SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

MAY 31, 2003 PAGES 337-352 VOL. 163, NO. 22

home, home in the gut

mad cow defense

a lovely earth out tonight

sperm-defect insight

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mirror image?

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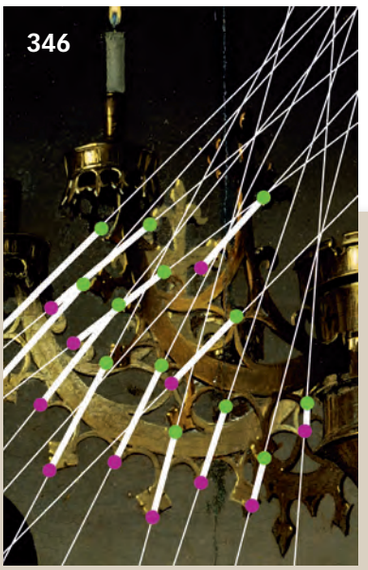

Features

This Week

Of Note

Departments

Cover Scientists are at odds over a proposal by artist David Hockney that Renaissance masters painted by tracing images projected by mirrors. Optics specialists use analyses—for instance, a computer-generated image of a mirror in "Portrait of Giovanni Arnolfini and His Wife" by Jan van Eyck—to test for the possible influence of optical aids. (National Gallery of London) Page 346

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Count Down

Chemicals linked to inferior sperm

Men's exposure to some compounds common in cosmetics and plastics is associated with sperm abnormalities, a new study suggests. The data don't establish a causative link between so-called phthalates and aberrant semen, but they bolster the case that phthalate concentrations typically seen in healthy people may have a negative effect on male reproduction.

Scientists have been working for years to understand the causes in developed countries of an apparent half-century-long decline in sperm quality—lower counts, reduced motility, and higher fractions appearing malformed. One hypothesis attributes this trend to the increasing prevalence of certain hormonally active chemicals, including phthalates, in the environment and in people's bodies.

Phthalates are used in cosmetics, deodorants, and many plastics that make up food packaging, children's toys, and medical devices. Studies indicate that the chemicals can interfere with sex hormones and impair reproductive health in animals (*SN: 4/3/99, p. 213*).

To look for links between phthalate exposures and sperm characteristics, Susan M. Duty and Russ Hauser of the Harvard School of Public Health in Boston and their colleagues analyzed semen and urine samples from 168 men. These volunteers were attending a clinic for couples experiencing difficulty conceiving a child.

The researchers analyzed volunteers' semen for sperm counts, sperm motility, and sperm shape and tested their urine for concentrations of eight phthalates that the body produces from more complex forms. Five of these compounds showed up in urine samples from at least 75 percent of the volunteers.

In the May *Epidemiology*, the researchers report an association between sperm count and urine concentrations of two compounds, monobutyl phthalate and monobenzyl phthalate. Among the volunteers, those with the highest concentrations of those compounds had the lowest sperm counts. Volunteers' monobutyl phthalate concentrations were also inversely correlated with sperm motility.

Those findings extend to men a pattern previously observed in rodents. However, in the animal experiments, the rodents received unusually large amounts of phthalates, whereas the men in the recent study had urine phthalate concentrations similar to those in the U.S. population at large (*SN: 2/22/03, p. 120*).

The new study is one of the first to link phthalate exposure to reproductive health in people, says Shanna H. Swan of the University of Missouri in Columbia. While not conclusive, the findings could "explain a substantial fraction of the reported decline in semen quality" in men in industrialized countries, she says.

Environmental epidemiologist Jane A. Hoppin of the National Institute of Environmental Health Sciences (NIEHS) in Research Triangle Park, N.C., says the new study adds heft to the notion that phthalates affect male fertility at concentrations common in U.S. men. Comments by both Hoppin and Swan appear in the issue of *Epidemiology* reporting the new Harvard results.

Interestingly, the two phthalates that the study links to semen abnormalities have not been considered the most toxic ones on the basis of animal studies, says Paul M. Foster, a reproductive toxicologist at NIEHS in Research Triangle Park. The new study didn't find a correlation between the men's reproductive characteristics and urine concentrations of another phthalate that is so toxic to young animals that the European Union recently prohibited its use in cosmetics.

If further studies establish that phthalates are human-reproductive toxins, researchers will also need to determine how people can best reduce their exposures to the chemicals, Duty says. —B. HARDER

Multiple Motions

Applied electrons make molecules vibrate and move

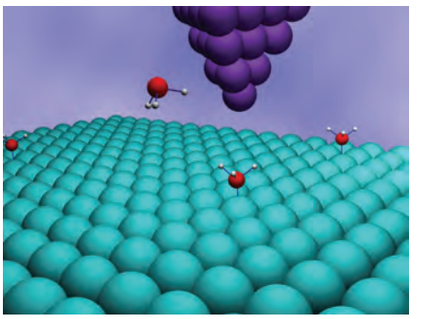
Chemical reactions involve billions of individual molecules enacting a complicated dance of bond breaking and formation. In an elegant technical accomplishment that could help researchers better understand these complex interactions, scientists have now choreographed individual molecules to vibrate, break bonds, and move on a surface in specified ways.

In the May 29 *Nature*, an international team of researchers describes how it used the electron-emitting tip of a scanning tunneling microscope (STM) to make individual ammonia molecules move in either of two ways.

Since the advent of STMs in the 1980s, scientists have used the instruments to produce striking images of surfaces at atomic scales and more recently to push or pull individual atoms and molecules around surfaces. In other experiments, researchers have bombarded molecules with electrons possessing enough energy to detach the molecules from an underlying surface.

In the current study, Jose Pascual of the Fritz-Haber-Institut der Max-Planck-Gesellschaft in Berlin and the Institut de Ciència de Materials de Barcelona-CSIC in Bellaterra, Spain, and his colleagues selectively tweaked the vibrations of individual molecules to produce two different movements. To do this, the team used STM electrons with precise energies that excited only one of two types of molecular vibration. That, in turn, primed individual molecules to react in specific ways.

The researchers demonstrated the technique with ammonia molecules, which are each made of a nitrogen atom linked to three hydrogen atoms in a pyramidal geometry. When ammonia rests on a copper surface, nitrogen chemically bonds to the copper and the hydrogens stick up. But when Pascual and his colleagues adjust their STM's tip to emit electrons of about 270 millielectronvolts, ammonia molecules that are hit invert like an umbrella in the wind. Their hydrogen atoms flip toward the surface, the copper-nitrogen bond breaks, and the molecule pops off the surface.



SURFACE ACTION An STM tip (purple) emits electrons that excite ammonia molecules (red and white). Depending on the electrons' energy, a molecule slides across a surface of copper atoms (turquoise) or pops off it.

When the researchers used electrons of about 400 millielectronvolts, however, the hydrogen atoms repeatedly stretched apart and pulled back together. This vibration weakened the nitrogen-copper bond, permitting the molecule to slide across the copper surface.

This is a pioneering experiment, says

PASCUAL

Dennis Jacobs of the University of Notre Dame in Indiana. Pascual's group has shown that it's possible to use STMs with "surgical precision" to dictate the behavior of individual molecules on a surface, he says.

Ammonia molecules and copper surfaces don't have special significance, notes Jacobs. Nor are the demonstrated behaviors—desorption from a surface and lateral movement—necessarily useful ones. Rather, he says, the exciting achievement is the technique itself, which may now be applied to a variety of molecules and motions. —J. GORMAN

Mad Cow Future

Tests explore next generation of defenses

As Canadian health officials press on in their investigation of mad cow disease within their borders and other countries bar Canadian beef, scientists are taking disparate approaches to developing defenses against such brain diseases.

Researchers in the United Kingdom studying livestock that resist so-called transmissible spongiform encephalopathies report mixed results. Although earlier tests had found some sheep resistant to infection by natural routes, extreme challenges—injections of diseased material directly into the brain—brought on the disease in 3 out of 19 animals, says Fiona Houston of the Institute for Animal Health in Newbury in the May 29 *Nature*.

Looking at meat treatments, U.S. and Italian researchers are blasting hot dogs with pressure and heat to inactivate agents for a spongiform encephalopathy. The researchers report in the May 13 *Proceedings of the National Academy of Sciences* that they have quashed risk of infection from the food.

The diseases actually leave brains full of holes, or spongy, ultimately killing susceptible species, which include minks, house cats, elk, and people (*SN: 11/30/02, p. 346*). Twisted forms of brain proteins called prions spread the disease, making normal proteins misfold.

