SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

DECEMBER 14, 2002 PAGES 369-384 VOL. 162, NO. 24

new approach to male pill

anthrax spores get a lift

virtual medical trials

blue jays are team players

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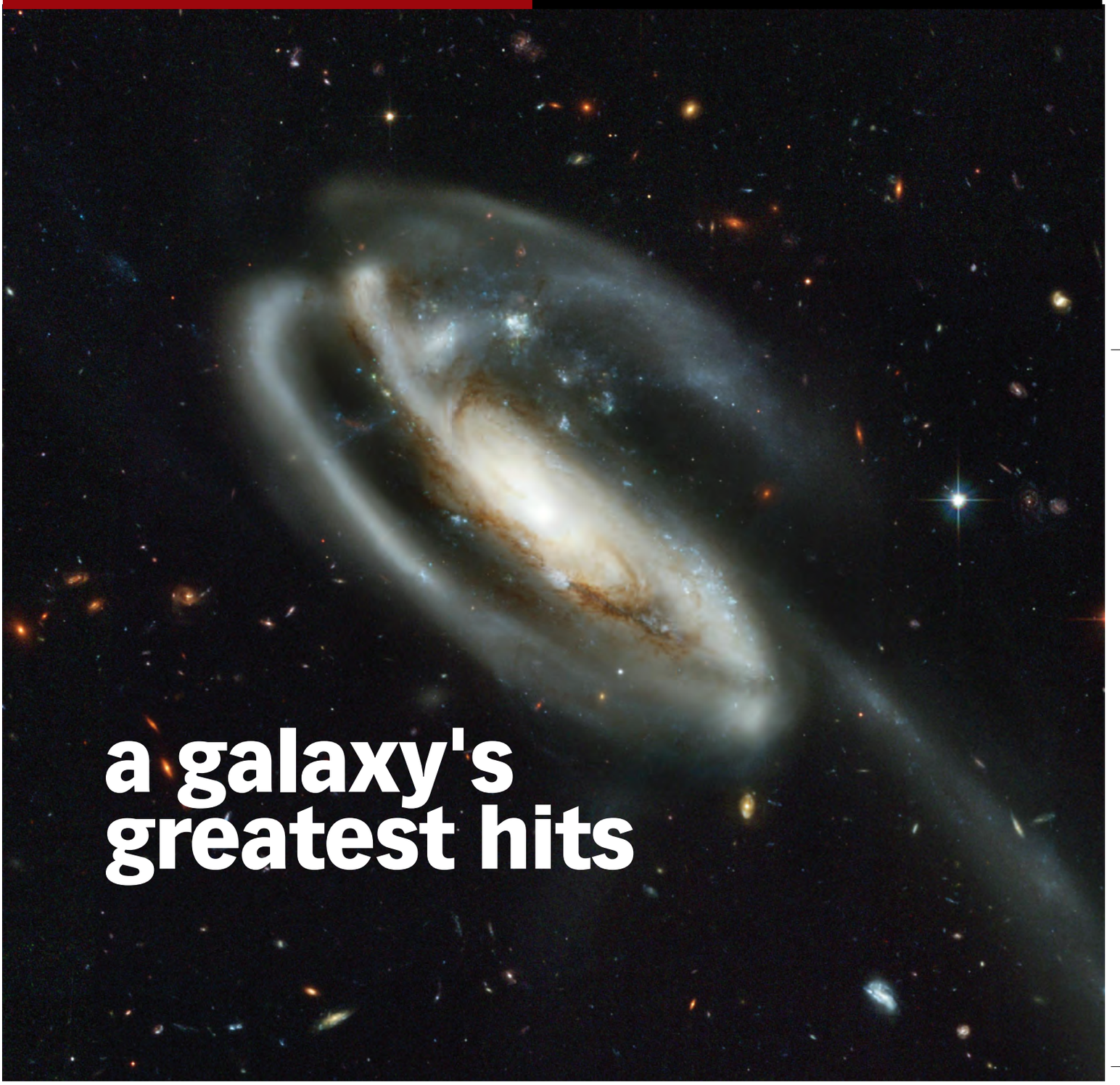

a galaxy's greatest hits

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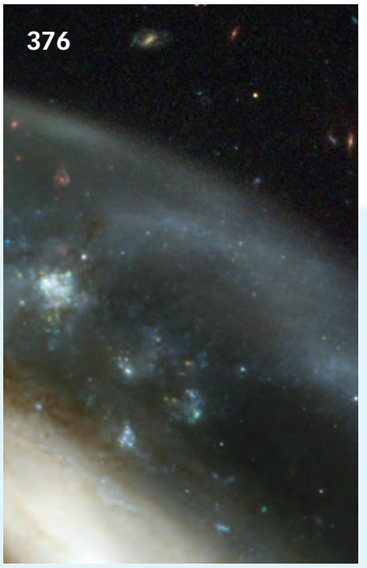

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Cover The Tadpole galaxy bears the scars—a 280,000-light-year-long streamer of stars and gas—of a collision with an intruder galaxy. New evidence supports the view that many galaxies suffered their last major collision billions of years ago. (NASA, H. Ford *et al*., ACS Science Team)
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More pieces of pi The computation of pi's value has reached a trillion decimal digits. See Ivars Peterson's MathTrek.

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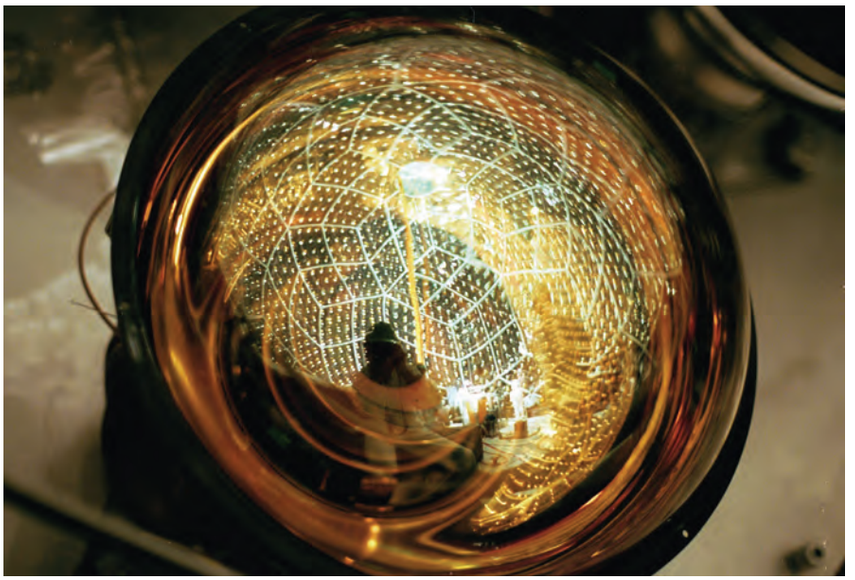
Identity Check

Elusive neutrinos morph on Earth, as in space



KAMLAND COLLABORATION

EYEFUL About 2,000 light-sensitive photomultiplier tubes like this one spotted telltale flashes produced by antineutrinos striking a detector. Reflections show arrays of other tubes.

For nearly half a century, physicists have scanned nuclear reactors' radiation for evidence that the wispy fundamental particles of antimatter known as antineutrinos undergo bizarre identity transformations. Now, an international team working at an antineutrino detector in Japan reports that it has observed a particle shortfall that it attributes to this subatomic morphing act.

By indicating a type of particle behavior not included in conventional particle physics, the new findings challenge the prevailing theory, or standard model, of that field. The results also build upon recent observations of similar transformations of neutrinos—the normal-matter counterparts of antineutrinos—emitted by the sun. Given those earlier findings, the new measurements indicate that unstable identities are characteristic of all neutrino types, many scientists say.

"We are now closing in on the detailed properties of neutrinos," comments solar-neutrino researcher Arthur B. McDonald of Queen's University in Kingston, Ontario. "This is a major result."

Neutrinos come in three types, or flavors—electron neutrinos, muon neutrinos, and tau neutrinos—and each of those has both matter and antimatter forms. Since the late 1950s, some theorists have predicted that as neutrinos travel long distances, they change from one flavor into another. "It's like a lion running along, morphing into a tiger, then into a leopard, and then back into a lion," says experimental team member John G. Learned of the University of Hawaii in Honolulu.

In 1998, researchers reported the first solid evidence of such neutrino transfigurations, which are called oscillations. The scientists were tracking neutrinos created in Earth's atmosphere by cosmic rays hitting atoms (*SN: 6/13/98, p. 374*). The more recent solar-neutrino observations appeared to clinch the case for oscillations but couldn't completely dismiss concerns that poorly understood properties of the sun itself might explain the data (*SN: 5/11/02, p. 301*).

Because antineutrinos can switch identities, just as neutrinos do, physicists also see the results as evidence of the consistency of physical laws in the universe, comments neutrino theorist S. Peter Rosen of the Department of Energy, in Germantown, Md., which partially funds the new experiment.

The team, which includes Learned and 91 other physicists, is performing its experiment at a huge, underground detector known as the Kamioka Liquid Scintillator Antineutrino Detector, or KamLAND. It's located near the city of Toyama. The team looks for light flashes caused by electron antineutrinos emitted by 69 distant nuclear power reactors in Japan and Korea.

