds were more than twice as likely as flying siblings to land on the home patch of soil around the tree. The tufted fliers were more likely to waft beyond and risk perishing homeless on concrete.

Researchers collected seeds from sidewalk weed patches in town and from populations in large vineyards with room to soar. Grown in the same greenhouse, the plants still carried the signature of their origins. Sidewalk seedlings grew up to produce more non-flying seeds than the country cousins did. Calculations suggest urban living made the difference within 12 years, the researchers report in the March 11 *Proceedings of the National Academy of Sciences*. —SUSAN MILIUS

Books

A selection of new and notable books of scientific interest

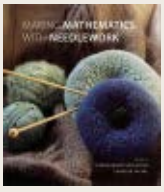
ENVIRONMENT: An Interdisciplinary Anthology

GLENN ADELSON, JAMES ENGELL, BRENT RANALLI, AND K.P. VAN ANGLEN, EDS.

This anthology of contemporary and historical writings encompasses disparate environmental issues while also exploring each in-depth. The editors, trained environmentalists, include text from scientific journals, legal decisions, historical accounts, economic analyses, fiction, and poetry. The first section addresses 10 current challenges in environmental studies with essays on statistics, historical records, and models related to the challenge of climate change. Articles on deforestation consider everything from logging practices to Alexis de Tocqueville's ideology of continental expansion. War forms another chapter on environmental challenges: The editors connect societal conflict to access to oil fields and other natural energy reserves. The book's part two covers fundamental topics such as biodiversity and agriculture. A true anthology, the collection also touches on more philosophical subjects such as ecofeminism and the continuity of being. ***Yale Univ., 2008, b&w photos and illus., 950 p., paperback, $45.00.***

MAKING MATHEMATICS WITH NEEDLEWORK

SARAH-MARIE BELCASTRO AND CAROLYN YACKEL, EDS.

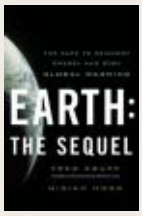


Math and crafts are two words not often spoken together. Belcastro and Yackel aim to change that with the first book to combine mathematical ideas with instructions for fabric arts projects that make abstract math problems tangible. The authors are all mathematicians and crafters who provide instructions on how to wear a passion for math on your sleeve, pant leg, head, or feet. Readers can learn how to crochet fractals, knit algebraic socks, and construct baby pants from octagons. Mathematics sections are written for mathematicians, but the authors strive to include enough basic information for general readers. A teaching guide offers ideas for lesson plans for levels from elementary through graduate school. Some projects require only basic sewing or embroidery, which just about anyone who can hold a needle should have some success with. Other projects require knitting or crochet skills. ***AK Peters, Ltd., 2007, color photos and illustrations, 200 p., hardcover, $30.00.***

EARTH: THE SEQUEL The Race to Reinvent Energy and Stop Global Warming

FRED KRUPP AND MIRIAM HORN

Industrialization has put Earth at the brink of climate calamity, say Krupp and Horn. Here, they describe a possible remedy, what they call "a new industrial revolution" that promises to "secure the world against the dangers of global warming." But the key players of this revolution may not succeed without immediate changes. Technologies using alternative energy haven't been more successful, they say, because there's no cost attached to greenhouse gases and pollution emitted by power plants, factories, and cars; and no benefit that flows to those who reduce pollution. Krupp and Horn, of the Environmental Defense Fund, describe inventors and investors with the courage and creativity to drive change. But first, they say, for innovators to have a shot at competing fairly in the global free market, the U.S. Congress must set "a legal and steadily declining limit on global warming pollution" to enable new solutions to launch into the mainstream. ***W.W. Norton, 2008, 279 p., hardcover, $24.95.***



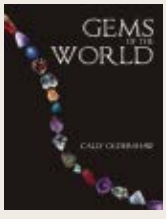
SYMMETRY: A Journey into the Patterns of Nature

MARCUS DU SAUTOY

Anyone who's stared at an M.C. Escher print knows the allure of geometrical symmetry. Bumblebees, too, prefer to pollinate symmetrical flowers, and many ancient cultures based buildings, decorations, and games on balanced forms. For Oxford University mathematician du Sautoy, symmetry is expressed in numbers and symbols as well. Each chapter begins as a memoir—a month in the life of a symmetry-obsessed mathematician. Fortunately, du Sautoy strays from this gimmick long enough to give readers an immensely fascinating history of the mathematics of symmetry. The ancient Greeks were the first to rigorously study symmetry, and the mathematician Theaetetus—described as a contemporary and friend to Plato—proved all three-dimensional dice (shapes having symmetry) possible could be formed from five basic shapes. More recently, the field's quirky modern practitioners have grappled with less concrete forms, including an object that has roughly 8 X 10^{53} symmetries (see page 25 for the exact number). This object is aptly named the Monster. ***Harper, 2008, 376 p., hardcover, $25.95.***

GEMS OF THE WORLD

CALLY OLDERSHAW



Diamonds, sapphires, rubies, opals, or emeralds—whatever your stone, Oldershaw knows how to identify, rate, and care for it. The rarer a beautiful gem, the greater the value, she says. And its durability will determine how it can be cut or mounted. Photographs of more than 130 varieties of precious and semiprecious gems, agates, and crystals accompany stories about how they are formed and who treasured (and treasure) them. In addition, the book begins with a description of the diamond trade, including a commentary on the ethics of diamond mining. An expert and former museum curator of gemstones, Oldershaw directs the information to anyone whose eyes sparkle at the sight of a jewel. ***Firefly Books, 2008, color photos and illus., 256 p., hardcover, $35.00.***

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LETTERS

Alpha bird(s)

There is a detail not explicit in the article "Birds network too" (*SN: 2/23/08, p. 125*) that fits the computer network analogy. By its flight path, each bird adds its personal input and helps guide the course of the flock.

DON BURNAP, RAPID CITY, S.D.

Andrea Cavagna, a physicist at Italy's National Research Council, says that those studying how flocks of starlings coordinate flight have long debated whether a few birds lead in setting the course of the flock. Simulations show that the flock's decisions could indeed emerge from systemwide self-organization principles, he says, rather than from individual actions of a few birds. He adds that further analysis of the data he and his collaborators collected may help settle the question. —DAVIDE CASTELVECCHI

Seeing is believing

"Extreme Measures" (*SN: 2/16/08, p. 107*) was wonderful. We have had light and electron microscopes. Can we look forward to atom-wave microscopes?

BILL SCHINDELE, THOUSAND OAKS, CALIF.

Yes. A team led by Bodil Holst at Graz University of Technology in Austria has built a microscope that bombards a sample with helium waves and then measures how the waves reflect to create a picture. In late 2007, Holst's team took the first-ever two-dimensional picture with a helium atom microscope: a blurry image of a tiny, honeycomb-shaped grating. —EWEN CALLAWAY

More Web threads

Regarding "Biological Moon Shot" (*SN: 2/2/08, p. 72*), there is already a Web site that also aims to answer "What's in my backyard?" At *ZipcodeZoo.com*, David Stang has assembled close to 3 million pages of information (one species per page) based on more than 37 million field observations that include latitude and longitude. Taxonomic information is provided, and there are more than 250,000 photographs on the site. The organisms covered by the site include plants, animals, fungi, Protozoa, bacteria, and Chromista, and coverage is constantly increasing.

MAREN H. BROWN, SYRACUSE, N.Y.

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