SCIENCE NEWS
THE WEEKLY NEWSMAGAZINE OF SCIENCE

JULY 21, 2007 PAGES 33-48 VOL. 172, NO. 3

electricity without wires
genome scan's hiv clues
flood carved english channel
polar bears shift to shore

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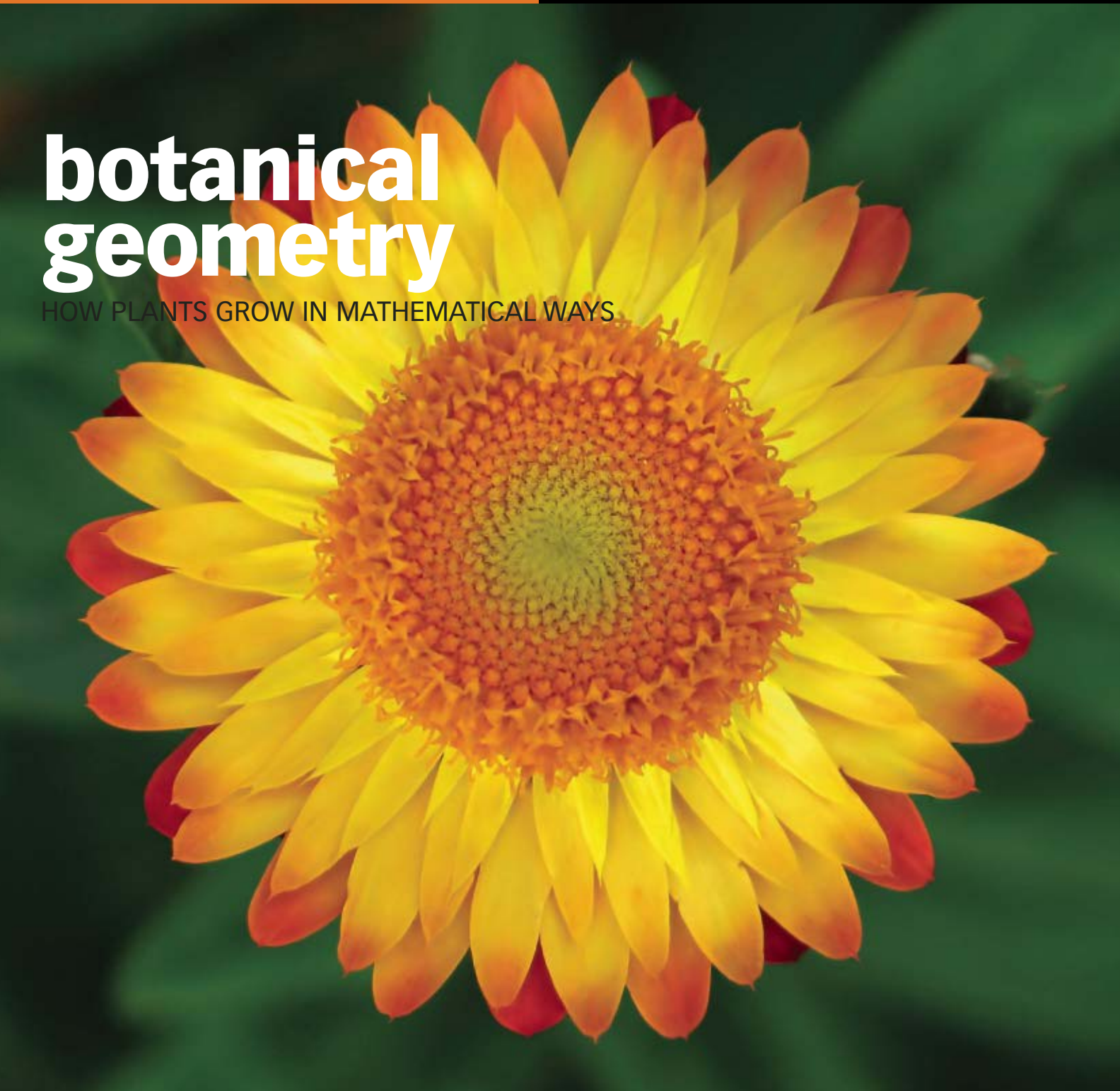

botanical geometry

HOW PLANTS GROW IN MATHEMATICAL WAYS

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Features

This Week

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

MathTrek A civil rights activist promotes mathematical literacy as a key to economic opportunity.

Food for Thought A study in twins indicates that genes underlie a person's perception of sour but not of salty.

Of Note

Departments

Cover This strawflower displays conspicuous spiral patterns that conform to simple but subtle mathematical rules. Researchers are beginning to understand how biological-growth mechanisms generate these intricate geometries. (iStockphoto) Page 42

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

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

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

Printed in U.S.A. on recycled paper.

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

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

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AIDS Abated

Genome scans illuminate immune control of HIV

Some people who contract HIV, the virus that causes AIDS, maintain low amounts of the virus in their bodies for years. These long-term nonprogressors—so called because a decade or more can pass before they develop full-blown AIDS—have attracted great attention from researchers.

Now, using powerful, whole-genome scans, researchers have identified three genetic variations that partially explain why some HIV-infected people develop AIDS quickly while others keep it at bay.

STATS

1 in 300

Proportion of HIV-infected people with undetectable amounts of virus

"This is a good head start to unraveling the genetic basis of good control of viral load," says Anthony Fauci, director of the National Institute of Allergy and Infectious Diseases in Bethesda, Md., which funded the study. Study leader David Goldstein of Duke University in Durham, N.C., says that the ultimate goal is to develop drugs or vaccines that boost the immune system's ability to fight HIV.

Upon HIV infection, the amount of virus spikes, after which the immune system establishes a détente that keeps the virus count in the blood steady. However, this viral set point, as it's called, varies tremendously from person to person. Some people maintain an undetectable amount of virus, while others carry millions of copies in each drop of blood.

To understand this variability, a large, multinational team reviewed the files of 30,000 HIV-positive patients and selected 486 with well-documented viral counts. Blood from each patient was analyzed with a genome chip—a small glass or plastic slide that detects variations at 550,000 specific points in the human genome. Such chips, which only recently became available, can quickly identify genes associated with disease (*SN: 6/9/07, p. 355*).

In this case, the scans pinpointed the three genetic variations that most strongly predicted a low viral count or a slow progression to AIDS, according to a report published online July 19 by *Science*.

One protective variation was in a gene called *HCP5*. Goldstein says that the gene presents an intriguing subject for further study because it is an endogenous human retrovirus. That is, *HCP5* is a genetic fossil of an ancient virus that once infected people and eventually wormed its way into the human genome. "We're working hard to establish if this new gene contributes to [HIV] control," says Goldstein.

The *HCP5* variation frequently occurs in conjunction with a particular version of an immune system gene called *HLA-B*. Earlier work with long-term nonprogressors also pointed to this gene as important in keeping HIV in check. "Right away, this [new finding about *HLA-B*] validates the methodology," says Fauci, who notes that the study is the first to use whole-genome chips in HIV research.

The second highlighted variation points to a closely related gene, *HLA-C*. This gene hadn't before been implicated in HIV control, says Goldstein. "It's possible that a vaccine that [boosts] *HLA-C* may hit a vulnerable point for HIV," he says.

The team found a third genetic variation in a genome region near two genes that are now being studied intensively but aren't involved in the immune system.

