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Alternative energy sources for a post-oil nation



According to the U.S. Department of Energy, petroleum currently supplies 40 percent of domestic energy demands and 99 percent of fuel for vehicles—an estimated 20.6 million barrels per day. Quite literally, oil is the lifeblood of the U.S. economy. Recent skyrocketing prices, supply shortages and concerns over pollution, however, have heightened the need and hastened research and development of alternative sources to supply our energy needs. Here's a look at potential energy sources of the future.

Biofuels

Recent government-subsidized efforts to produce ethanol from corn as a viable biofuel have revealed some costly consequences. The nine billion gallons of ethanol produced in 2008 required four billion bushels of corn—one-third of the U.S. harvest—to replace only 4.5 percent of our gasoline supply. Moreover, ethanol production consumed 28 gallons of water per mile traveled compared to 0.15 gallons for gasoline according to researchers at the University of Texas at Austin. Biofuels produced from other plant sources such as switchgrass show promise, but the technology has not been proven on a large scale. As with corn-based ethanol, large tracts of land would also be needed, competing for acreage for food crops.

In the longer term, biofuels may represent viable fuel alternatives to supplement our national energy needs. Research continues into creating biofuels from algae, farm wastes, woody biomass, and other sources. At UCLA, scientists have successfully modified *Escherichia coli* to produce long-chain amino acids with five carbon atoms—alcohols that contain more energy, separate more easily from water, and are less volatile and corrosive than ethanol.

Compressed and Liquefied Natural Gas

Since the 1800s, natural gas has been used as a reliable, low-cost fuel source for heating, lighting, and cooking. In many ways, it's been the ideal fossil fuel—clean, easy to transport, and easy to use. New horizontal drilling techniques to extract gas deeply embedded in formations of shale rock in many areas of the country have increased our supply of natural gas.

Now compressed natural gas and liquefied natural gas may provide us with an alternative vehicle fuel. Vehicle engines have been modified to run only on natural gas or as bi-fuel vehicles powered by natural gas or gasoline or diesel. Compared with traditional vehicles, natural gas-operated vehicles (NGVs) produced significantly lower emissions, increased service lives of two to three years, and extended time between required maintenance. Widespread use of NGVs will be limited until the vehicles can be mass produced and fueling stations are readily available nationwide.

Geothermal

Geothermal energy, or heat from inside the Earth, can be used for electricity production, for direct-use purposes (use without converting first to electricity), and for home heating. It's clean and sustainable, and according to the

Energy and Geosciences Institute's estimates, it could provide the equivalent of 42 million megawatts of power. As a leading producer of geothermal energy, the U.S. generates a yearly average of 15 billion kilowatt hours of power—the equivalent of burning approximately 25 million barrels of oil or six million short tons of coal per year or 150 billion cubic feet of natural gas.

Today, direct applications are found in 26 states; its availability in the U.S. varies significantly by region. Current use represents only a small portion of the potential power that could be generated from geothermal resources. As technology advances, costs and risks will likely continue to decline, increasing the viability of geothermal energy as an alternative fuel.

Nuclear

Nuclear energy—fission of an atom of uranium—produces 10 million times the energy produced by the combustion of a single atom of carbon from coal—without any greenhouse gas emissions. The first commercial nuclear reactor began operating in the U.S. in the 1950s, and today 104 reactors supply approximately 20 percent of U.S. electricity. However, no nuclear plants have been constructed in the U.S. since 1978, primarily due to community and environmental opposition.

In other areas of the world, particularly Asia, nuclear reactors are being constructed to meet escalating energy demands. The Intergovernmental Panel on Climate Change projects nuclear power will increase by two-and-a-half times by 2030 and will provide the equivalent of 27 percent of total electricity production.

Public concerns over nuclear energy center on spent fuel and safety. The spent fuel from nuclear power plants is highly radioactive and presents long-term disposal concerns as it must be securely contained for tens of thousands of years. Additional public concerns continue over the long-term fallout effects from accidents and the safety of plant workers.

Solar

Solar energy is free, its supplies are unlimited, and it can be captured in many ways. Numerous technologies have been developed to harness solar energy, including concentrating solar power systems, passive solar heating and daylighting, photovoltaic systems, solar hot water, and solar process heat and space heating and cooling. Solar power has been used successfully in large-scale applications and in smaller systems for homes.

Solar-power technologies have the potential to supplement growing energy needs, but they are dependent on the amount of available sunlight, which varies by location, time of day, time of year, and weather conditions. Because the sun doesn't deliver that much energy to any one place at any one time, a large surface area is required to collect energy at a useful rate. While solar energy produces no air or water pollution, it is not without environmental impact. Manufacturing photovoltaic cells

used to convert sunlight into electricity consumes silicon, and produces waste products.

Wind

One of the fastest-growing forms of electricity generation in the world, wind energy is a clean, inexhaustible energy resource. Windmills at 100 feet or more above the ground take advantage of faster, less turbulent wind and capture kinetic energy to generate electricity, charge batteries, pump water, or grind grain. Large wind farms have been used to produce electricity for utilities; small turbines provide power for use by homeowners and in remote villages.

The U.S. currently generates more than 10,000 megawatts of electricity from the wind, enough to power 2.5 million average American homes. With proper development, experts project wind energy could provide 20 percent of future energy needs in the U.S. The intermittent nature of wind presents the major challenge to its use as a power source—it doesn't always blow when electricity is needed. Wind energy cannot be stored without batteries, and not all winds can be harnessed to meet the timing of electricity demands. Additionally, good wind sites are often in remote locations, far from cities where the electricity is needed.

Technological advances, supply shortages, and escalating costs will encourage the growth of alternative fuels in the U.S. economy. Despite the growth of these alternative fuels, the Energy Information Administration estimates fossil fuels will still provide nearly 80 percent of our energy use through 2030.

—Mary Rose Thomas-Glaser

PASSIVE HOMES STAY WARM WITHOUT FURNACES

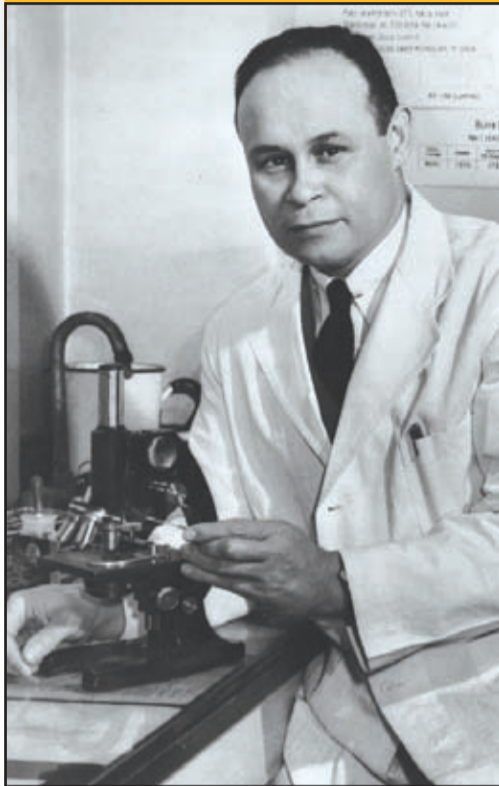
Pioneered in Germany, passive homes are creating a new paradigm in new home construction in several European countries. By using super thick insulation and sophisticated doors and windows to encase heat and prevent entry of cold air, these homes stay warm using the same amount of power needed to operate a hair dryer. Heat from the sun, appliances, and even occupants' bodies is captured to maintain uniform air temperatures.

Unlike earlier passive solar homes, plagued by stale air and mold, the new design incorporates a unique ventilation system. Before it's discharged, warm air passes alongside the intake of fresh cold air, where heat is exchanged with 90 percent efficiency.

While these homes offer exceptional energy savings, adopting these homes in the United States presents several challenges. Since windows and ventilation systems required for these homes are not readily available domestically, costs are prohibitive. Passive home designs incorporate compact, simple structures rather than larger homes and are difficult to adapt to many U.S. construction standards. Additionally, sites must be carefully selected to maximize solar heat. However, the growing trend in green construction and increasing energy costs may work to help to overcome these barriers.

PROFILE

CHARLES DREW, 1904 TO 1950



Surgeon Charles Drew developed the blood bank as we know it. In his childhood and young adulthood, he was known not only for his academic ability but also for his athleticism. Following his graduation from Amherst College, he took a position at Morgan State College in Baltimore, MD teaching biology and coaching. However, he

eventually resigned from that position to pursue his interest in medicine at McGill University's school of medicine in Montreal, Canada. There, he earned his doctorate of medicine and master of surgery degrees.

