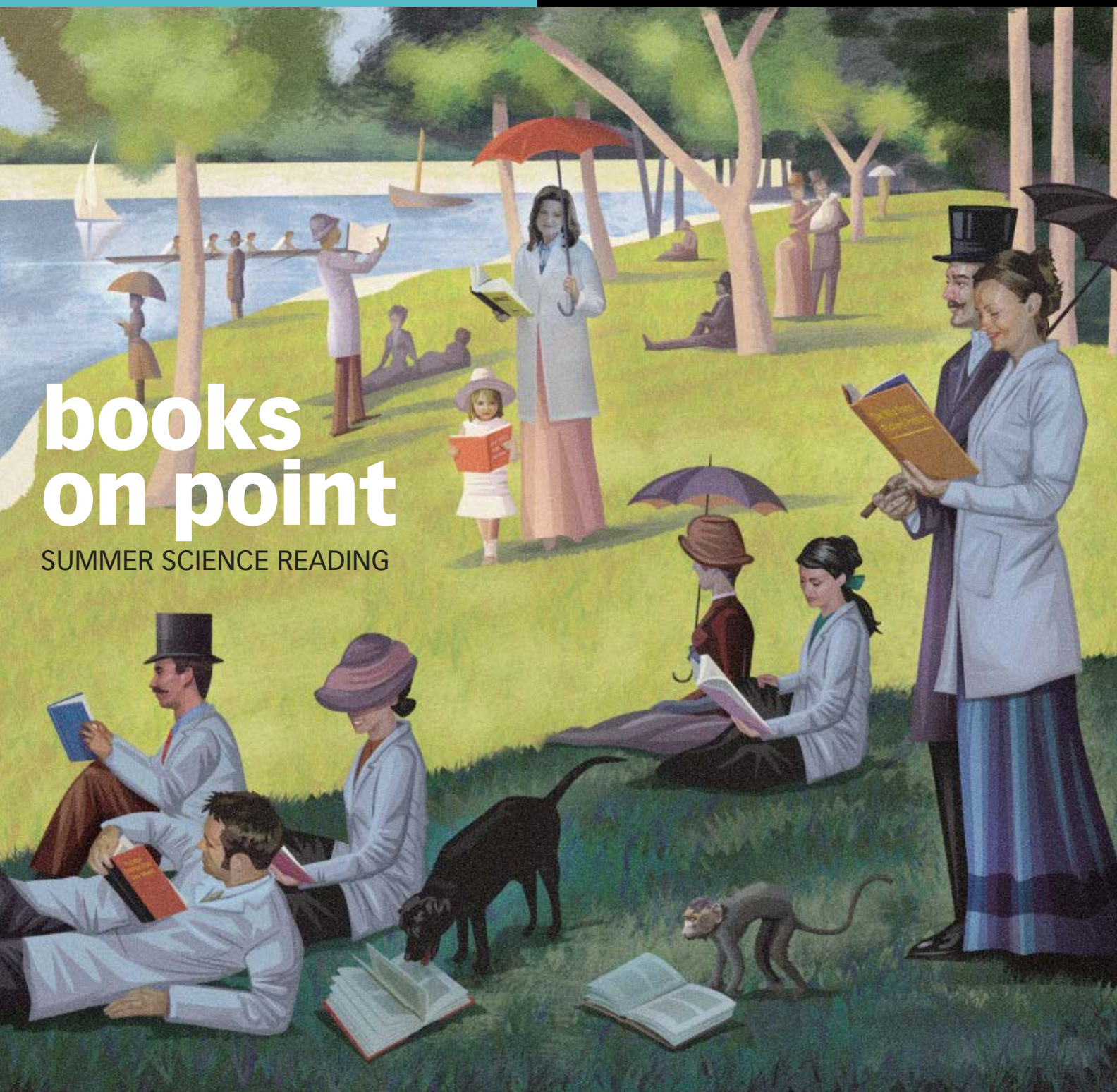
JUNE 30, 2007 PAGES 401-416 VOL. 171, NO. 26

SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

bacterial-dna swap
diamonds from the rough
feline family tree
more booze benefits

www.sciencenews.org



books on point

SUMMER SCIENCE READING

THE WEEKLY NEWSMAGAZINE OF SCIENCE

SCIENCE NEWS

JUNE 30, 2007 VOL. 171, NO. 26

Features

This Week

Of Note

Meetings

Departments

Cover A summer's day. Sunday afternoon on an island park. A few lab coats. A monkey keeping up with the literature. Could Georges Seurat himself have better illustrated "Summer Reading" recommendations from the staff of *Science News*? (Dean MacAdam) Page 408

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

Food for Thought In mice, misfolded proteins from foie gras trigger disease.

MathTrek These blue jeans sport a golden ratio.

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

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 Science Service, 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.

Science News (www.sciencenews.org) is published by Science Service, a nonprofit corporation founded in 1921. The mission of Science Service is to advance the understanding and appreciation of science through publications and educational programs. Visit Science Service at www.sciserv.org.

Life Swap

Switching genomes converts bacteria

In a step toward creating artificial microbes, scientists have managed to replace the entire genome of one kind of bacterium with the DNA of a related species. After the transplant, the recipient took on all the traits of the donor, effectively transforming into the donor's species.

The researchers say they hope to use this new technique to swap a bacterium's DNA for an artificial genome that they will assemble from scratch, thus creating the first synthetic life form. As well as helping scientists explore fundamental cell biology, such custom-made microbes could eventually be designed to produce biofuels and medicines efficiently, says study coauthor John I. Glass of the J. Craig Venter Institute in Rockville, Md.

"As you understand better how a cell works, it makes it possible to rationally design more-complicated [synthetic] organisms that meet some of the needs of humanity," Glass says.

Implanting an artificial genome into a cell would be tricky, however, because DNA molecules longer than about 50,000 genetic units are prone to breaking. In the recent study, the ring-shaped DNA molecules from the donor bacteria were more than a million genetic units long. "You have to be very gentle," Glass says. "Humpty Dumpty can't be put back together again."

The scientists gingerly extracted the DNA by first encasing a benign variety of *Mycoplasma mycoides* cells in a porous gel. With the donor cells cradled in this material, the researchers applied detergents and enzymes to dissolve all the components of the cells except their DNA. The scientists then moved the encased DNA into a solution containing the recipient cells, which belonged to the species *Mycoplasma capricolum*.

What happened next is still poorly understood. Somehow, about 1 cell out of every 150,000 took in the foreign DNA, displacing its own DNA in the process. Glass' team added to the solution chemicals that are known to cause cells to merge and to make their membranes more fluid, but the scientists don't yet understand how that change bacteria accomplished the DNA swap. The transplanted cells grew into colonies of bacteria identical to the donor bacteria, the team reports online and in an upcoming issue of *Science*.

"This is an important step toward the Holy Grail of whole-genome engineering," comments Pamela Silver, a systems biologist at Harvard Medical School in Boston. However, the donor and recipient species used in the experiments belong to the same genus, which could mean that the cells are more compatible with each other's genomes than they would be with a technique to build synthetic genome, notes Keith E. Tyo of the Massachusetts Institute of Technology.

Scientists can already create synthetic DNA molecules roughly 100,000 units long by piecing together a custom sequence of genetic units. In October 2006, J. Craig Venter, the study's senior scientist and former head of the private effort to map the human genome, filed for a patent on a technique to build a synthetic genome based on a bacterium called *Mycoplasma genitalium*, which has a genome only 580,000 units long. Glass says that the team will soon be able to synthesize a single DNA molecule of that length. —P. BARRY

QUOTE

"This is an important step toward the Holy Grail of whole-genome engineering."
PAMELA SILVER, Harvard Medical School

Cat History

DNA study finds domestic-cat kin

The Old World wildcat ranges from Scotland to China and down into Africa, but a new DNA study indicates that just one of its lineages, that of the Near Eastern wildcat, gave rise to today's domestic companions.

Domestic cats are still similar enough to their wild ancestor to belong to its species, *Felis silvestris*, explains Carlos Driscoll of the National Cancer Institute in Frederick, Md. He and his colleagues analyzed DNA from 979 cats, ranging from pampered darlings to wildlings caught in Kazakhstan. Their study resolves the wildcat family tree into five lineages. One group combines the Near East wild relatives and domestic cats worldwide, Driscoll and his colleagues report online and in an upcoming *Science*.

Driscoll says that the project grew out of efforts to conserve the surviving wildcats in the Scottish highlands. Killing them was forbidden, but an accused hunter protested on the grounds that biology couldn't prove that wildcats differ from domestic cats. To resolve the issue, David Macdonald of the University of Oxford in England encouraged Driscoll to sort out *F. silvestris* genetics.

Taxonomists had broken down the species into as many as 23 subspecies, but more-recent classifications had reduced those categories to three or four, says Driscoll. Following their new analysis, the number of wild subspecies could rise to five.

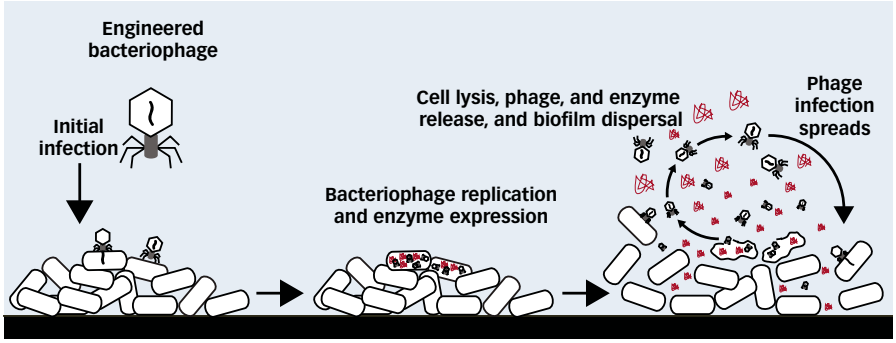
Driscoll, Macdonald, and their collaborators collected DNA samples from a range of sources, including the 33 show breeds, animals Driscoll trapped during a sojourn in Israel's Negev desert, and parts of Chinese desert cats from an Asian market. Regardless of where the domestic cats came from, their DNA looked more similar to that of the Near Eastern wildcats, the subspecies *lybica*, than to that of other subspecies, the researchers found.