Together, the three genetic variations account for about 15 percent of the variability in people's viral set points, the researchers say. With a larger group of patients, Goldstein "strongly suspects" that the team will soon find other genes that contribute to immune control of HIV. —B. VASTAG

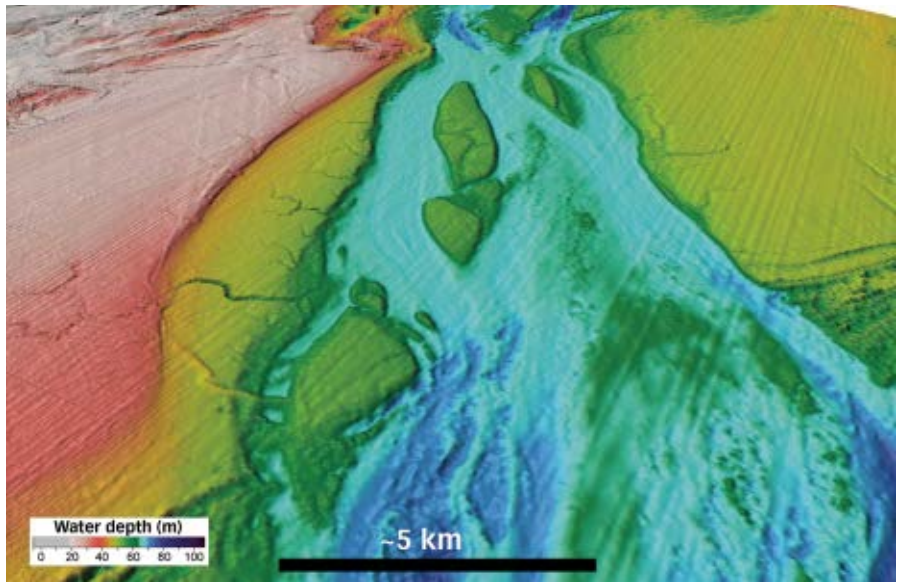
Birth of an Island

Megaflood severed Europe from Britain

Hundreds of thousands of years ago, as an ice age was ending, the spillover from an immense glacial lake in northern Europe sliced through a broad ridge that for millions of years had connected what is now England to the continent. The flood that resulted, one of the largest that scientists have ever identified, quickly created a breach that makes Britain the island that it is today.

The narrowest part of the English Channel is the 33-kilometer-wide Strait of Dover. The cliffs on both sides of this waterway were once part of a broad chalk ridge that connected England to France, says Sanjeev Gupta, a geologist at Imperial College London. The lowest spot on this ridge probably sat about 30 meters above today's sea level, he notes.

About 450,000 years ago, the Northern Hemisphere was locked in an ice age. A kilometers-thick ice sheet smothered Scandinavia, most of Britain, and much of the North Sea, and water carried by Europe's north-flowing rivers collected in a large lake along the ice sheet's southern boundary, says Gupta. As that ice age waned, meltwater from the ice sheet boosted the lake's level.



GUPTA

ROCK ISLANDS **The streamlined, flat-topped features seen in this sonar scan of part of the seabed south of England were probably carved in a matter of months by immense floods that occurred when sea levels were lower. Colors indicate water depths.**

Eventually, the lake began to spill over the chalk ridge, cutting rapidly into the soft material and, in a matter of weeks, turning into a chasm-carving torrent. Evidence for the resulting flood lies on the bottom of the English Channel, Gupta and his colleagues report in the July 19 *Nature*.

A sonar survey just south of England revealed a 100-km-long, submerged feature that scientists have dubbed the Northern Paleovalley. This valley, which contains little if any sediment, is as much as 50 m deep in spots, says Gupta. Large, flat-topped islands in the valley have streamlined shapes, suggesting that they were carved by massive amounts of water flowing over what had been dry land. Broad grooves carved into the bedrock, some of them at least 100 m wide and 15 km long, curve to follow the valley's terrain—a hint that the features were quickly created by a colossal deluge.

The size of the paleovalley's islands suggests that the floodwaters could have run as much as 20 m deep, says Gupta. Considering the width of the now-submerged valley, the scouring flow that created it could have carried about 1 million cubic meters every second and raged for months, he adds.

The purported flood probably rivaled the floods that scoured portions of the northwestern United States at the end of the most recent ice age, says Philip Gibbard, a geologist at the University of Cambridge in England. Those inundations, which occurred when a glacial lake burst through the edge of the ice sheet that constrained it, sculpted a chaotically eroded terrain in eastern Washington that geologists aptly call the Channeled Scablands.

Several of the features seen on the floor of the English Channel "certainly resemble those seen in the Channeled Scablands," says Timothy J. Walsh, a geologist with the Washington State Department of Natural Resources in Olympia. The new findings "are interesting and are bound to generate a lot of discussion," he notes. —S. PERKINS

Persistent Prions

Soilbound agents are more potent

Deformed proteins called prions cause fatal brain-destroying disorders, such as chronic wasting disease in deer and elk and mad cow disease, which can infect people. Evidence suggests that prions make their way into animals' nervous systems through ingestion, but scientists aren't sure.

A new study shows that prions become more infectious when they latch on to soil particles that animals eat, suggesting that ingestion is a primary route of disease transmission. "Our study points us in one direction that explains how these animals are getting infected," says study author Judd Aiken of the University of Wisconsin–Madison.

Prions enter the environment from the remains of infected animals, and, to some degree, from body fluids such as urine and saliva. Prions linger in soil for at least 3 years (*SN: 2/11/06, p. 93*) by binding tightly to clay and other minerals. Aiken had hypothesized that soil would hinder the action of the clingy prions, making them less infectious. He was surprised to find the opposite.

EAT DIRT AND DIE? Deer are susceptible to chronic wasting disease caused by malformed proteins called prions, which become more infectious when they bind to minerals in soil.

"The binding of infectious agents in soil actually greatly enhances the infection," Aiken says. "It makes the disease more transmissible."

Wild and farm animals often swallow up to several hundred grams of soil per day when eating plants, drinking muddied water, and licking the ground to get minerals. In doing so, they may consume prions. The relationship between ingestion and infectivity is unclear, though, because previous experiments showed that prions are inefficient at infecting animals that eat diseased tissue.

Aiken and his team fed each of three groups of hamsters a different soil type containing prions. Other hamsters were given an equivalent dose of a prion mixture derived from the brains of infected animals. All soil-eating hamsters were at least as likely to contract the prion disease as those that had ingested the prion-brain mixture, which has been considered an efficient transmitter of prions.

Two of the three soils had an even more dramatic effect. Hamsters that ate either of those soils had a higher rate of prion disease than did animals that ate the prion-brain mix. Animals that ate the third soil, which contained more organic matter than the other two did, had the same infection rate as hamsters that ate the prion-brain mix.

Researchers hypothesize that soil might protect prions from the destructive environment of the digestive system. Alternatively, Aiken says, soil particles might break up clumps of prions into smaller, more numerous clusters. Or, the particles could change the way in which prions enter nervous system tissues.

The study, in the July *PLoS Pathogens*, yielded "very fascinating findings," says Michael Miller, a wildlife veterinarian at the Colorado Division of Wildlife in Fort Collins. "It ties together observations that people have made throughout the years." He suggests that the different infectivity rates of prions in the three soils may also explain why the disease afflicts animals in some areas more than in others. —C. BARRY

Check on Checkers

In perfect game, there's no winner

Computers can now play a flawless game of checkers. A calculation that began almost 2 decades ago shows that if both players make perfect moves, the game will be a draw every time. The achievement makes checkers the most complicated game to have been solved completely.

Computers have been able to beat people at checkers since 1994, when a program called Chinook won the checkers world championship. The program, written by computer scientist Jonathan Schaeffer of the University of Alberta in Edmonton, used rules of thumb to guess the best available move, a method that imitates how people play. Now, Schaeffer has removed the guesswork with a program that examined every possible position that can occur on a checkerboard to find the best move every time.

The brute-force calculation underlying the new program was conceptually simple but logistically demanding, because checkers has approximately 500 billion billion

ISTOCKPHOTO

(5×10^{20}) possible positions. Each player starts with 12 pieces on an 8-by-8 checkerboard, and he or she moves a piece by sliding it forward and diagonally one square. A piece captures an enemy by jumping diagonally across it into an open square. The last player with pieces on the board wins.

Beginning in 1989, Schaeffer used as many as 200 computers simultaneously to grind out the problem. He started with the endgame, putting just two pieces on the board and calculating every possible outcome for each position they might assume. Then he did the same for three pieces, then four, and so on up to 10. At that point, 39 trillion positions were possible.

Each step in this process took 10 times as much work as the previous step, so continuing in this way was impractical. Instead, Schaeffer turned to the beginning of a game, calculating all the positions that could result from one move, then two moves, then three moves, and so on. The program continued the game until there were only 10 pieces left, at which point it checked its database of endgames to find the outcome. Ultimately, the analysis included somewhere between 100 trillion and a quadrillion checkers positions. Schaeffer and his colleagues report their results in an upcoming *Science*.

"We're pushing the frontiers of what computers can solve," Schaeffer says. "If we had waited 10 or 20 years, the machines would be faster," making the problem easy. As it was, he and his team had to invent clever ways of storing and searching the data.

For example, they stored the outcomes for the 39 trillion possible positions for endgames in a mere 237 gigabytes of computer-storage space, an average of 154 positions per byte. The mathematicians are now applying these techniques to bioinformatics, looking for ways to manage the massive quantity of data generated by the sequencing of genomes.