In 1935, he returned to the United States to teach pathology at Howard University. While there, he was recommended for a Rochester fellowship at Columbia University. During this time, Drew crafted his 200-page doctoral thesis "Banked Blood: A Study in Blood Preservation" based on two years of research.

His thesis describes the technique he developed to preserve blood for the long term by separating it into its components. He observed that separating red blood cells from plasma and refrigerating them allowed those components to remain fresh and usable when combined up to a week after collection. Prior to this revolutionary technique, blood could only be stored for two days because red blood cells break down rapidly. Also, although red blood cell antigens have "types" (A, B, AB and O), plasma has no type. Therefore, separating blood into its components, as Drew proposed, allows plasma to be transfused without regard to blood type. Drew not only convinced Columbia University to set up a blood bank in the United States, but he also set up the first blood bank in Britain.

Tragically, Charles Drew was killed in an auto accident on April 1, 1950. Despite his sadly shortened career, his work has saved the lives of millions.

—Lisa Jancarik

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ROBOTS INVADE DISASTER CITY

If you ever find yourself planning a road trip based solely on locations that have a sense of humor, please allow me to be your tour guide. Gas up the mini van, strap in your loved ones and (by all means) make your first stop in Hot Coffee, Mississippi. Deliberately bypass Boring, Maryland, and if you're feeling particularly sentimental, motor towards Romance, Arkansas. However, if your interests range to the catastrophic, your next stop should be Disaster City, Texas.

A City Born of Tragedy

In an effort to keep Texas's topography conversational, fifty-two acres of land have been developed into a world-renowned catastrophe training community known as Disaster City. Though the city's name is bound to attract the bare minimum of road-tripping mini vans, the city's purpose is of benefit to all. Created in 1996 by the Texas Engineering Extension Service (TEEX), Disaster City boasts one of the most comprehensive training facilities utilized by emergency response professionals around the globe.

A closer look inside this tragedy-inspired community reveals a state-of-the-art simulation center that focuses on everything from basic technical skills training to advanced structural collapse reconnaissance. Comprised of full-scale, collapsible structures, Disaster City is equipped to replicate even the most carnage-corrupted levels of Hollywood-worthy wreckage.

Emergency response students and professionals travel to Disaster City to be interactively trained in reactive strategies and search-and-rescue techniques. With an immediate focus on the location and extraction of hypothetical victims, Disaster City trainees are exposed to the artificial aftermaths of earthquakes, hurricanes, structural collapses, and passenger train derailments as well as man-made technological and terrorist events. In so many words, Disaster City manufactures heroes.

Anyone who was within viewing distance of an April 19, 1995 telecast would recall the horrifying events of the Oklahoma City bombing. Tortured images of soot-smudged faces and fatigued rescue workers flashed mercilessly across television screens and computer monitors. Blunt chunks of the Alfred P. Murrah Federal Building exploded and entombed innocent children and defenseless citizens. The

attack claimed 168 lives and left more than 800 people physically injured and mentally scarred. College Station, Texas, responded to this morbid misfortune by conceptualizing and developing Disaster City. Supported by the manpower and crisis-management expertise of Texas Task Force One, 210 emergency services personnel from 50 state-wide organizations and departments began to devise a template to transform and modernize search-and-rescue procedures.

Enter Robots

As technology evolved, so did the reconnaissance training template. Just recently, the National Institute of Standards and Technology (NIST) held a rescue exercise demonstration in Disaster City that introduced a more mechanically inclined hero to the search and rescue community. Approximately three dozen rescue robots were tested by developers and first responders in order to develop a standard suite of performance tests to better evaluate the chances of using mechanical rescuers in times of crisis.

Exercises included a series of terrain and mobility tests in which robots were monitored on their ability to maneuver steps, escalating ramps and gapped-ground simulations. Researchers tested battery capacity by having robots perform "figure eights" on a rolling course and led the mechanical rescue hopefuls through simulated wooded areas in an effort to monitor mapping skills and robotic sensor capabilities. NIST researchers, developing ultra-high resolution, three-dimensional sensors, ran a series of capability tests to be submitted to the American Society for Testing and Materials (ASTM) International as a potential rescue-robot test standard. In one day, Disaster City was transformed from a skills and training facility to a technology-fueled, algorithm-mapping arena.



Robin Murphy, Ph.D., professor of Computer Science at the University of Florida, has been exploring this brand of technological relief for over a decade. In an interview for TIME magazine, Murphy estimated that in the response time following a tragic event, one pinned survivor requires an estimated 10 man-hours to be freed. Statistically, only victims found within the first 48 hours are found alive. Murphy further concluded that utilizing rescue-robots ultimately minimizes the amount of time rescue personnel must work onsite, which reduces their fatigue-related errors.

Though researchers are still working to establish a universally accepted standard for robotic technology for search and rescue, international leaders in the field like Murphy are constantly working on the robotic-resume to seal the deal.

Murphy was the first recognized professional to introduce ground, air, and sea robots to disaster response relief teams. She conducted robotic research at Ground Zero after the World Trade Center disaster of 2001; the 2005 mudslides of La Conchita, California; and the aftermath of Hurricanes Charley (2004), Katrina (2005), and Wilma (2005).

Though the channel varies, the message remains the same. Emergency response professionals and celebrated rescue roboticists alike are in the business of saving lives. By fine tuning their crafts and benefiting from the training resources available in places like Disaster City, they are working toward the common goal of making the safety of our surroundings their priority.

—Angela Rydeski

NANO NEWS

NANOTECHNOLOGY BRINGS US RESEALING RUBBER

Rubber is well known for its elastic properties, allowing it to stretch and snap back into shape. The elasticity is the result of long-chain molecules linked together.

Now, French scientists have developed a type of rubber that actually seals again after being cut. Ludwik Leibler and his colleagues at Centre Nationale de la Recherche Scientifique in Paris developed this rubber, which can even regain its original strength when cut ends are put back together. The material is composed of fatty acids like those found in vegetable oils. These are much smaller than the traditional long-chain molecules. Each of these fatty acid molecules has hydrogen bonds reversibly binding it to others in only two or three places. When broken, the bonds can easily reform to allow the material to reseal.

TINIEST TRANSISTOR

University of Manchester physicist Kostya Novoselov and his team recently created the world's tiniest transistor from carbon atoms arranged roughly ten atoms by one atom. Larger transistors made from this carbon substance, called "graphene," have already been demonstrated to be up to 10 times faster than the traditional silicon transistor. However, miniaturizing a transistor to this degree allows exceptionally tiny electronic devices.

Graphene, composed of sheets of carbon atoms arranged into hexagons, has other properties of interest. Because graphene is only one carbon atom thick, it is transparent. The thickness of this graphene sheet is such that 25,000 layers would have to be piled up to reach the thickness of a sheet of paper. Moreover, graphene has also been demonstrated by scientists at Columbia University to be the strongest substance known on this planet, 200 times stronger than steel.

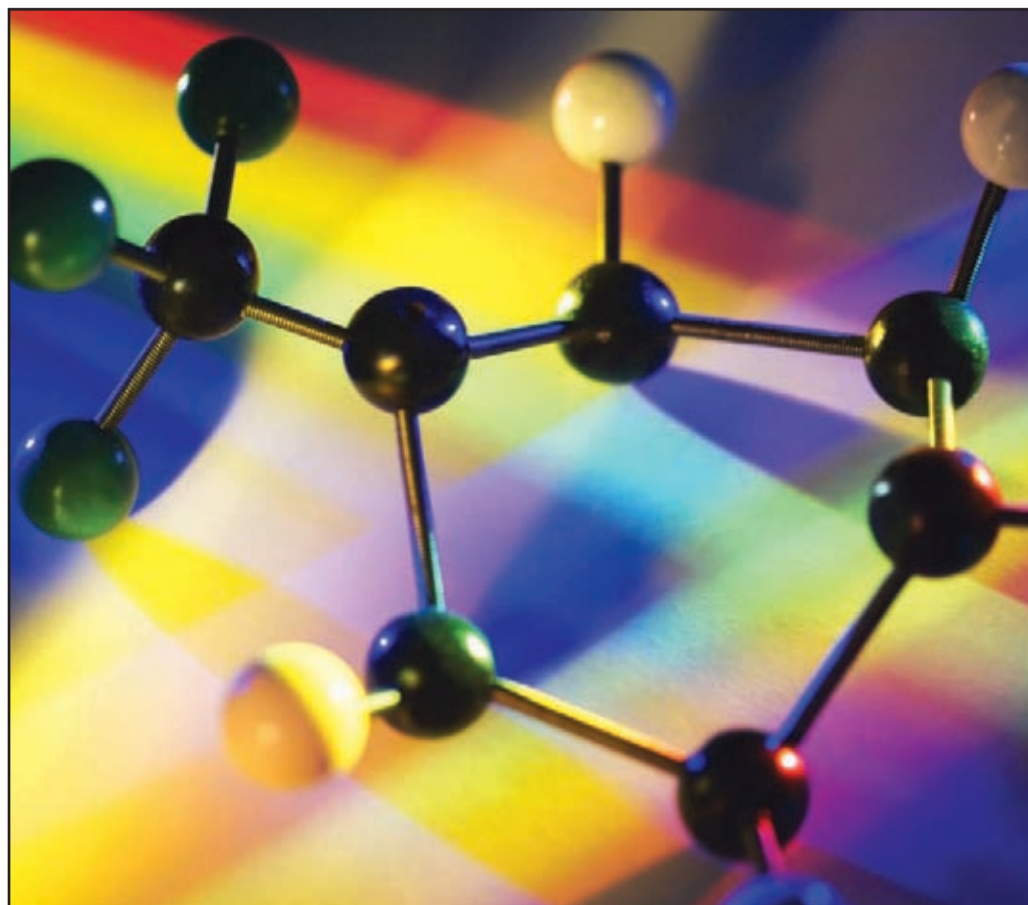
Graphene was isolated for the first time in 2004. Prior to that, some scientists questioned whether or not it existed. Novoselov and another colleague from Manchester, Andre Geim, were a part of the team that first isolated graphene.