Some scientists argue that cattle can get mad cow disease spontaneously, says Lisa Ferguson, a veterinarian for U.S. Department of Agriculture's Animal and Plant Health Inspection Service. "I think that's a bit difficult to accept," she says. If it were true, she'd expect that mad cow disease would have shown up in the United States by now.

Until May 20, North Americans hadn't reported any apparently homegrown case of mad cow disease. Canadian officials then announced that tissue from an 8-year-old cow slaughtered in January had tested positive for mad cow disease. Teams have been tracing the farms where the cow lived and where its calves have gone. The number of farms under quarantine has been climbing, and several hundred cows have been slaughtered for testing. The sick cow's most recent companions, a herd on an Alberta farm, have all tested negative for mad cow disease in a rapid test.

Britain has proclaimed an effort to breed livestock to get rid of prion diseases. Scientists are focusing on a form of a sheep gene called *ARR*. They're working to increase the frequency of that form because it has been linked to resistance to spongy-brain diseases. Sheep carrying two copies of the gene form and that were fed tissue from infected cattle still looked healthy after almost 6 years, but if the sheep were instead inoculated with the bovine material, they revealed symptoms after 3 years. Moreover, sheep without the gene form developed symptoms as early as 16 months after inoculation.

In other experiments, Paul Brown of the National Institutes of Health in Bethesda, Md., and his colleagues exposed meat to pulses of pressure starting at 100,000 pounds per square inch and temperatures ranging from 121° to 137°C. This dramatically reduced the dangers of infection, Brown says. —S. MILIUS

AP/WORLDWIDE

COW TROUBLE Canadian cattle, such as these in Alberta, have come under close scrutiny as officials investigate mad cow disease.

Memorable Shot

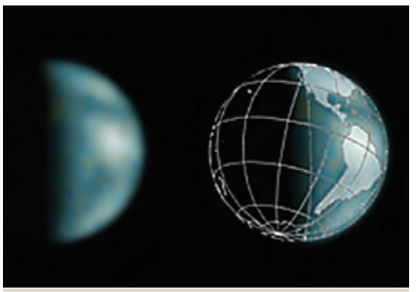
Smallpox vaccine has lasting effect

The threat that the smallpox virus could be used by terrorists as a biological weapon has become a cornerstone of modern angst. Now, a research team finds reason to assuage some of that anxiety: People vaccinated against smallpox decades ago retain significant antibody and immune-cell responses against the dangerous virus.

"We're finding long-term immunity," says Mark Slifka of Oregon Health and Science University in Beaverton. At last week's meeting of the American Society for Microbiology in Washington, D.C., Slifka and his colleague Erika Hammarlund reported the results of their survey of more than 300 people who had received one or more smallpox vaccinations over the past 75 years.

After a global immunization campaign against smallpox in the 1960s and 1970s, the disease was declared eradicated in 1980, and vaccinations were stopped. Fearful of an attack with the smallpox virus, however, the U.S. government recently began immunizing soldiers and health-care workers who would be the first to respond to an outbreak. Because the vaccine can have serious side effects, a debate has erupted over whether to widely vaccinate the public after an outbreak or just immunize people in the area where the outbreak occurs, a strategy called ring vaccination (*SN: 4/5/03, p. 218*).

To inform that decision, researchers have developed computer models that predict how smallpox would spread given a range of factors. One of the biggest sources of uncertainty in such models has been



New view of Earth

The image on the left is a portion of the first photo from the perspective of another planet showing Earth as more than a point of light. The bright areas are clouds over the Americas, depicted on the globe at right. The picture comes from the Mars Global Surveyor probe now orbiting Mars. The craft was about 139 million kilometers away from Earth when it snapped the black-and-white photo, which was colorized using data from an image captured in 1973 from a closer distance by the Mariner 10 probe on its way to Mercury. The full Mars Global Surveyor picture, taken May 8, includes Jupiter, three of its largest satellites, and our moon. —S. Perkins

NASA/JPL/MALIN SPACE SCIENCE SYSTEMS; BUDÁVARI, SLOAN DIGITAL SKY SURVEY

whether people vaccinated decades ago remain immune. An online fact sheet from the Centers for Disease Control and Prevention in Atlanta, for example, declares, "Smallpox vaccination provides high level immunity for 3 to 5 years and decreasing immunity thereafter."

Slifka, Hammarlund, and their colleagues took blood samples from one group of people who had received smallpox vaccinations between 20 and 75 years ago and another group of people who were immunized only recently. Then, in test tube studies, the scientists measured antibody and immune-cell responses to the virus.

The investigators found that more than 90 percent of the people vaccinated decades ago had an antibody response similar to the response of those recently vaccinated. The strength of the immune-cell response did decline with time, but virus-specific immune cells are still found in people vaccinated as long ago as the 1940s.

For Slifka, that finding all but settles the debate about how to respond to a new outbreak. "It would be unlikely that we would need to mass-vaccinate," he concludes. "The ring-vaccination approach would be very effective."

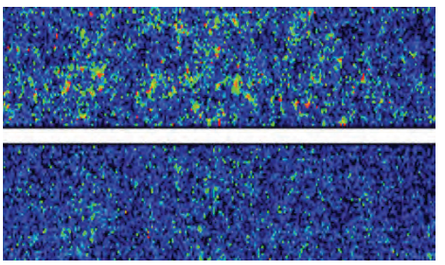
Not everyone agrees. Edward H. Kaplan of Yale University has modeled the spread of smallpox, including scenarios in which 50 percent of the public is already immune. "While [widespread immunity] would certainly reduce the number of deaths, it would still not tip me from recommending post-attack mass vaccination," Kaplan says.

Making public policy on the basis of test-tube studies is a challenge, notes Jeff Frelinger of the University of North Carolina at Chapel Hill, who has documented continued immune responses to the smallpox virus in about a dozen people vaccinated decades ago. "While the long persistence of immune responses suggests resistance, there exist no studies to calibrate the [test-tube] responses measured with protection from smallpox following exposure." —J. TRAVIS

Red Team, Blue Team

Galaxy survey shows that color matters

Using the largest survey of galaxies ever compiled, astronomers have found that the cosmos divides sharply along color lines. Old, red galaxies clump tightly, while young, blue ones are more spread out. Although the standard theory of galaxy formation predicts the same general trend, it permits a continuum, from very tight to very loose clustering. The survey, however, denies the middle ground.



GALACTIC CLUMPING Pattern shows that old, red galaxies (top) clump more tightly than do young, blue ones (bottom).

There's no ready explanation for this great divide among galaxies, says Alex S. Szalay of Johns Hopkins University in Baltimore. His Johns Hopkins colleague Tamás Budávari presented the findings this week at a meeting of the American Astronomical Society in Nashville.

The astronomers have analyzed 2 million of the roughly 50 million galaxies observed so far by the Sloan Digital Sky Survey. The survey, which uses a telescope at Apache Point, N.M., is scheduled to view some 100 million galaxies over the northern sky by 2005.

According to theory, the very first galaxies condensed from regions in the early universe where the density of matter was the highest. This material consisted mainly of invisible, mystery material dubbed dark matter. As time went on and gravity continued to pull material together, more rarified regions of the universe also began to form galaxies.

The first galaxies, which condensed less than a billion years after the Big Bang, are now elderly. They appear red because they stopped forming stars long ago and the longest-lived stars radiate most of their light at red or infrared wavelengths. Galaxies that formed later look blue because they contain a significant number of young stars, which emit bluer light.

The Sloan survey differs from other large astronomical surveys because it examines galaxies at a variety of wavelengths. This color information, which enables astronomers to easily estimate the distances to millions of galaxies, has revealed the difference in clustering, notes Szalay.

"There seems to be two [distinct] populations and not a gradual transition in clustering properties between red and blue galaxies," agrees Licia Verde of Princeton University. In contrast, data from a separate survey of 250,000 galaxies that Verde has analyzed offers only a hint of color segregation, she notes.

The main inference that Verde and her colleagues culled from the 2df Galaxy Redshift Survey is that, on average, galaxies cluster in the same way on large scales as do the vast clumps of dark matter that presumably prompted their formation (*SN: 1/5/02, p. 5*). The new Sloan finding "may be telling something about the distribution of dark matter," she suggests.