The work "provides important independent support for the archaeological evidence," comments Melinda Zeder of the Smithsonian Institution's National Museum of Natural History in Washington, D.C., who studies animal domestication.

She says that studies of ancient sites show that nomadic people in the Near East became increasingly sedentary—harvesting abundant wild plants and animals—even before they domesticated crops and livestock. Those settlements offered new niches for animals, which could live among people and pick over their refuse. "It also seems now to be the context in which the wild cat became the tabby cat," says Zeder.

ORIGINAL GARFIELD **A Near Eastern wildcat caught in the Negev desert in Israel represents the wild ancestors of domestic cats.**

Jean-Denis Vigne of the National Museum of Natural History in Paris welcomes the new work as "an excellent paper." He and his colleagues have studied a cat skeleton that they say appears to have been intentionally buried near a human skeleton some 9,500 years ago in Cyprus. That's some 5,000 years before the earliest cat



BEHIND ENEMY LINES A virus infects *Escherichia coli* in a biofilm (left), replicates, and forces the bacteria to produce a polymer-degrading enzyme (center). After the bacteria explode, the enzyme dissolves the biofilm matrix, and the viruses spread to other cells (right).

burials in Egypt, and Vigne has argued that Egyptians probably weren't the original domesticators of *F. silvestris*.

The DNA evidence doesn't have enough detail to say much about the date of domestication within the Near East, says Driscoll. Still, he says, it does open the way for DNA studies that may finally distinguish between domestic and wild Scottish cats. —S. MILIUS

Biowarfare

Engineered virus can invade bacterial film

Think of a bacteriophage—a bacteria-attacking virus—as a behind-the-lines saboteur. Scientists have now engineered bacteriophages that can penetrate and dissolve the dense films, such as dental plaque, that some bacterial colonies form. These phages, which produce enzymes that target the so-called biofilms, may offer a new way to circumvent antibiotic resistance in bacteria.

Despite being single-celled organisms, bacteria have social skills. Once they sense each other's presence through chemical signals, bacteria of one or more species collectively build their biofilms from polymers that they excrete.

James Collins, a biophysicist at Boston University, says that up to 60 percent of bacteria live in biofilms, which have been described as the coral reefs of microbiology (*SN: 7/14/01, p. 28*). Dental plaque may be the most familiar form, but biofilms can also form on medical devices such as implants and catheters. The films line water pipes and the lungs of cystic fibrosis patients, where they cause potentially lethal infections. Unfortunately, Collins says, the cooperative advantages of living in a biofilm enable the bugs to withstand the action of antibiotics far more effectively than free-swimming bacteria can. To fight biofilms, "the challenge is to penetrate the matrix," Collins says.

With Tim Lu of Harvard University and the Massachusetts Institute of Technology, Collins has now devised a two-pronged biowarfare strategy against biofilms. First, the scientists experimented with various enzymes to find one that could break down the polymers produced by a specific strain of *Escherichia coli*. The best enzyme they discovered is called dispersin B. They then genetically engineered a bacteriophage—which looks like a miniature Apollo lunar-landing module—by inserting the gene for the enzyme into the virus' DNA.

Next, the scientists dropped the phage onto an *E. coli* biofilm. After the viruses made their way into some of the bacteria, they hijacked the bacteria's cellular machinery and started making more phage copies as well as the enzyme.

As an overpopulation of phages caused bacterial cells to swell and burst, the viruses spread to infect more bacteria, while the released enzyme dissolved the biofilm's polymer matrix. The biofilm virtually disappeared within 2 days, the authors report in the July 3 *Proceedings of the National Academy of Sciences*.

Collins and Lu assert that their method gets better results than do earlier strategies that focused on either killing the bacteria or dissolving the film.

Philip Stewart of the Center for Biofilm Engineering at Montana State University in Bozeman says that Collins and Lu were "clever" in coming up with the two-pronged attack. "You're not only killing cells, which is the old way of thinking," he says. "You're also weakening the biofilm mechanically."

The challenge, Stewart says, will be to compile a toolbox of many enzymes that scientists and ultimately doctors can use to target various biofilms. —D. CASTELVECCHI

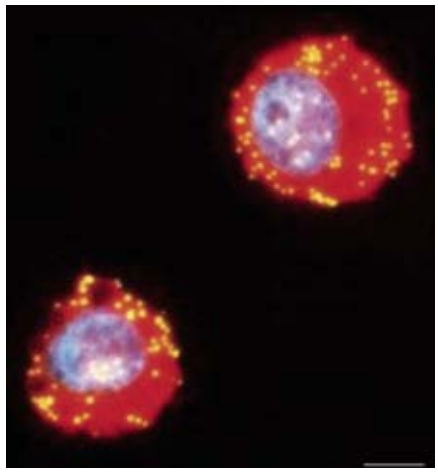
Cellular Smugglers

Laden nanoparticles hitch a ride on bacteria

By loading genes onto nanoparticles, then attaching the nanoparticles to bacteria, scientists have devised a new way of shuttling potentially therapeutic material into mammalian cells. Because the nanoparticles could carry a variety of molecular cargo, the system could have a wide range of applications, including cancer therapy and insertion of cellular biosensors.

Rashid Bashir and his colleagues at Purdue University in West Lafayette, Ind., worked with *Listeria monocytogenes*, which are bacteria with molecular machinery that can penetrate a cell's defenses. The recipient cells naturally package the cargo-coated bacteria, which the researchers call "microbots," in a fatty envelope and bring them inside. Bacterial proteins then poke holes in the cellular packaging and release the nanoparticles and their cargoes.

To demonstrate the technique, the researchers attached fluorescent genes to polystyrene nanoparticles and loaded *Listeria* cells with the two-part cargo. They applied the microbots to human cells cultured in the lab or put them into living mice. Successful delivery produced glowing cells.



GLOWING CARGO Bacteria carried nanoparticles laden with fluorescent genes (yellow) into these human cells. Cell nuclei are stained blue.

LU/PNAS; AKIN/PURDUE UNIV.

Up to 40 percent of the cells incorporated the genetic cargo, Bashir and his colleagues report in an upcoming *Nature Nanotechnology*.

An established technique using genetically modified bacteria to deliver a desired gene achieves only 2 to 20 percent efficiency, the researchers say. Moreover, the microbots can haul more than one type of gene or molecule at a time. Changing the

cargo is as simple as swapping the nanoparticles, says Purdue's Demir Akin. "The cargo can be anything."

Other researchers have tried a variety of strategies to deliver molecules into cells. For example, they have slipped molecules inside fatty envelopes called liposomes. But liposomes move passively through the body. And although they can efficiently bring cargo into cells, that cargo can then be hard to unpack, Bashir says. An alternative is to use viruses, which, like bacteria, can deliver a gene to a target cell, says Guido Dietrich of Berna Biotech AG, a vaccine manufacturer in Berne, Switzerland. However, involving viruses in such a procedure risks an infection that can't be controlled with drugs.

The new technique could also be limited by the risk of infection, but bacteria can be killed by antibiotics, Bashir and Akin point out. In fact, *Listeria* bacteria aren't approved for use in humans and are toxic to mice, so the researchers dosed the animals in their experiments with antibiotics. They are already planning to use bacterial strains that don't cause disease. "Live bacteria have been in use for decades as an active ingredient of … vaccines against tuberculosis and typhoid fever," Dietrich says. If such strains can be used, "there should be no safety issue," he says.

Because the bacterial microbots can deliver their loads efficiently and to specific cells, the technique could be particularly suitable for targeted cancer therapy, the researchers say. Such a system would deliver drugs in safe doses or in tailored combinations directly to the cells that need treatment. —S. WEBB

Alcohol Answer?

Drinks lower glucose to protect heart

Alcohol's health benefits have shown up in numerous studies, but some of the mechanisms involved have remained a mystery. Now, scientists have shown that imbibing moderate amounts of beer, wine, or gin lowers blood glucose, an important benefit in staving off type 2 diabetes and reducing heart disease risk.

Previous reports of alcohol's effects against heart disease pointed to how it boosts high-density lipoproteins, the so-called good cholesterol (*SN: 10/28/00, p. 283*). Research also shows that moderate alcohol intake improves the body's use of insulin, one of the keys to controlling blood-glucose concentrations.

Jennie Brand-Miller of the University of Sydney in Australia and her colleagues report a new pathway by which alcohol lowers blood glucose. In a study of young, healthy volunteers, the researchers found that alcohol drunk before or during a meal controlled glucose without increasing insulin production. The researchers concluded that moderate amounts of alcohol can directly influence the release of glucose from tissues such as the liver or muscle.

"It's an unrecognized mechanism by which we might be able to explain the evidence of alcohol's protective effects against cardiovascular disease," Brand-Miller says.

Blood-glucose concentration naturally spikes after a meal as digestive processes break down carbohydrates in food. But prolonged elevation can increase a person's risk of developing diabetes and heart disease. Brand-Miller says that reducing the concentration of blood glucose immediately after a meal can have long-lasting benefits in protecting against both conditions.

In the three-part study, the participants were given beer, white wine, and gin on separate days. Amounts were intended to mimic what a moderate drinker imbibes.