Suspended about a kilometer belowground in a mine, the heart of the detector is a weather balloon big enough to hold a school bus. The balloon is filled with some 1,000 tons of liquid, radiation-activated organic chemicals. These compounds emit light, or scintillate, when struck by fast-moving electrons such as those generated during complex reactions triggered when electron antineutrinos strike protons in the detector fluid.

After 145 days of observations at KamLAND, the experimenters report detecting only 63 percent of the electron antineutrinos that they had expected from calculations based on the reactors' output. Their tally indicates that the missing antineutrinos morphed into muon or tau antineutrinos en route. The team announced its results in Japan on Dec. 6.

The new antineutrino findings parallel what's been seen with solar neutrinos, notes Giorgio Gratta of Stanford University, a KamLAND co-spokesman. The data indicate that oscillations are "a property of neutrinos and not of the sun," he says. —P. WEISS

First-Line Treatment

Chronic-leukemia drug clears a big hurdle

The cancer drug imatinib created a stir a few years ago when it rescued leukemia patients who had failed to improve on other treatments. Now, in the first large-scale test of the drug in people newly diagnosed with chronic myeloid leukemia (CML), imatinib has stopped or reversed the disease in nearly all patients receiving it.

These findings indicate that imatinib—originally called STI-571 and now marketed under the name Gleevec—ought to be formally approved as the first-line treatment for CML, says study coauthor Richard A. Larson of the University of Chicago. Currently, the Food and Drug Administration endorses imatinib only for CML patients who have failed on standard therapy, although many U.S. physicians prescribe it more widely, Larson says.

He presented the results before a packed hall at a meeting of the American Society of Hematology in Philadelphia this week.

Larson and a team of collaborators in 16 countries randomly assigned 1,106 CML patients to two groups, each of which received either a daily imatinib pill or a standard CML treatment—injections of interferon-alpha boosted with a compound called cytarabine. At least 18 months after the start of treatment, 97 percent of the

patients getting imatinib were in leukemia remission, although only 5 percent were completely free of all cancer signs. Of the initial imatinib group, 86 percent were still taking the drug with few side effects at the end of 18 months, Larson says. In contrast, the interferon treatment proved effective and tolerable in only about 11 percent of the people originally assigned to receive it.

During the study, participants were given the option to switch to the other regimen if side effects became intolerable or their treatment wasn't working. In all, 58 percent of the interferon group switched to imatinib during the trial. Because of this change, Larson says, fewer than 10 percent of participants in the initial interferon group died. Only 2 percent of the original imatinib group switched to interferon treatment, he says.

These results "clearly show that imatinib is superior to interferon," comments Stephen MacKinnon of University College London Hospital. He notes, however, that some CML patients have another option—a bone marrow transplant. This procedure—if it works—is the only established way to cure CML, says MacKinnon. The rigorous treatment requires that a patient's marrow cells first be killed off and then replaced by healthy marrow from a donor, a procedure that carries severe risks.

Despite recent advances in transplant science, many patients and their doctors may nevertheless see imatinib as a lower-risk option than bone marrow transplant, MacKinnon says. Roughly 20,000 people in the United States have CML. The average age of contracting it is between 40 and 50 years.

Although imatinib appears highly promising, it has been studied for less than 5 years, cautions Ronald Hoffman of the University of Illinois College of Medicine in Chicago. Only long-term follow-up of patients in this and other studies will reveal whether the drug can keep CML at bay indefinitely and continue to spare patients the side effects that have plagued interferon therapy, Hoffman says. —N. SEPPA

Martian History

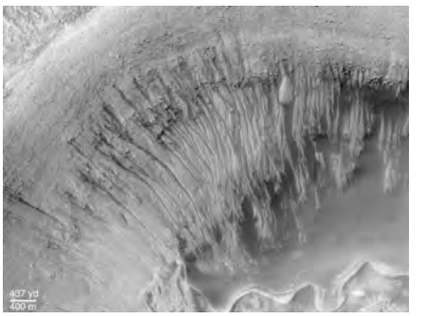
Weathering a new notion

A frigid desert transformed, now and again, into hell. That's the view of ancient Mars just proposed by a team of planetary scientists, who suspect that intermittent impacts by huge asteroids and comets some 3.5 billion years ago profoundly influenced the planet's personality.

Those massive bodies may have melted surface and underground deposits of ice, vaporized debris that then fell out of the sky as a global shower of molten rock, and generated a torrent of scalding rain lasting for decades or possibly centuries. The hot rain would have carved and filled the channels and tributary-like structures seen on Mars today.

Although the impactors could have brought water to the planet, or melted the ice already there, they were so rare—arriving every 10 to 20 million years—that Mars has generally been locked in winter.

"We believe that throughout most of its history, Mars has been a cold, dry planet," says Teresa L. Segura of NASA's Ames Research Center in Mountain View, Calif. She and her colleagues, including Owen B. Toon of NASA Ames, reported their findings last week in San Francisco at a meeting of the American Geophysical Union. They also describe the study in the Dec. 6 *Science*.



WATER DELIVERY? The body that created large craters may have supplied water or melted existing ice on Mars about 3.5 billion years ago.

This portrait clashes with the prevailing model, in which ancient Mars had a thick atmosphere of greenhouse gases that kept it warm and sustained bodies of liquid water for millions of years. Such conditions might have provided a haven for life.

Toon says that he and his collaborators were motivated to consider the role of impactors in creating ancient Martian rivers because recent studies have revealed problems with the greenhouse-gas model.

The researchers seized on an observation that most other scientists had viewed as a mere coincidence: The drainage networks were carved at about the same time that large asteroids and comets routinely roamed the inner solar system and gouged the largest craters on Mars. In the new study, Segura's team shows that the comets and asteroids that produced these craters generated enormous amounts of liquid water.

Jonathan I. Lunine of the University of Arizona in Tucson comments that the new model provides a ready explanation for why the drainage systems on Mars aren't nearly as large as those on Earth. If Martian surface water was liquid for only short periods, it couldn't have carved extensive tributary systems, he says.

Although the prospect that Mars was almost always cold and dry might make the existence of Martian life less likely, it "by no means closes the book on that possibility," asserts David J. DesMarais of NASA Ames. During its first billion years, Mars experienced extensive surface upheavals, and its interior retained a fair amount of the heat left over from its formation. Those conditions, as well as the liquid water they may have produced, could have given life a foothold. They also could have created underground niches suitable for protecting organisms from the scalding rains triggered by large impactors, DesMarais says.

Toon says that his team's model suggests that the usually dried-up drainage systems aren't the best places to seek life. Instead, researchers should take a closer look at areas such as Martian gullies where buried reservoirs of water seem to have recently seeped to the surface (*SN: 7/1/00, p. 5*). Such locations may be tied to extensive underground sources of water where organisms might thrive.

"I'm sure there will be an organized effort over the next year to disprove this theory," says Toon. "And I think people will learn a lot" in trying to do so. "This is a new idea, and there hasn't been a new idea in this field for quite some time now." —R. COWEN

Dust Up

Office bustle launches anthrax spores

The commotion of everyday business can give anthrax spores a second wind, a new study suggests. Normal office activity stirs up the dangerous particles parked on contaminated indoor surfaces and sends them into the air.

After letters packed with the bacterium *Bacillus anthracis* passed through several buildings in the eastern United States in the fall of 2001, anthrax infections killed 5 people and sickened 17 others.

In an office suite in the Hart Senate Office Building in Washington, D.C., while it was closed after workers received an anthrax-containing letter, government investigators set out to assess the environmental risks. The tainted letter had scattered spores onto surfaces and into the air in the suite where it was opened.

Christopher P. Weis of the Environmental Protection Agency in Denver and

NASA, JPL, MALIN SPACE SCIENCE SYSTEMS

his colleagues conducted three sets of tests in the Hart building offices over a week in November 2001. During the first of their trials, they minimized movements that might create air currents within the suite. For subsequent tests, however, they simulated normal workday activities such as sorting and handling documents, pacing, and moving chairs, trashcans, and other objects.

Meanwhile, the researchers collected clumps of *B. anthracis* spores as they settled onto stationary lab dishes or were sucked into air filters that the scientists set on the floor or mounted on their protective gear. The team also vacuumed up spores from carpets and other surfaces.

The researchers recovered many more airborne spores under simulated workday conditions than under calmer circumstances. More than 80 percent of the airborne clumps of spores were 3.5 micrometers or smaller in diameter. Such small clusters remain airborne longer than larger clumps and are more likely, if inhaled, to penetrate deep into the lungs, where *B. anthracis* is most dangerous.

The team's results, which appear in the Dec. 11 *Journal of the American Medical Association*, indicate "how lucky we were that so few people became ill," says Martin Hugh-Jones of Louisiana State University in Baton Rouge, who investigated a 1979 anthrax outbreak in Russia.

Matthew Meselson of Harvard University says the EPA researchers "have shown that there's a residual hazard" in contaminated indoor spaces. However, he adds, it shouldn't be assumed that if *B. anthracis* was released outdoors by terrorists, it would easily lift back into the air after landing on the ground.