The Sloan study represents "an important transition," says David N. Spergel of Princeton. "Astronomers are now using the large-scale distribution of galaxies to probe the physics of galaxy formation rather than to learn about the composition of the universe." —R. COWEN

Flawed Therapy

Hormone replacement takes more hits

Expectations for hormone-replacement therapy for postmenopausal women have turned topsy-turvy in recent years. Initial studies suggesting remarkable benefits from the drugs gave way to reports of little gain. Most recently, the rap sheet on estrogen and progestin includes signs of harm.

The latest bad news for the treatment appears in two articles in the May 28 *Journal of the American Medical Association,*

where scientists report that the hormone combination boosts the risk of dementia and stroke in otherwise healthy women. Another recent report challenges the view that the therapy increases women's feelings of well-being.

The findings all stem from the Women's Health Initiative, a nationwide study that began in the early 1990s and enrolled more than 27,000 women in its hormone-replacement component. In 2002, researchers stopped part of this component, 3 years before its scheduled conclusion, because interim results showed that postmenopausal women taking estrogen-progestin supplements had a greater risk of circulatory disorders, breast cancer, and stroke than women getting inert pills did (*SN: 7/27/02, p. 61*).

During the study, the scientists had monitored a subgroup of 4,532 healthy women over age 65 for signs of dementia. The researchers had randomly assigned participants to receive hormones or placebos. Over 5 years, 40 women getting hormones were diagnosed with Alzheimer's disease or other dementia, compared with only 21 getting a placebo, coauthor Sally A. Shumaker of Wake Forest University in Winston-Salem, N.C., now reports. That the half receiving hormones actually had greater incidence of dementia came as a surprise because earlier research had suggested the opposite (*SN: 2/17/01, p. 110*).

"The risk for any individual remains low," says Judith A. Salerno of the National Institute on Aging in Bethesda, Md. However, she says, "we had hoped [hormones] would be a good intervention for the prevention of dementia and other cognitive decline, and this isn't what the study found."

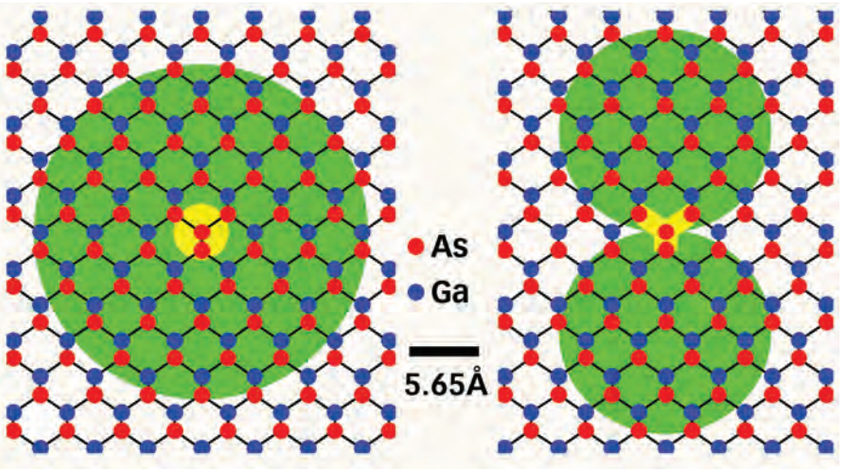
The analysis of stroke included 16,608 postmenopausal women from the nationwide study. Sylvia Wassertheil-Smoller of Albert Einstein College of Medicine in New York and her colleagues report that 1.8 percent of women getting hormones and 1.3 percent of those taking a placebo had had strokes after nearly 6 years in the trial. The findings bolster early results from the study (*SN: 7/27/02, p. 61*).

Researchers continue to monitor the women taken off the hormones at the study's termination to see whether their risk of dementia, stroke, or other problems diminishes, Shumaker says.

Scientists don't know whether estrogen, progestin, or the combination contributes to the higher risk for these ailments. A separate and continuing portion of the study, involving only women who had a hysterectomy and are receiving just estrogen or a placebo, may shed light on that, says Salerno.

While hormone-replacement therapy was originally prescribed to alleviate menopausal symptoms such as hot flashes, many women reported that the drugs improved their general feeling of well-being. Even that notion took a hit in another study released this month. Jennifer Hays of the Baylor College of Medicine in Houston and her colleagues report in the May 8 *New England Journal of Medicine* that postmenopausal women on hormones have no better vitality, mental health, or sexual satisfaction than women not taking the drugs do.

Shumaker suggests that many quality-of-life benefits in previous hormone studies may be attributable to a placebo effect. Meanwhile, scientists are continuing to investigate two potential benefits of hormone therapy that still appear to hold—gains in bone density and decreased colorectal cancer risk. —N. SEPPA



GOOD FLAWS At a crystal defect, an electron's distribution in space (green and yellow) oscillates between two different patterns (left and right). As it oscillates, the electron emits a useful wavelength of infrared light. Red indicates arsenic atoms; blue, gallium.

Light Switch

Crystal flaws tune the wavelengths

By exploiting a defect in a semiconductor's crystal structure, researchers have come up with a potentially inexpensive way to make fast fiberoptic communications components. That development, in turn, might speed the long-awaited extension of optical networks into homes, says Janet L. Pan of Yale University.

Working with gallium arsenide, the primary material from which lasers for compact-disk players and the high-speed electronics for cell phones are made, Pan and her colleagues have created a light-emitting diode (LED). The device converts electric pulses into light emissions at the pivotal infrared wavelength of 1.55 micrometers (μm), the one used for long-distance optical-fiber communications. Ordinarily, gallium arsenide emits at 0.85 μm.

Many manufacturers currently use indium phosphide for making LEDs, lasers, photodetectors, and other components of fiberoptic systems. However, for electronics, indium phosphide is difficult to use and leads to many defective components that can't be sold.

By contrast, because gallium arsenide parts can be fabricated in the same automated processes that create gallium arsenide–based microelectronics, the new fiberoptic devices may prove to be relatively cheap, Pan says.

In the June *Nature Materials*, the Yale team explains how it exploited gallium arsenide defects known as arsenic anti-sites. At those locations, the scientists introduced extra arsenic atoms to replace some gallium atoms in the compound's crystal lattice. In that manner, the team built an LED that contains a layer especially rich in arsenic anti-sites.

In LEDs, mobile electrons drop from higher to lower energy levels and fire off photons whose wavelengths correspond to the differences between those levels. In gallium arsenide, anti-sites permit electrons to assume intermediate energy levels that aren't otherwise present. When electrons drop into those middle levels, they emit photons with less energy, and therefore longer wavelengths, than usual.

The new LED is "a clever way to make use of a very high concentration of defects," comments David C. Look of Wright State University in Dayton, Ohio.

For the moment, Pan notes, the LED's light-producing efficiency is too low to be useful, adding that "practical devices may be possible within 3 to 5 years." —P. WEISS

PAN

GUT CHECK

The bacteria in your intestines are welcome guests

BY JOHN TRAVIS

New York and London are famous for both their congestion and the diverse origins of their residents. But if you're looking for the ultimate teeming metropolis of immigrants, check out the large intestine. In people, some 500 to 1,000 kinds of bacteria reside in this part of the gastrointestinal (GI) tract, and these gut microbes outnumber all the cells in your body, perhaps by as much as a factor of 10.

"The density of this society is mind-boggling," says Jeffrey I. Gordon of Washington University School of Medicine in St. Louis.

It's a society overlooked by most microbiologists, who generally stick to the myriad bacteria that cause disease. Yet some scientists argue that it's shortsighted to ignore what they call the microflora living in our intestines.

"What these bacteria do definitely makes a very significant contribution to our health—or lack thereof," says Mark Schell of the University of Georgia in Athens, who studies an intestinal microbe called *Bifodobacterium longum*.

Shell and a few other researchers have recently begun to probe exactly what individual microbes do for or to the intestine.

Consider *Bacteriodes thetaiotaomicron*. Although not as well known, it's more than 1,000 times as abundant in the guts of people and mice as the extensively studied bacterium *Escherichia coli*. Some researchers have proposed that in return for a steady food supply, *B. thetaiotaomicron* breaks down indigestible complex carbohydrates into easily absorbed sugars and produces other substances, such as vitamins, that benefit its host.

There may be much more to this microbe-host relationship, however. About a decade ago, Gordon chose *B. thetaiotaomicron* as a prototypical germ for studying how microbes influence the GI tract. This bacterium normally becomes a predominant member of the intestinal community about the time an animal is weaned from its mother's milk. Gordon's research team has discovered that the microbe can turn on specific intestinal genes, promote the growth of blood vessels necessary for the gut's function, and trigger production of a chemical that may kill competing bacteria. Investigators are now asking just how much gut bacteria regulate the developing and adult human body.