In the first phase of the study, each person was given either a drink or a slice of white bread with the same calorie count. The scientists found that eating the bread raised blood glucose more than drinking the alcohol did, though beer showed a less dramatic effect. Postmeal insulin concentrations were also lower after drinking alcohol than after eating bread.

Second, each person got a margarine sandwich along with either an alcoholic drink or water. All the alcoholic drinks reduced the blood-glucose spike caused by the sandwich, compared with the spike experienced after drinking water. However, there were no differences in insulin concentrations after volunteers drank wine, beer, gin, or water with a sandwich.

Finally, each volunteer received two glasses of either water, gin and tonic, beer, or white wine. The drinks were served 1 hour before a meal of potatoes. Drinking any alcohol lowered peak postmeal blood glucose, but only gin increased postmeal insulin concentration more than water did. The results of all the trials appear in the June *American Journal of Clinical Nutrition*.

While the results are a boon for people who drink moderately, Brand-Miller cautions that people shouldn't step up alcohol intake. Consuming more than one to two drinks daily would reverse the benefits.

"It's a very interesting and important finding," says David Ludwig, director of the Optimal Weight for Life program at Children's Hospital Boston. "It's a new understanding for the potential powerful effects of alcohol on blood sugar." —C. BARRY

CHEERS Gin, white wine, and beer can reduce a person's blood-glucose concentration after eating, and that could reduce the risk of heart disease.

ISTOCKPHOTO

Immune Abuse

Methamphetamine is linked to cardiac damage

Use of the drug methamphetamine can drastically alter the array of immune proteins unleashed in the body, a study of rats shows. The finding may explain some cardiac problems seen in longtime methamphetamine abusers.

Methamphetamine is an inexpensive drug made illegally in home laboratories. It's a strong stimulant that can lead to brain damage.

Methamphetamine use also leads to a racing heartbeat and high blood pressure, which may result in chronic strain and heart injury.

In addition, the drug may cause inflammation in heart arteries, says study coauthor Tobin J. Dickerson, a biochemist at the Scripps Research Institute in La Jolla, Calif.

In earlier work, he and his colleagues had found that methamphetamine binds to proteins in the body, using glucose as glue. The result is what's called a glycated protein. When the scientists injected rodents with methamphetamine-glycated proteins, they found that the animals made antibodies against the aberrant proteins as if they were foreign bodies.

Dickerson and his colleagues hypothesize that this immune response is part of a destructive inflammatory reaction triggered when glycated proteins form deposits in blood vessels.

In the new study, the scientists analyzed this process in rats that were able to self-administer methamphetamine at various times during a 3-month period. The researchers surgically implanted intravenous lines into the backs of 27 laboratory rats. Whenever a rat pressed a lever in its cage, the line delivered a small dose of methamphetamine or an inert substance to the animal's circulatory system. The drug was available for 6 hours a day for some rats and 1 hour a day for others. A control group of rats received the placebo infusions.

The animals getting the drug soon sensed its stimulatory effects. "The 6-hour rats were pressing the lever pretty often," says Dickerson. These animals formed five times as many antibodies against the glycated proteins as did rats not getting the drug, the researchers report in an upcoming *Proceedings of the National Academy of Sciences*. Rats with less access to methamphetamine made half as many antibodies as the more heavily exposed rats did. Other tests showed that the rats that had access 6 hours a day had higher concentrations of inflammatory proteins in their blood than did rats in either of the other two groups.

"We think the glycated proteins bind to cells along blood vessel walls, and then antibodies bind to them," Dickerson says. Such binding would attract a flood of inflammatory immune cells that in normal circumstances would be attacking pathogens. "In this case, they attack your own blood vessels," he says. "This is a chronic-damage scenario."

Previous research suggested a link between methamphetamine and aberrant immunity, says Timothy W. Lineberry, a psychiatrist at the Mayo Clinic College of Medicine in Rochester, Minn. "This provides a more complete understanding of the possible mechanisms that underlie chronic [methamphetamine] problems."

Immunologist Ronald R. Watson of the University of Arizona in Tucson says that his team has done work suggesting that methamphetamine damages the heart by weakening collagen, a protein that forms part of the heart's structure. The new study offers "an alternative explanation," he says, acknowledging that both theories might prove valid. —N. SEPPA

Ape Aid

Chimps share altruistic capacity with people

Many researchers have asserted that only people will assist strangers without receiving anything in return, sometimes at great personal cost. However, a new study suggests that chimpanzees also belong to the Good Samaritan club, as do children as young as 18 months of age.

Without any prospect of immediate benefit, chimps helped both people and other chimps that they didn't know, and the 18-month-olds spontaneously assisted adults they'd never seen before, say psychologist Felix Warneken of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and his colleagues.

The roots of human altruism reach back roughly 6 million years to a common ancestor of people and chimps, the researchers propose in the July *PLoS Biology*.

"Learning and experience are involved in altruistic helping, but our claim is that there is a predisposition [in chimps and people] to develop such behavior without explicit training," Warneken says.

His team conducted three experiments with adult chimps living on an island sanctuary in Uganda and two experiments with 18-month-old German children. In the chimp version of the first experiment, 36 animals watched one at a time from a barred enclosure as an experimenter in an adjacent room—who had had virtually no prior contacts with the animals—reached through the bars for a stick on the other side. The stick was within reach of only the observing chimp.

Most chimps snatched the stick and gave it to the experimenter, whether or not the experimenter offered a piece of banana as a reward. No assistance came if the experimenter didn't first reach in vain for the stick.

A similar trial with 36 youngsters yielded comparable altruistic behavior, regardless of whether the experimenter offered toys as a reward.

The second round of experiments included 18 chimps and 22 infants who had helped at least once in the first experiment.

The chimps still retrieved a stick for an experimenter, although they now had to climb a 2.5-meter-high platform to reach the item. The children navigated barriers and hurdles to get a pencil for an experimenter. No reward was offered in either case.

The third experiment tested nine chimps' willingness to aid other chimps that they neither knew nor were related to. One chimp watched another in a separate room try to enter an adjacent space through a chained door in order to obtain food. Only the observing chimp could remove a peg in its enclosure to release the chain, allowing the other chimp to nab a snack.

All but one observing chimp did just that in numerous trials.

"These are wonderful experiments and present a real challenge to previous findings," remarks anthropologist Joan B. Silk of the University of California, Los Angeles. Silk and other investigators have reported that chimps don't give food rewards to their comrades, even at no cost to the potential donor.

Chimps may help others who fail to achieve observable goals, as in the new experiments, Warneken suggests. Further studies need to compare individuals' reactions to different types of cooperative tasks, Silk says.

The results "come as no surprise to any field worker who has spent lots of time close to wild chimpanzees," comments anthropologist William C. McGrew of the University of Cambridge in England. —B. BOWER

MAX PLANCK INST. FOR EVOLUTIONARY ANTHROPOLOGY

MAY I HELP YOU? New experiments indicate that chimpanzees aid strangers, regardless of personal gain, much as people, including very young children, do.

Can New Ideas Really Change a Society?

Trace the exciting history of ideas with an acclaimed professor of physics and philosophy

Why has science so dramatically altered how we live and how we think about ourselves?

With characteristic energy and verve, Professor Steven L. Goldman declares, "One is tempted to speak of scientific discoveries as being the source of science's power to be a driver of social change—that scientists have been discovering new truths about nature, and that the change follows from that. But I argue that it is scientific ideas that are responsible for this change. Ideas are the source of science's power—not discoveries."

And what is the greatest scientific idea of all? For Professor Goldman, "The idea of science itself is an idea that had to be invented."

Explore ideas that—when society has been willing to pursue them—have helped form the foundation of modern life. You'll interpret the term "scientific idea" broadly, so as to include ideas that made science possible at all, as well as ideas that make science immensely powerful.

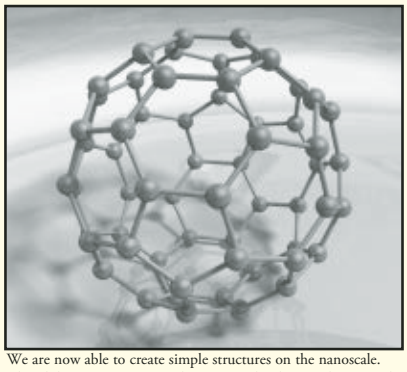
Each of Professor Goldman's 36 lectures highlights in a provocative way a single idea or development critical to the development of science in the West. The lectures are broadly chronological, beginning with pre-scientific know-how and the invention of writing, and advancing through modern times all the way to the development of chaos theory. In each lecture, Professor Goldman looks at not only the content of an idea that is fundamental for science, but also how that idea arose and what its impact has been throughout the centuries.

About Your Professors

Professor Steven L. Goldman is Andrew W. Mellon Distinguished Professor in the Humanities at Lehigh University, where he has taught for 30 years. He received his Bachelor of Science degree in Physics at Polytechnic University of New York and his M.A. and Ph.D. in Philosophy from Boston University. Professor Goldman has written or edited eight books and many scholarly articles and reviews and has received Lehigh's Lindback Distinguished Teaching Award.

About Our Sale Price Policy

Why is the sale price for this course so much lower than its standard price? Every course we make goes on sale at least once a year. Producing large quantities of only the sale courses keeps costs down and allows us to pass the savings on to you. This approach also enables us to fill your order immediately: 99% of all orders placed by 2:00 pm eastern time ship that same day. Order before July 17, 2007, to receive these savings.



© Digital Art/Corbis.

We are now able to create simple structures on the nanoscale. This ability promises to revolutionize technology, industry, and medicine.