Past studies of outdoor sites contaminated by naturally occurring *B. anthracis* haven't suggested that much of the pathogen returns to the air, notes Weis. He attributes the unexpected behavior of the spores in the Hart building to the small size of the clumps created by the letter's sender.

Another factor that could account for the new findings is the smaller average size of grains of normal indoor dust compared with outdoor soil particles, says Kenneth S.K. Chinn, a retired weapons researcher for the U.S. Department of the Army who lives in Dugway, Utah. Small particles are more likely than large ones to become suspended in air currents, where spores clinging to them could detach and get inhaled, Chinn says.

The ease with which spores rise into indoor air emphasizes the importance of thoroughly evaluating decontamination efforts, says Bill Kournikakis of Defence Research and Development Canada–Suffield in Medicine Hat, Alberta. Air-quality tests done under calm circumstances might turn up no apparent threat in a space that could nevertheless become a hot zone as soon as it's reoccupied, he says. —B. HARDER

Trust That Bird?

A bit of future-think lets jays cooperate

A blue jay will cooperate with a buddy for mutual gain in food despite opportunities to betray the partnership, according to a new laboratory study.

Such cooperation among animals had remained elusive and controversial during decades of scientific studies, explains David W. Stephens of the University of Minnesota, Twin Cities. Now, he says, he has demonstrated why. The earlier work hadn't taken into consideration the timing of the benefit for cooperation, he and his colleagues contend in the Dec. 13 *Science*. The partner's reciprocity also influences a bird's choice to cooperate, they find.

J. PIEHOWSKI

WHEN TO CHEAT
Animals often betray a partner in lab tests of cooperation, but under certain conditions, blue jays prove surprisingly steadfast.

This work will push behavioral biologists to think about the timing of rewards in other contexts, such as foraging, aggression, and mating, predicts Eldridge S. Adams of the University of Connecticut in Storrs. "I think it's quite clever," he says.

Many examples of animal cooperation in the wild turn out on close examination to be cases in which no partner benefits unless all act together, Stephens says. However, he's more interested in the situations where there's an incentive for cheating. Scientists have modeled these with a scenario, called the Prisoner's Dilemma, in which human conspirators under interrogation can either protect their partnership or rat on their ally. The model predicts that an animal in such a setup will cooperate when it repeatedly encounters a partner that reciprocates cooperation.

"The animals in the lab always seem to cheat," says Stephens. "There's this compelling question of what's gone wrong with this elegant model."

He says that he's long suspected that experimental animals don't cooperate because of temporal discounting, a tendency to devalue the future possibilities in favor of immediate gain. In a variety of other tests, "animals often behave as if they care only about the next few seconds," he says.

He and his colleagues have now designed a way to coax animals to focus on long-term consequences. The researchers put a test bird in its own enclosure, with a single perch at the back and two in the front. Its partner had an identical setup next door. The researchers trained the birds to fly from the back perch to a front one, and opaque partitions kept the birds from seeing each other until they reached a front perch.

Landing on one perch earmarked a small food reward for a bird. Landing on the other choice, the cooperation perch, assigned a larger food reward for the neighbor but none for the chooser. The innovative twist of the setup was a clear box that accumulated each bird's winnings and released them either immediately or after four rounds of the game.

One bird, the test subject, could choose either perch, but the researchers controlled the choice of the other bird during 1,000 rounds of the game.

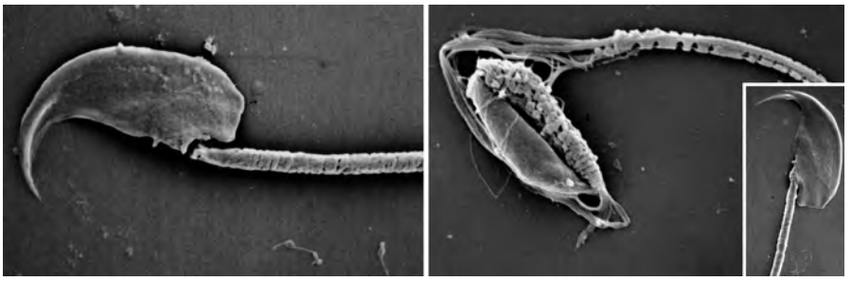
When the researchers let animals have their rewards immediately, the test bird reduced its cooperation no matter where the neighbor landed. When the researchers kept the neighbor steadily uncooperative, the test birds likewise reduced cooperation. However, the researchers did see sustained reciprocity when they delayed rewards and kept the neighbor cooperating, too. —S. MILIUS

Male Pill on the Horizon

Drug disables mouse sperm but wears off quickly

A practical birth control pill for men has long been on medicine's wish list. Now, researchers have discovered that a new oral drug created to ease a genetic disorder could have contraceptive benefits.

To date, the only government-approved male birth control methods are condom use and vasectomy (*SN: 9/30/00, p. 222*). Experimental hormone-based contraceptives, such as testosterone-progestin injections, block men's sperm production. But these can take up to 10 weeks to become effective and don't wear off for months after



ALTERED STATES Compared with a normal mouse sperm (left), a sperm exposed to *N*B-DNJ is deformed (right). After the drug treatment stops, sperm cells become normal again (inset).

they're discontinued.

The promising drug, known as *N*-butyldeoxynojirimycin or *N*B-DNJ, might offer another choice, say researchers at the University of Oxford in England. They report that in low doses, the drug prevents sperm cells from developing normally in mice. Moreover, *N*B-DNJ has relatively few other side effects, and its contraceptive action is readily reversed.

The Oxford researchers stumbled upon *N*B-DNJ's potential birth control effects while exploring its potential use in treating diseases of the nervous system. During that research, male mice exposed to the drug became temporarily infertile. "So, we started a study to look at what this drug was doing to male-mouse fertility," says Frances M. Platt.

She and her colleagues spiked mouse feed with varying doses of *N*B-DNJ and gave it to male mice for 5 weeks. A control group received unspiked nourishment. In mating tests that followed, those females coupling with the control males produced normal litters. Treated males—even those administered low doses of the drug—didn't impregnate females.

The researchers found that *N*B-DNJ damages sperm nuclei and mitochondria, impairing the cells' swimming. The drug also thwarts the formation of the acrosome—a cap on the sperm's head that normally enables the gamete to penetrate an egg.

These effects are reversible. Sperm of the mice treated with any dose of *N*B-DNJ returned to normal by 3 weeks after the researchers stopped administering the drug. "The males have to go through one round of making new sperm cells, and then they acquire fertility again," says Platt. The pups sired by these mice grew to adulthood with no obvious abnormalities, report Platt and her colleagues in an upcoming *Proceedings of the National Academy of Sciences*.

In another test, male mice regained fertility even after taking *N*B-DNJ for 6 months. "For a laboratory mouse, that is a substantial portion of its lifetime," which normally lasts 2 years, says research-team leader Aarnoud C. van der Spoel.

Last month, the European Union approved a version of *N*B-DNJ called miglustat for Gaucher's disease, a debilitating genetic disorder. But any researchers who aspire to turn *N*B-DNJ into a contraceptive will have to jump other hurdles, says Diana Blithe of the National Institute of Child Health and Human Development in Bethesda, Md. For example, use of *N*B-DNJ by healthy men for birth control will require further scrutiny of the known toxic effects, such as damage to sperm internal parts.

"Whether or not this compound will lead to contraception depends on its safety profile," says Blithe.

*N*B-DNJ appears less risky than some other promising drugs that lack its good features, says Ronald Swerdloff of the Harbor-UCLA Research and Education Institute in Torrance, Calif. He adds, *N*B-DNJ "is a long way from a final, tested product, but it seems to be an exciting lead." —C. MARZUOLA

Brain's Moving Experience

Motion illusion yields a neural surprise

The primary motor cortex has a well-earned reputation as the brain's action center. This strip of tissue initiates limb movements ranging from walking up steps to wielding dining utensils.

However, the primary motor cortex also harbors an introspective side, according to a new study. This brain structure revs up during an experimentally induced illusion in which people mistakenly perceive that a stationary part of their body is moving, say neuroscientist Eiichi Naito of the Karolinska Institute in Stockholm and his colleagues.

In addition to its better-known duties, the primary motor cortex belongs to a brain network that monitors limb positions and plans upcoming actions, the investigators propose in the Dec. 5 *Neuron*. Scientists have traditionally attributed the sense of one's bodily position to so-called somatosensory tissue, located adjacent to the primary motor cortex.

The "extraordinary" new findings add to preliminary indications that the primary motor cortex not only issues motor commands but "also participates in the analysis of sensory information coming from the muscles," say Victor de Lafuente and Ranulfo Romo, both of the National Autonomous University of Mexico in Mexico City, in a commentary published in the journal.

Naito's group studied brain activity in eight adults as they experienced an illusory perception of hand movement. This trickery stems from mild vibrations applied by a small device to a tendon of a wrist muscle. After a few seconds, the vibrating tendon stimulates its connected muscle and creates a false sense of the wrist flexing back and forth.