"It's just a prodigious amount of work," says Ken Thompson of Mountain View, Calif.–based Google, who in 1983 developed the first master-level chess computer program. Thompson says that solving checkers brings computers a step closer to being able to solve more-complicated games, such as chess or go. However, he estimates that those tasks will take another 100 years to complete. Chess has about 10^{20} times as many positions as checkers does, Schaeffer says. —J. REHMEYER

AMSTRUP

COLD CASE A female polar bear often has two cubs at a time in a den dug into the shore or floating ice. The cubs then stay with her for more than 2 years.

Den Mothers

Bears shift dens as ice deteriorates

Pregnant polar bears in northern Alaska are now more likely to dig their birthing dens on land or landbound ice than on the offshore ice they once used, according to 20 years of records.

This landward trend probably reflects the decline of the sea-ice habitat these bears have traditionally relied on, says Steven Amstrup of the U.S. Geological Survey in Anchorage, Alaska. He and his colleagues found the trend toward coastal denning in a long-term data set that records polar bear movements.

These bears don't hunker down in dens to survive winter. They specialize in prowling ice to ambush seals. Only pregnant females dig dens, where they spend winters giving birth and nursing cubs.

Alaskan polar bears spend summers hunting on ice north of Alaska. As that ice shrinks, bears that find it unsuitable for denning face a long journey back to coastal denning sites. So the trend to landward denning may be only a stopgap adaptation to climate change, Amstrup says. "The biggest concern is that if the ice continues to retreat, there may come a time when bears can't return to land."

Amstrup startled biologists during the early 1990s when he reported, from radio-tracking data, that more than half of northern Alaskan polar bears' maternity dens were on offshore, drifting pack ice. Polar bears in the rest of the Arctic den on land or on ice frozen fast to the shore.

The new study started as an attempt to see whether information beamed by radio collars to satellites could reliably indicate denning sites, says coauthor Anthony Fischbach, also of the USGS in Anchorage. It does, the researchers report online and in an upcoming issue of *Polar Biology*.

What surprised the researchers, however, was the distribution of their sample of 124 dens. From 1985 through 1994, 62 percent of dens detectable by satellite were on floating ice. From 1998 to 2004, only 37 percent of dens were at sea.

Other research has documented that the amount of sea ice that stays frozen from year to year shrank 27 percent during the past 30 years, notes Amstrup. "If you're a mother bear, you probably want to be on ice that's pretty doggone stable," he says.

The researchers reject the idea that female bears are lured to land to feed on scraps from the increasing number of bowhead whales killed by hunters. Tracking records show that pregnant bears rarely feed on the scraps.

The researchers also discount the impact of reduced bear hunting. Laws minimized hunting as of the early 1970s but didn't change during the study period, says Fischbach. However, polar bear researcher Ian Stirling of the Canadian Wildlife Service, based in Edmonton, Alberta, says that it could have taken decades for changes in the law to show an effect.

Still, he agrees that deteriorating ice contributes to the denning shift. "As the climate is warming and we're losing ice, you don't have to be a rocket scientist to know that that's going to have a significant negative effect on an animal that depends on ice for life," he says. —S. MILIUS

Brain Seasoning

A common spice could deter Alzheimer's

Past research has suggested that a common spice in Asian and Middle Eastern cuisine may improve mental perform-

ance in elderly people. Now, scientists have discovered a mechanism by which this spice, called turmeric, could help the body clear plaque deposits associated with Alzheimer's disease.

Those deposits consist of a protein called amyloid-beta. Healthy people's bodies make the protein, but immune system cells called macrophages regularly identify, engulf, and remove it. In the new study, a team led by Milan Fiala of the Greater Los Angeles Veteran's Affairs Medical Center found that macrophages in blood samples from people with Alzheimer's couldn't destroy amyloid-beta.

Fiala's team then compared the gene activity of these impaired macrophages with that of macrophages from healthy people. The researchers identified several genes that were less active in the impaired cells.

When they exposed these dysfunctional macrophages to a chemical in turmeric, the subdued genes switched on, restoring the ability of some of the cells to destroy amyloid-beta.

"These genes are critical for the function of macrophages, so if these genes aren't being expressed, then macrophages wouldn't function properly," says Fiala.

Many of the genes identified as vulnerable belong to a family that makes cell parts called toll-like receptors, which enable immune cells to recognize foreign microbes and other disease-causing agents.

The gene apparently most impaired by Alzheimer's was *MGAT3*, which was more than 300 times as active in the healthy macrophages as in those from Alzheimer's patients.

In separate experiments, the researchers blocked the function of *MGAT3* in lab-cultured monocytes, immune cells that are similar to macrophages. The procedure prevented the cells from engulfing amyloid-beta, a critical step in clearing the plaque-forming protein.

MEDICINAL SPICE? A chemical in turmeric, a common ingredient of curry powder, could help the immune system fight Alzheimer's disease.

Exposure to the turmeric chemical increased activity of *MGAT3* and the receptor genes in blood samples from all 73 Alzheimer's patients. However, only about half the samples showed a full recovery of gene activity, the team reports online and in an upcoming *Proceedings of the National Academy of Sciences*. Differences in the causes of the disease among patients could account for the variation in response, Fiala says.

"I think [the study] is very fascinating," says Bharat Aggarwal of the M.D. Anderson Cancer Center in Houston, who has also done research on chemicals in turmeric. "There is definitely something interesting going on here."

Whether the chemical in turmeric will affect macrophages in Alzheimer's patients remains to be seen. The researchers didn't test whether the compound might influence the patients' immune systems or clear any amyloid-beta plaques from their brains. Fiala notes that the experiments involved higher doses of the compound than a person would get by eating foods prepared with turmeric.

Further studies would be needed to investigate why the macrophages of people with Alzheimer's become impaired in the first place. —P. BARRY

Chemical Conversation

Red blood cells send a signal that makes platelets less sticky

Primarily known for their work hauling oxygen to tissues throughout the body, red blood cells may also play a part in regulating activities of another blood component. The cells can release a chemical that signals blood-clotting platelets to become less sticky and therefore less likely to clog a narrow vessel, chemists report.

Red blood cells change shape as they maneuver through the curves and narrows of the body's circulatory system. As they flex, the cells release small amounts of adenosine triphosphate (ATP), an energy-storing molecule, into the bloodstream. Earlier research had established that ATP can stimulate cells lining the walls of blood vessels to produce nitric oxide (NO), which causes the walls to relax, allowing blood to flow more easily.

Researchers also knew that platelets respond to ATP in the bloodstream by producing NO, which reduces their tendency to clump. Using a technique that mimics the natural flow of blood cells, Dana Spence and his colleagues at Wayne State University in Detroit have now shown that platelets respond specifically to ATP released by red blood cells in a way that promotes blood flow.

"It's possible that red cells and platelets are communicating and working together," comments Randy Sprague of Saint Louis University in Missouri.

Spence and his collaborators pumped red blood cells and platelets through tubing 50 micrometers in diameter. They used a standard method to track ATP release within the tube, adding chemicals that react with ATP to produce a fluorescent signal. To track NO, they used a different fluorescent molecule that they trapped within the platelets. "We made all these measurements in the blood," Spence says. "We had platelets in there, red blood cells in there; they were flowing."

To establish the connection between ATP from red blood cells and NO production in platelets, the researchers conducted a variety of tests in which they modified either ATP production by red blood cells or the platelets' response to ATP. Two drugs, iloprost and pentoxyfilline, increased ATP production by red blood cells and NO production by platelets, the researchers report in the July 15 *Analytical Chemistry*. Researchers had known that these drugs increase blood flow, but the new study establishes a mechanism for how they do so, Spence says.

The results may help researchers understand circulatory problems in diabetes patients. Studies have shown that red blood cells in people with diabetes have limited flexibility and a reduced capacity to release ATP.

Spence and other researchers have gathered "strong evidence that there's something wrong with this pathway in diabetic patients," says pathologist Rakesh Patel of the University of Alabama at Birmingham. If red blood cells play a role in controlling both platelets and blood vessels, they represent a new target for drugs that could fight diabetes symptoms, he adds.

"Even 2 or 3 years ago, no one in diabetes or in red cell biology would have thought there was a connection," Patel says. "These studies open up a new avenue of thinking." —S. WEBB

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is a huge cultural artifact. ... But most people don't have any knowledge of the New Testament, and that's the *raison d'être* of this course."