About The Teaching Company

We review hundreds of top-rated professors from America's best colleges and universities each year. From this extraordinary group we choose only those rated highest by panels of our customers. Fewer than 10% of these world-class scholar-teachers are selected to make The Great Courses. We've been doing this since 1990, producing more than 3,000 hours of material in modern and ancient history, philosophy, literature, fine arts, the sciences, and mathematics for intelligent, engaged, adult lifelong learners. If a course is ever less than completely satisfying, you may exchange it for another or we will refund your money promptly.

Lecture Titles

1. Knowledge, Know-How, and Social Change
2. Writing Makes Science Possible
3. Inventing Reason and Knowledge
4. The Birth of Natural Science
5. Mathematics as the Order of Nature
6. The Birth of Techno-Science
7. Universities Relaunch the Idea of Knowledge
8. The Medieval Revolution in Know-How
9. Progress Enters into History
10. The Printed Book—Gutenberg to Galileo
11. Renaissance Painting and Techno-Science
12. Copernicus Moves the Earth
13. The Birth of Modern Science
14. Algebra, Calculus, and Probability
15. Conservation and Symmetry
16. Instruments as Extensions of the Mind
17. Time, Change, and Novelty
18. The Atomic Theory of Matter
19. The Cell Theory of Life
20. The Germ Theory of Disease
21. The Gene Theory of Inheritance
22. Energy Challenges Matter
23. Fields—The Immaterial Becomes Real
24. Relationships Become Physical
25. Evolution as Process Science
26. Statistical Laws Challenge Determinism
27. Techno-Science Comes of Age
28. Institutions Empower Innovation
29. The Quantum Revolution
30. Relativity Redefines Space and Time
31. Reconceiving the Universe, Again
32. The Idea behind the Computer
33. Three Faces of Information
34. Systems, Chaos, and Self-Organization
35. Life as Molecules in Action
36. Great Ideas, Past and Future

THE TEACHING COMPANY®
The Joy of Lifelong Learning Every Day™
GREAT PROFESSORS, GREAT COURSES, GREAT VALUE GUARANTEED.™

SAVE UP TO $275!
OFFER GOOD UNTIL JULY 17, 2007

1-800-TEACH-12 (1-800-832-2412)
Fax: 703-378-3819

Special offer is available online at
www.TEACH12.com/4sn

The Great Courses
THE TEACHING COMPANY
4151 Lafayette Center Drive, Suite 100
Chantilly, VA 20151-1232

Priority Code 23734

Please send me **Great Scientific Ideas That Changed the World**, which consists of 36 half-hour lectures and complete Course Guidebooks.

☐ **DVD $99.95** (std. price $374.95) **SAVE $275!**
plus $15 shipping, processing, and lifetime satisfaction guarantee.

☐ **Audio CD $69.95** (std. price $269.95) **SAVE $200!**
plus $10 shipping, processing, and lifetime satisfaction guarantee.

☐ **Audiotape $49.95** (std. price $199.95) **SAVE $150!**
plus $10 shipping, processing, and lifetime satisfaction guarantee.

☐ **Check or Money Order Enclosed**

* Non-U.S. Orders: Additional shipping charges apply.
For more details, call us or visit the FAQ page on our website.

** Virginia residents please add 5% sales tax.

Charge my credit card:

☐ VISA ☐ MasterCard ☐ Discover ☐ American Express

ACCOUNT NUMBER _____ EXP. DATE _____

SIGNATURE _____

NAME (PLEASE PRINT) _____

MAILING ADDRESS _____

CITY/STATE/ZIP _____

PHONE *(If we have questions regarding your order—required for international orders)* _____

☐ **FREE CATALOG.** Please send me a free copy of your current catalog (no purchase necessary).

Special offer is available online at www.TEACH12.com/4sn
Offer Good Through: July 17, 2007

SUMMER READING

Recommended books, on topics from growing potatoes to imagining other universes

BY THE SCIENCE NEWS STAFF

Is "summer science reading" an oxymoron? Isn't this the season for light fare, and don't science books belong on the cabbage-and-mutton side of the menu? The *Science News* staff doesn't think so. Here we recommend a picnic basket of lively books. Scientists soaring through trees and camping out with ivory-billed woodpeckers are our action heroes. Storytellers describe natural living, raising flowers for profit, and surviving as original Americans. Our dose of summer school seriousness comes from authors trying to explain climate change, the religion-science divide, and the universe itself. Enjoy.

—Keith Haglund, Managing Editor

DEAN MACADAM

Aerial Oceans

THE WILD TREES:
A Story of Passion and Daring

RICHARD PRESTON

Random House, 2007

"The forest canopy is the Earth's secret ocean," Richard Preston writes in *The Wild Trees*. That anything in California can remain secret might seem incredible, but Preston includes among the world's enigmatic canopies that of the temperate redwood rain forest stretching from San Francisco to Oregon. Somehow, much of this forest remained unexplored until the 1990s.

That was when Steven Sillett, a botanist at Humboldt State University, and oddball knife salesman–cum–tall-tree hunter Michael Taylor independently began surveying the redwoods in earnest. Sillett started as a lichen fanatic, donning long spikes and rigging elaborate rope systems to hoist himself to the top of 300-foot giants. Taylor, overweight and afraid of heights, stayed below and searched for the tallest trees with a protractor and binoculars.

Meanwhile above, Sillett and his colleagues discovered unexpected life. Rare salamanders, beetles, earthworms, and voles make their homes in the aeries. Shrubs and small trees thrive in the loamy soil piled within crotches of the redwoods. Sillett once found an 8-foot-tall spruce growing on a redwood, and he cataloged huckleberry, hemlock, laurel, and even Douglas fir in the canopy.

Preston weaves Taylor's and Sillett's stories with that of Marie Antoine, who also began as a lichen lover. Midway through the book, Antoine and Sillett meet and fall in love. The two consummate their relationship in a hammock strung some 30 stories above ground—untethered from safety ropes—a scene that offers a frisson rarely found in science journalism. Sillett later proposes to Antoine in the treetops, and they find a minister willing to ascend a redwood to marry them. Antoine sews flowing lichen into her veil.

In his previous books about deadly pathogens, such as the best-seller *The Hot Zone* (1994, Random House), Preston captured the inner lives of scientists by immersing himself in their world. He does the same here, learning advanced climbing techniques so that he can join his protagonists in the canopy, notebook in hand.

While a conservation message is implicit, Preston wisely avoids preaching. Instead, through the adventures of Sillett, Taylor, and Antoine, *The Wild Trees* engenders a sense of awe. Redwoods live 2,000 years or more, we learn; they survive hurricane-force gales and hellish blazes; they drink the fog. In short, they're amazing.

The Wild Trees almost is too. But for long stretches, Preston's passive tone turns tedious.

Despite this, the story is engaging, especially Preston's portrayal of the oddball Taylor, who ends the book married and an engineer, and with an unabated redwood habit.

Inexplicably, Preston fails to detail Taylor's biggest triumph, an expedition to measure the world's tallest known tree, a 379-footer that Sillett and Taylor discovered and named Hyperion. Preston wrote about the adventure in the Oct. 6, 2006 *New Yorker* but provides only a glancing reference at the end of the book.

Perhaps he simply ran out of time. A reader can only hope the remaining redwoods—only 4 percent of the trees found 200 years ago—don't suffer the same fate. —B. VASTAG

Think Globally, Eat Locally

ANIMAL, VEGETABLE, MIRACLE:
A Year of Food Life

BARBARA KINGSOLVER, WITH STEVEN L. HOPP AND CAMILLE KINGSOLVER

HarperCollins, 2007

Although best known as a novelist, Barbara Kingsolver is also a biologist, mom, wife, and former science writer. In this lively and informative book, all those facets of her life shine through. Husband Steve Hopp and daughter Camille also contribute to this family story of "a year in which we made every attempt to feed ourselves animals and vegetables whose provenance we really knew ... and of how our family was changed."

The book, in a nutshell, is about good food and how to grow and cook it—all with an eye to being gentle with the environment. It's a new, hybrid science that one might call "ecogastronomy." Kingsolver's talent is to make her family's radical change of lifestyle sound

both practical and appealing. All readers, urban dwellers included, could adopt at least some of the strategies that the authors describe.

In 2004, Kingsolver, Hopp, and their two daughters left Tucson for a southern Appalachian farm. The family spent a year remodeling the farmhouse and preparing the land. Parents and daughters developed ground rules. First, they would try to eat only vegetables and fruits grown in their own garden or within a short radius of their home base. Most dairy products and meats would be purchased locally, and the clan would raise its own chickens and turkeys. Nine-year-old daughter Lily took on responsibility for the chickens, which she promised to not make pets. "It's OK," Lily assured her mom. "I won't name them."

The period covered in the book starts in March 2005 and ends a year later. Beginning with April's asparagus harvest, continuing through traditional year-end feasts of turkey and pumpkin pie (the family did have to forgo cranberries), and closing the following spring with contemplative reflections on the family's adventure, Kingsolver recounts a year's local-food experience.

Living off the land had its ups and downs, and one of this book's charms is its candor. March was the "hungry month" that demanded dependence on canned, frozen, or dried fruits and vegetables. But July and August were bountiful with dozens of veggies, particularly zucchini and tomatoes, ripe for harvest. Kingsolver describes each month's bounty from the perspective of a scientist (explaining, for example, the reproductive cycle of angiosperms) as well as that of a steward of the environment.

In sidebars, daughter Camille, a college student, recounts the experience from her generation's view. She offers recipes and a sample meal plan for each month. Included, for example, are four recipes for potato salad—each using a different variety of seasonal potato.

Hopp, a professor of environmental studies, contributes sidebars that put his family's experience in a global perspective. He discusses the ethical, environmental, and health consequences of high-volume animal-feeding operations, as well as chemical pesticides and fair-trade agreements.