Moreover, when volunteers hold their hands palm to palm, the vibrating device on either the right or left wrist tendon makes them perceive both hands as moving back and forth. Primary motor cortex on the right side of the brain regulates left-side movements, and that on the left side controls right-side movements. Thus, in this experiment, the hemisphere controlling the unstimulated hand received no sensory information related to the wrist-muscle activity.

Using functional magnetic resonance imaging scans, the researchers determined that the illusion of movement in an unstimulated hand was accompanied by a characteristic elevation of blood flow in primary motor cortex in the hemisphere that controls movement in that hand. A surge in blood flow serves as a marker of heightened brain-cell activity.

The same illusory movement yielded increased blood flow in several other parts of the cortex and the inner brain.

In a second set of eight volunteers experiencing the motion trick, the scientists used a magnetic device (*SN: 9/23/00, p. 204*) to spark neural activity in the primary motor cortex and thus magnify the illusion. Participants perceived more pronounced illusory movement in an unstimulated hand when their brains were prodded in this way. During the illusion, the heightened brain activity also coincided with increased electrical activity in the wrist muscle of the unstimulated hand—a sign of primary motor cortex activation. —B. BOWER

VAN DER SPOEL ET AL./PNAS

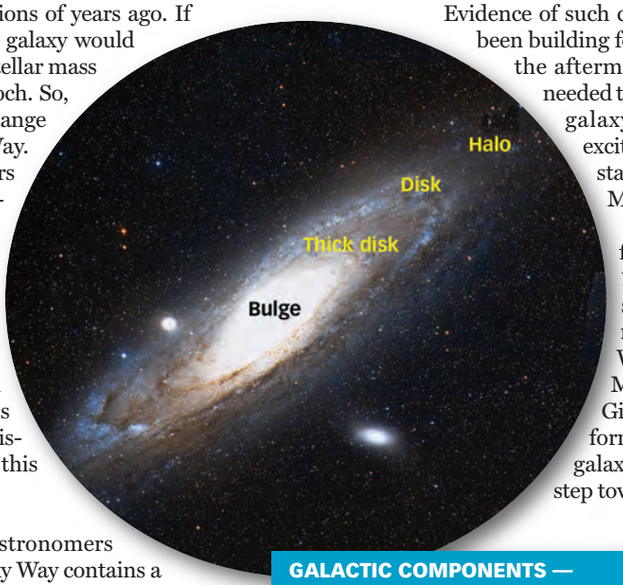
MILKY WAY'S LAST MAJOR MERGER

New clues about galaxy formation thicken the plot

BY RON COWEN

Orbiting above and below the bulged center of the Milky Way is an elongated, wispy contingent of stars. It could be considered a mere footnote amidst the galaxy's stellar hordes, but astronomers are reading it as if it were an entire chapter early in the galaxy's autobiography. That's a surprising view, given that these stars didn't even start out in the Milky Way. Discovered over the past year, the orbiting contingent appears to be the tattered remnants of a galaxy that collided with ours billions of years ago. If this were confirmed, the intruder galaxy would have had about 15 percent of the stellar mass of our galaxy during that early epoch. So, it packed enough of a wallop to change the overall shape of the Milky Way. This collision about 10 billion years ago was probably the most consequential event in our galaxy's 13-billion-year history. Since then, the galaxy has enjoyed a relatively peaceful existence.

Now, astronomers are reconstructing what happened during the Milky Way's big collision and wondering if many other galaxies across the universe have a similar history. New evidence suggests that this may be the case.



GALACTIC COMPONENTS — Andromeda, the galaxy that's nearest to the Milky Way, has the same structural components as the Milky Way.

R. SWORD, PALOMAR OBSERVATORY, INSTITUTE OF ASTRONOMY

SPIRALING COMPLEXITY Astronomers have long recognized that the Milky Way contains a central bulge surrounded by a flat disk with spiral arms ablaze with newborn stars. An ancient spherical halo envelopes it all.

The cosmic collision jumbled all the stars that were then in the disk, says Gerard Gilmore of the University of Cambridge in England. Our galaxy's orderly spiral shape was destroyed. "It would have looked very irregular and distorted, like the sort of galaxies one sees in the Hubble Space Telescope images of the early universe," Gilmore says.

Over the next billon years, he calculates, the gas already in the Milky Way, along with the material added by the intruder galaxy, cooled down and formed new stars. This mix of gas and young stars reassumed the familiar spiral geometry.

But the collision had a permanent effect on the Milky Way, according to a new study by Gilmore, Rosemary F.G. Wyse of the Johns Hopkins University in Baltimore, and John E. Norris of the Australian National University in Canberra. When the collision heated and puffed up our galaxy's flat disk, it created a distended, tenuous fog of gas and stars—the so-called thick disk—that persists to the present day.

The collision also seems to have marked the end of the era of frequent impacts. According to an analysis by Gilmore and his collaborators, that ancient smackdown was the last major collision the Milky Way has endured, and the creation of the thick disk was the last significant change in the galaxy's structure.

If Gilmore and his colleagues are right, the Milky Way's evolution could provide a case study for cosmologists exploring galaxy formation throughout the universe. According to a well-accepted scenario, known as the hierarchical model of galaxy formation, galaxies start out small and grow bigger by capturing material from galaxies that collide with them.

Evidence of such collisions in faraway galaxies has been building for years, but to get a close look at the aftermath of such an event, scientists needed to find remnants of one in our own galaxy. That's why astronomers are excited about the newfound string of stars orbiting above and below the Milky Way's plane.

The finding that the galaxy suffered its last major impact about 10 billion years ago places new constraints on any model of galaxy formation, says theorist Martin D. Weinberg of the University of Massachusetts in Amherst. Adds Gilmore: "If we can understand the formation of one apparently typical galaxy—the Milky Way—that is a big step towards understanding them all."

CONDENSED MILK It was nearly 2 decades ago that Gilmore and a colleague, Neil Reid, both based at the University of Edinburgh in Scotland, found evidence that something was missing in the standard picture of the Milky Way. When they counted the galaxy's stars, the pair found that there were far more than the known components of the Milky Way could account for. To explain the discrepancy, the two scientists suggested that the galaxy's disk has a second part—a thicker, diffuse one extending about 3,000 light-years above and below the familiar flat disk. They calculated that this thick structure contains 5 to 10 percent of our galaxy's stars.

Over the next few years, as astronomers measured the age, composition, and distribution of these stars, they confirmed the existence of the so-called thick disk. In 1985, Wyse and Gilmore proposed that a massive intergalaxy collision created this structure.

The energy absorbed by the impact would have heated the Milky Way's thin, primordial disk, causing it to swell to its present pro-

portions. The available evidence puts that impact in the distant past. Today, the thick disk is composed only of stars that are at least 10 billion years old. In contrast, the thin disk contains stars of all ages, from newborns to ancients that are 13 billion years old. "If the thick disk were produced by later merging events, we would expect to see younger stars from the thin disk puffed up into the thick disk," explains Kenneth Freeman, also of the Australian National University in Weston.

An early collision between our galaxy's flat disk and an intruder galaxy plausibly accounts for the extra stars that Gilmore and Reid first detected in the early 1980s, but the researchers lacked direct evidence for their model.

Two years ago, Gilmore, Wyse, and Norris went hunting for the remnants of that ancient collision. Using a spectrograph on the Anglo-Australian Telescope in Coonabarabran, which can examine 400 objects simultaneously, the researchers measured the velocities of a group of 2,000 stars in the thick disk.

Orbital velocity is an important diagnostic tool, notes Gilmore, because "it's one of the very few conserved quantities" in the aftermath of a collision.

The team found that the stars' velocities—on average about 100 kilometers per second—didn't match those of any known population of stars in the Milky Way's disk or surrounding halo. Finding a batch of stars with a unique velocity is a sign that another galaxy had infiltrated our own, Gilmore says. Moreover, the researchers report in the July 20 *Astrophysical Journal*, this velocity is just what would be expected of stars from an intruder galaxy.

The researchers add that the narrow spread of stellar velocities indicates that the thick disk was generated by a single collision.

The team's results are "interesting but not very secure yet," Freeman says. He notes that it's difficult to distinguish by velocity alone a grouping of stars in the thick disk from the plethora of stars found in the Milky Way's enveloping halo. Showing that the chemical composition of the stars studied by Gilmore and his colleagues differs from that of those in the halo would make a more convincing case that a separate galaxy indeed had intruded, he says.

DODGING PUNCHES The findings by Gilmore's team raise a new question: Why hasn't the Milky Way been struck by another massive galaxy during the past 10 billion years? Weinberg says that it could be mere happenstance. He notes, for example, that there are no large galaxies nearby. If the Large Magellanic Cloud, a massive satellite galaxy of the Milky Way, resided closer, the Milky Way would probably have been pummeled in the more recent past.

Further, says Weinberg, collisions are but one element of a galaxy's life story. Theorists now see galaxy evolution as a two-phase process. Early in the universe, when galaxies were closer together, collisions were commonplace. Then, after about 7 billion years of cosmic expansion, collisions became less frequent. In this second phase of evolution, galaxies have accumulated matter more slowly and less dramatically by gravitationally coaxing material from its near neighbors.