"Bacteria do an awful lot for us and with us," says Gordon. "Most people's views of bacteria are of menacing, disease-promoting entities. *Au contraire*, I think that most of our encounters with bacteria are mutually beneficial, friendly, and part of our normal biology . . . . They've insinuated themselves into our biology and coevolved with us."

SWEET-TALKING GERM Perhaps the best way to understand the significance of intestinal microorganisms is to see what happens when an animal doesn't have them. During the past 50 years, researchers have created germfree mice and rats by delivering the animals by cesarean section into sterile environments and maintaining them there. "It's a very demanding technology," says Gordon. Scientists have generally used such germfree animals to study how particular pathogens cause diseases.

One of the most striking aspects of a germfree rodent is that it must consume about 30 percent more calories to maintain its body weight than a typical rodent does. Germfree animals are also unusually susceptible to infections, presumably because the microflora in a normal gut ward off foreign pathogens.

As a way to study animals hosting a simplified society of gut bacteria, Gordon and his colleagues have introduced *B. thetaiotaomicron* into germfree mice. Their first significant discovery was that the bacterium could change what sugars the intestine makes.

The surfaces of intestinal cells of typical mice are coated with complex sugars containing the simple sugar fucose and *B. thetaiotaomicron* consumes the fucose for energy. In germfree mice, however, fucose production ceases around the time of weaning.

> "I think that most of our encounters with bacteria are mutually beneficial, friendly, and part of our normal biology."
>
> —JEFFREY I. GORDON

If *B. thetaiotaomicron* colonizes a germfree mouse before weaning, however, normal fucose synthesis continues throughout life, the researchers found. Through a still undiscovered signal, the microbe apparently induces the intestinal cells to make one of its favorite foods. The bacterium even has a fucose sensor that informs it when this food source is scarce, according to Gordon and his colleagues.

The capacity of *B. thetaiotaomicron* to instruct intestinal cells to make fucose was just a hint of things to come. To get a more comprehensive picture of the bacterium's influence, Gordon's group turned to microchip-size devices, called DNA microarrays, that monitor the activity of thousands of genes at once (*SN: 3/8/97, p. 144*).

With such instruments, the scientists took a snapshot of the gene activity in the mouse intestine. By comparing tissue from germfree mice and mice hosting *B. thetaiotaomicron*, the team found that the presence of the bacterium significantly reduces or boosts the activity of about 100 of the approximately 25,000 rodent genes in the microarray survey.

Some of the intestinal genes triggered by the microbe help mammals absorb and metabolize sugars and fats, Gordon and his colleagues reported in 2001. Other activated genes fortify the cellular barrier that prevents bacteria, both dangerous and friendly, from sneaking out of the intestine into other tissues and the bloodstream. And yet other affected genes determine how the intestine detoxifies compounds and how the gut matures.

"We were amazed at the breadth of normal intestinal functions affected by a single microbe," says study coauthor Lora V. Hopper. Gordon adds, "It's difficult to anticipate the full range of host func-

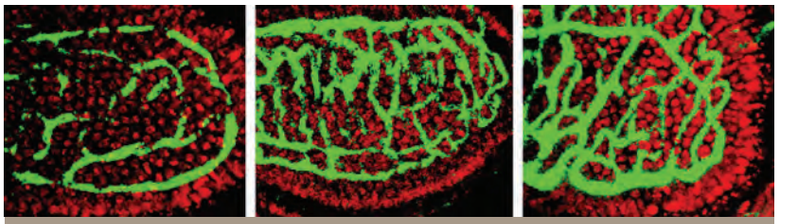
tions that might be manipulated by these microbes."

The genetic activity that the researchers didn't see in the bacteria-colonized mice was interesting, too. Even though the originally germfree mice had never encountered *B. thetaiotaomicron* before, there was no increase in activity of the genes underlying an immune or inflammatory response. That's a reflection of the microbe's still mysterious skill at convincing a host that it's a friendly visitor and not a danger, says Gordon.

RAISING FENCES Among the intestinal genes activated by *B. thetaiotaomicron* is one suspected to stimulate the growth of new blood vessels. The finding spurred Gordon's group to investigate the microbe's control over the system of blood vessels that runs through the GI tract. These blood vessels are crucial to a body's absorption of nutrients.

The researchers discovered that their germfree mice have a poorly formed network of the capillaries that normally supply the inner intestinal surface with its blood supply. This could partly explain the difficulty that germfree animals have absorbing nutrients.

The team also found that it could stimulate germfree mice to grow a normal network of intestinal capillaries by exposing the animals to either a full complement of microflora or just *B. thetaiotaomicron*. The investigators reported the finding in the Nov. 26, 2002 *Proceedings of the National Academy of Sciences*.



BACTERIAL BOOST — The intestinal blood vessel system (green) of a germfree mouse (left) is less mature than that of mice colonized by typical gut microbes (middle) or *Bacteriodes thetaiotaomicron* alone (right).

T. STAPPENBECK ET AL./PNAS

This is a vivid illustration that the physical development of the gut can depend on the microbes that normally inhabit animals, says Gordon. The researchers also found cells in the mouse gut that seems to work with the microbes to spur vessel growth.

In the small intestine, so-called Paneth cells normally secrete antimicrobial compounds (*SN: 8/26/00, p. 135*). This keeps the intestine healthy by protecting other cells that continually replenish the gut lining. Gordon's team created germfree versions of mutant mice that lack Paneth cells and found that *B. thetaiotaomicron* couldn't trigger the maturation of blood vessels in such rodents. While most investigators have regarded Paneth cells simply as defenders against invading bacteria, it makes sense that these cells mediate interactions between a host and its natural microflora, says Gordon. "What better cell to respond to the presence or absence of a microbe?" he remarks.

The Paneth cell is at the heart of another microbe-intestine interaction uncovered recently by Gordon's group. One of the intestinal genes triggered in germfree mice by *B. thetaiotaomicron* encodes a protein called angiogenin 4 or Ang4. Cancer researchers are particularly interested in this protein, because they have evidence that it nourishes tumors by creating new blood vessels. Gordon's team suspected that Ang4 plays a role in the intestinal blood vessel maturation that they had documented earlier. Indeed, it turned out that Paneth cells make Ang4 and secrete it when they detect bacteria.

While the suspicion that Ang4 makes intestinal blood vessels has not yet been proven, it looks like the protein has a more certain role. It can kill several bacteria and fungi that cause diseases in mammals, Gordon, Hooper, and their colleagues report in the March *Nature Immunology*. In contrast, *B. thetaiotaomicron* and other common residents of the mouse intestines are largely resistant to Ang4.

"One interpretation of the interaction between host defense and the resident flora is that the resident bacteria that are resistant to Paneth-cell secretions stimulate these host-defense mechanisms to prevent competition by nonresident bacteria. The host in turn benefits by decreasing its exposure to potential pathogens," says Tomas Ganz of the University of California, Los Angeles in a commentary accompanying the March report.

Hooper agrees that the normal inhabitants of the gut may use Paneth cells and Ang4 to raise what she calls an "electric fence" to keep out competing microbes. Beyond fending off foreign pathogens, such fences may also keep typical intestinal microbes within the gut. "Anything can become a pathogen if it crosses the fence," she says.

EATING LEFTOVERS Scientists have estimated that the hundreds of bacterial species within the human gut may together possess as many unique genes as a person does, and perhaps far more. "How much of our biology is dependent on metabolic traits encoded in the collective genomes of our microbial partners?" asks Gordon.

Investigators have begun to address that question. For example, Schell recently worked with scientists at the Nestlé Research Center in Lausanne, Switzerland, to unravel some of the genetic secrets of *B. longum*. This microbe typically colonizes the intestines of a newborn mammal, thrives during the breast-feeding period, and then subsides after weaning, when *B. thetaiotaomicron* and other bacteria take hold. Nestlé incorporates *B. longum* into some of its products, such as infant formulas and yogurts, to promote gastrointestinal health.

In the Oct. 29, 2002 *Proceedings of the National Academy of Sciences*, Schell and his colleagues unveiled the entire DNA sequence of *B. longum* and identified a large roster of genes for enzymes that break apart sugars and other edible substances. Some of these enzymes may degrade complex sugars found in breast milk, speculates Schell. Others, such as ones that apparently break down plant gums, may help the bacterium survive later in its host's life when *B. longum* is in the minority in the intestines.