Using the Dewey Decimal system, my local library shelved this book under Category 641—Food and Drink. That classification will help others find *Animal, Vegetable, Miracle*, but it doesn't do justice to this unique and thought-provoking book. A cross-reference to "Miracle" might do the trick. —L. HARTEKER

The Art and Science of Blooms

FLOWER CONFIDENTIAL: The Good, the Bad, and the Beautiful in the Business of Flowers

AMY STEWART

Algonquin Books of Chapel Hill, 2007

A rogue lunch is a terrible thing. "One of the first rules of operating a flower shop is to never, ever store a sack lunch in the cooler, out of fear that a piece of fruit could ruin the roses," writes Amy Stewart. An apple, for instance, will release a lot of ethylene, which will speed plant-tissue aging.

Stewart's *Flower Confidential* takes readers behind the bud vases for a lively exploration of the breeding, growing, and marketing of cut flowers. She starts with flower breeding the old-fashioned way by the late Leslie Woodriff. Stewart calls him a horticultural legend but says that people in his hometown remember him as "the eccentric old guy in the broken-down greenhouse along the highway." Few outside his profession know his name, but just about everyone has seen his work: the big, fragrant, upturned Star Gazer lily.

Moving to the high-tech extreme, Stewart describes the Florigene company's quest for a blue rose. Genetic engineers succeeded in getting roses to carry a gene that produces delphinidin, a pigment that looks sky blue under the right circumstances. But so far, Stewart reports, the roses are more violet than true blue.

In the $40 billion cut-flower trade, farms in South America and Africa rush their products to Europe, North America, and Russia. "Flowers today may be better traveled than the people who buy them," Stewart writes. She shows readers Ecuador's rose farms, where premium flowers have enormous heads on straight, 5-foot-tall stems. Their growers ship most of these luxurious blooms to Europe and Russia.

DEAN MACADAM

Flowers may be pretty, but the farms producing them outside the United States don't have such an attractive reputation. Stewart discusses allegations that the operations exploit workers and abuse pesticides. She finds a mixed picture but offers a hopeful note, describing certification programs to let consumers know that growers have met certain standards for growing and labor practices.

Stewart follows flowers from their growers to their buyers, such as those at the Dutch auctions at Aalsmeer, which handle 20 percent of the cut flowers in the world. The book ends, as so many flowers do, on Valentine's Day in a flower shop. This particular Feb. 14 is a weekday, and that's good. Florists tell her that sales crash when the date falls on a weekend.

A more serious woe for U.S. florists comes from supermarkets that set out buckets of bouquets. These sellers are expanding their market share, even as many break the basic flower-shop rule. As a Dutch import-export representative laments to Stewart, "They put everything together—the cheese, the fruit, the flowers—all that ethylene. It's awful." —S. MILIUS

The Heat Is On

PLOWS, PLAGUES, AND PETROLEUM: How Humans Took Control of Climate

WILLIAM F. RUDDIMAN

Princeton University Press, 2005

An explosion of human population and burgeoning technology use are causing planet-warming greenhouse gases to build up in Earth's atmosphere. That statement is true today, was true at the beginning of the industrial revolution nearly 2 centuries ago, and—in what probably is a surprise to most people—was true thousands of years ago.

In a straightforward and evenhanded way, climatologist William F. Ruddiman explains how researchers reconstruct our planet's climatic history. One technique they use, for example, is to track the varying concentrations of gases in the atmosphere by analyzing bubbles trapped in ice caps worldwide. The longest records, from Greenland and Antarctica, cover hundreds of thousands of years and chronicle how concentrations of greenhouse gases such as carbon dioxide and methane have varied.

For the past few hundred millennia, the amount of carbon dioxide in our atmosphere has gone up and down roughly every 100,000 years, while methane has followed a 22,000-year timescale. Those changes, Ruddiman explains, correspond to long-term cycles in Earth's orbital path that influence the seasons and the amount of the landscape occupied by wetlands.

But the natural patterns have been disrupted, he writes. After the peak of the latest ice age, about 11,000 years ago, both carbon dioxide and methane at first declined in the expected way. But about 8,000 years ago, the amount of carbon dioxide began to increase, with methane following suit about 3,000 years later.

What caused these anomalies? The simple if surprising answer, Ruddiman argues, is human activity. About 8,000 years ago, long

before the industrial revolution, people began clearing forests to create agricultural land. As populations grew, the carbon dioxide that would have been soaked up by trees instead remained in the atmosphere. Then, around 5,000 years ago, especially in Southeast Asia, people began to irrigate their rice paddies—in effect, expanding the amount of landscape covered by methane-generating wetlands.

Ruddiman finds other evidence that human activity affected greenhouse gases in the atmosphere before large-scale industrialization got under way. Occasional but substantial decreases in carbon dioxide during the past 2,000 years coincide with plagues that devastated populations across broad regions. Following the largest pandemic of recent time—the one that European explorers caused in the Americas in the 1500s—reforestation of neglected farm plots caused atmospheric concentrations of carbon dioxide to drop substantially, cooling worldwide average temperatures by as much as 0.1°C.

Such temporary changes in carbon dioxide concentrations pale in comparison to those caused by people today, when industries and automobiles are increasing greenhouse gases in the atmosphere by almost 1 percent every year.

Plows, Plagues, and Petroleum is a primer on natural variations in Earth's climate and on how human activity is having even more of an impact. While some readers might find it disturbing that people have been influencing the planet's climate for millennia, others may be even more alarmed to think about climate changes yet to come. —S. PERKINS

The Parting of the Ways

BEFORE DARWIN:
Reconciling God and Nature

KEITH THOMSON

Yale University Press, 2005

William Paley was not the simpleton his modern detractors claim he was. It was Paley, Archdeacon of Carlisle, England, who in his 1802 book *Natural Theology* made famous an argument concerning a pocket watch. Such a machine could not arise of its own accord, he observed, but must have come about through deliberate acts of design and creation. So too, he said, the wondrously complex natural world requires a designer.

Paley's argument was a good deal subtler than that, however. Keith Thomson, a professor emeritus of biology with a deep understanding of theology, takes readers on an intellectual tour through the 2 centuries preceding the 1859 publication of Charles Darwin's *Origin of Species*. During that period, geologists and biologists were beginning to put together a recognizably modern account of our planet and the life it carries. Their novel ideas provoked a fretful conflict with long-established Judeo-Christian views.

Of all the scientists' new ideas, none was more awkward than the notion of change. Geologists realized that landscapes slowly transform. The discovery of fossils corresponding to no modern creature showed that forms of life must have disappeared.

Change posed a problem for theologians who believed in a perfect creation, because perfection to them implied permanence. But an additional perplexity loomed. If the disparate elements that make up the world were always changing, how could the ensemble continue to function in such an apparently harmonious way?

Guiding us through the work of James Hutton, Charles Lyell, Erasmus Darwin, David Hume, and many others, Thomson explains how some thinkers were happy to evict God from a world ruled by science. But he sympathetically portrays the struggle of those who wished to maintain their religious views.

Paley's *Natural Theology* represents the culmination of that struggle. The example of the watch calls attention to the way in which many parts must mesh perfectly to create a functioning machine. Similarly, Paley said, the human eye is composed of many parts working toward a common purpose. That purpose, moreover, depends on the behavior of light, which has nothing to do with biology.

Only God's enduring influence, Paley insisted, can explain how the complex assemblies of life fit so well in their varied environments on Earth, and how their fitness persists as those environments change. Although deeply impressed by Paley's eloquent presentation, Charles Darwin had the genius to hit on a very different solution: adaptation through natural selection. After Darwin, many thinkers began to see scientific and religious views on life's origin as inescapably at odds. Thomson concludes that Paley couldn't help but fail in his attempt to keep science and religion in harmony. But unlike most of today's critics of evolution, he was no blind defender of dogma, and he sought earnestly to answer the questions that science presented. —D. LINDLEY

Nice Guys Finish Last

IVORYBILL HUNTERS:
The Search for Proof in a Flooded Wilderness

GEOFFREY E. HILL

Oxford University Press, 2007

Nobody remembers who comes in second. That rule shouldn't apply to Geoffrey Hill, the Auburn University ornithologist whose small band of swamp scientists last year reported sightings and recordings of ivory-billed woodpeckers, presumed extinct since 1944, in the Florida panhandle. The group's report came more than a year after the famed Cornell Laboratory of Ornithology splashily claimed to have rediscovered the bird in Arkansas. Hill presents better evidence and the promise of more to come.

The Cornell team wasn't the first to report sightings, or even to supply blurry pictures, of the "Lord God Bird" since its alleged demise. Hill reviews serious but flawed studies of ivory-billeds along with a thread of mostly crackpot sightings, including one from the Pea River in south Alabama that came over his office transom in 1995.

It wasn't until April 2005, after the Cornell group had made its announcement, that Hill took the 1995 report semiseriously. He and two young colleagues made a kayaking trip to the Pea River but quickly decided that the decimated forest there was inhospitable to ivory-billeds. On a whim, they drove a few miles south to Florida's Choctawhatchee River. Woefully unprepared for even a casual paddle on the river and its tangled tributaries, the three nevertheless found a vast, little-known, nearly intact tract of perfect ivory-billed habitat, rich in hardwoods and cypress.

At about 7:30 on their first morning there, the least-experienced birder among the scientists swore that he saw an ivory-billed, and all three men heard several of the double knocks that distinguish the woodpecker from all other birds in the United States.