Many observers argue that the first, collisional era was the most critical for generating the structure of galaxies. And for the Milky Way, at least, there's no evidence that its most recent acquisitions, such as its capture of the Sagittarius dwarf galaxy, has significantly altered our galaxy's structure (*SN: 4/9/94, p. 228*).

Astronomers have recently found evidence that thick disks may be routine features of spiral galaxies. In a study of 47 spiral galaxies that span a wide range of masses, Julianne J. Dalcanton of the University of Washington in Seattle and Rebecca A. Bernstein of the University of Michigan in Ann Arbor found that all of them have thick disks. The astronomers note that they can't study these thick disks with anywhere near the detail that Gilmore has uncovered in the Milky Way. But the red hue of these disks suggests they are composed of old, red stars—just as the thick disks of our galaxy—the researchers reported in the September *Astronomical Journal*.

Dalcanton cautions that the color data are insufficient for accurately pinning down the age of thick disks. She also cautions that the galaxies she and Bernstein examined may undergo fewer collisions than the average spiral galaxy.

Nonetheless, if these thick disks were created during a collision—the way Gilmore's team proposes our own galaxy's thick disk arose—then their home galaxies have also been free of major collision for billions of years.

"When people have constructed galaxy-formation models, they've accounted for the bulge of galaxies and the halo and the thin disk," Dalcanton says. The detection of so many thick disks could prove to be an important step forward in deciphering the puzzle of how galaxies form, she says. ■

R. SWORD, PALOMAR OBSERVATORY, INSTITUTE OF ASTRONOMY

FUTURE SHOCK — Astronomers predict that in a few billion years, the Andromeda galaxy will collide and merge with the Milky Way as in this simulation. The two spiral galaxies will merge into one giant elliptical, or football-shaped, galaxy.

IN SILICO MEDICINE

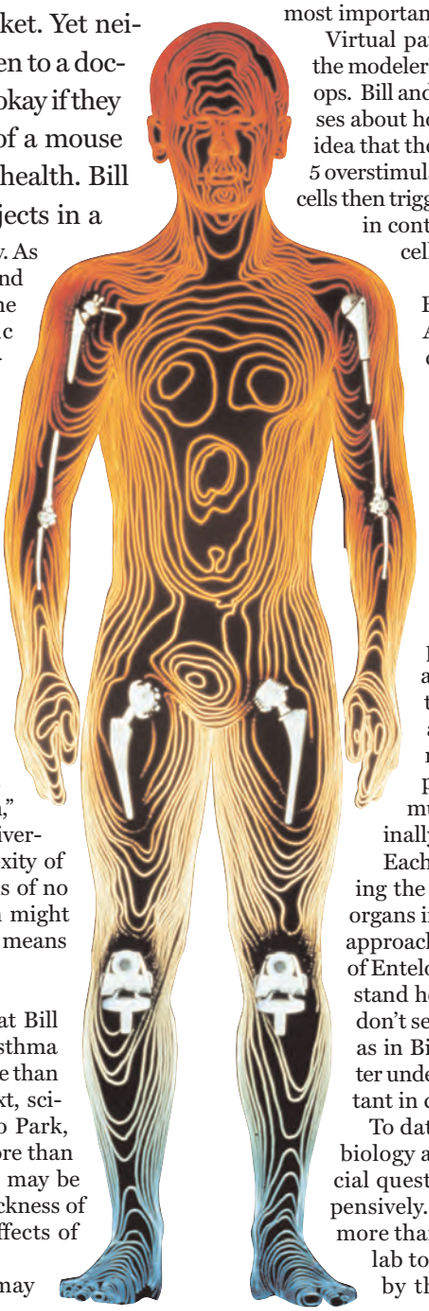
Computer simulations aid drug development and medical care

BY DAMARIS CHRISTENSEN

Like millions of people in the United States, Bill and Allen have asthma. They're lucky enough to take the newest therapies, sometimes even before the drugs come to market. Yet neither Bill nor Allen has ever been to a doctor's office or the hospital. After all, it's okay if they get sick or even die—a simple click of a mouse can restore these patients to perfect health. Bill and Allen are two of the newest subjects in a growing research area called *in silico* biology. As basic researchers, drug developers, doctors, and health-care administrators struggle with the sheer volume and complexity of scientific information that they face every day, information gathered from computer-generated patients like Bill and Allen may lead to better decisions.

Computer simulations aren't new in nonmedical research and development. Much of climatology and geology is modeled with computers, and engineers routinely design products—from airplanes to tire treads—using mathematical simulations rather than building and testing prototypes. But such computer applications have been slow to reach people studying the vagaries of the human body. Today, however, researchers are increasingly turning to computers to explore medical science.

"Computer simulation is the modus operandi for the future of biomedical research," says James B. Bassingthwaighte of the University of Washington in Seattle. "The complexity of [biological] systems is such that intuition is of no help in figuring out where an intervention might have an effect or what is the most efficient means of diagnosis and treatment."



DEVELOPING DRUGS The company that Bill and Allen call home created its model of asthma patients by compiling information from more than 3,500 scientific studies on the disease. Next, scientists at the company—Entelos in Menlo Park, Calif.—wrote equations that account for more than 7,500 parameters of a person's health that may be important in asthma. These include the thickness of the mucous lining in the lungs and the effects of inflammation in blocking the airways.

From one to the next, virtual patients may respond differently to drugs depending on their health parameters, just as real patients do, and their diseases may take different courses. But because the researchers know the exact differences between their virtual patients, they can more easily tease out the most important factors in complicated interactions.

Virtual patients may also respond differently when the modelers use different views of how a disease develops. Bill and Allen, for example, represent two hypotheses about how asthma attacks begin. Bill reflected the idea that the immune-signaling molecule interleukin-5 overstimulates immune cells called eosinophils. Those cells then trigger inflammation and asthma attacks. Allen, in contrast, had an asthma attack when immune cells called macrophages blocked his airways.

Entelos developed Bill and Allen when the Bridgewater, N.J.-based drug company Aventis was considering tests of whether compounds that block interleukin-5 work as treatments for asthma attacks. When exposed to virtual allergens and no drugs, Bill's asthma attacks lasted 3 days, much longer than is typical for people with asthma. Simulated injections of interleukin-5 blockers prevented Bill's asthma attacks but not Allen's.

Because Bill's asthma didn't seem to reflect real life and Allen didn't respond to the interleukin-5 blockers, Aventis didn't pursue these compounds as potential asthma therapies. The Entelos model seems to have been accurate. Despite promising animal studies, when other companies recently tested interleukin-5 blockers in people, they found that the compounds have much less effect than the researchers had originally expected.

Each simulation of a disease begins by modeling the normal physiology and interaction of the organs involved. "We are striving for a whole-body approach to health and disease," says Jeff Trimmer of Entelos. "We want to use [our models] to understand how a person gets sick." Even when models don't seem to simulate what happens in real life—as in Bill—the findings can help researchers better understand physiological factors that are important in causing diseases, says Trimmer.

To date, computer simulations of basic human biology are closely intertwined with the commercial quest to develop new drugs quickly and inexpensively. Pharmaceutical companies can now take more than a decade to move a compound from the lab to the clinic, and many potential drugs fall by the wayside in that journey. Companies

report that about 20 percent of the drugs that succeed in preliminary trials are abandoned once doctors test them in large, expensive clinical trials: Either they don't work as expected, or troubling side effects emerge.

The current system is so bad that anything would be an improvement, says Lewis Sheiner of the University of California, San Francisco, who models drug responses.

Drug companies hope that computer simulations will focus their efforts on the candidate drugs most likely to work in people. With biological models of cells, organs, and metabolic pathways, industry scientists can pick out genes or proteins involved in a disease and then sort through various drug candidates. Only the most promising ones would then be tested in cells and animals. Such modeling is gaining proponents, says Karin Jorga of Hoffmann-La Roche in Basel, Switzerland.

Computer simulations may also reduce the number and size of human trials that a company has to conduct on the way to a drug's approval by the Food and Drug Administration, Jorga says. The simulations can indicate the most efficient trial designs to reveal beneficial effects. Some computer models that simulate how drugs are broken down in the body can predict the most effective dose, she says. At a meeting on drug effects in the Netherlands earlier this year, Jorga reported that such modeling reduced the time Hoffmann-La Roche needed to develop and test a new formulation of a drug for preventing bone loss. With the new formulation, people could take the drug once a month rather than once a day.

Another example of how computer simulations have guided drug design is a virtual heart developed by Denis Noble of the University of Oxford in England. The model consists of a mass of virtual cells, each processing virtual sugar and oxygen. On a computer screen, this heart beats just like the real thing. The virtual heart can be programmed to develop different diseases, and scientists can see how it responds to treatment with different drugs.