The bacterium appears to break down substances that *B. thetaiotaomicron* and other *Bacteriodes* can't handle. "It seems to be more specialized for the leftovers of metabolism," says Schell. In a strategy similar to Gordon's, investigators at Nestlé are now using germfree mice to evaluate *B. longum*'s impact on intestinal genes.

Gordon's team is drawing its own insights from the group's recent deciphering of *B. thetaiotaomicron*'s genome. Among that microbe's nearly 4,800 genes, several hundred encode proteins that bind carbohydrates, enzymes that degrade bonds between sugars, or enzymes that create new sugars, the investigators reported in the March 28 *Science*. And the activity of many of these genes appears to be regulated by genes encoding molecules related to known environmental sensors, suggesting that the microbe can monitor the contents of the intestines and quickly deploy the molecular machinery needed for it to digest nutrients.

"This organism has a sweet tooth. It knows how to process carbohydrates," says Gordon.

Over the next 5 to 10 years, predicts Schell, researchers will decode the genomes of many more intestinal microbes. Investigators may also begin to address such issues as whether a person's diet changes his or her intestinal microflora. "I think the gut population of a vegetarian is clearly going to be different" from that of a meat eater, says Schell.

Gordon offers an even more provocative question: Do intestinal microbes influence a person's weight? "Over time, could relatively minor differences in the ability to extract nutrients in some individuals predispose them to obesity?" he asks.

The complicated nation of bacteria within our intestines is a "window into our biology and how we've evolved as a species," concludes Gordon. ■

REFLECTIONS ON ART

Scientists debate whether the old masters used optical aids

BY PETER WEISS

Like a defense lawyer in court, David G. Stork was eager to know whether his closing argument was winning over his audience. Would a jury vote to convict? Stork asked the group assembled at NASA Goddard Space Flight Center early this month. None of the of the 100 or so people in the Greenbelt, Md.–facility raised a hand—just the response that Stork, chief scientist of Ricoh Innovations in Menlo Park, Calif., was hoping for.

Stork is no lawyer, but he definitely has a group of people to defend. An investigator of pattern recognition and an amateur artist, he's on a mission to scientifically disprove the assertion by renowned British-born artist David Hockney that many of Europe's greatest artists of the 15th and 16th centuries secretly used mirrors or lenses to project traceable images onto their canvases and thereby achieve the arresting realism of their paintings.

First publicized in a *New Yorker* article in January 2000, Hockney's proposal jolted the art world and has received wide attention from the media and general public. Although Hockney recoils at the suggestion, many people interpret his hypothesis as an accusation that the old masters cheated.

RENAISSANCE SNAPSHOT? — The top of the octagonal motif on the table rug is blurry, suggesting to David Hockney that Lorenzo Lotto's "Husband and Wife" was painted with images projected by a mirror in the early 1500s.

The theory "touches some very raw nerves as to what we think art and artists are about," says art historian and Hockney colleague Martin Kemp of Oxford University in England. Optical aids such as slide projectors are in widespread use today among painters, but art lovers typically revere the superb realism that Renaissance masters achieved without the apparent use of such devices.

In addition to the mass media coverage of his radical proposal, Hockney has made a documentary film on the topic and even published a book, *Secret Knowledge: Rediscovering the Lost Techniques of the Old Masters* (2001, Thames & Hudson, Viking Studio).

That the Goddard audience was wary of Hockney's thesis was particularly gratifying to Stork. That's because a year ago, art aficionado and Hockney collaborator Charles M. Falco, an optics professor at the University of Arizona in Tucson, had presented the scientific case for Hockney's proposal from that same Goddard rostrum. At the end of his talk, Falco, too, had polled the audience to see whether it was with or against Hockney. By a show of hands, he says, 97 out of 100 listeners had declared themselves convinced of the Hockney hypothesis.

Falco had volunteered his scientific services to the artist after reading the *New Yorker* article. The optics specialist developed nearly all of the scientific evidence supporting Hockney's original idea that many Renaissance paintings are simply too precise to have been done strictly by eye.

"I had the optics training to add the scientific information to what [Hockney] had seen," Falco explains. "It took both [visual and scientific evidence] to make a compelling argument." For instance, Falco used the sizes of objects and people in the paintings to calculate diameters, focal lengths, and other characteristics of lenses and mirrors that might have been used to project those forms.

In scientific circles, Falco's ideas have been warmly received, except by a few vocal critics such as Stork and Christopher W. Tyler of the Smith Kettlewell Eye Institute in San Francisco. Tyler calls the idea that optics were used in the 1500s and earlier "just storytelling." Particularly galling, he and other critics say, is the absence of any clear evidence from that time that the optical devices available could produce the kind of images Hockney claims the masters used.

In turn, Falco derides the objections raised by Stork and Tyler as unworthy of scholarly debate. Their criticisms are "an anomaly," Falco says.

In recent talks and publications, Hockney, Falco, Stork, and Tyler have taken an especially close look at a few Renaissance artworks. Much of the discussion has focused on two paintings: "Husband and Wife" by Lorenzo Lotto and "Portrait of Giovanni Arnolfini and His Wife" by Jan van Eyck. Depending on the analyst's point of view, even the same observations regarding those paintings lead to startlingly different conclusions.

ART RESOURCES

CALLED ON THE CARPET Hockney and Falco have dubbed Lotto's painting the Rosetta stone of their "opticality" theory. Completed in approximately 1525, the painting depicts a man and a woman seated at a table covered by a small oriental rug.

What Hockney and Falco consider so telling about this masterpiece is the curious distortion of a foreshortened, octagonal pattern in the front-center portion of the rug. The octagon is formed by a kind of train-track motif that jogs around a flower-blossom design. Hockney noticed that the octagon becomes indistinct—like an out-of-focus portion of a photograph—as it recedes from the viewer.

The octagon's blurring is just the sort of distortion that someone might see in a projection of the rug by a concave mirror, Falco contends. Moreover, it's a visual effect that an artist looking with his eyes alone wouldn't see because human eyes automatically refocus as they range over a scene.

Falco has computed, down to the millimeter, just how Lotto might have used a mirror. To reproduce the complex details of the rug, the painter would have positioned a mirror roughly a meter and a half from the edge of the table at which his models were sitting, Falco calculates. Then, by placing himself to the side and about halfway between models and mirror, Lotto could have bounced a traceable image directly onto his easel.

Apparent mistakes by the artist in rendering the image in proper perspective strengthen that supposition, says Falco. According to the principles of geometric perspective, parallel lines appear to converge at a single point in space, known as the vanishing point, as they recede from the viewer. However, a short way back from the edge of the table depicted in "Husband and Wife," some of the presumably parallel lines of the train-track motif converge to a vanishing point different from that of other parallel lines in the motif.

That's easily explained, Falco argues, because a mirror wouldn't be able to project the whole rug pattern in focus at once. He calculates that Lotto twice would have had to shift the mirror a bit further back from the table in order to refocus on details of the rug closer to the background figures. Each time, if the artist misaligned the mirror even slightly, the vanishing point would shift.

There's a simpler explanation, claims Tyler, who finds a hodgepodge of vanishing points in Lotto's painting. This multiplicity of perspectives suggests that Lotto painted freehand, not worrying about getting the perspective exact, as he would have done were he using an optical aid, Tyler says.

In another experiment to test whether the rug's octagon was drawn in proper perspective, Tyler scanned the painting into a computer and used Photoshop, a popular image-processing software program, to digitally reorient the rug-covered tabletop to look as if it were seen from directly above instead of at an angle. With the perspective removed, the octagon appeared asymmetric. Tyler says this suggests that Lotto botched the perspective in the first place—further evidence that the rug was painted by eye instead of reproduced optically.

Tyler unveiled his findings last October at the annual meeting of the Society for Literature and Science in Pasadena, Calif. He also has posted an online report of his investigation (*www.diatrope.com/hockney.html*).

In Falco's view, however, Tyler "completely blew the analysis." In his own Photoshop experiment, Falco treated the octagon as if it were composed of several pieces. That's because each time Lotto would have moved the mirror to bring a portion of the octagon into focus, he also would have automatically changed the magnification of the projected image, the Arizona scientist explains. Indeed, if the octagon's pieces are each resized adequately, "the octagon fits the entire Lotto tablecloth pattern to plus or minus a percent. It's quite stunning," Falco says.

ANALYZE THIS — Details of the chandelier and mirror in Jan van Eyck's "Portrait of Giovanni Arnolfini and His Wife" (1434) are used as evidence both for and against the painter's use of optical instruments.