They started with graphite, the substance found in ordinary pencils, which is made of graphene. The method they used was akin to taking a piece of tape and using it to lift a layer of a few atoms from a sheet of graphite, then sticking the tape to a piece of paper and lifting that tape to pull off an even thinner layer of atoms...and repeating until the layer was only a single atom thick. This approach turned out to be impractical for generating very much graphene at all. Instead, efforts have now turned to developing a larger-scale, more cost-effective means of producing graphene. One possible approach could be to mix certain liquids with graphite to cause large flakes of graphene to pull away from the graphite.

NANOSCALE LEVITATION

Harvard physicist Federico Capasso and his team have observed a force that could be described as "quantum buoyancy" – in other words, levitation of very small amounts of matter. This discovery has implications for nanotechnology. Although it may not seem intuitive, the repulsive force responsible for quantum buoyancy is related to a previously described attractive force, the Casimir effect.

The Casimir effect is a quantum-level attractive force, first described in 1961 by Russian scientists. Imagine two parallel metal plates placed close together in a vacuum. Within the vacuum, quantum particles wink into and out of existence. Their very brief interactions with other matter can be significant enough to push on the plates. Now imagine that the metal plates are so close to each other that the space restricts the size of the quantum particles that can fit between them (while there are no restrictions of this kind on the other side of each plate). The Casimir effect says that the restriction causes the pressure from the outside surfaces of the plates to overwhelm the pressure on the facing sides of the plates, pushing them together to make them stick. This effect can make moving parts of small objects (like nanomachines, in theory) stick together, creating "stiction."



The Russian group predicted that the effect could be seen as a repulsive force. However, no one had directly observed this repulsive effect until Capasso's team. Capasso's research group detected a very weak repulsive force between a tiny gold bead and a thin sheet of silica. In this case, "tiny" means the diameter of the gold bead was about half that of a human hair. The force measured only a few tens of a piconewton, which is extremely feeble.

Levitation on this scale can act as a lubricant for nanomachines, eliminating the friction that contributes to wear and tear on machines. Such research has implications for surgery, food manufacturing, and computer processing speed.

—Lisa Jancarik

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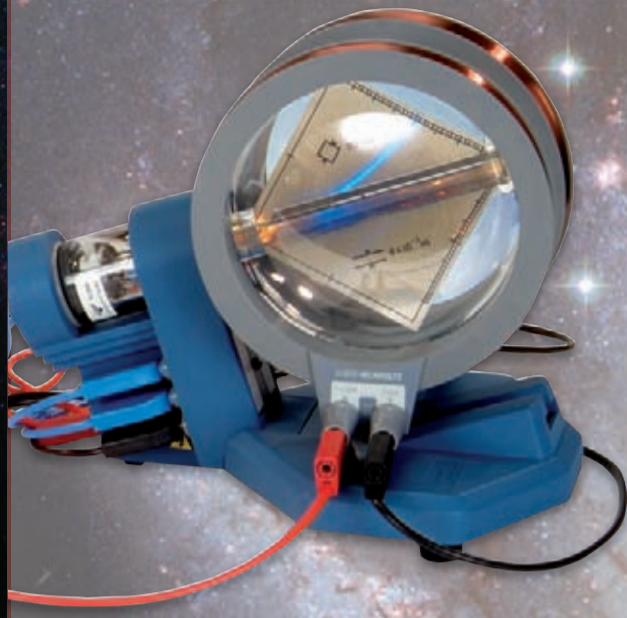
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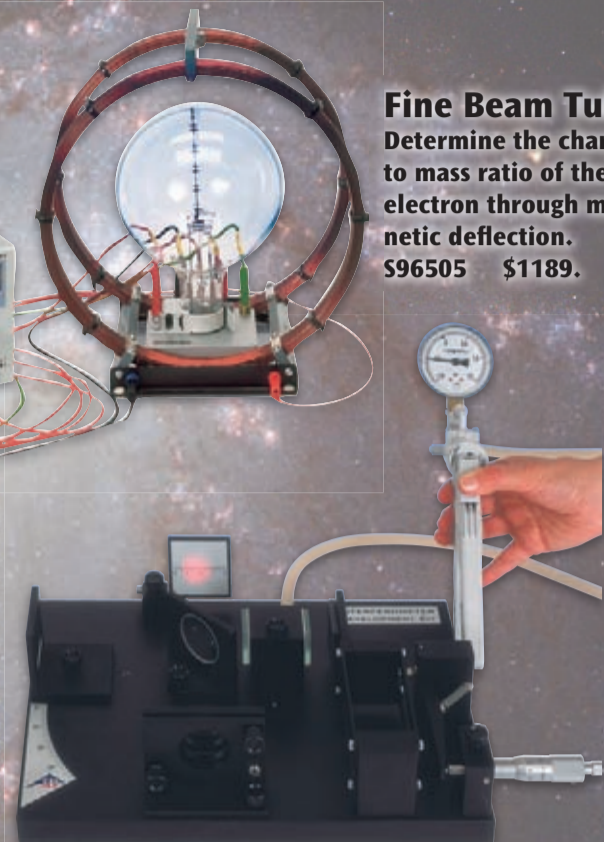
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SOME NEOLITHIC STONES MAY HAVE REALLY ROCKED

Built sometime between 3000 and 1600 B.C., the circle of Neolithic megaliths known as Stonehenge remains one of the world's most recognizable prehistoric monuments as well as an enduring symbol of the British Isles. Its purpose remains shrouded in mystery, as most clues to its origin have been erased by thousands of years of elapsed history. But innovative analyses performed both in England and the United States suggest that a new chapter in Stonehenge's story may be unfolding—or perhaps a new stanza.

At a recent conference of academics, musicians, and archaeologists at England's Bristol University, Dr. Rupert Till, a senior college lecturer and expert in music technology, described a new approach to the puzzle that goes well beyond traditional archaeological methodologies. "Archaeologists have been able to gather evidence about the tools that were used and the way the stone was shaped, but everything is usually based on visual aspects of the site," stated Till in a Huddersfield University press release. However, Till's research—a combination of onsite acoustic analysis and computer-based modeling—reveals hints as to Stonehenge's function more easily discerned by the ear than the eye.

Have Microphone, Will Travel

Recreating the acoustic environment of a prehistoric structure poses something of a problem when the original site has not survived the millennia unscathed. Only about one third of the eighty monoliths that make up Stonehenge are still standing today. For that reason, Dr. Till and fellow researcher Dr. Bruno Fazenda turned their attention in a direction not previously explored by other experts on the subject—the Americas.

While it may not be common knowledge, the United States is actually home to numerous replicas and adaptations of the ancient English monument. Of these, one in particular caught the attention of the research team: Maryhill in Washington state. Built as a war memorial by the eccentric road builder Sam Hill, the Maryhill structure is a full-scale concrete replica of the original site as it may



have looked when fully intact. Of no value to those applying traditional archaeological methods, the Maryhill site represents an interesting laboratory for acoustic analysis.

Visiting the American replica equipped with a 3-D soundfield microphone, a dodecahedron speaker, and a huge bass speaker, Till and his colleagues collected interesting results. Says Dr. Till, "By comparing results from paper calculations, computer simulations based on digital models, and results from the concrete Stonehenge copy, we have been able to come up with [some] theories about the uses of Stonehenge. We have also been able to reproduce the sound of someone speaking or clapping in Stonehenge 5000 years ago."

Echoes of Days Long Past

So what theories are supported by Till's observations?