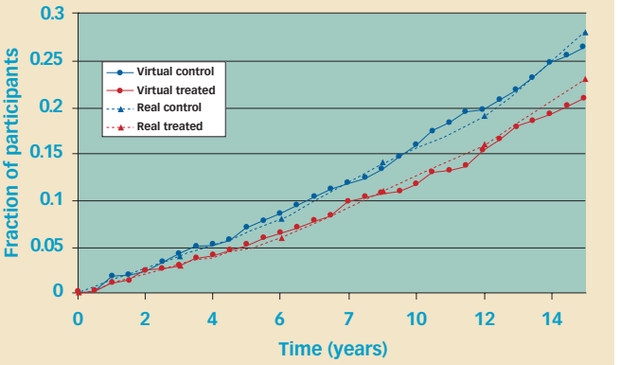
Noble's model has been used, for example, to predict whether one drug is likely to cause abnormal heart rhythms, a widely recognized, potentially dangerous side effect. Computer simulations, however, aren't good at predicting unexpected side effects.

Greater advantages could result if biomedical researchers combine the models they're developing. Entelos is trying to hook together models of several different diseases to increase its chances of detecting side effects or spotting dangerous drug interactions. For example, heart disease, obesity, and diabetes tend to occur in the same patients, Trimmer says, so it would be useful to model all those ailments at the same time.

Bassingthwaighte and other researchers are combining individual computer models of genes, proteins, cells, organs, and metabolic pathways. With such a set of coordinated models, he suggests, medical scientists might see effects of disease that are hidden by the complexity of the human body.

This effort—sometimes called the virtual human or physiome project—is just beginning. Many technical and scientific hurdles remain: getting the models to communicate with one another, finding the powerful computers to run such simulations, even gathering the data needed to develop some of the models.

Heart Attacks: Virtual vs. Real



REALITY CHECK — Graph shows similar fractions of people with diabetes having heart attacks in the real United Kingdom Prospective Diabetes Study and a computer simulation of that trial. The trials both compared the benefits of lowering blood sugar to concentrations typically achieved by therapy (control) and those of controlling blood sugar more aggressively (treated).

And not everyone is convinced that unified models will offer helpful information. "If you're an engineer, it isn't useful to use a quantum mechanical model of the world to talk about girders and bridges," says Sheiner. "Getting the scale of the model to match the scale of the question is tricky, so that working from the genes up may not be an efficient way to determine the best ways of treating particular diseases."

MODELING MEDICAL CARE Some researchers are applying computer simulations to an even broader realm of health care. Rather than studying cells and organs, researchers associated with the Oakland, Calif.–based health-care plan Kaiser Permanente have created a computer simulation of a virtual world where people develop diseases—asthma, diabetes, and heart disease so far—and go to doctors for tests and treatments. Called the Archimedes model, it may help Kaiser Permanente set guidelines for patient care and find ways to monitor caregivers' performance, says physician David M. Eddy, a consultant to Kaiser Permanente. He and physicist Leonard Schlessinger of Kaiser developed the model.

Archimedes may also predict results from clinical trials that simply can't be carried out in the real world. It may also give physicians results more quickly than would be possible with an actual trial. Eddy cites a variety of obstacles for carrying out real-world trials: "the pace of innovation, the high cost of doing research, the long follow-up times required, the large number of options to be compared . . . and the unwillingness of the world to stand still until the research is done."

All those factors "severely limit our ability to evaluate all the options [for patient care] through clinical research alone," he adds.

The model takes into account many influences on disease in real people, says Eddy. For example, each virtual patient has a virtual liver and pancreas. The health of these organs affects the concentration of sugar in a virtual patient's blood. When sugar concentrations rise high enough, a patient may experience symptoms of diabetes, such as thirst or frequent urination, and go to a doctor. Although the underlying causes of diabetes aren't well understood, Archimedes uses equations that reproduce the disease's known characteristics, such as the observed incidence of the disease in different ethnic groups.

"As in reality, each patient is different," says Eddy. Some patients may take medicine or follow a doctor's recommendations more meticulously than others do. Moreover, patients may receive care of different quality. Reflecting studies of doctors' habits, a virtual primary-care physician is less likely to accurately follow treatment guidelines than is a virtual specialist. These factors, in turn, affect

Who develops diabetes?

	ACTUAL TRIAL*	COMPUTER SIMULATION†
Placebo	25 percent	26 percent
Metformin	19 percent	21 percent
Counseling	12 percent	12 percent

*THE DIABETES PREVENTION PROGRAM
†SIMULATION (INCLUDING PARTICIPANTS' WEIGHT GAIN) BY A COMPUTER MODEL CALLED ARCHIMEDES.

a number of physiological variables in the computer, as in life.

For example, different simulated diet and exercise plans reduce the cholesterol, blood pressure, and weight of the virtual patients by different amounts. Those changes then affect the likelihood that, say, an overweight patient would develop diabetes or heart disease.

At the annual meeting of the American Diabetes Association in June, Eddy reported results from an Archimedes simulation of a real-life, large clinical trial. The actual trial was known as the Diabetes Prevention Program (*SN: 9/8/01, p. 159*). Mimicking that trial, the virtual one enrolled virtual overweight people with a variety of risk factors for developing diabetes. It randomly assigned them to receive intensive counseling about diet and exercise, a drug called metformin that increases a person's sensitivity to insulin, or a placebo.

To program the model, Eddy and his colleagues used results from a variety of real-life studies about the effects of various interventions on weight and a variety of other risk factors for diabetes. The first time Archimedes simulated the actual diabetes trial, the virtual results were very close to the real results—as close as one would expect results of two actual trials to be, says Eddy. The simulation almost exactly mimicked the clinical trial when the modelers included the weight regained by participants.

"If we could not have afforded that trial, we could have predicted the results quite well using this model," says Richard Kahn of the American Diabetes Association in Alexandria, Va. "The [simulated] health-care system responded very much like the real one, and that suggests that Archimedes could help improve the way we treat patients."

SIMULATING REALITY Despite the promise of technology, "no model is perfect," cautions Bassingthwaighte. "The limitation is our database of knowledge. If we don't understand it, we can't model it."

Thanks to the Human Genome Project, which recently decoded essentially the entire human genome, researchers now have a large database of genes and proteins, he says. A new field of research, called proteomics, is adding information about the expression of proteins and their interactions in cells. However, Bassingthwaighte cautions, relatively little is known about how most of those molecules affect cells and organs. He expects that extensive experimenting will be required to tease out that information.

Models can give you an intelligent basis for making decisions when you're faced with uncertainty.

Likewise, simulations of disease processes and health care can reproduce what's known but can't always identify an unexpected side effect. For instance, even today, a computerized model probably wouldn't predict the damage that the diet drug fenfluramine causes to heart valves, as revealed in studies in 1997 (*SN: 10/18/97, p. 252*), says Trimmer. It's for such reasons that he notes, "This [simulation] technology is not a replacement for traditional research but a complement to it."

"The fundamental idea is that if you can model a real thing on a computer, you can answer a lot of questions without experimenting with the real thing," says Sheiner. "While models are far from perfect because they depend on imperfect information, they can give you an intelligent basis for making decisions when you're faced with uncertainty."

Early progress with computerized biomedicine has modelers enthusiastic about its future. "My goal is to move medicine onto a quantitative footing," Eddy says. "There's still a long way to go, but simulations will certainly help. We've shown that this plane will fly." ■

OF NOTE

PHYSICS

Icicle waves go with the flow

Many icicles develop wavy surfaces that look as wrinkled as pushed-up shirtsleeves. That's strange, but what really has captured some scientists' attention is that the distance between surface bulges always averages around 1 centimeter, no matter how thick the icicle is.

A trickle-down effect could generate that surprisingly regular waviness, propose Naohisa Ogawa and Yoshinori Furukawa of Hokkaido University in Sapporo, Japan.

During an icicle's growth, a thin film of water from melting snow and ice above an icicle flows along the hanging shaft and refreezes onto the icicle's surface. Because any slight, random bulges in an icicle's girth pack extra surface area, heat more readily escapes from them and so meltwater more readily refreezes onto them than onto smoother areas.

As a result, the bulges thicken, encouraging the formation of a rippling surface. On the other hand, water that's slightly churned by passing over the bulges doesn't carry heat away from them efficiently. This tendency counteracts the enhanced freezing at the bulges.

Using a mathematical model for the competition between those trends, the Japanese researchers calculate that the average between-bulge spacing for any icicle should indeed always be around a centimeter. They report their findings in the October *Physical Review E*. —P.W.

OGAWA

RIPPLY RODS Competing heat-loss patterns can cause these icicle waves.

ASTRONOMY

Sizing up small stars

Combining the light from two of the world's largest visible-light telescopes, astronomers have measured, for the first time with high accuracy, the size of a small star. The diminutive body, Proxima Centauri, lies just 4.2 light-years from Earth and is the known star nearest to our solar system. Weighing in at only 15 percent of the sun's mass, the star is one of many faint, small stars in our galaxy.

Damien Ségransan of the Observatory of Geneva in Sauverny, Switzerland, and his colleagues combined the starlight collected from two of the four 8-meter telescopes collectively known as the Very Large Telescope in Paranal, Chile. Rather than producing an image, this light-gathering process creates an interference pattern of light and dark bands. By analyzing that pattern, astronomers imaged Proxima Centauri as a disk instead of a point. They similarly measured the diameter of three other very small stars. The feat is similar to measuring from Earth the height of a child on the surface of the moon.