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

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THE POWER OF INDUCTION

Cutting the last cord could resonate with our increasingly gadget-dependent lives

BY DAVIDE CASTELVECCHI

Marin Soljačić was understandably nervous. The young physicist was about to give his first public presentation of an idea that sounded almost too good to be true. There was no telling how his audience, at a Berkeley, Calif., symposium, would receive his daring proposal. Design two antennas to be as inefficient as possible at transmitting radio waves, Soljačić began.

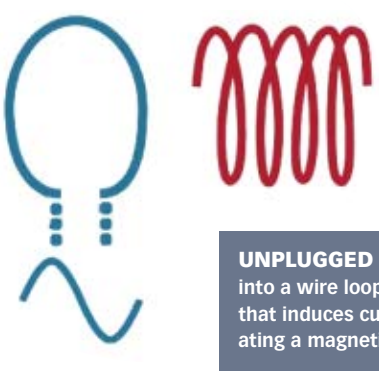
Separate the antennas by a few meters and, with some fine-tuning, you can safely and efficiently transfer electricity from one to the other—without wires. Put this system inside your home, and you would have a wireless network for electrical power. You could recharge your laptop or turn on a light without plugging anything in.

The crucial bit would be the fine-tuning: The two antennas would have to be tweaked so that one would create a pulsating magnetic field with a specific frequency and geometry, which the other would then transform into an electric current.

When Soljačić first presented the principle, it was unproved. All he could show were his calculations. "I expected that some people would think I was a crackpot," says Soljačić, a physicist at the Massachusetts Institute of Technology (MIT). "This was pretty far out."

Perhaps it also didn't help that the participants at the symposium—a celebration of the 90th birthday of Charles Townes, who pioneered the laser in the 1950s—included 18 Nobel prize winners and dozens of other luminaries. Much to Soljačić's relief, he sold the scientists on his presentation.

A year and a half later, a bulb lit up in an MIT lab—unplugged. Soljačić and his collaborators had demonstrated a new way of coaxing magnetic fields into transferring power over a distance of several meters without dispersing as electromagnetic waves. The demonstration ushered in a technology that might eventually become as pervasive as the gadgets it could power. Laptops, cell phones, iPods, and digital cameras might someday recharge without power cords. With the proliferation of wireless electronics, perhaps it was just a matter of time before power transmission would go wireless, too.



UNPLUGGED — Alternating current fed into a wire loop (blue) generates a field that induces currents in the coil (red), creating a magnetic field that …

The device that Soljačić and his collaborators put together had a disarming simplicity. On one side of the room, hanging from the ceiling, was a ring-shaped electrical circuit, about half a meter across, plugged into the wall. Hanging adjacent to the circuit, but with no physical connection to it, was a slightly larger copper coil looking like an oversize mattress spring. A few meters away hung a similar system with an ordinary lightbulb attached to the circuit. When the physicists sent power through the first circuit, the bulb lit up.

As expected, some energy was lost on its way to the lightbulb. However, a surprising amount reached its destination, the team reports in the July 6 *Science*. "The efficiency was 40 percent at the biggest distance we probed [more than 2 meters]," Soljačić says. At shorter distances, the efficiency was much higher.

The coils of this demonstration device would be too big to fit inside a laptop, let alone a cell phone. But this was only the first and simplest of several prototypes that the physicists have in mind. More tests are to come. The MIT team and other physicists say that in principle they see no obstacle to making such devices more compact and more efficient.

MAKING NO WAVES The idea of transmitting energy wirelessly isn't new. For almost two centuries, scientists have known that rapidly changing magnetic fields, such as those produced by an alternating current flowing through a wire, can induce an electric current in another wire. That's how the coils inside power transformers transmit energy from one coil to another without touching. But this form of induction usually works efficiently only when the two coils are very close to each other.

In the early 1900s, long before the power grid made electricity widely available, electricity pioneer Nikola Tesla devised a grand scheme to transfer large amounts of power over long distances from a tower 20 stories tall, to be built on Long Island in New York. To this day, historians puzzle over how Tesla's system was supposed to work, or whether it could have worked at all, says Bernard Carlson, a historian of science at the University of Virginia in Charlottesville who is writing a biography of the great engineer. "We can't even begin to understand what he was doing with this power stuff," Carlson says.

The project died when Tesla's financial backers pulled the plug, possibly because Tesla seemed unclear as to how to bill customers receiving wireless power. Ironically, Tesla also invented the alternating current (AC) system of power production, transmission, and distribution that would become the standard for the modern grid.

But electromagnetic radiation can indeed carry energy through air or empty space and over large distances. One familiar example is the energy we receive from the sun, mostly as visible light. Another is radio waves, first detected by Heinrich Hertz in 1888. An electromagnetic wave is a synchronized dance of an electric field and a magnetic field. Because an oscillating magnetic field generates an oscillating electric field, and vice versa, the two fields sustain each other as the wave propagates.

Radio waves and light waves, however, tend to shoot out in all directions. This makes for very inefficient power transmission, because the farther the waves travel, the larger the volume of space throughout which their energy spreads. Technologies such as lasers and parabolic antennas can confine the energy of electromagnetic

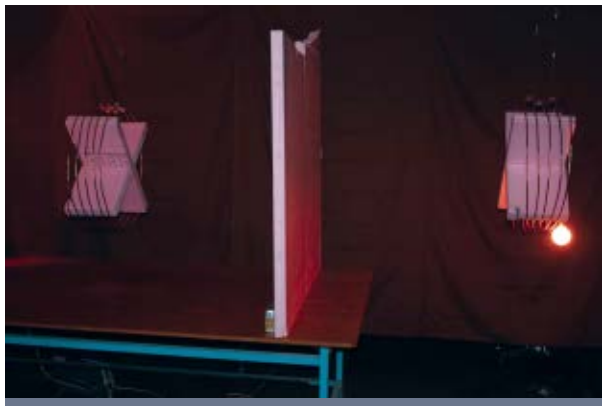
waves in tight beams, that can transfer power. But beams have disadvantages. One problem is that anything that happens to cross a beam's path may get fried.

Soljačić's wireless power system harnesses oscillating electric and magnetic fields in a novel way. Although it doesn't radiate energy as a radio antenna does, it transmits power across greater distances than a conventional transformer can.

A typical antenna—the simplest type being essentially a rod—has a size comparable to the wavelength of the radiation it emits. The electric and magnetic fields it creates are in phase. They rise and fall in sync with each other, a property that's crucial to the self-sustaining feedback that allows a wave to propagate.

The circuit in Soljačić's device carries an alternating current with a frequency of about 10 megahertz (MHz). It generates a magnetic field that induces a current in the adjacent coil, which then amplifies the magnetic field.

Electromagnetic waves of 10 MHz have a wavelength of about 30 m. Because the coils are much smaller than that, they don't generate conventional waves, explains Aristeidis Karalis, an MIT graduate student who helped with Soljačić's theoretical model and computer simulations. Instead, "the electric field is at its maximum when the magnetic field is zero, and vice versa," which is the opposite of being in phase, Karalis says. This arrangement means that the fields' energy stays mostly in the vicinity of the coil, and only a small percentage of the total power disperses as waves.



ABRACADABRA — The first demonstration of energy transfer based on magnetic resonance. The receiving circuit (right) picks up 40 percent of the power consumed by the emitting circuit (left) and lights the bulb.

The MIT team introduced two additional ingredients into its design, the first to make it safe and the second to make it efficient.

For safety, they took the advice of John Pendry, an Imperial College London physicist who visited the MIT lab in 2005. Pendry recommended designing the system to minimize exposure to electric fields, since rapidly changing electric fields can heat up the surroundings, including any people close by. "With the electric field you'd get hot, like in a microwave oven," Pendry says, whereas the body "hardly responds to magnetic fields."

In the team's designs, the magnetic fields change slowly enough to not create strong electric fields. The magnetic fields themselves are comparable in strength to Earth's magnetism, Karalis says, and only one-thousandth as strong as the field inside a magnetic resonance (MRI) machine. On the other hand, both MRIs and Earth have constant, not rapidly oscillating, fields. But the MIT scientists say that their fields stay within safety guidelines issued by the Institute of Electrical and Electronic Engineers.

RESONATING POWER The second ingredient is Soljačić's use of resonance—the innovation that makes efficient energy transfer possible. Just as guitar strings and wine glasses vibrate at specific frequencies, electric circuits have their own natural AC oscillation modes. The diameter of the MIT coils and the spacing between their turns are suitably adjusted, so the coils act as electrical circuits with a natural AC frequency of 10 MHz, putting them in sync with the magnetic oscillations and with each other. One coil can then transfer energy to the other by the same principle that enables a violin played at just the right pitch to break a wine glass.