From there, Hill and his makeshift crew began a secret, yearlong hunt. They remain confident that the 14 sightings they describe and about three times as many audio recordings are indeed of the supposedly extinct birds. The impression is that the study area must be teeming with the birds. Many of the large nest cavities that they found were fresh cut, for example, and tree bark had apparently been chiseled by unusually powerful woodpeckers.

Yet this exciting story ends in frustration, without any proof-positive still or motion picture. Like the Cornell researchers in Arkansas, Hill and his crew came away with a "lousy video"—in their

DEAN MACADAM

case, showing three (!) smudges that might be ivory-billeds—that Hill considers "far from conclusive proof" of the birds' presence.

Recounting the tale with a pleasing balance of human drama and scientific cool, Hill also interjects a wonderful chapter on what is and isn't science. "When we hunt for ivorybills ... we are not doing science. We are not trying to explain processes of nature. We are searching for a bird. We are birding," he writes.

Hill ends his book by inviting other birders to help him look for ivory-billeds. "I end this book in the middle of the adventure," he writes, leaving the reader with a sense that the group could get its definitive picture any day. Evidently, that's not the case so far, as Hill indicates on his Web site (*www.auburn.edu/ivorybill*), which features updates of the 2006-2007 season's search. —K. HAGLUND

The Grandeur That Was the Americas

1491: New Revelations of the Americas before Columbus

CHARLES C. MANN

Vintage Books, 2005

For people who accept the Hollywood version of Native Americans—small, nomadic bands living in bucolic landscapes—this book could come as a bit of a shock.

The romanticized images of Native Americans that pervade popular culture are largely wrong, Mann writes. Current archeological thinking is that many Native American societies were neither small nor environmentally benign.

Indians built technologically advanced civilizations, particularly in present-day Mexico and Central and South America. With populations often exceeding those of 15th-century European cities such as Paris, urban centers built by the pre-Columbian civilizations radically altered their natural surroundings. Fly low over these landscapes today, as Mann vividly recounts, and one can see the faint outlines of massive drainage ditches, arrow-straight berms, and geometrical mounds built by these ancient people.

During the past few decades, archaeologists have pieced together much of the history of sites such as these. Advances in scientific techniques—from epidemiology and climatology to satellite imagery and DNA testing—have begun to reveal the rich history of the Americas before Christopher Columbus arrived in 1492. Yet this new understanding has remained mostly unknown outside academia. Mann tells of his son being taught the same quaint falsehoods about Native American culture that Mann himself had learned as a schoolboy 30 years earlier.

DEAN MACADAM

One of those misconceptions is that New World societies lacked the intellectual and technological achievements of the Old World. Mann points out that cultures in the Americas independently developed agriculture about 10,000 years ago and gave rise to the technologically complex Olmec civilization 3,800 years ago.

Native American peoples "invented a dozen different systems of writing, established widespread trade networks, tracked the orbits of the planets, created a 365-day calendar (more accurate than its contemporaries in Europe)," Mann writes. The Maya discovered the mathematical concept of zero, which mathematicians peg as a seminal human accomplishment.

The most advanced and populous civilizations—the Maya, Wari, Tiwanaku, Inca, and Aztec—all inhabited lands south of the Rio Grande. But early European colonists and traders wrote of even present-day New England as a densely populated land. If later explorers found a wilderness peopled only sparsely by small tribes, it was because diseases inadvertently brought by the Europeans had already depopulated local societies, Mann asserts.

A journalist rather than an academic, Mann has avoided writing a scholarly chronology—a style he derides as "one damn thing after another." Instead, he highlights the juiciest stories and most interesting bits of information, keeping this information-packed book enjoyable to read. —P. BARRY

Much Ado about Nothing

MANY WORLDS IN ONE: The Search for Other Universes

ALEX VILENKIN

Hill and Wang, 2006

By its very definition, cosmology deals with the universe as a whole—everything. These days, however, in true *Seinfeld* fashion, cosmology is often about nothing too. More precisely, cosmologists seem most concerned with empty space, also known in physics parlance as the vacuum.

Alex Vilenkin is among the cosmologists who believe that many, perhaps infinitely many, parallel universes could exist, each with its own kind of vacuum. We happen to live in one such bubble, with no hope of ever coming into contact with another. To get to that startling conclusion, Vilenkin offers a short and sweet introduction to the most hotly debated ideas in modern cosmology—ideas to which the author has himself made key contributions.

The trend began in the early 1980s, when physicist Alan Guth—now of the Massachusetts Institute of Technology—and others showed how they could resolve a number of perplexing difficulties in the Big Bang scenario by postulating an explosive epoch called inflation. Guth imagined an early universe in which the vacuum had an intrinsic energy that acted like antigravity. During the earliest moments of the Big Bang, this repulsive force would have expanded the universe from microscopic size to cosmic scale in a zillionth of a second. Then, as the initial kind of vacuum turned into another, the antigravity would have suddenly disappeared. The universe would have settled back to a sluggish pace of expansion that would later allow galaxies, stars, and planets to form.

But in 1998, astronomers discovered that Guth's antigravity never really went away. Although much weaker now than it was during inflation, antigravity even today seems to push galaxies apart. The vacuum dominates the universe's destiny.

One of the greatest puzzles in this scenario is why the vacuum should end up in one state rather than in another. The mystery only deepened in 2003, when physicists tried calculating the vacuum states using string theory, the yet-untested "theory of everything" that would replace elementary particles with tiny, vibrating strings. By their reckoning, the magnitude of the vacuum's energy in our modern universe is just one among a stupendous number (10^{500}) of possibilities.

Vilenkin excels at illustrating these and many other difficult concepts, peppering his account with personal anecdotes. His explanations are among the tersest in the popular cosmology literature, yet also among the least watered down.

As Vilenkin admits, his claims are not uncontroversial. Some scientists regard speculation about other universes as unscientific, since no experiment can ever be done to directly detect them. String theory itself has recently come under fire for being disconnected from experiment.

But the speculative nature of the subject becomes one of the book's strengths. The author, for example, toys with the idea of visiting regions within our universe's bubble that could be inhabited by replicas of ourselves—an idea that physicists have shown isn't entirely out of the question. Want to take a vacation in such a parallel universe? When it comes to summer reading, it doesn't get much more escapist than this. —D. CASTELVECCHI

A GEMSTONE'S WILD RIDE

How diamonds erupt from deep within Earth

BY SID PERKINS

Thanks to their hardness, durability, and rarity, diamonds are symbols of eternal love and wealth. A new analysis of how these gems emerge from the depths where they were forged billions of years ago suggests that they should also evoke images of diamond-studded fountains of gas and rock.

Almost all diamonds come from volcanic deposits called kimberlites. Tens of thousands of such deposits, some more than a kilometer across, have been found protruding through Earth's surface. However, only one in every 200 of them contains gem-quality diamonds. Increasingly, scientists are looking at kimberlites' odd mix of geological characteristics to discern how diamond deposits get there in the first place.

MYSTERIOUS MINERALS With or without diamonds, kimberlites are enigmatic, says James W. Head III, a planetary geologist at Brown University in Providence, R.I. The carrot-shaped deposits, which can extend to depths of 2.5 kilometers, are clearly volcanic in origin, but areas around them aren't marked by large amounts of lava. Furthermore, kimberlites contain large numbers of glass spherules that typically form from airborne droplets of molten rock. Locked within kimberlites, however, the spherules apparently never make it above ground. Finally, as much as half the jumbled rocks in kimberlite deposits comes from Earth's mantle, the hot, viscous material that lies below depths of 35 km.

The presence of diamonds in kimberlites suggests that these volcanic deposits originate at depths of at least 250 km, where immense pressures keep the gems' crystal structures stable. Furthermore, the material in diamond-bearing kimberlites must have risen from there to Earth's surface in just a few hours. That's because at shallower depths, where pressures are lower but temperatures remain high, the instability of diamonds would lead to their quick transformation into graphite.

IN THE ROUGH — This 3-carat octahedral diamond, still embedded in rock from a kimberlite deposit, erupted from deep within Earth at incredible speed, new research suggests.

C. CLARK/SMITHSONIAN INSTITUTION

In the May 3 *Nature*, Head and volcanologist Lionel Wilson of Lancaster University in England describe a model of a kimberlite eruption that explains the resulting mix of diamonds, spherules, and mantle rock in a carrot-shaped deposit.

At the beginning of an eruption, the researchers suggest, a wedge-shaped mass of carbon dioxide, pointing upward, forms inside a crack of some sort in Earth's semi-solid mantle. At such depths, carbon dioxide is typically a liquid.

Beneath the wedge is a large, buoyant mass of molten rock saturated with carbon dioxide. Its buoyancy forces the wedge of liquid carbon dioxide upward, further cracking the overlying rock. As the crack grows and the tip of the wedge races toward Earth's surface, pressures in the topmost layers of magma begin to drop, and some of the carbon dioxide in the molten rock fizzes out, creating a layer of foam.

Immense pressures in the mantle cause diamond-bearing chunks of rock to explode from the walls of the fissure and fall through the wedge of liquid carbon dioxide into the magma below. Once this rock-busting process begins, the wedge of carbon dioxide and the magma immediately below it race upward at speeds up to 180 kilometers per hour.

BREAKING GROUND When the wedge of carbon dioxide breaches the surface, pressure is released and the liquid evaporates explosively. This sends a jet of carbon dioxide gas, molten rock, and rubble skyward at a rate up to four times the speed of sound.

The rapid expansion of the carbon dioxide cools the molten rock, freezing it solid and plugging the eruption. Then, pressure builds and shock waves reverberate through the cavity, shattering its walls as well as the magma plug. The eruption begins anew, says Head.