In agreement with predictions, Proxima Centauri has a diameter of 202,000 kilometers, or about one-seventh the girth of the sun, the astronomers report in an upcoming *Astronomy & Astrophysics*. —R.C.

BIOMEDICINE

Bilirubin: Both villain and hero?

Bilirubin, the bile pigment that yellows the skin of babies born with jaundice, is generally considered a toxic molecule. According to a new study, however, bilirubin may actually protect cells from dangerous oxygen-containing molecules called free radicals.

Bilirubin forms during the breakdown of hemoglobin, the oxygen-carrying protein in blood cells, and can build up to high concentrations in the blood. Several lines of evidence indicate that bilirubin is toxic, but why then is there a specific enzyme that converts the seemingly harmless molecule known as bilverdin into bilirubin?

Scientists puzzled by this question have unearthed data suggesting that bilirubin, when present at the right concentration, is helpful instead of harmful. A research team headed by Solomon H. Snyder of Johns Hopkins University School of Medicine in Baltimore reports that bilirubin protects brain cells growing in lab dishes from the damage typically caused by hydrogen peroxide, a free radical.

The scientists compared normal cells with ones in which the bilirubin-making enzyme was inhibited. The normal cells were able to survive a dose of hydrogen peroxide 10,000 times greater than the lethal dose for the bilirubin-deprived cells. The investigators report their findings in an upcoming *Proceedings of the National Academy of Sciences*.

Snyder and his colleagues also garnered evidence for a mechanism by which bilirubin, which is altered when it defuses free radicals, is recycled back into its original form. This reuse amplifies its protective powers. A protective role for bilirubin may explain previous findings that have linked low blood concentrations of the molecule to cancer, heart attacks, and other diseases, the scientists note. —J.T.

Radiological Society of North America
Chicago, Ill.
December 1–6

CANCER

Zapping bone brings relief from tumor pain

By unleashing radio waves inside bone, researchers have stopped intractable pain in people with cancer that has spread to their skeletons.

Tumors that form inside bone when cancers spread can be especially painful. The new technique, called radio-frequency ablation, unleashes energy via a needle inserted into bone to reach the edge of the tumor. The radio waves create intense heat that kills nearby tumor cells within about 10 minutes, says study coauthor Matthew R. Callstrom of the Mayo Clinic in Rochester, Minn.

Targeting the surface where the tumor meets the bone seems critical, he says. "Our thought is that nerve fibers in that area—where tumor cells are eroding bone—are the pain generators," he says. Bone itself appears unaffected by the procedure.

The researchers treated 62 patients in whom conventional cancer therapy had failed. Of these, 59 reported significant pain relief, and 28 said they experienced total pain relief at some times, Callstrom says.

"We're not curing cancer with this treatment," he says. "But we're affecting the pain that patients have. The most important [concern] for all these patients is their quality of life." —N.S.

NEUROSCIENCE

Imaging Parkinson's

Scientists in Ireland report that a new brain-imaging technique can supply proof of Parkinson's disease in people whose symptoms fall short of the standard definition of the disease.

The researchers recruited volunteers with only minor muscle tremors, says study coauthor David J. Tuite of the Adelaide and Meade Hospital in Dublin.

The scientists gave each patient a double-acting infusion. It contained a compound called ioflupane that binds to brain tissue that's producing dopamine—the neurotransmitter lacking in Parkinson's patients. The compound was tagged with an isotope that temporarily gives off gamma rays detectable by a special kind of computerized tomography (CT) scanner. After a person received the infusion, a scan indicated overall dopamine production.

The scan revealed that 45 of the 50 patients indeed had a significant lack of dopamine-making neurons, Tuite says. "With this test, we can say that a person has Parkinson's [disease] and should be put into treatment," he says. The new technique could serve as an alternative to positron emission tomography, which can also detect loss of dopamine neurons, he notes.

Parkinson's disease is now typically diagnosed by testing a person's motor skills. "In the next few years, you'll see a change," Tuite predicts. Scans can provide "a much more objective test," he says, so doctors will begin to use them more frequently. —N.S.

ENDOCRINOLOGY

Bone scan reveals estrogen effects

There's little debate among scientists that the female hormone estrogen is integral to maintaining strong bones. Osteoporosis, in which the bones become brittle, most commonly strikes women after menopause cuts their natural estrogen supply.

Using a scanning technology called microcomputerized tomography, or micro-CT, scientists have a new way to look at the difference between bone exposed to estrogen and bone deprived of it. Researchers are already starting to use micro-CT scans to test the effects of new drugs designed to duplicate estrogen's bone-building power without its side effect of promoting cancer growth.

Applying micro-CT to a biopsy sample produces a three-dimensional image of a bone that is 100 times as detailed as that of a typical CT scan. Harry K. Genant of the University of California, San Francisco and his colleagues scanned the weblike matrix of crisscrossed fibers within bones of premenopausal and postmenopausal women. They found that in the former, the fibers form predominantly flat, rectangular structures, whereas in postmenopausal women lacking estrogen, most of these fibers have a rodlike appearance.

To directly test estrogen's effect on bone, the scientists then obtained pelvic-bone samples from 20 women with osteoporosis. After 2 years of estrogen therapy, the women underwent another bone biopsy.

The scans revealed that the ratio of plates to rods had increased on average by 14 percent after treatment, even though the bones themselves hadn't changed in volume, thickness, or density.

"It was principally [the] more platelike appearance of the bone that led to what should be a healthier and stronger skeleton," Genant says. "This helps to explain . . . the reduction of spine and hip fractures in women who are placed on estrogen therapy." —N.S.

RADIOLOGY

Visionary science for the intestine

Compared with other parts of the digestive tract, the small intestine is difficult for doctors to access. While a camera-tipped tube slipped down the throat can get images of the stomach and a tube inserted at the other end of the tract reveals the large intestine, no such device reaches into most of the small intestine. So, physicians rely on externally generated images.

Scientists recently devised a disposable flash camera only slightly larger than a vitamin pill. In a procedure called capsule endoscopy, the patient swallows the minicam, which then takes pictures inside the small intestine. On its journey through the digestive tract, the tiny tumbling camera transmits images that are stored in a recorder that the person wears around the waist. After 8 hours, the camera's battery runs out, and the capsule is eliminated in the feces. Scientists then download the recorder's images into a computer.

To test the value of capsule endoscopy, researchers recruited 42 people who had had either an X ray after drinking a barium solution or a computerized-tomography (CT) scan to image the condition of the small intestine. Each person then underwent capsule endoscopy.

The minicam missed a few abnormalities but detected nine intestinal ulcers, compared with only three found by the CT scan and one by the X ray, says Amy K. Hara of the Mayo Clinic in Scottsdale, Ariz. The capsule camera also revealed 11 cases of an intestinal condition, called arterial-venous malformation, in which blood vessels in the intestines leak. Neither the X ray nor the CT detected any.

"Compared with these other techniques, the capsule is a major step forward," Hara says. "It's noninvasive, doesn't require any medications or radiation, and, we now know from our study, it results in better and more complete evaluations of the small intestine."

Capsule endoscopy is, however, more expensive than the other procedures. Nevertheless, combined with CT scans and X rays, capsule endoscopy could vastly improve diagnosis of small intestinal ailments such as Crohn's disease, inflammatory bowel syndrome, and arterial-venous malformation, Hara says. —N.S.

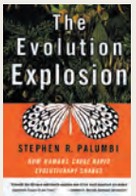
Books

A selection of new and notable books of scientific interest

THE EVOLUTION EXPLOSION: How Humans Cause Rapid Evolutionary Change

STEPHEN R. PALUMBI

The author describes a crisis that he contends can no longer be ignored. This crisis is evolution as intensified by ecological change wrought by human activity. Three elements are necessary for evolution of organisms to occur: variation between individuals, physical differences that natural selection can act upon, and inheritance. People have provided these elements in the evolution of antibiotic resistance, HIV, insects' resistance to pesticides, and weeds' resistance to herbicides. Trying to improve our quality of life, we have inadvertently given nature the tools it needs to select for species that can hurt us. Palumbi suggests that as genetic modification of crops becomes commonplace, many more unexpected evolutionary effects will result. He ends his text by considering the provocative question of whether humans are still evolving. Originally published in hardcover in 2001. ***Norton, 2002, 277 p., paperback, $14.95.***



FROM CONCEPTION TO BIRTH: A Life Unfolds

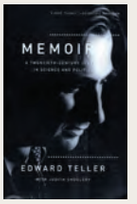
ALEXANDER TSIARAS

By manipulating computer software and lighting to change computerized tomography scans and magnetic resonance images, Tsiaras has depicted organs and cells in human embryos the size of a peanut. He uses digital techniques to rotate each image and add shading and color, revealing its essence in three dimensions. These amazing color pictures chart embryonic development from conception. Readers witness the appearance of color in the eye, the initial movement of legs and arms, and the initial indications of gender. These images are in an oversized format and accompanied by clear text detailing the maturation process. The book is produced in conjunction with the National Institutes of Health. ***Doubleday, 2002, 283 p., color photos, hardcover, $50.00.***