When Pendry revisited the MIT lab this March, he got a first-hand view of the bulb lighting up. "What they've done is take some very basic physics concepts [and] brought these ingredients together. It's the synthesis which is the novel thing," says Pendry.

Shanhui Fan, a physicist at Stanford University, says that the use of magnetic resonance as a means of transferring energy is a completely new concept, and "very clever." Although it's a simple principle, nobody seems to have thought of it before, he says. "Many great things look simple from hindsight."

Soljačić and his colleagues have applied for two patents, and they have branded their idea with the name WiTricity to suggest an electrical-power version of Wi-Fi wireless-Internet technology.

But if the physics is simple, why didn't anyone think of it sooner? Soljačić suggests that before the spread of cell phones and laptops, there was little need for a wirefree power source. In fact, Soljačić admits that what got him thinking hard about wireless power was the frustration of being awakened at night by a beeping cell phone that needed to be recharged.

In a smaller way, wireless power has already crept into our lives and our wallets. The access cards of many office buildings and public-transportation systems now carry embedded radio frequency identification (RFID) tags. RFID tags have no batteries. They are semiconductor chips that draw a tiny amount of energy—typically microwatts—from radio waves generated by the device that reads them, and in response beam back an identification code.

In a similar vein, Powercast, a start-up company in Ligonier, Pa., recently began marketing a new kind of chip that can harvest several milliwatts from radio waves. The company's chips have a patented design that converts up to 70 percent of the radiofrequency energy picked up by a small antenna into direct current (DC) power, says Powercast's Keith Kressin.

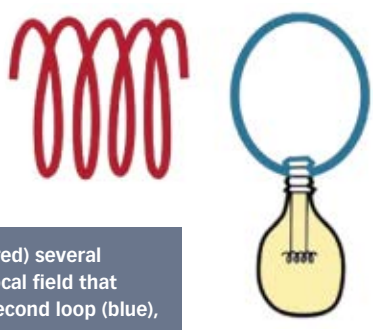
Powercast's small, dedicated radio sources can be hidden in fixtures such as desk lamps. One chip can provide enough power to keep a cell phone charged while it sits in standby mode a few inches from the emitter, Kressin says. Eventually, the technology could be used in environmental sensors and in medical implants.

In comparison, the MIT team's system could potentially furnish a room with hundreds of watts of wireless power, which could drive a wide range of devices. The system's ultimate limitation derives from the physics of the magnetic fields. A few meters from the source, the fields' strength quickly drops. "Eventually, you have to face the fact that the fields decay very fast," Soljačić says.

Efficiency is limited primarily by the power dissipated as heat in the copper coils. The physicists plan to experiment with different materials and designs to reduce electrical resistance.

If Soljačić's "far-out" idea bears fruit and engineers manage to squeeze WiTricity into electronics products, then in a few years homes, workplaces, and coffee shops could be pulsating with magnetic energy, greatly reducing the tangles of cords that clutter floors and eliminating the need to plug gadgets in. A simple, relatively low-tech idea could make everyone's life a little more hasslefree.

As Pendry puts it, "The power cord is the last cord that needs to be cut. Everything else has been severed." ■



... reaches a second coil (red) several meters away, creating a local field that induces a current in the second loop (blue), lighting a bulb.

SCIENCE

MATHEMATICAL LIVES OF PLANTS

Why plants grow in geometrically curious patterns

BY JULIE J. REHMEYER

The seeds of a sunflower, the spines of a cactus, and the bracts of a pinecone all form whirling spiral patterns. Remarkable for their regularity and beauty, these natural structures also show some surprising mathematical properties.

In more than 90 percent of the spiral formations made by plants, the angle between successive elements of the spiral—the leaves on a stem, for example—is approximately the golden angle. That geometrical quantity, which is about 137.5°, is closely related to the famous "golden ratio" and was first studied by the ancient Greeks. Furthermore, hidden within the spirals of many plants is a pattern involving the celebrated Fibonacci sequence of numbers, which is closely related to the golden ratio. Spiral patterns involving the golden angle and the Fibonacci sequence pop up throughout the natural world, in objects as disparate as galaxies and seashells.

Scientists discovered these mathematical regularities in the spiral patterns of plant growth hundreds of years ago and have been puzzling over them ever since. Why would plants prefer the golden angle to any other? And how can plants know about Fibonacci numbers?

Recently, biologists, mathematicians, physicists, and computer scientists have made a start on explaining how and why plants accomplish their mathematical feats. Biologists now understand the basic biochemistry that drives patterns of plant growth, called phyllotaxis, and that knowledge has fed into mathematical and computer-based models of the process.

Some scientists are beginning to tackle an even more difficult problem: Why do some plants show peculiar phyllotactic patterns? In some spiral-growth patterns, the angle between successive elements is not the golden angle, but an angle of about 99.5°. There are even plants in which that angle varies systematically within a single spiral formation. And spiral structures in some plants transition from one pattern to another as the plants grow.

NATURAL GEOMETRY — The bracts on this pinecone form 13 spirals running clockwise (top) and 8 running counterclockwise (bottom). One spiral in each image is marked in blue to assist in counting.

"Nature is playing a geometric game with phyllotaxis," says Pau Atela, a mathematician at Smith College in Northampton, Mass. "We are now starting to figure out the geometric essence of what is going on."

DO PLANTS DO MATH? Two magnitudes, A and B, form the golden ratio if A/B = (A+B)/A. The golden angle is essentially the golden ratio applied to a circle: Two radii of a circle form the golden angle if they divide the circle into two areas, A and B, whose ratio is the golden ratio.

As a plant puts out leaves or seeds around some central structure, each seed or leaf spaced from the last by about the golden angle, interlocking spiral arms form in clockwise and counterclockwise directions. The number of clockwise arms never equals the number of counterclockwise arms; in fact, they are almost always two consecutive members of the Fibonacci sequence. That's the sequence 1, 1, 2, 3, 5, 8, 13, 21, and so on, in which each number is the sum of the previous two.

The appearance of Fibonacci numbers isn't entirely surprising, because they have an intimate connection to the golden-ratio. As one proceeds along the Fibonacci sequence, the ratio of successive numbers gets ever closer to the golden ratio.

In 1837, crystallographer Auguste Bravais and his brother Louis, a botanist, used this relationship to prove that in golden-angle spirals, the numbers of clockwise and counterclockwise spiral arms must be consecutive Fibonacci numbers. But that doesn't explain why plants prefer the golden-angle and Fibonacci numbers in the first place.

Researchers once thought that these patterns might provide an evolutionary advantage by somehow promoting plants' survival. Mathematical models show, for example, that a golden-angle spiral packs a maximum number of leaves onto a minimum of stem space while also allowing each leaf sufficient access to light.

But because plants grow and bend in response to the irregular ways in which sunlight reaches them, the ideal packing of a golden-angle spiral is unlikely to significantly improve the efficiency of light absorption. Scientists have now come to believe that spiral phyllotaxis is a side effect of the biochemistry of growing plants.

GOLÉ

GROWTH SPIRAL In 1868, German botanist Wilhelm Hofmeister suggested that the mechanisms of plant development might help explain spiral phyllotaxis. He was studying the growing tips of plants, which contain cells that haven't yet acquired a specific function. These immature cells form tiny bumps called primordia, which eventually develop into flowers, leaves, or other plant structures.

Hofmeister proposed that each new primordium develops on the tip of the growing stem in the spot that is farthest from older primordia. As the tip continues to grow from its center, the primordia are pushed outward and form spiral patterns. In recent decades, electron microscope images have added support to the idea that primordia arrange themselves according to Hofmeister's rule.

In 1992, physicists Stéphane Douady and Yves Couder of l'École Normale Supérieure in Paris performed a compelling experiment that showed how Hofmeister's rule could explain spiral patterns. They let droplets of a magnetized liquid fall into a dish that was filled with silicone oil and magnetized along its outer edge. Magnetic forces attracted the droplets to the edge of the dish but made them repel one another.

When Douady and Couder added droplets slowly, each new droplet would move toward the side of the dish, directly opposite from the previously added drop. But when they added droplets faster, the two most recently added droplets would both strongly repel the new one. Instead of marching to one side or the other, the new droplet would move in a third direction—at the golden angle from the line connecting the drop's landing point with the previous droplet. A stream of droplets added in this way formed a spiral pattern.