First and foremost, Till's research at Maryhill confirms and expands upon claims made in earlier studies of the original site. Previous researchers had noted that the stones at Stonehenge appear to amplify and contain the higher-frequency sound of a human voice while allowing lower-frequency

sounds such as drum beats to be reflected around the circle and heard some distance away from the site. According to Stonehenge scholars such as archaeologist and artist Aaron Watson, this suggests that the builders of the original monument understood how to use the stones to direct sound for various effects—a belief that Till and his colleagues share.

Till's team reports that certain types of sounds would have been easier to produce and therefore acoustically "encouraged." Specifically, Till believes that the acoustics of the structure would have been ideal for amplifying a certain type of music. "We find that a percussive, repeating rhythm is implied from the stones." The music could have consisted of a simple rhythm played in the space of the echo or at some multiple of it. Till notes that a tempo of 160 beats per minute would be at the top range of musical tempos as well as the top range of the human heartbeat. Ultimately, Till and company were able to get the entire Maryhill replica structure to resonate, somewhat like a wine glass will ring if you slide your finger around the top of the glass.

The picture that emerges is one of participants dancing "really energetically," as if dancing a samba or to trance music, and perhaps at the direction of another. "Our research shows that there are particular spots in the site that produce unusual acoustic effects, intimating that perhaps a priest or shaman may have stood there, leading the ritual," Till reports. It is a picture that jibes well with both of the most popular theories of Stonehenge's function: as a place of the dead and as a place of healing. Says the researcher, "It [could] imply a place where people were possessed by the spirits of the dead, [or] entranced by simple fast rhythmic music in order to heal themselves physically, emotionally, spiritually, or as a community."

Rave(r) Reviews

While Drs. Till and Fazenda are still examining the data from their recordings in Washington state, it remains to be seen how the larger archaeological community will receive findings generated from a structural replica and not the original monument. When questioned about the relevance of his observations given that the Maryhill structure was built from modern materials, Till told ABC News, "Concrete is far more porous than sandstone, so it's not as reflective. It meant that any conclusions we had would be conservative... any effects would be underestimated not overestimated." As part of the same interview, Till explained that he now plans to study how different instruments would sound in different positions inside the site using computer modeling.

Even as this work continues, his initial results have captured the imagination of many outside the world of academia and have been published in various mainstream music media as well as scholarly publications. Several of those articles carry titles evoking visions of modern raves set against the backdrop of ancient Britain. While the imagery is anachronistic, it suggests a present-day fascination with Stonehenge that is unlikely to wane as more of its secrets are unlocked, a fascination that will prompt researchers like Rupert Till to leave no stone unturned.

—Ed Schock

IT'S ABOUT TIME...

Across the eons of human history, the concept and measurement of the mysterious thing we call "time" has evolved in complexity and accuracy to the point where we can now measure accurately to 30 billionths of a second per year. It was not always thus...

Silent Time: The Early Days of Time Measurement

The earliest prehistoric civilizations were probably content to use the apparent motions of the Sun, the Moon, the planets and stars as a means of demarcating the year, and then seasons of the year, and then dividing these into smaller periods we now call months. Of course, there is no historic record of prehistoric timekeeping (or it wouldn't be "prehistoric"), but the occasional artifact and sparse ancient records that do exist, tell us there have always been people, in every civilization yet uncovered, who were obsessed with measuring and preserving records of the inexorable march of time. (We have them yet today.) More than 20,000 years ago in the Ice Age, hunters marked objects like sticks and bones to measure the time between phases of the moon. And between 5000 and 6000 years ago, the Sumerians developed a calendar of months (each of 30 days), with days divided into 12 periods, each period having 30 subdivisions.

Next to attempt to tame time were the Egyptians, who noted the star Sirius rose with the sun every 365 days and made their calendar based on this observation. About 5500 years ago (circa 3500 BCE), they began constructing tall, slim obelisks, whose shadows, moving with the passing of the sun across the sky, allowed them to separate morning and afternoon; additional markers around this early incarnation of the sundial marked off smaller divisions of the day. Later, they even developed a sundial-like instrument that was likely the first portable timekeeping device (but you wouldn't want to try wearing it on your wrist). Other people, meanwhile, were experimenting with timekeeping: the Babylonians with a moon-based calendar of 12 months alternating between 29 and 30 days and the Mayans, developing calendars of 260 and 365 days based on movements of the Sun, Moon, and planet Venus.

The Clock Begins Ticking or—as the Case May Be, Dripping

Not all early timekeeping was based on astronomical observations. Candles had probably been used to mark shorter lengths of time since their invention, with marks placed at intervals to clock short to medium time periods. And the water clock was developed sometime before 1500 BCE: one such item was discovered with Amenhotep I, the Egyptian pharaoh entombed about that time. Many of these were stone jars filled with water, dripping at a fairly constant rate through a hole in the bottom of the slope-sided vessels. Variants of the water clock used containers of many types that were filled slowly from a water source of predetermined flowrate, the current time being indicated by markings on the inside of the container.

As with the sundial, other civilizations developed, improved and elaborated on the water clock. The Greeks and Romans concentrated on regulating water pressure for a more consistent flow, but they also added bells and whistles (actually, bells and gongs), dials, pointers, and even apertures that opened to reveal miniature people (probably waiting for someone late for an appointment). The difficulty of flow control in a water-driven clock led eventually to the need for a different approach.

Though their early development is unknown, mechanical clocks existed early in the 1300s: first in Italy, and later across Europe. They were big, big clocks, ensconced in their own towers and powered by a verge-and-foliot escapement. This mechanism controls the rate of the gears or "ticks" using a combination of a crown, verge (rod) and a foliot (primitive type of balance wheel). Though they existed for more than 300 years and were a distinct improvement, the driving force of the mechanism and the friction of the parts limited their accuracy.



By the early 1500s, Peter Heinlein of Germany invented spring-driven clocks. They were much smaller, without heavy weights, and made possible portable clocks and, eventually, watches.

The Pace Quickens

In 1656, the first pendulum clock was invented by Christiaan Huygens. It utilized the natural oscillation of a pendulum, with accuracy to about one minute per day. John Harrison capped decades of experimentation in 1761 by winning a British government competition—worth about \$10 million in today's currency—with a marine chronometer having an accuracy of about one-fifth second per day. A little over a century later in 1889, Siegmund Riefler developed a clock with hundredth-of-a-second accuracy per day.

How Accurate Can We Get?

In this century, the accuracy of timekeepers has improved dramatically.

- **1920s:** Quartz crystal clocks, using the piezoelectric properties of the crystal to generate electricity at constant frequency, reduced error to between 10 seconds per day to 0.3 second per year.
- **1949 to 2009:** Atomic Clocks—first developed in 1949 by National Institute of Standards and Technology (NIST) and based on predictable oscillations of atoms under bombardment by microwaves—steadily improved accuracy to 30 billionths of a second per year (2002).

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—Ray Schafer

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ASTRONOMY BRIEFS

DISCOVERED: HOTTEST STAR EVER FOUND TO HAVE A PLANET

Three undergrads studying at Leiden University in the Netherlands were only trying to develop search algorithms, which they did—so well in fact they had time left over to test their algorithm in an unexplored database.

For their extra work, they stumbled upon something much better than extra credit; they discovered an extrasolar planet four and a half times the size of Jupiter.

The unexplored database upon which the students tested their search algorithm was the Optical Gravitational Lensing Experiment (OGLE), an ongoing project which began in 1992 with the goal of searching for dark matter with microlensing phenomena. The students—Meta de Hoon, Remco van der Burg, and Francis Vuisje—looked at the brightness variations of almost 16,000 stars which had been captured by OGLE once or twice a night from 1997 to 2000.

One star's brightness decreased by one percent for two hours every 2.5 days, an event, they suspected, to be caused by a planet passing in front of it. Closer observation was made using the European Organisation's (ESO) Very Large Telescope in Chile.

The planet (aka "OGLE2-TR-L9b") is the first of its kind in two respects. First, it is the first planet discovered around a fast-rotating star. Extrasolar planets have been discovered previously by astronomers looking for the wobble that the gravitational tug of an orbiting planet produces—the radial velocity method.

The spin of fast-spinning stars makes measuring the wobble difficult. While the newly discovered planet has not been seen directly, the transit method by which it was detected is gaining credibility.

The second extraordinary first of this extrasolar planet involves its star, OGLE-TR-L9; it is the hottest host star ever found to have a planet. This host star is at least 20 percent hotter than our sun. (OGLE-TR-L9's estimated temperature is about 12,000°F, while the part of the sun we see reaches 10,000°F.) At the same time, the extrasolar planet sits at only three percent of the distance existing between the Earth and our Sun.