Repeated eruptions of carbon dioxide, magma, and rubble blast a cone-shaped hole at Earth's surface. The series of eruptions runs out of steam probably no more than an hour or so after the carbon dioxide wedge breaches the surface. As the action wanes, the hole becomes filled with a porous mix of glass spherules, chunks of rock carried up from the mantle, fragments of volcanic ash and chilled magma, and, sometimes, diamonds.

The Head-Wilson hypothesis "very nicely explains how mantle rocks are transported to the surface," says Stephen E. Haggerty, a geologist at Florida International University in Miami. However, he notes, many questions remain about what happens deep within Earth at the beginning of an eruption.

For example: How might the viscous, nearly molten rocks in the mantle become cracked in the first place? At such high temperatures and pressures, why don't cracks in the rocks seal themselves?

"I like [Wilson and Head's] model, which takes a holistic view and tracks diamonds from their source to the surface," says Kelly Russell, a volcanologist at the University of British Columbia in Vancouver. Like Haggerty, Russell says that there are plenty of questions left to be answered by further analysis and fine-tuning of the model. For one thing, the role that water in mantle rocks might play in the eruption process isn't yet clear.

"This model makes a good target," Russell notes. "Now, the rest of us [scientists] can shoot at it." ■

OF NOTE

BIOTECHNOLOGY

A computer in every cell

Scientists have designed a "biological computer" that can calculate logical expressions using RNA implanted in living cells.

The advance could eventually lead to new tools for biologists studying the inner workings of cells. It could also lead to "smart medicines" that respond in preprogrammed ways to a patient's state of health. "It's a great way to do ... logic," says Yaakov Benenson of Harvard University. Our system "can basically make decisions based on multiple [input] signals," he adds.

The computer consists of several kinds of engineered RNA molecules produced by synthetic DNA that Benenson's team inserted into cultured human-kidney cells. Each input for the computer would be either the presence (a logical "true") or absence ("false") in the cell of some molecule, perhaps a cancer-related protein. To make the connections between inputs and outputs, the scientists constructed logical circuits with a type of RNA called small interfering RNA (siRNA), which can control the activity of other RNAs. The team assembled these units into a network of biological switches that produces an output by triggering a gene to become active or not active.

That gene might produce a fluorescent protein to signal to a doctor when disease is present or make an enzyme that either repairs or kills a precancerous cell.

The system that Benenson's team designed had five inputs, but it could be scaled up to compute any logical expression with many inputs and outputs, the team reports online and in an upcoming *Nature Biotechnology*. —P.B.

PLANETARY SCIENCE

Eris dwarfs Pluto

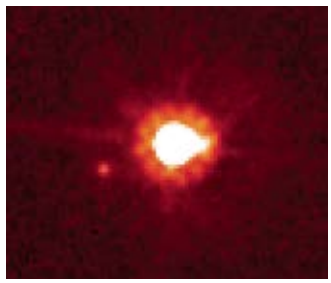
Ex-planet Pluto just got a further demotion. Observations in 2005 had already revealed that it wasn't the kingpin of the outer solar system: A more remote denizen called Eris has a diameter 5 percent bigger than Pluto's.

That finding triggered last year's decree by the International Astronomical Union that Pluto should no longer be considered a planet. Instead, like Eris, it belongs to a newly defined class of objects called dwarf planets (*SN: 9/2/06, p. 149*).

Now, there's additional evidence that Pluto merits only second-class status. Data taken by two observatories show that Eris, previously nicknamed Xena, is nearly one-third more massive than Pluto.

Mike Brown and Emily Schaller of the California Institute of Technology in Pasadena were able to weigh Eris by tracking the orbit of its tiny moon, Dysmonia. Using images of the moon taken by the Hubble Space Telescope and the Keck Observatory on Hawaii's Mauna Kea, the researchers determined that Eris is 27 percent heavier than Pluto. The mass of Eris, along with its previously determined diameter, suggests that it contains both rock and ice and is similar in density to Pluto; Neptune's moon, Triton; and an outer–solar system object called 2003 EL61.

Brown and Schaller report their findings in the June 15 *Science*. —R.C.



BROWN, NASA, ESA

KINGPIN The largest and heaviest known outer–solar system object, Eris, is pictured with its tiny moon, Dysmonia.

ZOOLOGY

West Nile virus hits bird populations

At least five common birds, including robins and bluebirds, suffered sustained, large-scale population declines because of West Nile virus, a new study suggests.

The mosquitoborne virus, already known to sicken and kill wildlife as well as people, was first documented in the United States in 1999. Now, birders' records give the first look at what the disease has done to whole bird populations, say researchers from the Smithsonian Migratory Bird Center in Washington, D.C., and the Consortium for Conservation Medicine in New York City.

Shannon L. LaDeau of the Smithsonian turned to records from the annual nationwide Breeding Bird Survey. Each June, volunteer surveyors drive predetermined 25-mile routes along secondary roads and stop every half mile for 3 minutes to count birds.

LaDeau and her colleagues studied 20 species commonly reported in these surveys. The researchers selected a range of species that earlier experiments had suggested would have different sensitivities. Lab studies had exposed various species to the virus and tracked the percentages of deaths. Field studies had identified the bird species that disease-carrying mosquitoes prefer to bite.

After developing statistical approaches to cope with the irregular data from a huge corps of birders, LaDeau plotted trends in reports from 1980 to 2005 along 228 routes in 10 states. Once the virus hit a particular state, she used the older data to predict what the birds' numbers would have been without the disease.

For seven species, numbers dropped significantly below these predicted levels. House wrens and blue jays dipped but rebounded by 2005. Declining and not rebounding were American crows, American robins, Eastern bluebirds, black-capped chickadees, Carolina chickadees, and tufted titmice, she and her colleagues report in the June 7 *Nature*. —S.M.

ENVIRONMENT

Double-acting bacteria immobilize toxic nanoparticles

Bacteria found lurking in the bowels of an abandoned Wisconsin mine might have a role in cleaning up toxic metals. A new study shows that these bacteria make compounds that cement minute metallic particles into balls that naturally drop out of contaminated water.

As part of their metabolic cycles, certain bacteria that live in watery, oxygenfree environments take up one type of sulfur-containing chemical, a sulfate, and transform it into another type, a sulfide, that they then release. The sulfide binds to metals dissolved in water to form nanoparticles.

John Moreau of the U.S. Geological Survey in Middleton, Wis., and his colleagues studied the activity of such bacteria in a flooded lead-and-zinc mine. They discovered that zinc sulfide nanoparticles "were being scooped up and glommed together into spheroids," he says.

The larger spheroids tend to settle out long before they get into the water supply.

The researchers found that, by weight, proteinlike material formed 10 to 15 percent of the metal spheroids. In lab tests, zinc sulfide nanoparticles clumped when placed in contact with the amino acid cysteine, a protein component. The team reports its findings in the June 15 *Science*.

Scientists had previously come across

metal spheroids in other oxygen-deprived environments and had proposed that heat, pressure, or magnetism might have formed the balls. Moreau and his colleagues now say that the bacteria can do double duty, creating a sulfide that leads to nanoparticle formation as well as making the proteinlike compounds that appear to promote nanoparticle clumping. —S.W.

BIOMEDICINE

Nerves are key to longevity effect

The brain may be involved in triggering the life-extending effects of a calorie-restricted diet, new research shows.

Scientists first observed in the 1930s that feeding animals about 30 percent fewer calories than normal extended the animals' life spans by 30 to 40 percent. The effect emerged in several animal species, including roundworms, mice, dogs, and monkeys, and the cause seemed to be physiological changes in muscle and fat tissues.

But in roundworms, pairs of neurons in the animals' heads play a critical role too, according to research by Nicholas A. Bishop and Leonard Guarente of the Massachusetts Institute of Technology. Destroying the neurons with a laser prevented calorie restriction from having any effect on the worms' longevity, the scientists report in the May 31 *Nature*.

"It's the first indication that the brain is going to send that initial signal for longevity in response to calorie restriction," Guarente says. He adds that his team's next step is to determine whether hormones released by these neurons are responsible for the longevity effect.

The human brain area comparable to these neurons is the hypothalamus, Guarente says. However, life extension from calorie restriction has never been unambiguously demonstrated in people. —P.B.

CHEMISTRY

A sweet way to replace petroleum?

A variety of products now manufactured from petroleum could one day be made instead from simple sugar molecules, thanks to a new chemical process.

Compounds derived from petroleum are the chemical building blocks of many consumer goods, including plastics and pharmaceuticals. With the price of crude oil skyrocketing, researchers are on the lookout for alternatives, says Z. Conrad Zhang, a chemist at the Pacific Northwest National Laboratory in Richland, Wash. One promising candidate is a molecule called 5-hydroxymethylfurfural or HMF.

Chemists typically make HMF from fructose in a strongly acidic, water-based solution. Under such conditions, much of the HMF that forms quickly breaks down, and it's difficult to purify what remains intact.

Now, Zhang and his colleagues have developed a technique to produce HMF efficiently, which they describe in the June 15 *Science*. Instead of stirring the ingredients into water, the researchers dissolved them in an ionic liquid, which consists solely of positively and negatively charged ions (*SN: 9/8/01, p. 156*). Adding various catalysts to the acidfree mix quickened the reaction and stabilized the HMF that was produced.

The team's best results occurred when it cooked the fructose mixtures at 80°C for about 3 hours and used chromium chloride as a catalyst. Under those conditions, up to 83 percent of the fructose was converted into HMF, says Zhang.

Preliminary tests suggest that a variation of this process could generate HMF from the cellulose in wood and plant stems, says Zhang. Cellulose molecules are chains of fructose and glucose. —S.P.

MEETINGS

Acoustical Society of America
Salt Lake City, Utah
June 4 – 8

MUSICAL INSTRUMENTS

Stradivari's secrets

Antonio Stradivari's coveted violins have been around for more than 3 centuries, but experts are still struggling to understand just why they sound so magnificent. A new study of the vibrations of 17 violins from various makers finds one Stradivari that's especially efficient at directing sound toward the audience.