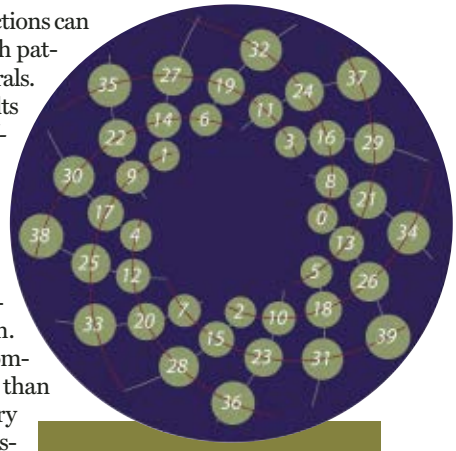
Douady and Couder's results galvanized the study of phyllotaxis. The droplets in their experiment behaved like primordia, in that their attraction to the edge of the dish corresponded to the primordia's outward march on the growing tip. But what biological mechanism could push the new primordia away from the older ones, in the same way that magnetization made the droplets repel one another?

In 2003, biologists Didier Reinhardt and Cris Kuhlemeier of the University of Bern in Switzerland and their collaborators published a paper in *Nature* fingering a plant-growth hormone called auxin as the critical factor.

A growing stem continually produces auxin, and a new primordium forms only when the concentration of auxin reaches a critical value. Once a primordium begins to form, more auxin flows into the primordium's cells "like a river carving a canal in the sand," says computer scientist Przemyslaw Prusinkiewicz of the University of Calgary in Alberta. This inflow not only stimulates the growth of the existing primordium but also depletes the surrounding stem of hormone and suppresses the formation of new primordia nearby.

Auxin is depleted least in the spot on the growing stem that is farthest from the older primordia. As auxin production across the stem tip continues, that farthest spot will be the first to reach the critical threshold to form a new primordium. In this way, Reinhardt and Kuhlemeier showed that the biochemistry of plant growth can explain Hofmeister's rule that new primordia form farthest from older primordia.

The discovery of auxin's role has led to an explosion of research unraveling the details of this growth process. Prusinkiewicz has worked with Kuhlemeier and his team to create a computer model that demonstrates how the hormone's actions can create most common growth patterns in plants, including spirals. The group published its results in the Jan. 31, 2006 *Proceedings of the National Academy of Sciences*.



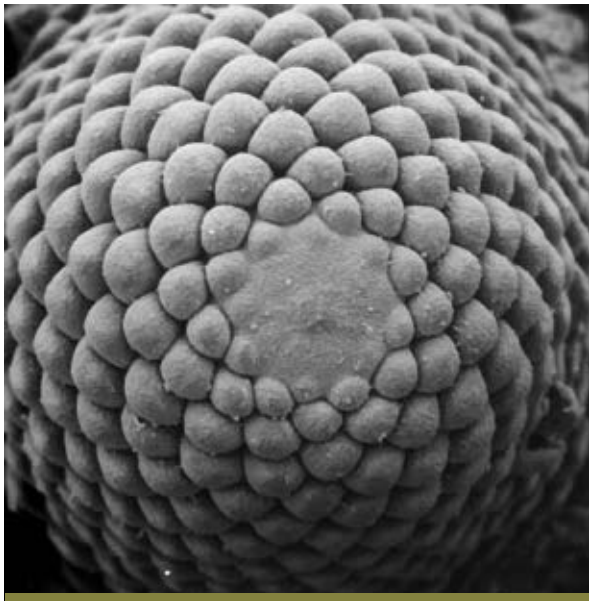
GOLDEN SPIRALS — In this schematic, each new numbered element is placed at the golden angle relative to the previous one, as measured from the center of the diagram. Spirals running in both directions build up from nonconsecutive elements in the series.

MATHEMATICAL MELD Meanwhile, mathematicians have been developing models of their own. Their scenarios are far less complex and biologically precise than Prusinkiewicz', but that very simplicity has brought surprising insights into puzzling patterns of plant growth.

"I feel the biological models are so complicated that some of the beauty of phyllotaxis is lost in the process. It becomes purely computational," says Jacques Dumais, a Harvard University botanist who works closely with mathematicians. "The mathematical models are so simple and yet so powerful, and they explain so much of what we see. What we're looking for is, 'What is the essence of phyllotaxis?'"

Harvard mathematician Scott Hotton produced a model based on Douady and Couder's oil-drop experiment. The model shows how the forces in that experiment—designed to mimic the motion of primordia—indeed produce golden-angle spirals.

Hotton's work also gave theoretical foundation to a surprising result of Douady and Couder's experiment, which was that patterns other than golden-angle spirals can form. That finding corresponds with the observation that plants sometimes produce their primordia at angles of approximately 99.5°. In that case, the numbers of spirals in each direction would be members not of the Fibonacci sequence but of the closely related Lucas sequence. In both series, each number is the sum of the previous two, but the Lucas sequence begins with 1, 3, 4, 7.



SPRUCE NEEDLES — The buds in this electron microscope image of the tip of a Norway spruce branch are primordia that will eventually develop into needles.

Hotton has found some even more peculiar possibilities. Instead of producing primordia at the same angle each time, his model shows that some plants could produce primordia at a series of angles in a cycle. He found one pattern that goes 131°, 88°, 88°, 131°, 89°, 87°, 131°, 315° and then repeats.

"What's interesting about this is that the pattern that actually forms would be hardly distinguishable from the one where the angle was the same," Hotton says. "You could actually see opposing pairs of spirals. You could count them and see that there were [for example] five in one direction and eight in the other. But the angles wouldn't be the same every time: It would be following this periodic sequence."

Botanists believe that they have seen plants that grow in these periodic patterns, and Dumais is currently working to verify these observations.

ATELA AND GOLÉ; R. RUTISHAUSER

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Sumerian Medical Tablet

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Mesopotamian *Legal* Tablet

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DETHRONING THE GOLDEN ANGLE Hotton is now working with Atela and Christophe Golé, also of Smith College, on a more general and powerful model that can explain growth patterns the biologists can't yet explain biochemically.

The team began by noting that in flowers with hundreds of seeds, such as sunflowers, so many primordia form so quickly that many of them must develop simultaneously. In that case, it doesn't make sense to talk about the angle—golden or not—between successive primordia.

Indeed, Atela and Golé argue that the golden angle doesn't really appear in the growth patterns of plants. "The golden angle comes up when you superimpose a spiral lattice on top of the plant and force it a bit," Atela says. "It's very close, but there's wiggle room, especially when you have many, many primordia."

PLANT PHYSICS — Magnetic forces acting on oil drops falling into a dish generated golden-angle spirals. Numbers indicate the order in which the drops were added.

DOUADY AND COUDER

Atela, Golé, and Hotton have replaced models involving the golden angle with a new model that they call the "coin game," which allows many primordia to develop at once. They presented their new results in January at the Joint Mathematics Meetings in New Orleans.

The researchers imagine sticking pennies to the outer surface of a cylinder to represent primordia on a stem. The pennies must sit as close as possible to the base of the cylinder, but they must not overlap. Each new penny therefore goes into the lowest-possible vacant spot, and multiple pennies may be added simultaneously in multiple low spots. The rules of the game are a variation on Hofmeister's observation that primordia form wherever the most space is available.

Pennies placed in this way can form a pattern of interlocking spirals. Atela, Golé, and Hotton have shown that in many such cases, the numbers of clockwise and counterclockwise spirals are in the Fibonacci sequence.

But the coin-game model can also account for a variety of more-complex patterns that appear in plants. One such example is when the number of spirals changes as the plant grows.

In addition, the model may resolve a puzzle about the early development of plants with spiral leaves. When the seed of such a plant sprouts, it puts out two primitive leaf structures 180° apart. As it grows, the plant somehow transitions to a pattern in which its leaves form a golden-angle spiral. Because the coin-game model produces Fibonacci spirals from a variety of initial penny placements, it may be able to explain the observed transition to spiral growth in plants.

The simplicity of the new model means that it doesn't correlate in detail with the mechanisms that biologists are discovering, the mathematicians acknowledge.

"We're digging on one side of the tunnel," says Golé, while researchers who are creating detailed biological models "are digging on the other side of the tunnel. What we need to do at some point is to match their complicated models with our simple models and prove that our models are an abstraction of theirs in some sense." ■

OF NOTE

NEUROSCIENCE

Brain stem cells help Parkinson's monkeys

Monkeys with a Parkinson's disease–like disorder showed signs of improvement after receiving transplants of human-brain stem cells. The treated monkeys began to walk and eat again, while their untreated companions continued to degenerate.