NATIONAL GALLERY OF LONDON

Even granting the thesis that Lotto used a concave mirror to paint "Husband and Wife," a mystery would remain: Why, ultimately, would Lotto have left a blurry section of the octagon in the painting? Falco and Hockney conclude that the refocusing steps led to several separately magnified octagon pieces that Lotto couldn't completely reconcile. So the artist fudged the details as best he could to minimize the visual impact.

To Tyler, given that the octagon is such a noticeable feature of the painting, the refocusing explanation is farfetched. Had Lotto enjoyed the benefit of a projection mirror, he would have arranged his set-up to capture that figure correctly, Tyler argues. "The octagon was the one thing he would have needed the lens for, so he would get it right," he says. A better explanation, Tyler suggests, is that Lotto painted the rug freehand without fretting too much about the details.

ALL THAT GLITTERS If it's controversial to claim that Lorenzo Lotto used optical aids, then it's even more so to say the same of Jan van Eyck, a Flemish artist who was painting a century before Lotto. Nonetheless, in his book, Hockney argues that van Eyck may have used a concave mirror to create his famous 1434 portrait of the local merchant Giovanni Arnolfini and his wife.

In the book, in television interviews, and on Web pages, Hockney and Falco have argued that van Eyck would have needed a mirror or lens to render so faithfully the chandelier depicted in the portrait.

To Hockney's eye, the chandelier is in "perfect perspective," he told a *60 Minutes* interviewer. However, by identifying points on the chandelier that lie along parallel lines and then plotting those lines by computer over a reproduction of the chandelier image, Stork has determined that the lines don't merge to the expected vanishing points. "Wham! What a mess," he declares, showing a slide of van Eyck's chandelier covered with a jumble of colored lines. "It's in terrible perspective," he says. And that, Stork argues, is evidence that van Eyck didn't use a mirror.

The painted chandelier's arms also fail another test. Were the arms identical, lines drawn through the same features of each arm should meet at the chandelier's axis of rotation. That's not the case with the couple's chandelier, Stork finds.

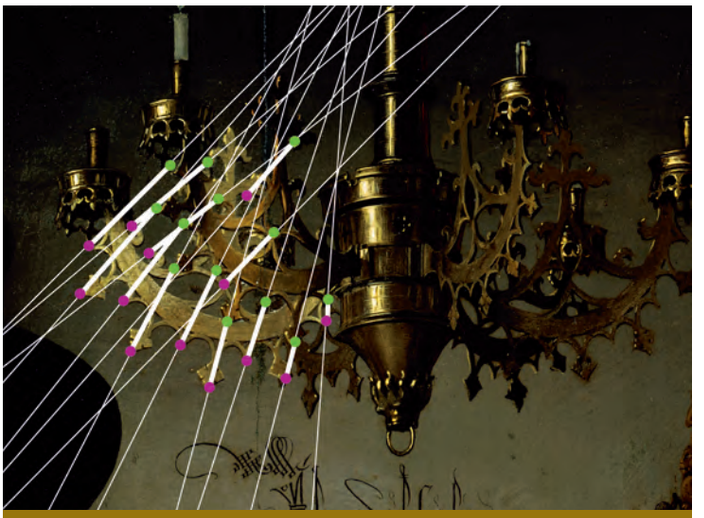
Both Hockney and Falco also have drawn attention to a convex mirror that appears in the painting on the back wall of the room in which the couple stands. Had van Eyck flipped over that mirror, they suggest, the painter could have created the optical equipment required to make the painting.

Yet Stork determined the probable focal length of a concave mirror made by inverting and silvering the convex mirror shown in the painting. For instance, by computer-correcting the reflection painted, he found that the focal length of the mirror would have been too short to project images of Arnolfini and his wife and other features of the painting. This mismatch, he says, militates against the Hockney-Falco claim that the painter relied on optical aids.

Stork presented his challenges to the chandelier and mirror claims in his talk at Goddard, which also ranged over several other paintings, and other criticisms of the Hockney-Falco thesis.

For instance, to explain the sudden blossoming in the early 1400s of a painting style that's almost photorealism, Stork recommends alternative explanations to optical technology. For example, the advent of oil paints and the control they offered artists are well documented in the historical record.

Not that any of these arguments are convincing the father of the opticality theory. "Mr. Stork doesn't really change my view at all," says Hockney.



WHAT'S YOUR ANGLE? — These lines, presumably parallel when superimposed on a real chandelier, fail to meet at a single vanishing point. Their misalignment indicates that a major feature of Jan van Eyck's painting isn't in perspective and so wasn't created with mirrors, says David Stork.

NATIONAL GALLERY OF LONDON

Even so, Stork has scored some points. Hockney-supporter Kemp rates Stork's chandelier deconstruction as "pretty convincing." So does H. John Wood, lead optical engineer for the Hubble Space Telescope, who heard Stork's argument at Goddard. Both Wood and Kemp say they still find the Hockney-Falco theory persuasive but not convincing beyond the reasonable shadow of a doubt.

With his hypothesis now supported and challenged by technical analyses, Hockney muses about whether science can ever settle the issue. After all, he arrived at his hunch about optics by looking at paintings and, later, tested it by trying out optical devices in his own art.

"The only way you'd know [whether those devices were used] is by looking at pictures," he says. To him, the photographic style that started showing up in the early 15th century is a dead giveaway that the old masters used optical technology.

Now that he has sparked an art-history debate among scientists, Hockney is retreating from the fray. "I've gone back to painting now," Hockney says. "I'm bored with the optical view of the world." ■

Continued from page 351

species hadn't prepared her for the shock of looking at a lush green landscape and realizing that none of the plants in sight was native to the island. Finally, she says, it's exciting to have had first-hand experience with tropical agriculture by sampling breadfruit, taro, fresh coconut milk, and lychees just picked from a tree.

Susan, who has covered life sciences for *Science News* since 1998, was also honored with the selection of "Why Turn Red?" (*SN: 10/26/02, p. 264*) as one of the best journalistic science articles of last year. It will appear in the book *The Best American Science Writing 2003,* published by Ecco/HarperCollins. The article examines scientists' current ideas about why an autumn leaf with only a few weeks left summons its faltering resources for a burst of production of bright red pigment. Susan presents relevant experimental results from fields as diverse as geography and biochemistry. The article can be viewed at *Science News Online* (*http://www.sciencenews.org/20021026/bob8.asp*).

JULIE ANN MILLER, EDITOR

Placebo defect

In your article "Protein Pump: Experimental therapy fights Parkinson's" (*SN: 4/19/03, p. 245*), the possibility is mentioned that patients with Parkinson's disease might have improved in the study because of the placebo effect rather than the administration of the protein glial-cell-line-derived neurotrophic factor. The article then says, "However, brain scans of these patients . . . showed that dopamine supplies in the putamen improved over that time," seemingly suggesting that such an increase in dopamine would not be likely to occur if the improvement were due to the placebo effect. But it seems entirely plausible and even likely, given that Parkinson's is caused by low dopamine levels, that the placebo effect would work through increased dopamine levels. To say otherwise seems dangerously close to saying, "The patients' health improved; therefore the placebo effect was not responsible for their improvement," which would, of course, be nonsense.

BEN HALLER, REDWOOD CITY, CALIF.

Low regard for low fat

The surprising statistic that teenage calorie consumption has remained stable while obesity has burgeoned ("Teen taters, too," *SN: 4/26/03, p. 270*) and that physical activity among this group has fallen sharply may well suggest a cause and effect, but such a conclusion is premature and untested, at best. I wonder whether closer analysis of food intake would demonstrate an overall shift away from fat and protein and toward increased simple and complex carbohydrates. Recent well-designed studies have shown the superiority of low-carb, high-fat diets for weight loss and cholesterol control in adults. Our market shelves now abound with many more low-fat and "healthy" products, in which sugars and other carbohydrates replace fat, than they did 20 years ago.

LEE F. WEISMAN, CHARLOTTE, VT.

Compared to what?

"Fertile Ground: Snippets of DNA persist in soil for millennia" (*SN: 4/19/03, p. 244*) was a very interesting article. How do they know that the DNA is from the specific animals mentioned, especially the extinct ones?

BEAU T. JARVIS, TUSTIN, CALIF.