DISCOVER THE UNIVERSE IN 2009, THE INTERNATIONAL YEAR OF ASTRONOMY

The International Astronomical Union (IAU) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) declared 2009 the International Year of Astronomy (IYA2009) to coincide with the 400th anniversary of Galileo Galilei's first astronomical observation through a telescope. Thus far, 136 countries have signed up to participate at more than 150 different venues with the central theme "The Universe, yours to discover."

Activities are planned at regional, national, and global levels. Among other goals, the IYP2009 seeks to increase scientific awareness, promote access to knowledge and observing experiences, facilitate new networks, and help preserve and protect the dark skies in urban oases, national parks, and astronomical sites.

Several interesting worldwide projects are planned for the year:

COSMIC DIARY: Starting January 1, more than 50 full-time astronomers have been blogging about their lives, work, and daily challenges.

365 DAYS OF ASTRONOMY: This project features a different podcast each day from people of various astronomical backgrounds.

100 HOURS OF ASTRONOMY: A main goal of this project, which starts in April, is for as many people as possible to look through a telescope.



FROM THE EARTH TO THE UNIVERSE: Exhibits for this project started in January, bringing large-scale astronomical images to the public in nontraditional venues like parks, gardens, art museums, and shopping malls.

THE WORLD AT NIGHT: At more than 30 worldwide exhibits, viewers will witness time-lapse videos and photographs of landmarks around the globe with the sky in the background.

DARK SKIES AWARENESS: With the increase of urban areas, the night sky is becoming harder to see. This project will organize star-counting and other events to raise awareness about light pollution.

In addition to these projects, several naturally occurring astronomical events are expected for 2009. The longest total solar eclipse is predicted for July 22, lasting 6 minutes and 39 seconds. October promises to be a great Jupiter-viewing month, and Leonid meteor showers are expected in November.

According to Catherine Cesarsky, IAU president, "IYA2009 will reinforce the links between science education and science careers, stimulating a long-term increase in student enrollment in the fields of science and technology and an appreciation for lifelong learning."

—April Smith

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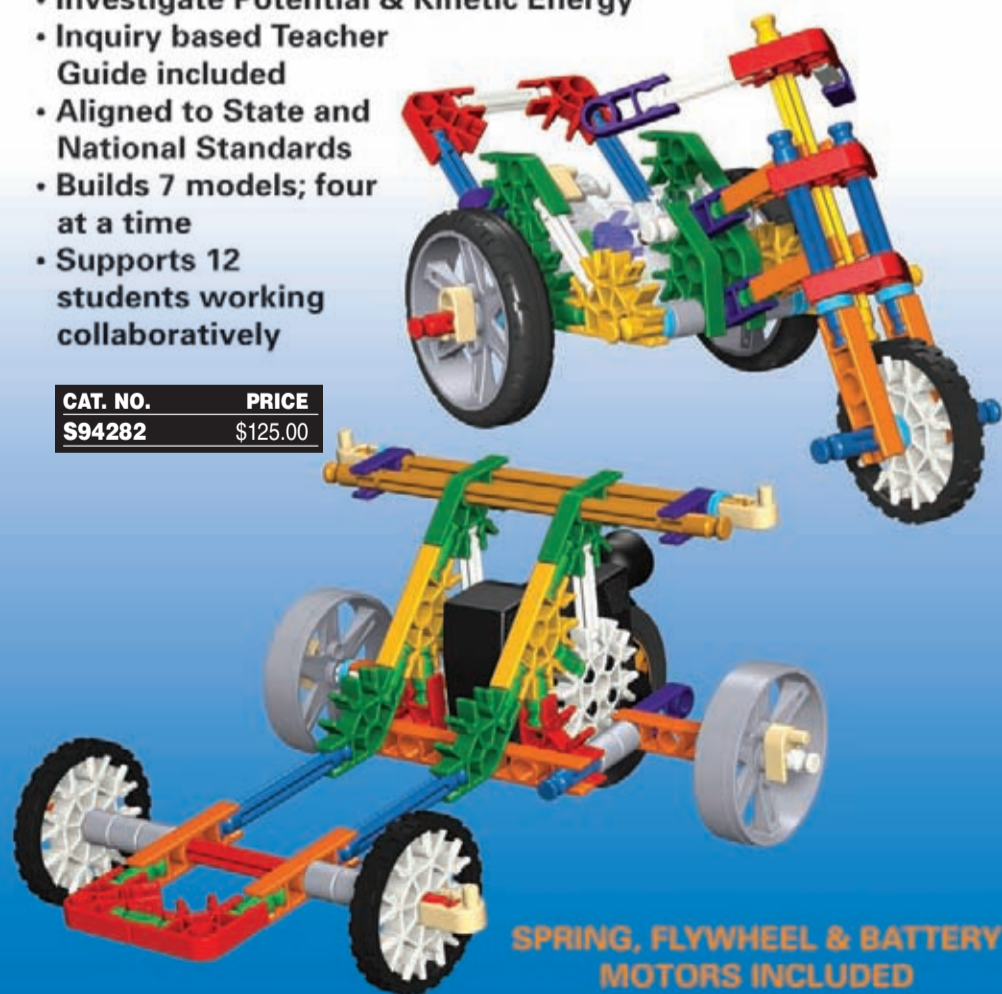
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A STAR IS BORN...

Star formation helps us understand many of the mysteries of the celestial sphere. It explains why our universe looks the way it does today and where the atoms in our world and—even in our bodies—come from.

The birthing of a star is a violent, chaotic process that begins within clouds of dust and gas so dense they block visible light. Spinning clouds of gas form around the nucleus of a new star, feeding it with matter and serving as an "incubator" of sorts. They rotate so fast they naturally form spinning disks. When these gaseous, swirling clouds become massive enough, they collapse and form a dense central region. Warmer than the surrounding gases, this central region continues to grow and heat up. As it progressively gets hotter and pressure builds, nuclear reactions start to occur in the core, and a protostar is born. Now infrared telescopes have allowed astronomers to understand this process in greater detail.

Very Large Array Radio Telescopes

This greater understanding is possible with the Very Large Array of radio telescopes (or VLA), also called an interferometer. The VLA operates by multiplying the data from each pair of telescopes together to form interference patterns. The VLA consists of 27 radio antennas, each measuring 82 ft. in diameter and weighing 230 tons, arranged in a Y-shaped pattern. Located on the plains in San Agustín, New Mexico, it is one of the largest of its kind in the world. The VLA is operated by the National Radio Astronomy Observatory and is used by astronomers throughout the world.

Due to its primary makeup of thick dust and gas, the Milky Way is an extremely difficult galaxy to study. Visible light is unable to make it to the center of the Milky Way, limiting astronomers to other research tools, such as infrared and radio waves. These longer wavelengths can penetrate dust more easily. Astronomers with the Harvard-Smithsonian Center for Astrophysics and the Max Planck Institute for Radio Astronomy used the Very Large Array of radio telescopes to identify the two protostars forming very close

to the Milky Way's central black hole. They searched for water masers—radio signals near the black hole. These masers often serve as markers of star formation.

The two recently observed protostars are forming seven- and 10-light years from the Milky Way's black hole, previously thought to be one of the last places you would expect to find stars forming. Powerful gravitational tides at the galactic center are so strong that they should rip apart the molecular clouds that act as stellar nurseries, thus preventing stars from forming. The discovery of these stars falling inward after forming elsewhere is perplexing to astronomers and indicates the clouds of dust at the center of the Milky Way are denser than previously believed.

Spitzer Space Telescope

In 2003, NASA's launch of the Spitzer Space Telescope helped astronomers get a better grasp on the star-formation process. Spitzer trails behind Earth's orbit around the sun at a distance of approximately 56 million miles. Its delicate infrared-sensitive instruments need to be far away from the Sun and Earth's reflection of the Sun to remain it at a frigid temperature. With Spitzer's three-foot-wide infrared eye, astronomers will provide new insight into the formation of stars and their surrounding environments.

COMING SOON— The Expanded Very Large Array

Technology is always evolving, as is our universe, and will continue to push the frontiers of science and knowledge for decades to come. The VLA is currently being transformed into the Expanded Very Large Array, with completion expected by 2012. With 10 times the sensitivity of the VLA, it will provide astronomers with far more detailed images of outer space. Spitzer Space Telescopes' earlier version suggested over the last 20 to 30 years that star birth was a calm process, not affected by other stars forming nearby. However, these infrared and radio telescopes have shown us new views of star formation with unexpected



The Evolution of a Star

Stars have been shown to undergo a number of changes as they grow older:

- Giant Molecular Cloud
- Protostar
- T-Tauri star
- Main Sequence star
- Subgiant, Red Giant,
- Core Fusion
- Red Giant, Supergiant
- Planetary Nebula or Supernova
- Remnant
- Black Hole

violence that disrupts the formation of nearby stars. Spitzer's technology will continue to provide astronomers with new information and new views that both change and expand our current knowledge of the universe.
—Brianna McCurley

WHAT IS THE MILKY WAY GALAXY?