In Parkinson's, neurons that produce the nerve-signal transmitter dopamine die off. Researchers have implanted fully mature dopamine-producing neurons into the brains of a few people with Parkinson's, but those cells sometimes produced too much of the chemical, causing spasms.

Hoping to bypass that problem, D. Eugene Redmond Jr. of the Yale University School of Medicine and his colleagues deployed immature brain stem cells collected from fetuses. Such cells have the potential to mature into the whole array of brain-cell types, including dopamine producers.

The researchers induced Parkinson's symptoms in eight African green monkeys by injecting a toxin into their brains. Later, the team transplanted 3 million cells into the brains of five of the monkeys. Some of those cells indeed began making dopamine, but most grew into astrocytes, which are cells that nourish and support neurons.

The researchers say that the extra astrocytes orchestrated a "protect-and-repair" effort that jump-started the innate healing capabilities of the monkeys' brains. The astrocytes apparently secreted growth factors that stopped nerve damage, boosted blood vessel growth, and prompted existing neurons to start making dopamine.

Over 4 months, the monkeys receiving the human cells made partial recoveries, the researchers report in the July 17 *Proceedings of the National Academy of Sciences.* —B.V.

BEHAVIOR

Alcohol problems hit nearly 1 in 3 adults

A new, large-scale survey of U.S. adults finds that about 30 percent report having engaged in harmful patterns of alcohol consumption. Nearly 18 percent cite past or current alcohol abuse, which includes repeatedly missing work because of inebriation and driving while drunk. Another 12.5 percent have grappled with alcohol dependence, which typically includes a need to drink increasing amounts of alcohol and the emergence of physical withdrawal symptoms when sober.

Bridget F. Grant of the National Institute on Alcohol Abuse and Alcoholism in Bethesda, Md., and her colleagues analyzed data from interviews conducted in 2001

OF NOTE

and 2002 with 43,093 adults chosen to represent the whole U.S. population.

Serious alcohol problems had afflicted 8.5 percent of the subjects during the 12 months prior to interviews. Slightly more than half of that group reported symptoms of alcohol abuse, and the rest had experienced alcohol dependence.

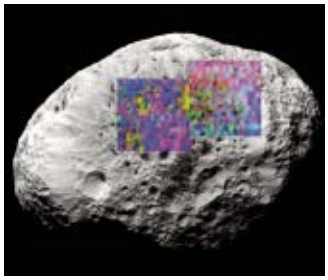
Alcohol dependence occurred most frequently among men, whites, Native Americans, poor people, and young, unmarried adults. Moreover, alcohol abuse and dependence often accompanied illicit-drug abuse, heavy cigarette smoking, and various mood, anxiety, and personality disorders.

The new findings appear in the July *Archives of General Psychiatry*. —B.B.

PLANETARY SCIENCE

Hyperion's hydrocarbons

Astronomers have confirmed the existence of frozen water on the surface of Saturn's moon Hyperion and have also discovered solid carbon dioxide there. The evidence comes from spectra taken by the Cassini spacecraft during the first flyby of the moon, in September 2005. The craft's observations of Hyperion's craggy surface also reveal dark material that appears to be other hydrocarbons.



HYPER MAP On a section of Saturn's moon Hyperion, blue denotes frozen water, red indicates frozen carbon dioxide, magenta represents a mix of those two, while yellow indicates carbon dioxide mixed with an as-yet-unidentified material.

Hydrocarbons have been found on Titan and a few other Saturnian moons as well as on several of Jupiter's icy moons. When ultraviolet light strikes these carbon-based, ice-embedded molecules, they produce more-complex compounds that might provide the ingredients of life, notes Dale Cruikshank of NASA's Ames Research Center in Mountain View, Calif. He and his colleagues describe the findings in the July 5 *Nature*.

The frozen carbon dioxide isn't found in a pure form but appears to be chemically bound to other material. That arrangement may allow the carbon dioxide to stay on the surface rather than slowly evaporate, Cruikshank notes.

In the same issue of *Nature*, another team using Cassini data attributes Hyperion's distinctive surface, riddled with sharp-edged craters, to the moon's low density. Peter Thomas of Cornell University and his colleagues suggest that material smacking into the moon's porous outer layers forms craters by compressing material, rather than by blasting it off the surface. Any debris ejected by impacts probably escapes the moon instead of falling back into the craters. Together, these processes give the moon its unusual, spongelike appearance. —R.C.

ENERGY

Double-decker solar cell

Researchers have created a two-layer solar cell that's the most efficient yet among cells made of organic materials. It's essentially a two–solar cell sandwich with a transparent film in the middle. The top layer picks up the higher-energy photons from the blue part of the spectrum. Most of the lower-energy photons make it unscathed through both the first cell and the film. The bottom layer is optimized for absorbing photons in the lower-energy, red part of the spectrum.

Together, the layers absorb more than 6 percent of light's energy. That's a record for organic solar cells, say Alan Heeger of the University of California, Santa Barbara and his colleagues in the July 13 *Science*.

Heeger says that his team's is the first double-layer organic solar cell that can be manufactured by painting polymers on top of each other. Costs could be far less than those of conventional silicon-crystal photovoltaics.

On the other hand, compared with silicon crystals, polymers have an irregular structure that increases electrical resistance and limits efficiency (*SN: 5/26/07, p. 328*). However, Heeger says, the cell's microscopic structure can be improved. "There's a lot of headroom for increasing the efficiency," he says. —D.C.

MATERIALS SCIENCE

Crystal matchmaker

Having evolved from mathematical playthings to curiosities of physics, the structures known as quasicrystals could become great tools for the electronics industry.

Like crystals, quasicrystals are built from units of atoms arranged in an orderly fashion. But, unlike crystals, quasicrystals have building blocks that interlock in a pattern that doesn't repeat at regular intervals (*SN: 10/12/96, p. 232*).

Wolfgang Theis of the Free University of Berlin and his collaborators have now shown how to use layers of quasicrystals as connecting interfaces between different types of crystals that wouldn't otherwise match up well at the atomic scale.

The researchers grew an aluminum arsenide crystal on the surface of an aluminum-arsenic-cobalt quasicrystal. The two structures meshed well because the distances between each surface atom of the crystal and its nearest neighbor on the quasicrystal's surface were roughly, although not exactly, the same, the team reports in an upcoming *Physical Review Letters*.

Theis adds that it should be possible to fabricate a quasicrystalline structure that's a good match for any two crystal types. It could then mesh with different crystals on its two surfaces, holding them together.

The technique might enable electronics manufacturers to use a wider range of semiconductors in chips, says Renee Diehl of Pennsylvania State University in University Park. The quasicrystal scheme is "a clever idea that has been around for awhile," Diehl says, "but this is the first demonstration that it can be achieved, as far as I know." —D.C.

TECHNOLOGY

fryPod: Lightning strikes iPod users

A jogger wearing one of the popular iPod music players suffered second-degree ear and neck burns, burst eardrums, and jaw fractures after lightning struck a nearby tree.

Doctors say that the wires leading to the iPod's earbuds channeled electricity up the man's torso and into his ears. Linear burns extended from the ears to the cheeks and down the neck, tracing the wires.

Emergency physicians at Vancouver (British Columbia) General Hospital describe the case in the July 12 *New England Journal of Medicine*.

The doctors say that the skin's naturally high electrical resistance usually dissipates lightning across the body's surface, an effect known as flashover. But "sweat and metallic objects in contact with the skin can disrupt flashover," and in this case directed the jolt into the man's head.

The facial fractures were probably caused by electrically triggered contractions of the strong jaw muscles, while explosive expansion of the air around the earbuds probably caused the ear damage.

Last year, a Colorado teen sustained similar injuries while wearing an iPod.

The Vancouver doctors say that iPods and similar devices, including cell phones, probably don't increase the likelihood of being struck by lightning. They just make the experience much more electrifying. —B.V.