The scientists compared the DNA they found with the genetic sequences described in GenBank, a repository of genetic information compiled by the National Institutes of Health in Bethesda, Md. The DNA from the 38 extinct animals and plants in that 130,000-organism database came from the fossils of species as diverse as dodos that lived until the 1600s, mammoths that lived during the last Ice Age, and beetles that were trapped in amber more than 120 million years ago. —S. PERKINS

OF NOTE

BIOLOGY

Eggs and more grown from mouse stem cells

In a series of recent experiments, scientists have transformed cells from mouse embryos into skin, heart muscle, and even eggs. In addition to providing insight into how such tissues develop, these feats have renewed the political and ethical debate over whether similar experiments should be conducted with cells derived from human embryos.

Known as embryonic stem cells, the lab-grown mouse cells are unspecialized and can grow in lab dishes seemingly forever. Scientists at the University of Pennsylvania created apparently normal mouse eggs from such stem cells, according to an upcoming report in *Science*. While observing batches of stem cells, the biologists detected a small number of cells that began to display a genetic marker of egg cells.

The stems cells that appear to have become eggs cells also ended up surrounded by structures similar to the so-called follicles that envelop typical eggs. These appear to be the first mammalian eggs formed completely in a lab dish, but researchers haven't yet shown that these eggs can generate normal mice if fertilized with sperm.

"It is particularly surprising that [the researchers do] not appear to have done anything really unusual . . . to get the cells to make follicles," says John Eppig of Jackson Laboratory in Bar Harbor, Maine.

In another experiment, reported in the April 15 *Circulation*, researchers from Brigham and Women's Hospital in Boston screened 880 compounds for their capability to induce mouse stem cells to take on the attributes of heart muscle cells. They found that only ascorbic acid, better known as vitamin C, did the trick.

And in the May 13 *Current Biology*, a group from the French Institute of Health and Medical Research in Nice, known as INSERM, reports that mouse embryonic stem cells become skin cells called keratinocytes if the stem cells are grown on a matrix of proteins and other molecules in the presence of vitamin C or a substance called bone morphogenic protein-4. The resulting skin cells form layers reminiscent of normal embryonic skin. —J.T.

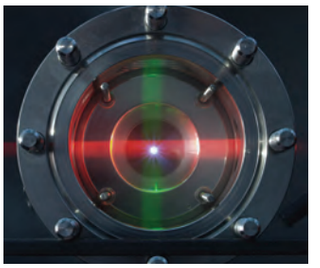
A. ZSCHAU

PHYSICS

Taking a shine to number 100

Scientists have for the first time literally shed light on properties of the radioactive element fermium—a metal discovered some 50 years ago.

Spectroscopy, or the measurement of the wavelengths of light that materials emit or absorb, is a standard way to probe characteristics of materials, including what energy levels their electrons can assume. However, spectroscopy of heavy elements, such as artificially made fermium, element number 100, is difficult because such substances are scarce and decay soon after they're made.



SHOOTING GALLERY Laser beams that knock electrons off fermium atoms in this chamber reveal traits of the heavy element.

Now, Harmut Backe and Norbert Trautmann of the University of Mainz in Germany and their colleagues report using their own particularly sensitive method to measure wavelengths of light absorbed by some of the element's electrons. The team studied less than 2 billionths of a gram of fermium painstakingly produced by Oak Ridge (Tenn.) National Laboratory and then flown to Germany.

The findings, reported in the April 25 *Physical Review Letters*, agree with somewhat controversial calculations, based on relativity, by which scientists predicted the wavelengths that fermium's fast-moving electrons might absorb. Besides probing fermium further, the team plans next to study element number 101, mendelevium, Backe says. —P.W.

INFECTIOUS DISEASES

Gene therapy thwarts hepatitis C in mice

Gene therapy that induces infected liver cells to self-destruct slows hepatitis C dramatically in mice, scientists report.

Christopher D. Richardson of the Ontario Cancer Institute in Toronto and his colleagues implanted human liver cells into mice and infected the animals with the hepatitis C virus. The researchers then gave the mice three injections. Some got a self-destruct gene housed in an adenovirus that shuttles the gene into liver cells. Others received adenovirus without the therapeutic gene.

Five of six animals getting the gene therapy showed decreased amounts of hepatitis C virus in the infected tissue. Two appeared to clear the virus completely, Richardson and his colleagues report in the May *Nature Biotechnology*. Mice that didn't get the gene ended up with severe damage in the transplanted liver tissue.

The therapeutic gene encodes a protein called BH3-interacting domain death agonist precursor (BID). This protein can trigger cell suicide, but only when cleaved by a type of enzyme not normally present in people or mice. The researchers modified the BID gene so that its protein is recognizable to an enzyme made specifically in cells infected with hepatitis C virus. In that way, only these cells cleave the BID protein and unleash a suicide signal.

The therapy works by killing infected cells before they can send out legions of hepatitis C viral particles to infect other cells, says Richardson. The signal doesn't appear to affect nearby healthy liver cells, he says.

The therapy may expose "an Achilles' heel of the virus," Richardson says. The researchers are now looking at ways other than an adenovirus to deliver the modified BID gene. —N.S.

ANTHROPOLOGY

Humanity's pedestal lowered again?

People and chimpanzees share an even closer genetic kinship than is usually assumed, according to a new study. So close is the connection that living chimp species belong to the genus *Homo*, just as people do, contend Morris Goodman of Wayne State University in Detroit and his colleagues. Until now, chimps have been classified in a separate genus, *Pan*.

Genetic analyses also indicate that all living apes—chimps, gorillas, and orangutans—belong to the evolutionary family known as hominids, Goodman's group

OF NOTE

claims in an upcoming *Proceedings of the National Academy of Sciences*. Researchers traditionally have regarded hominids as a group consisting only of people and our prehistoric ancestors who originated at least 5 million years ago.

From a genetic perspective, "humans appear as only slightly remodeled chimpanzee-like apes," the scientists contend.

Goodman and his colleagues focused on so-called functional DNA mutations known to alter protein production in favorable ways and thus likely to have been preserved through natural selection. Sequences of DNA components from 97 human genes were compared with corresponding chimp DNA sequences and with available sequences from gorillas, orangutans, Old World monkeys, and mice.

People and chimps exhibited the closest genetic relationship, sharing 99.4 percent of the sequences at functional mutation sites. The scientists estimate that a common ancestor of chimps and people lived between 5 million and 6 million years ago. Living chimps have diverged genetically from that common ancestor about as far as people have, the researchers add.

Goodman's controversial theory also folds other ancient apelike ancestors into the *Homo* lineage, including the 3-million- to 4-million-year-old genus *Australopithecus*. —B.B.

ENVIRONMENT

Vermiculite turns toxic

Most people know vermiculite as that foam-like mineral that gets mixed into potting soil or poured into attic spaces as lightweight insulating pebbles. Last week, the Environmental Protection Agency and the federal Agency for Toxic Substances and Disease Registry issued a joint warning about vermiculite: If it's a decade or more old, it may be laced with asbestos, a potent lung carcinogen.

The federal agencies report that most U.S. vermiculite mined prior to 1990 came from a site near Libby, Mont., where a natural asbestos deposit ran through the mine, tainting much of the vermiculite.

Based on just-released data from a study conducted 2 years ago in six Vermont homes with vermiculite insulation, EPA reports that "the asbestos content of the vermiculite was as high as 2 percent in bulk samples . . . yet asbestos was not detected in the air or dust."

What led to the federal warning were the results of additional tests, such as a simulation of a homeowner wiring a ceiling fan located underneath vermiculate insulation. Such activities released small amounts of asbestos.

"Any disturbance has the potential to release asbestos fibers into the air," according to the EPA report released on May 21.

EPA advises people who have vermiculite insulation of unknown age in their homes to assume it's contaminated and not touch it. The agency recommends that these homeowners keep their attic visits to a minimum, store nothing near the vermiculite, and hire professionals if they want to remove the insulation. Because vermiculite may sift through cracks in the ceiling, especially around light fixtures and ceiling fans, EPA recommends caulking any holes. —J.R.

ENVIRONMENT

To contain gene-altered crops, nip them in the seed

Canadian researchers have demonstrated that, in principle, they can engineer genetically modified (GM) crops to be incapable of breeding with conventional crops or wild relatives. The new approach could help contain the unintended spread of artificial traits, which is a major source of public concern about GM crops.

Although several alternative strategies for such containment exist, "there is no perfect solution," says Johann P. Schernthaner of Agriculture and Agri-Food Canada in Ottawa.

To engineer a crop that would theoretically require no intervention by farmers to keep it reproductively contained, Schernthaner and his colleagues inserted into some tobacco plants a genetic element called a seed-lethal trait. That element prevents the plants' seeds from germinating under any circumstances.