The Milky Way is the galaxy in which our solar system is located. Our solar system is situated on one of the spiral arms of the galaxy. It is approximately 100,000 light years in diameter and estimated to contain at least 200 billion stars and as many as three trillion stars. The exact number is highly uncertain.

WHAT IS A BLACK HOLE?

A black hole is an object whose gravity is so great that nothing—including light—can escape. The Milky Way's black hole is 27,000 light years or 158 thousand million, million miles away from Earth. It is believed to be four million times the mass of the sun.

CYBORG INSECTS: AMERICA'S NEWEST SUPER SPIES

Remember that pesky little moth that fluttered into your kitchen and came to rest comfortably on your window sill last night? Believe it or not, he may have been more than just a bug. In fact, he may have been "watching" you, recording what you say, and even taking pictures! It all sounds a bit futuristic, but, with the help of some highly advanced technology, that tiny winged creature could actually be an undercover agent—a "cyborg" insect, the latest buzz in spy technology and the newest recruit in America's war on terror.

What is a Cyborg?

Appearing for years in the pages of science fiction literature and other media, cyborgs have long been a subject of popular intrigue. Technically, a cyborg is a cybernetic organism—that is, an organism that contains both artificial and natural systems. It is a synthesis of organic and synthetic parts. In the past, the term was often applied to human beings who had enhanced physical abilities due to technology (such as the *The Six Million Dollar Man* from the 1970s television series). But in recent years, the term has also become associated with the creation of cyborg animals—creatures that can be remotely controlled for purposes of rescue or undercover surveillance operations.

Early cyborg research involved the insertion of electrodes into the brains of various animal species, including bulls, to acquire a crude control over their movement. In the 1950s, Jose Delgado at Yale University created the first cyborg animal. In one dramatic demonstration, he stood firmly in the path of a charging bull and flicked a switch at the last second, causing the "cyborg" animal to skid to a sudden halt. In 2002, a team of scientists at the State University of New York Health Science Center in Brooklyn developed a cyborg rat whose movement could be controlled remotely. Eventually, the rats were trained to identify specific scents, such as humans or explosives, demonstrating that they could be used for search-and-rescue missions, or to sniff out bombs.

Insects for Military Use

It was only a matter of time before the military turned its focus to smaller and less conspicuous creatures in their quest to develop the ultimate superspy: insects. U.S. scientists are now fitting moths, beetles, and other bugs with special,

high-tech implants so they can be controlled from a remote location and used for surveillance operations. It is hoped that someday, in the not-too-distant future, these special insects may fly vital undercover missions for the U.S. military. This initiative—the creation of cyborg insects for the purpose of tactical advantage—is one of the most ambitious robotics projects ever undertaken by the Defense Advanced Research Projects Agency (DARPA), the research and development arm of the U.S. Department of Defense.

Spy Moths

Moths are ideal candidates because they require little food and are capable of flying in a wide variety of environments. These small, remote-controlled creatures could be deployed for surveillance, search-and-rescue, and other critical missions. Nearly indistinguishable from the average insect, these cyborg spies would provide our military and counter-terrorism specialists with a major surveillance advantage. They could be deployed in hostage situations and even sent into enemy barracks. Ideally, the insects would be able to fly up to 300 feet away, land within 15 feet of the target and stay in a specific place until commanded to leave.

To prepare a cyborg moth, a computer chip is implanted into the insect during the pupal stage, while in the cocoon. As the moth develops into an adult, the implant is naturally incorporated into its body (in effect, wired into its nerves). This allows the moth's entire nervous system to be controlled remotely, with information being sent back to a central computer. "Once the moth hatches, machine learning is used to control it," said Rod Brooks, director of the Computer



Science and Artificial Intelligence laboratory at the Massachusetts Institute of Technology.

Once the implant is in place, the insect's motion is controlled from a MEMS, or Micro-Electro-Mechanical System. This uses electrical stimulation techniques to influence the flapping and flight direction of the moth. But what about starting and stopping the moth's flight? A team of scientists at Cornell University in Ithaca, NY, recently came up with a possible solution to this dilemma: chemical-releasing microfluidic implants.

Chemical Control through Microfluidics

The Cornell team, led by David Erickson, has figured out a way to manipulate the metabolism of moths, dictating when and for how long they can flap their wings. It is achieved by implanting tiny microfluidic chips, each about the size of a moth's head, into the insects. The chips contain chemicals that paralyze the insects for short periods of time, providing scientists with a sort of chemical "on-off" switch. One of the chemicals is a neurotransmitter called gamma-aminobutyric acid (GABA), which is found in spider venom.

The chip, implanted into the thorax of the moth before adulthood, is filled with chemicals when the moth reaches maturity. When scientists trigger an electric potential, the chemicals are released into the moth's body and, within one minute, the moth is immobilized and prevented from flying for up to two hours.

The Cornell study utilized a species of tobacco hornworm moth with a sizable 10cm wingspan and a flight range of kilometers, making them ideal for reconnaissance and dangerous missions. According to Jon Harris, an insect flight specialist at Arizona State University, "These moths can be trained to detect all different kinds of chemicals, so they could be used to find explosives or fly out and land on buried landmines." He points out that a combination of chemical and electrical techniques will be needed to effectively make this work. He further adds that these chemicals are limited in the fact that they can only stop the insect from flying and not promote flight.

The Future of Surveillance

Cyborg insect spies could soon be deployed in combat zones around the world. Equipped with special electrodes, batteries, and even video cameras, these tiny winged creatures will have the ability to land, virtually unnoticed, in enemy territory and beam valuable information back to a central computer. By plugging into and hijacking these living animals' existing sensory abilities, we are taking advantage of superior systems that have evolved and perfected over millions of years. And effectively hiding our control system within the cyborg's body makes it nearly impossible to distinguish from its natural insect counterparts. If all goes as planned, cyborg insects are sure to become America's newest high-tech super spies.

—Joe Giacobello



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OXYTOCIN: MORE THAN A LOVE POTION

Oxytocin, a brain chemical known primarily for promoting parent-child and male-female bonding, earned its nickname, "The Love Chemical," as part of the cocktail of chemicals and hormones researchers claim produce the feelings in love. With the interactions of oxytocin, dopamine, norepinephrine, vasopressin, and endorphins, the body reacts to "love" almost like an addiction, inducing elation, energy, sleeplessness, craving, loss of appetite, and focused attention (a.k.a., "obsession"). However, there seems to be more to oxytocin than love-sickness; a series of studies conducted in the last year indicate it may act as a potent mediator of human social and emotional behavior.

Released during a hug or pleasant touch, oxytocin plays a part in the human sexual response cycle and particularly the initial mother-child relationship. The chemical—in its drug form, Pitocin—has been used to induce labor and promote lactation. Recently, Larry Young, professor of neuroscience at Emory University in Atlanta, Ga., even found a correlation between the chemical and long-term relationships in his re-

search on the prairie vole, rodents who practice monogamy. These findings support the role of oxytocin as imperative to bonding, but in the past year, several researchers have looked for ways to apply the chemical for treatment where bonding issues are common, such as in schizophrenia or autism, which affect an estimated 2.4 million and 1.5 million Americans a year, respectively.

A study led by Ulike Rimmel, Ph.D., at New York University gave one group oxytocin in the form of nasal spray while another group received a placebo. Both groups viewed photos of various faces as well as inanimate objects like houses and landscapes. The next day when quizzed to see which images they recalled, each group fared the same in the inanimate object category; however, the oxytocin group more accurately recognized the human faces than the placebo group. If oxytocin heightens the ability to recognize and discriminate faces, the chemical may be of use for disorders where processing of social information is impaired.

Adam J. Guastella, Ph.D., further solidifies oxytocin's connection to social recall, again giving one set of volunteers oxytocin and the other a placebo before showing each a series of faces—some happy, some angry, and some neutral. When asked to recall these faces the next day, the oxytocin group remembered the happy faces with which they were presented more so than the faces depicting anger or neutrality. According to Dr. Guastella, the research indicates "for the first time that oxytocin facilitates the encoding of positive social information" over neutral or negative information. With its success in aiding positive social memories, applications include help for the socially isolated.

Other studies have indicated doses of oxytocin increase levels of eye contact, which has been found to be key for intimate emotional communication and bonds. Eye-to-eye contact is difficult for those with disorders like schizophrenia or autism; scientists are hopeful that increasing it could lead to better levels of trust or emotional contact between doctor and patient. A particularly interesting study suggests that in addition to promoting eye-to-eye contact and forming positive social memories, oxytocin also inhibits negative reactions to social information, such as anxiety.