UNIV. ARIZONA, JPL-AMES/NASA, SPACE SCIENCE INSTITUTE

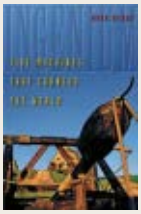
Books

A selection of new and notable books of scientific interest

INGENIUM: Five Machines That Changed the World

MARK DENNY

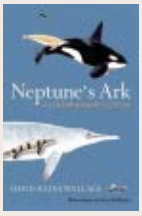
The automobile, the computer, and countless other technological advances have obviously changed the way we live. In a book that blends history and physics, Denny introduces five lesser-known machines that also changed our world: the bow and arrow, the waterwheel, the counterpoise siege engine, the pendulum clock anchor escapement, and the centrifugal governor. Each is a worthy example of an *ingenium*, which is medieval English vernacular for an "ingenious contrivance." Using diagrams and equations, Denny emphasizes the remarkable intuitive and technological leaps that these devices represent. He traces the evolution of each machine, profiles key players in its development, and reveals the modern innovations that these machines inspired. ***Johns Hopkins, 2007, 176 p., b&w images, hardcover, $25.00.***



NEPTUNE'S ARK: From Ichthyosaurs to Orcas

DAVID RAINS WALLACE

Hidden beneath the tranquil waters off the Pacific coast of the United States is a dynamic, diverse assortment of sea creatures. Wallace profiles the ancient and modern aquatic life of the Pacific using a combination of historic record, paleontology, folklore, and personal observation. For instance, he reviews ancient seafarers' accounts of mysterious "sea apes," horse-headed sea serpents, and other creatures. Wallace ponders the possibility of each creature's existence and explores the evolution of animals in the Pacific, which he deems "Neptune's ark" because it retains an abundance of animals that have been driven to extinction elsewhere. Expanding his perspective, he then examines boat-making and exploration by native coastal peoples. ***Univ. Calif. Press, 2007, 282 p., b&w illustrations, hardcover, $27.50.***



THE TELESCOPE: Its History, Technology, and Future

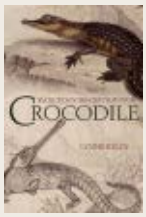
GEOFF ANDERSEN

The first documented patent for a telescope was awarded to spectacle maker Hans Lippershey. Galileo simply perfected the design. His true claim to fame stems from the fact that he used the telescope to make the observations that helped establish the idea of a sun-centered universe. Andersen, a research physicist, recounts the telescope's history and describes how a telescope works. He also explains why building an observatory is such an expensive endeavor and profiles the Hubble Space Telescope. Finally, Andersen lists some of the major discoveries made with telescopes, including Pluto and Halley's Comet, and profiles plans for future telescopes. Appendixes cover such topics as the basics of space-related math as well as tips for purchasing or constructing your own telescope. ***Princeton, 2007, 248 p., b&w images and color plates, hardcover, $29.95.***

CROCODILE: Evolution's Greatest Survivor

LYNNE KELLY

A living relic of the past, the crocodile is at once attractive and terrifying. Kelly, a science teacher and writer, takes a close look at these fierce predators, which often appear in the legends of people living near the crocs' native habitats, ranging from Africa to India and the Americas. She describes the anatomy, mating behavior, and predatory techniques of crocodiles and their close relatives, alligators and gharials. She notes that despite their dinosaurlike appearance, crocodiles have evolved greatly over millions of years. Although hunters have sought out crocodiles for their hides and as a source of food, they have also slain the creatures in great numbers out of sheer primal fear. And it's a fear well earned, claims Kelly, who describes in detail a crocodile attack. Modern-day conservationists have sought to preserve the crocodile's habitats in an attempt to prevent its extinction. The book brings to light many of the underappreciated characteristics of these fascinating animals. ***Allen & Unwin, 2007, 272 p., b&w images and color plates, hardcover, $24.95.***



THE WORLD OF THE VIKINGS

RICHARD HALL

The Vikings, author Hall reveals, were much more than the plunderous adventurers of popular legend. In this comprehensive guide, he traces the Viking people from their origins in Scandinavia around the first millennium A.D. to their last surviving settlements in 15th-century Greenland. He tells of the rise of various tribes within Scandinavia at the end of the Roman Empire and describes the beginning of the Viking Age, traditionally marked by the first documented Viking raid overseas in 793. Scandinavia soon became a hub for international trade. While some enterprising Vikings set their sights on seizing foreign wealth, others looked for unexplored lands. Hall also documents the Vikings' everyday life and culture. Of key importance was an emphasis on iron mongering and woodworking, which made possible the construction of their famed ships and sparked the birth of the Viking Age. The book documents the major sites occupied by these seafarers, both in Scandinavia and elsewhere. Hall describes the rich history of Vikings as raiders and invaders, profiling their targets and describing in detail the silver hoards they acquired from far-flung societies. Finally, Hall outlines the resurgence of interest in Viking culture that came in the wake of archaeological finds of the 19th century and considers the persistence of the Viking archetype in modern society. ***Thames & Hudson, 2007, 240 p., b&w and color images, hardcover, $34.95.***

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LETTERS

Quantum leak?

Perhaps there need not be "degrees of quantumness" ("Degrees of Quantumness: Shades of gray in particle-wave duality," *SN: 5/12/07, p. 292*). As the beams pass increasingly closer to the surface, the plate will induce a small (but increasingly larger) spread of energies (hence wavelengths) in the electrons within the beam, possibly explaining the "smearing out" of the fringes in the interference pattern.

MICHAEL D. MELOY, SANTA BARBARA, CALIF.

Peter Sonnentag of the University of Tübingen in Germany says that the loss of energy is tiny: less than 0.1 percent. Moreover, Sonnentag says that the change in energy could account for a change only in fringe spacing, not in fringe visibility. —D. CASTELVECCHI

Good bugs, bad bugs

Kudos for "Our Microbes, Ourselves" (*SN: 5/19/07, p. 314*). I think this holistic view of the microbe community—rather than investigating the single organism—offers a hopeful path to numerous insights for preventive measures for optimum health.

TERRY MOORE, CORVALLIS, ORE.

The article states, "Mice bred to be obese had a larger proportion of Firmicutes and a smaller proportion of Bacteroidetes than their lean counterparts did." Later, you wrote, "Sure enough, as individuals of both groups lost weight, the proportion of Firmicutes in their guts rose, while the proportion of Bacteroidetes dropped." On the surface, this seems contradictory.

MIKE SPECINER, ACTON, MASS.

The second quoted passage from the story had it backward. It should have read, "The proportion of Bacteroidetes in their guts rose, while the proportion of Firmicutes dropped." —A. GOHO

Tea to a fit

The fact that various teas contain beneficial antioxidants is well-known ("Slimming on oolong," *SN: 5/19/07, p. 318*). Many claim to be slimming. Is it only oolong that inhibits fat absorption, and, if so, why?

JAMES C. MATTHEWS, CORAL SPRINGS, FLA.

Lauren Budd of the University of California, Davis works only with oolong. She acknowledges that research by others has shown a slimming effect from other teas. However, most of that research hasn't focused on oolong, the tea that traditional Chinese medicine has linked with dieting. —J. RALOFF

Do Science, Religion and Ethics Collide?

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By Kevin T. FitzGerald, S.J., Ph.D.

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The world marveled at Dolly, the first cloned sheep, and now cloning is widespread. What is cloning, how is it done, are humans being cloned now?

Nanotechnology has captured world's imagination; tiny technologies one hundred thousandth the width of a human hair can fit into cells like small machines. How do they work? What can go wrong? What social justice issues arise regarding the availability of potentially powerful but costly individualized treatments?
Did you know that chimeras—genetic blends of different animals that create new species— are a reality? Can a part-human part-animal chimera be created? Are they 'persons' in spiritual, ethical or legal terms?

The study of genetics is rapidly advancing to map genetic codes of humans and animals with ever greater precision. How are genes changed and manipulated? What does this mean for our food supply and for future generations of humans?

Explore the relationship between the brain and behavior and consider the implications for understanding the soul.

What will individually customized pharmaceuticals mean? As genes are mapped ever more carefully, what are the implications for privacy, genetic discrimination, and genetic screening?

Fr. FitzGerald examines each issue with sensitivity and perspective. Looking into the future, he gives you the tools you will need to determine which way is forward. If we gain more power over our biology, how can we use this power for good? Where are the limits? How can faith, ethics and science come together to help us make the right choices?

About Your Presenter

Your presenter, Kevin T. FitzGerald, SJ, PhD, is the Dr. David Lauler Chair in Catholic Health Care Ethics at Georgetown University. A Catholic Priest, he recieved his PhD in molecular genetics and a PhD in bioethics from Georgetown University. Fr. Fitzgerald publishes on science and ethics in peer-reviewed journals, books, and in the popular press, and delivers presentations internationally. He is often interviewed by the news media on topics such as human genetic engineering, cloning, stem cell research, and the Human Genome Project.

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