George Bissinger of East Carolina University in Greenville, N.C., used three lasers and the Doppler effect—the familiar phenomenon that makes a siren's pitch drop when an ambulance speeds by—to image the vibrations of each violin's surfaces.

The real-time three-dimensional mapping, which Bissinger says is unprecedented, enabled him to distinguish vibrations that move the violin's surface up and down from those that compress and stretch it. Only the former, called transverse vibrations, move the air and thus produce sound. One of the two Stradivaris tested had the strongest transverse vibrations of any of the violins, Bissinger says.

When he measured sound intensity, that violin also turned out to project a larger proportion of its total sound energy from its front, which usually faces the audience.

Bissinger says that the Strad's peculiarities could derive from the treatment given to the wood or from the varnish applied to it, both of which are largely unknown. —D.C.

SPACE SCIENCE

Music to alien ears

What would a Deep Purple concert sound like on another world? The best rock venue in the solar system, it turns out, might be the surface of Saturn's moon Titan.

The atmospheres of different celestial bodies have different chemical compositions, densities, viscosities, and temperatures, all of which affect the way sound propagates.

Apart from two Soviet probes that sent crude sound data back from Venus in the early 1980s, the only space mission to have recorded sounds on another world was the European Space Agency's Huygens probe, which landed on Titan in 2005. Huygens mostly recorded wind noise during its descent.

Space scientists say that acoustical instruments on future missions could measure wind speeds and might answer such questions as whether there's thunder on Mars.

To help design such experiments, Andi Petculescu of the University of Louisiana at Lafayette and Richard Lueptow of Northwestern University have done the most extensive computer simulations yet of the propagation of sound on three alien bodies—Venus, Mars, and Titan—plus Earth, for comparison.

As expected (*SN: 7/8/06, p. 29*), Mars' thin atmosphere would cause sound to fade away after traveling just a few meters. The atmosphere of Venus, almost entirely carbon dioxide, would muffle high-pitched sounds. Titan's frigid, nitrogen-based atmosphere would offer the best sound transmission across all frequencies.

Petculescu played his simulations of Deep Purple's guitar riff from "Smoke on the Water" as it would sound on each of the four bodies. Titan is the place to be—if you can stand the –178°C weather, that is. —D.C.

Books

A selection of new and notable books of scientific interest

FAUST IN COPENHAGEN: A Struggle for the Soul of Physics

GINO SEGRÈ

April 1932 marked both a peak in physics and the end of a carefree era, Segrè writes. The meeting at

the Copenhagen Institute of influential scientists was much like earlier annual assemblies pulled together by Niels Bohr. But this would be the last meeting before Adolf Hilter's ascent to power in Germany. Discoveries made that year provided plenty of material for discussion. Both the neutron and antimatter were identified, and scientists were able to induce the first nuclear disintegration. Segrè, a professor of physics and astronomy, focuses on the human element at this landmark meeting. The attendees included Bohr, Paul Dirac, Werner Heisenberg, Lise Meitner, Max Delbruck, and Paul Ehrenfest. Wolfgang Pauli, another Bohr-meeting regular who happened to miss the 1932 get-together, is profiled as well. Segrè discusses each character and recounts his or her insights and achievements in physics. Finally, he reveals the toll that World War II took on each scientist, including several who endured Nazi persecution. ***Viking, 2007, 310 p., b&w plates, hardcover, $25.95.***

NO TWO ALIKE: Human Nature and Human Individuality

JUDITH RICH HARRIS

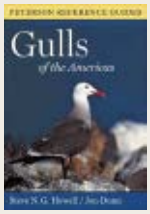
If each person is the product of his or her own combination of genes and environment, why do identical twins develop different personalities,

hopes, and ambitions? What is really at the root of human individuality? Harris, a journalist, seeks answers beyond the nature-nurture debate, which she views as insufficient for explaining the development of personality. She cites classic psychology experiments as well as cutting-edge research on DNA as evidence of the complexity of human individuality. She first dispels many of the myths that surround human development, including, for instance, the idea that birth order has an effect on personality. Harris' view is that three factors—relationship, socialization, and status—interact to develop personality and to prepare people as members of a society. ***Norton, 2007, 329 p., b&w images, paperback, $16.95.***

GULLS OF THE AMERICAS

STEVE N.G. HOWELL AND JON DUNN

Familiar to any beachgoer, gull species are nevertheless notoriously difficult to identify. At first glance, all gulls may appear to be the same. Howell, a birding-tour leader, and Dunn, chief consultant for and an editor of the *National Geographic Field Guide to the Birds of North America*, offer in this Peterson Reference Guide tips for identifying the 36 species of gulls that populate North America. The authors offer each photo as an aid to bird-

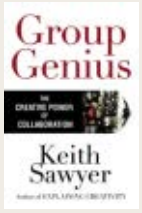


watchers in appreciating the subtle variations among gull species. The guide contains vivid color plates with captions that highlight criteria for identifying each bird, text with detailed information including geographic range, plumage and other physical features, taxonomy, migration routes and timing, and maps of breeding and nonbreeding ranges. The book ends with a glossary and an extensive bibliography. ***Houghton Mifflin, 2007, 516 p., color plates, hardcover, $35.00.***

GROUP GENIUS: The Creative Power of Collaboration

KEITH SAWYER

Although an artistic or business success is often credited to the genius of an individual, Sawyer, a professor of psychology at Washington University in

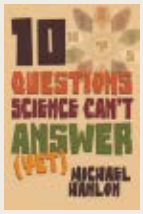


St. Louis, posits that all creative processes are ultimately the product of collaboration. Indeed, many innovations that have changed modern life—e-mail, the automatic teller machine, the mountain bike—are the results of collaborative creation. Sawyer recounts his own research findings about what he calls group genius and describes this creative process in action. He demonstrates the power of guided improvisation and the key characteristics of creative teams, from jazz ensembles to boardroom brainstormers. He outlines the notion of group flow, which occurs among people operating at their optimal levels of collaboration and concentration. He then turns the focus from collaboration among contemporaries to collaboration within a person's mind and collaboration among people over time. Real creativity emerges from many ideas, most of which are failures, Sawyer asserts. Finally, Sawyer profiles companies that have tapped into the power of collaboration. ***Basic, 2007, 274 p., hardcover, $26.95.***

10 QUESTIONS SCIENCE CAN'T ANSWER (YET): A Guide to the Scientific Wilderness

MICHAEL HANLON

In 1900, Lord Kelvin proclaimed that there was no more to be discovered in physics. He was wrong. Even after a century of remarkable advances since



then, there are still unanswered questions large and small in physics as well as in every other field of science. Hanlon, a science writer, takes a close look at 10 such questions and describes the research that has gone into attempts to settle those issues and to solve other mysteries about the world. For example, scientists have still not decided whether animals other than people are self-aware. Hanlon also addresses the mysteries behind aging and the limits to human life spans. Other quandaries include whether dark matter (invisible stuff) and dark energy (invisible force) really control the universe, why obesity is so rampant, whether there is any truth to parapsychology, and what's so real about reality. ***Macmillan, 2007, 192 p., hardcover, $24.95.***

HOW TO ORDER Visit *http://www.sciencenews.org/pages/books.asp* to order these books or others. A click on a book's title will transfer you to the Amazon.com bookstore. Sales generated through these links contribute to Science Service's programs to build interest in and understanding of science.

LETTERS

Hot and cold on the topic

No mention was made in "In the Zone: Extrasolar planet with the potential for life" (*SN: 4/28/07, p. 259*) of the possibility that, being so close to its star and having a 13-day orbital period, the planet would keep the same surface to the star. Having one side baked by unrelenting sunlight and the other side frozen would leave only a narrow ring between eternal day and eternal night that might have what could be called average conditions suitable for liquid water. I would think that the probability for life to start and survive would be very unlikely.

EDMUND SMITH, BROGUE, PA.

In some models of planets, especially those with atmospheres, heat flows between the day and night sides, so the temperatures aren't so extreme. —R. COWEN

Kids' stuff

The lines on the cave ceilings remind me very much of what a large pot of finger paints look like after children extract what they want to draw with ("Children of Prehistory: Stone Age kids left their marks on cave art and stone tools," *SN: 4/28/07, p. 264*). I could easily see my children (especially when younger) drawing on their own faces and bodies all kinds of designs using the colored clay.

DAN WOITULEWICZ, DETROIT, MICH.

I appreciated conjectures by John Shea regarding manufacture of ancient stone tools by children rather than adults. As a modern-day flint knapper of 20 years, I have long suspected that many artifacts from ancient sites were made by beginners. Many of them look like the same junk I made my first 2 years of knapping.

MICHAEL WILLIAMS, COLUMBIA, MO.

Correction *"Quantum Capture: Photosynthesis tries many paths at once"* (SN: 4/14/07, p. 229) *incorrectly stated that plants "use up to 90 percent of the light that strikes them." Photosynthetic organisms can use more than 90 percent of the energy they absorb, but the absorbed photons are a small percentage of those that strike an organism.*

SEND COMMUNICATIONS TO:
Editor, Science News
1719 N Street, N.W., Washington, D.C. 20036
or editors@sciencenews.org
All letters subject to editing.

SUBSCRIBE TODAY

AS LITTLE AS 94¢ PER ISSUE

WWW.SCIENCENEWS.ORG

1-800-552-4412

6 months (26 issues for only $1.05/issue).
1 year (52 issues for only $1.05/issue).
2 years (104 issues for only $.94/issue).

SOURCE CODE:
A02HR