In the study, Swedish scientists presented pictures of four faces to two groups: one oxytocin and one placebo group. A harmless-yet-uncomfortable shock accompanied two of the faces. Predictably, the placebo group found the shock-coupled faces unpleasant; the oxytocin group, on the other hand, did not find them disagreeable. Furthermore, when British scientists analyzed fMRI scans of the participants, the shock-associated faces caused activity in two areas of the placebo groups' brains—the amygdala and the "fusiform face area"—but not in the oxytocin group. According to Dr. Predral Petrovic from the Department of Clinical Neuroscience of Karolinska Institute in Sweden, "This suggests that oxytocin can reduce anxiety and increase the chances of social contact for people with certain types of psychiatric disorder."

Other applications include situations where reducing the activation of brain circuits involved in fear would be beneficial, perhaps for those with social phobias. Indeed, in December 2008, researchers at the University of Zurich found in an oxytocin vs. placebo study that oxytocin

decreased the stress reaction in the brain as well as prolonged the duration of positive behavior. In a laboratory setting, couples were asked to argue about a typical point of conflict. Measurements of the stress hormone, cortisol, in the saliva of the participants were lower in the oxytocin group. In addition, scientists compared positive and negative behaviors between the groups and saw more listening, confirming, and laughing in the oxytocin group while witnessing more interrupting, criticizing, and degrading in the placebo group.

Oxytocin's connection to "love-sickness" has been proven to the point of public acceptance; oxytocin love sprays and similar-type products are already available over the Internet. With the new findings of the studies above and others like it, the "love chemical" may find more serious uses for those with social disorders.

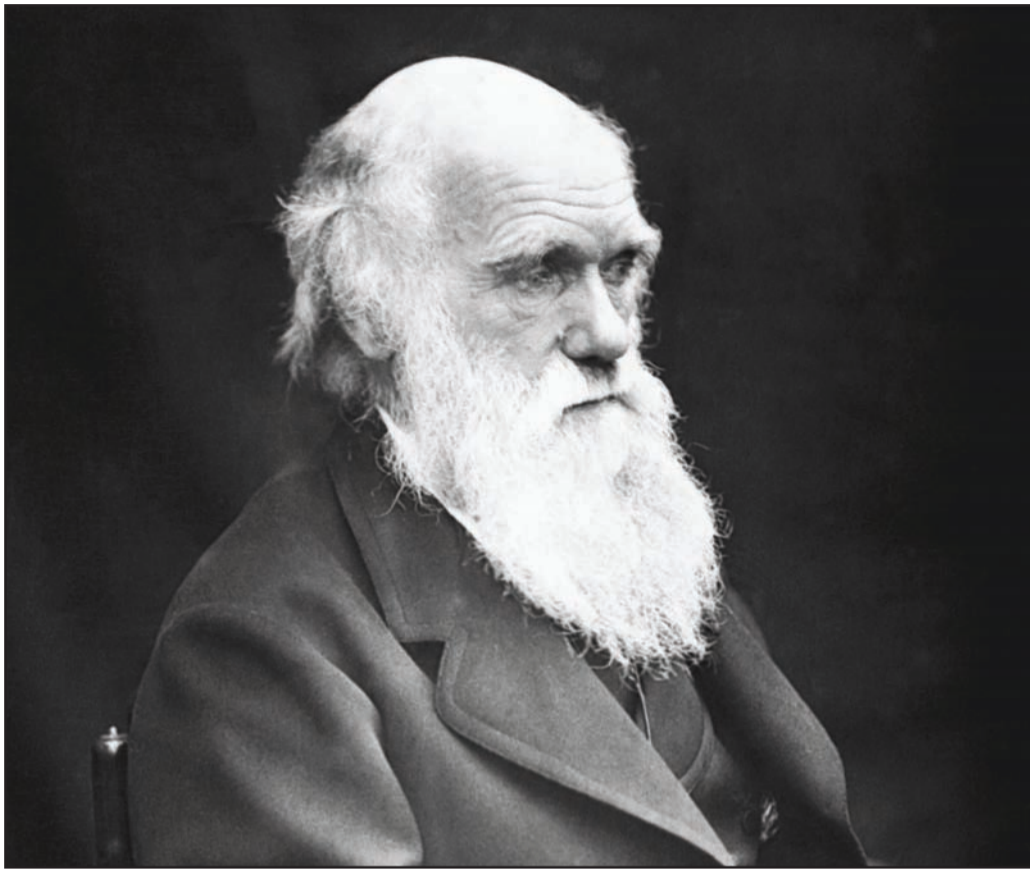
—Aprile Smith

EYE-TO-EYE CONTACT Is this love or are you ready for a fight?

Eye-to-eye contact, promoted by oxytocin in schizophrenic and autistic individuals, is a powerful social action. Depending on the circumstances, it can be a "come-hither" look or an invitation to conflict. In many cultures, prolonged eye contact after an initial introduction is considered an intrusion of a most unwelcome kind.

On the other hand, in our culture, we promote eye contact as a sign that we are trustworthy and above-board, not "shifty-eyed." We advise people in sales, nursing, public speaking, teaching, parenting—and many other activities—to maintain eye-to-eye contact as a means of assuring communication and recognizing the other's worth. We even consider "seeing eye-to-eye" on a topic to mean that we have communicated with one another and established complete agreement.

HAPPY BIRTHDAY, CHARLES DARWIN



In case you haven't heard, 2009 is the 200th anniversary of Charles Darwin's birth, and the 150th of the publication of *On the Origin of Species by Means of Natural Selection*. Born in England on February 12 (the same day as Abraham Lincoln), Darwin is best known for his observations on how species change or evolve gradually over time. The phrase "survival of the fittest" (coined by fellow scientist Herbert Spencer, by the way) is often used to describe Darwin's theory of natural selection, the idea that species evolve as the strongest members reproduce, passing their genetic traits on to future generations.

An unenthusiastic student, Darwin first set out to study medicine, but finding it dull, he turned his efforts towards theology. He decided against a career in religion, instead

pursuing a lifelong interest in natural history. Immediately after graduating, he joined the crew of the *H.M.S. Beagle* as a naturalist, embarking on a five-year voyage that included an extended stay on the Galapagos Islands.

During the trip Darwin kept detailed field observations in hundreds of notebooks, drawing and describing wildlife and fossils. He noted local variations in the anatomy of birds, butterflies, tortoises, lizards, and other animals, collecting specimens and cataloging the differences between species.

He spent the next 20 years breeding and observing domestic animals and publishing short accounts of his work while developing his ideas on evolution. Publication of *On the Origin of Species* in 1859 caused great controversy and sparked protests; the book sold out immediately. Darwin continued to write in later years, most notably expanding his idea of man as the most domesticated of animals in the book *The Descent of Man*.

Today Darwin's theories about evolution and natural selection are accepted by most scientists, though religious arguments continue. His ideas are considered to be the foundation of modern evolutionary biology.

What is Natural Selection?

Basically, the theory of natural selection proposes that when environmental changes occur, those animals best suited to the new circumstances will survive. Those who are not ideally suited will not be able to compete and their numbers will decrease. Charles Darwin developed this idea in part after observing population variations in finches.

Darwin found a single variety of finch in South America while the nearby Galapagos Islands boasted 13 varieties that differed slightly from one island to another. Each variety had a different beak design that seemed to correspond to the primary food source. For example, finches that lived on grubs had a thin extended beak to poke into holes in the ground and extract the grubs. In areas where buds were plentiful, finches had claw-like beaks to grind down their food.

These observations led Darwin to conclude that the original South American population, containing a variety of beak styles, diverged into distinct species as the birds were exposed to different environments in the Galapagos.

Darwin believed that nature selected the design best-suited to a particular island; those species continued to grow and reproduce while others began to die out.

The Species Darwin Missed

The many unique species in the remote Galapagos provided inspiration for Darwin's ideas about evolution. Although he observed both land and marine iguanas, he would be surprised to find out that pink iguanas have been living on the archipelago for millions of years. These unusual creatures are only found near a single volcano that was not part of Darwin's explorations.

First seen in 1986, fewer than 40 have been documented. After years of research, scientists have determined that the pink and black-striped iguanas are a distinct species rather than a mutation of the land iguana. Genetic testing suggests that the rosy reptile originated in the Galapagos about five million years ago, evolving from other iguana populations as the islands were forming. It is considered to be one of the oldest recorded events of species divergence in the Galapagos, far earlier than Darwin's famous finches.