To enable the GM plants to reproduce amongst themselves, the researchers then inserted another artificial trait that represses the seed-lethal construct. GM plants with both traits develop and reproduce normally, the researchers report in an upcoming *Proceedings of the National Academy of Sciences*.

To create an inherently containable GM crop, the researchers suggest that a different seed-lethal construct be placed on each member of a pair of chromosomes, so the constructs wouldn't be inherited together. Each chromosome would also receive a repressor trait that inactivates the seed-lethal construct on the other chromosome. That way, unintended crossings of the GM crop with related plants should produce nonviable seeds because they'd contain only one of the two engineered chromosomes.

The new approach faces several potential problems, says Henry Daniell of the University of Central Florida in Orlando. For example, it's still possible that with certain chromosomal rearrangements, both the seed-lethal and the repressor traits could spread to a non-GM plant. —B.H.

MATHEMATICS

Uncovering a prime failure

Mathematicians have returned to the drawing board after what looked like a dramatic step forward in understanding prime numbers—those whole numbers divisible only by themselves and 1. Daniel A. Goldston of San Jose (Calif.) State University and Cem Y. Yildirim of Bogaziçi University in Istanbul have acknowledged a flaw in work they announced in March, which appeared to say that tight clusters of primes show up among whole numbers no matter how large the numbers are (*SN: 3/29/03, p. 195*).

For more than a century, mathematicians have speculated that there are infinitely many pairs of "twin" primes, such as 11 and 13, which differ only by two. Goldston and Yildirim had created much excitement among number theorists when it appeared that they had come much closer to proving the twin-prime conjecture than others had managed to do in previous attempts.

Mathematicians Andrew Granville of the University of Montreal and Kannan Soundararajan of the University of Michigan in Ann Arbor discovered the error in Goldston and Yildirim's work after realizing, to their surprise, that they could adapt the new result to prove in just a few additional lines that there are infinitely many pairs of primes differing by 12 or less—a finding almost as strong as the elusive twin-primes conjecture.

This result seemed too good to be true. Scrutinizing Goldston and Yildirim's work line by line, Granville and Soundararajan found that one term in a complicated expression wasn't as well behaved mathematically as Goldston and Yildirim had thought, making the final result fall through.

Goldston is now trying to assess which of the earlier findings still hold. "I think some interesting math is going to come out of this, whatever the outcome," he says. —E.K.

Books

A selection of new and notable books of scientific interest

DR. BEACH'S SURVIVAL GUIDE: What You Need to Know About Sharks, Rip Currents, and More Before Going in the Water

STEPHEN P. LEATHERMAN

As beach season begins, Leatherman provides a short but complete guide to beach safety. He scientifically and sensibly addresses beach hazards explaining which should be of greatest concern and how to minimize risk. Among the questions asked and answered here are: What is the danger of red tide? Which U.S. beach records the most shark attacks each year? How can rip tides be avoided? and Is a stingray dangerous? ***Yale U Pr, 2003, 106 p., b&w photos/illus., paperback, $9.95.***

IN THE BLINK OF AN EYE

ANDREW PARKER

Evolution's Big Bang took place beginning 543 million years ago, in the Cambrian period. At that time, all the major animal phyla of today evolved into their distinctive forms. In recent times, the reason behind this transition has vexed geologists and naturalists alike. Parker, a zoologist at Oxford University, says that he has the answer in something he calls the "light switch theory." He suggests that the development of vision in primitive animals caused a vast evolutionary explosion—some animals having eyes forced all animals to adapt or die. In this compelling book, Parker outlines how he's come to this conclusion and bolsters his case through a comprehensive overview of the fossil record. He cites evidence that creatures of the Cambrian explosion began to show coloration, an obvious connection to vision, and builds a case for this physical feature then leading to development of defense mechanisms and hunting. ***Perseus Publng, 2003, 316 p., b&w photos/illus., hardcover, $24.95.***

AN OBSESSION WITH BUTTERFLIES: Our Long Love Affair with a Singular Insect

SHARMAN APT RUSSELL

As early as the Middle Ages, people believed that butterflies were disguised fairies that stole butter, milk, and cream. This fascination remains, and now there are hoards of professional and amateur lepidopterists who track some 18,000 species of butterflies that flit around the planet. In lyrical prose, Russell charts the natural history of the butterfly and describes how people become fixated with these beautiful, delicate creatures. In doing so, she details the many interesting facets of a butterfly's sex life, parenting techniques, and migratory habits. She also describes how butterflies use their looks to defend themselves against predators. ***Perseus Publng, 2003, 237 p., b&w illus., hardcover, $24.00.***

OUR FINAL HOUR: A Scientist's Warning: How Terror, Error, and Environmental Disaster Threaten Humankind's Future in This Century—on Earth and Beyond

MARTIN REES

It used to be that our greatest threats were natural disasters such as earthquakes, volcanoes, and asteroid impacts. Now, Rees argues, our future may be more imperiled by our own scientific advances. A science communicator and England's Astronomer Royale, Rees considers the ultimate challenge for humanity in this century to be to tame our inventiveness before it proves our undoing. He fears that advances in microbiology and genetics, combined with their rapid dissemination on the Internet, could be a hazardous mix. Biological terrorism is one example, but Rees asserts that malicious intent isn't a prerequisite for danger. Rogue nanomachines could replicate catastrophically or experiments within particle accelerators could get out of hand and erode all the atoms of Earth. Rees considers how science is advancing at an exponential rate and urges us to consider the consequences. ***Basic, 2003, 228 p., hardcover, $25.00.***

VOLCANOES

MAURO ROSI, PAOLO PAPALE, LUCA LUPI, AND MARCO STOPPATO

This fully illustrated guidebook profiles 100 of the world's most active volcanoes. Categorized by the volcano's location, each entry is accompanied by cutaway views of the structure, diagrams showing the type of volcano, and color photographs of the site, along with text explaining the history, prevalent volcanic activity, other natural attractions in the area, and directions for getting there. Several sections are also devoted to volcanology, explaining how volcanic cones, calderas, and necks form, how lava is made, and why volcanoes erupt. ***Firefly, 2003, 335 p., color photos/illus., flexibind, $24.95.***

THE WRIGHT BROTHERS FOR KIDS: How They Invented the Airplane—21 Activities Exploring the Science and History of Flight

MARY KAY CARSON

In addition to learning a detailed history of Orville and Wilbur Wright's invention of the airplane, readers experience some of the challenges the brothers had to overcome in mastering the four forces of flight: lift, thrust, gravity, and drag. For instance, readers learn how to make a Chinese flying top, the type of kite that inspired the Wright brothers as boys, paper gliders, and an anemometer for measuring wind. The book contains profiles of people integral to the advancement of aviation technology, beyond the Wrights. Also included is a glossary of terms. Recommended for age 9 and up. ***Chicago Review Pr, 2003, 146 p., b&w photos/illus., paperback, $14.95.***

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S. NORCROSS

LETTERS

Editor's Letter

As we scramble to put out the issue of *Science News* each week, there's little time for reflection. Fellowships, which generally last a week to a year, can give our writers a broader perspective on the fields that they cover. Two *Science News* writers have recently received prestigious fellowships. In addition to providing valuable opportunities for the individual writer, these awards indicate an appreciation of the quality of the articles published in the magazine. As further recognition, one of our articles has been selected to appear in an annual collection of the best U.S. science writing.

WINNING WORDS Writers Jessica Gorman (left) and Susan Milius (right) have received fellowships.

Jessica Gorman, who has covered chemistry for *Science News* for 3 years, was named as a Knight Science Journalism Fellow. With nine other fellows, she will spend the next academic year at the Massachusetts Institute of Technology attending seminars and classes, interacting with scientists in their laboratories, and conducting independent journalistic research. Jessica plans to focus on work in materials science, chemistry, and nanotechnology, as well as the intersection of these disciplines with biology. She also intends to explore the societal impact of new developments, such nanotechnology (*SN: 3/30/02, p. 200*), and see first-hand how scientists are responding to concerns about their work.

Susan Milius recently completed the National Tropical Botanical Garden's Environmental Journalism Fellowship Program. She was one of nine journalists who traveled to Kauai, Hawaii, to deepen their background in tropical ecology and environmental issues. Activities included field excursions to some of the island's imperiled ecosystems, lectures in tropical specialties such as breadfruit biodiversity and medical ethnobotany, and demonstrations of Pacific cultural uses of plants. Susan says that even years' of hearing and reading botanists' laments about invasive

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