MEMOIRS: A Twentieth-Century Journey in Science and Politics

EDWARD TELLER WITH JUDITH SHOOLERY

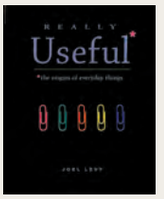
Few scientists, as personalities, stir people's emotions. Teller does, however. People either love him or hate him. This autobiography will probably solidify many people's preconceptions, as he reiterates and elaborates on his positions regarding the hydrogen bomb, nuclear power, and the Strategic Defense Initiative. While revisiting the events of his life, Teller personalizes the history of the 20th century. This is evident as he begins by recounting his childhood in Hungary in the wake of World War I. His role in the Manhattan Project helped shape the outcome of World War II, a period he reflects on extensively. He also shares his experiences in developing the hydrogen bomb. Teller reveals his relationships with some of the most influential scientists of the past century, including Werner Heisenberg—under whose tutelage Teller received his Ph.D.—Enrico Fermi, Albert Einstein, and Robert Oppenheimer. Teller attempts to explain the damaging testimony he gave during Oppenheimer's security review in 1954—a full transcript appears as an appendix—and to reveal the complicated nature of the two atomic scientists' relationship. After World War II, Teller helped found Lawrence Livermore National Laboratory and was an influential figure in policy decisions regarding nuclear weapons and power. These experiences round out the volume. Originally published in hardcover in 2001. ***Perseus Publng, 2002, 628 p., b&w plates, paperback, $18.95.***



REALLY USEFUL: The Origins of Everyday Things

JOEL LEVY

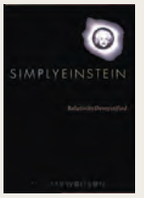
In the morning, you get up, take a hot shower, drink a cup of coffee, make a couple slices of toast, and put the dishes in the dishwasher, yet you probably never consider what objects make those activities possible. Levy challenges you to stop and smell the coffee as he explores the history of more than 100 objects used in daily life, from air conditioners to zippers. For instance, coffee comes from Turkey and dates to A.D. 575. The Greeks had plumbing systems that would spray water onto bathers. This technology faded, however, and was not seen again until Victorian times. Sliced bread, on the other hand, is a newer invention. A bread slicer was introduced in 1912, but it was flawed. The inventor first used hairpins to keep the slices together before conceiving a wrapping system. Levy shares these and hundreds of other tidbits in this engaging look at everyday things. ***Firefly, 2002, 240 p., color photos, paperback, $24.95.***



SIMPLY EINSTEIN: Relativity Demystified

RICHARD WOLFSON

A teacher of physics to nonscientists, Wolfson lays out the seminal ideas that define the field. Topics include consideration of the possibility of time travel and the predicted fate of the universe. These ideas stem from Albert Einstein's general theory of relativity. In a text refreshingly free of mathematical formulas, he introduces the origins of relativity theory and the concept's implications for understanding space and time. Along the way, he explains why the theory is so convincing and addresses questions commonly associated with it, including: Why can't anything go faster than light, and could I really age more slowly? With straightforward language and clear examples, Wolfson proves that you don't have to be an Einstein to understand his great ideas. ***Norton, 2003, 261 p., b&w illus., hardcover, $24.95.***



LETTERS

Get cooking

The scientists in "Solar Surgery: Sunlight acts like laser" (*SN: 10/5/02, p. 212*) may want to adapt their solar concentrator for a more prosaic use: cooking. In the early 1970s, I was involved in a project to build a self-sufficient dwelling that drew solely on the wind and sun for its power. We looked into using fiber optics to transmit solar energy to the cooking area, but the materials available at the time turned out to be too inefficient and costly. Maybe it's time to take another look at the culinary applications of fiber optic materials.

ROBERT G. CHESTER, TUMWATER, WASH.

Mummy dearest

The picture of the mummified dinosaur was amazing and a bit spooky ("Dear Mummy: Rare fossil reveals common dinosaur's soft tissue," *SN: 10/19/02, p. 243*). It is a great find.

PATRICK LEAHEY, GENEVA, N.Y.

Consciousness thoughts

The most profound consequence of the research in "Spreading Consciousness" (*SN: 10/19/02, p. 251*) is that there is no such thing as "now." Since consciousness is spread out across the brain, and since those centers of brain activity cannot communicate faster than the speed of light, "now" is not the hard point in time we usually imagine.

RICK NORWOOD, JOHNSON CITY, TENN.

No distinction was made in the article between conscious thought and awareness. People who practice deep meditation often experience a state described as "pure awareness." This is not awareness of specific objects or thoughts. Understanding consciousness will not happen until researchers seriously consider what meditators experience.

D.K. EDWARDS, VICTORIA, B.C.

Splashdown

In "Sea Squirt's DNA makes a splash" (*SN: 10/19/02, p. 254*), you report that "the sea squirt has the beginnings of a spinal cord, making it a so-called chordate." That's the same mistake I fight against each time I teach my zoology class. What makes a sea squirt a chordate is the notochord in the animal's larval stage. A notochord is a skeletal component, not a primitive nerve cord.

J. ROGER EAGAN, QUEENSBURY, N.Y.

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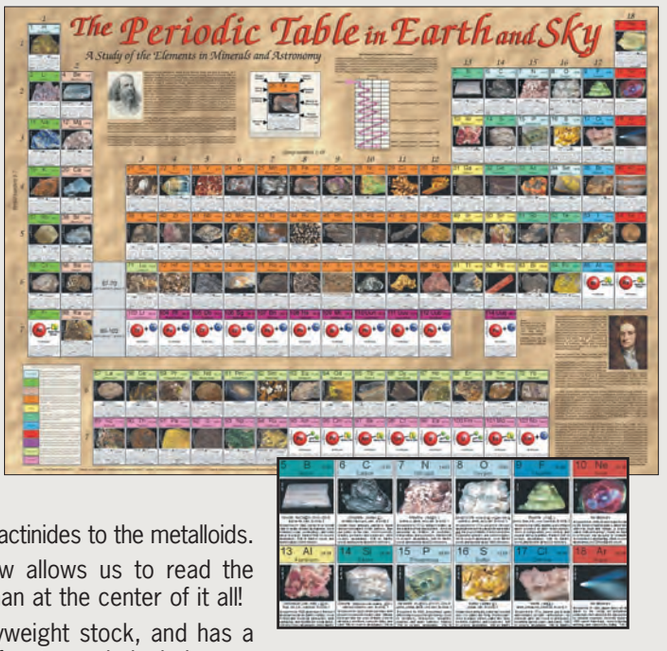
Elements of Nature

Featuring 116 razor-sharp color photos and graphics, this tour de force of the elements of the universe shows samples of minerals and crystals containing each element. Some samples are quite common, but others so rare that only microscopic specimens are available for study. For certain elements, there are no examples of minerals on Earth. In these cases, the element is shown where it occurs in space, whether in star-forming galaxies or the tail of a comet. The human-made elements are shown in graphics describing how they were created in the lab.

Providing the usual periodic table—poster details of element symbols, numbers, atomic weights, and electron configurations, the **Periodic Table in Earth and Sky** also gives information about the discovery of each element, its ranking in earthly and cosmic abundances, where it occurs, how it is used commercially, and how toxic it may be in its mineral form.



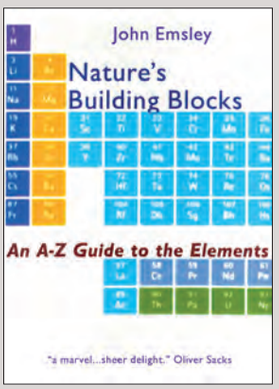
- Understand the nature of 11 families of elements, from the actinides to the metalloids.
- Learn about the amazing chain of discoveries that now allows us to read the specific elements in individual stars . . . and about the man at the center of it all!

The 38½" x 27" poster is printed in full color on heavyweight stock, and has a protective UV gloss coating that will even resist splashes of water and alcohol.

—from Jensan Scientifics

Jensan Scientifics, 2002, $17.00

What is the most common element in the universe? Can you name the noble gases? Everything we see around us is made of chemical elements, but most of us know little about them.



Penned by award-winning science writer John Emsley, *Nature's Building Blocks* explains the what, why, and wherefore of the chemical elements. Arranged alphabetically, from actinium to zirconium, it is a compete guide to all 115 of those elements that are currently known, with more extensive coverage of those elements we encounter in our everyday life. The entry on each element reveals where it came from, what role it may have in the human body, and the foods that contain it. There are also sections on each element's discovery, its part in human health or illness, the uses and misuses to which it is put, and its environmental role. Readers discover that Earth consists of around 90 elements, some of which are abundant, such as the silicon and oxygen in rocks and soils, while some are so rare that they make gold seem common. Our own bodies contain about 30 elements, some in abundance, some in trace amounts, some vital to our health, and some that are positively harmful. A list of the main scientific data is given for every element, and each section ends with an "element of surprise," which highlights some unexpected way in which the element influences our everyday life.

Both a reliable reference source and a highly browsable account of the elements, *Natures Building Blocks* offers a pleasurable tour of the very essence of our material world. —from Oxford University Press

Oxford University Press, 2001, 538 p., 6 ¾" x 9 ¾", hardcover, $29.95

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