—Debbie Kopyta



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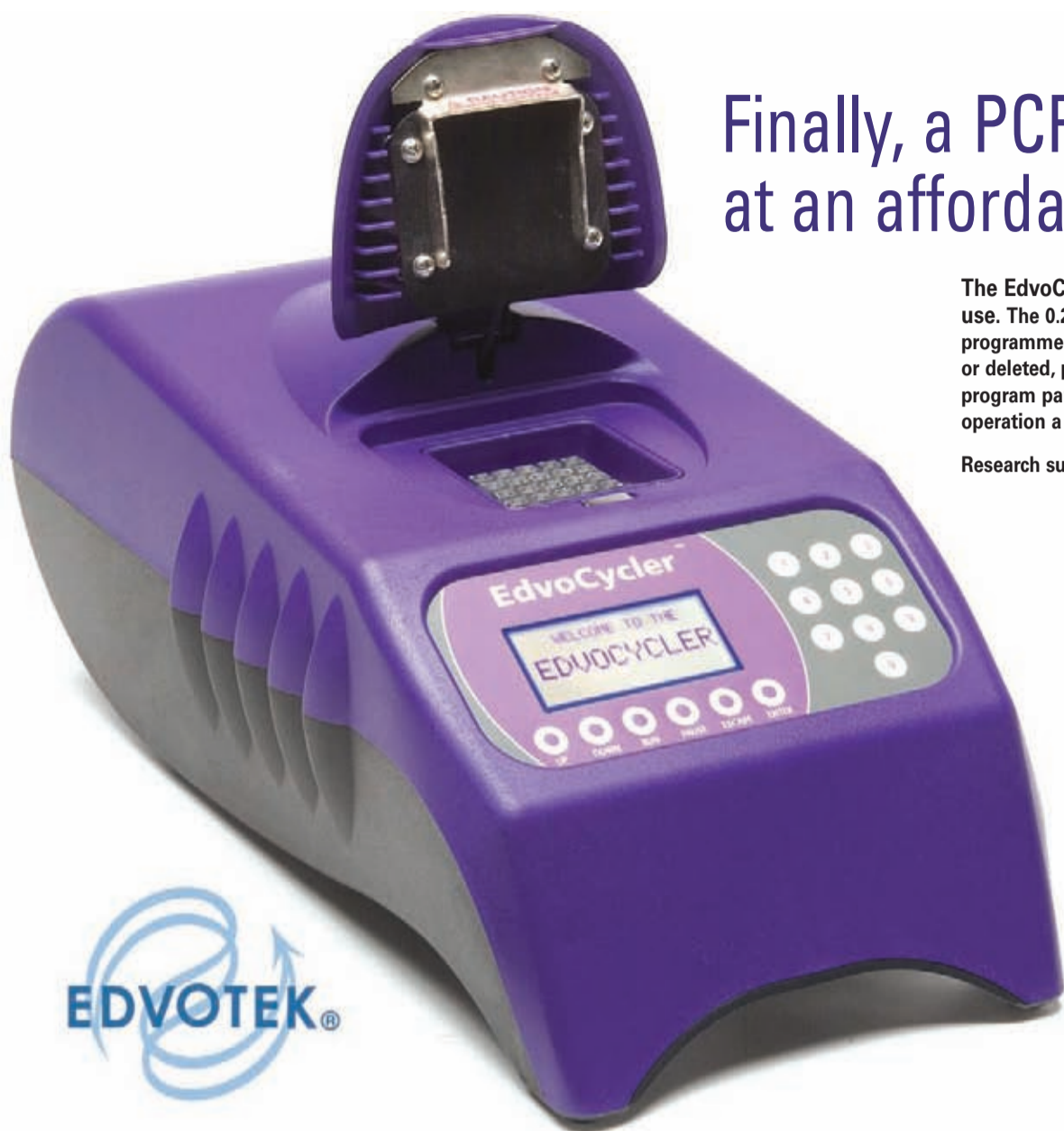
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Description	Cat. No.	Price
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Research supported in part by NIH SBIR NCRR Grant #5R44RR18670.

EdvoCycler Features:

- Easy to use!
- Holds 25 x 0.2mL PCR Samples
- Heated Oil-free Lid with Magnetic Latch
- Pre-programmed Edvotek PCR Protocols
- Vivid Seven-line LCD Display with Live Program Information
- Standalone Machine—No PC Required!
- Temperature Range: 4°C to 99°C
- Maximum Ramp Rate: 3°C/sec.
- Dimensions: 16 x 8.5 x 7"

Description	Cat. No.	Price
EdvoCycler	S68640	\$1950

NEW ASSESSMENT TECHNIQUE ALLOWS SCIENTISTS TO SEE BRAIN AGING BEFORE SYMPTOMS APPEAR



Scientists at UCLA have pioneered a new assessment technique that helps diagnose brain aging, often before symptoms appear—a breakthrough that may lead to a better understanding of degenerative brain diseases such as Alzheimer's, Parkinson's, and ALS (Lou Gehrig's Disease).

The new method combines patient-specific information on age and cognitive status along with positron emission tomography (PET), an imaging technique that allows researchers to view "a window into the brain" of living people. Specifically, PET scans reveal plaques and tangles, which are classic symptoms of degenerative brain disease.

In the study, researchers tested a volunteer sample of 76 people with no history of dementia, including 36 with mild cognitive impairment. Thirty-four of the 76 volunteers carried the gene for heightened risk of Alzheimer's development. All study subjects were injected with FDDNP, a new chemical marker that binds to plaque and tangle deposits and makes them easier to spot on PET scans. Researchers were then able to pinpoint where the abnormal protein deposits were accumulating.

The study reports a parallel between older age and higher concentrations of FDDNP in the medial and lateral temporal regions of the brain—areas involved with memory. The 34

volunteers who carried the gene associated with heightened risk of developing Alzheimer's disease exhibited increased levels of FDDNP in the frontal region of the brain (which is also involved in memory) than study participants who didn't carry the gene.

The 36 volunteers with mild cognitive impairment had higher measures of FDDNP in the medial temporal brain region than normal volunteers. Those who had both mild cognitive impairment and the Alzheimer's gene had higher concentrations of FDDNP in the medial temporal region of the brain than volunteers who had mild cognitive impairment but not the Alzheimer's gene.

"We found that for many volunteers, the imaging scans reflected subtle brain changes, which take place before symptoms manifest," said study director Dr. Gary Small, Director of the UCLA Memory and Aging Research Center at the Semel Institute for Neuroscience & Human Behavior.

Dr. Small hopes that this new assessment technique will help predict which patients are more at risk for developing degenerative brain disease, and sees a future where brain aging may be controlled like other medical issues, such as high cholesterol or high blood pressure. Patients would receive a brain scan and perhaps a genetic test to determine their risk. Medications and other interventions could be prescribed, if necessary, to prevent or delay future degeneration, allowing doctors to protect a healthy brain before extensive damage occurs. The brain scans may also prove helpful in tracking the effectiveness of treatments.

"Eventually, this imaging method, together with patient information like age, cognitive status, and genetics, may help us better manage brain aging," Small said.

—Sandra Bledsoe

MORE ABOUT PET SCANS

PET scanning machines, developed in the 1970s, are still relatively new to the medical industry. As a result, they are very expensive, and few hospitals actually have them. A PET scan is often used alongside other scanning methods, such as x-rays and MRIs (magnetic resonance imaging), to help determine an accurate diagnosis of a suspected condition. PET scans, unlike MRIs, do not produce clear images of the internal parts of the body. Instead, they show the chemical activity present in the area being studied, which shows up on the image as colorful blotches. The colorful patches on the image can suggest to a doctor that tissue or organs are becoming diseased, making PET useful for detecting diseases in their early stages.

PET scans are particularly effective in detecting disease in the heart and brain. By performing a PET scan, doctors can look for signs of disease and, if disease has already been diagnosed, can determine its stage. PET, combined with the FDDNP probe, is currently the only imaging technology that offers a full profile of brain degeneration that includes both plaques and tangles.

Degenerative Brain Diseases

What is Alzheimer's Disease?

First described by German physician Alois Alzheimer in 1906, it is a disease occurring in middle age or later. It causes a progressive loss of mental functions and memory as a result of brain tissue changes. The central cortex, responsible for intellectual function, shrinks and the brain begins to show more "plaques" (abnormal deposit of material in body tissue) and "tangles" (masses of protein).



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SPUTNIK VIRUS: HIJACKING THE HIJACKER

They are minuscule in size, they have one of the simplest structures, comprised of genetic material wrapped within a protein coat, and they barely find a place among the living organisms. Yet, viruses have always been a big threat to the living cells of animals, plants and bacteria. In humans, viruses are notorious for all the troubles they cause, from the annoying common cold to the life-threatening AIDS.

A recent study reports that a certain type of virus does not even spare one of its own kind.

Mimiviruses and Mamaviruses

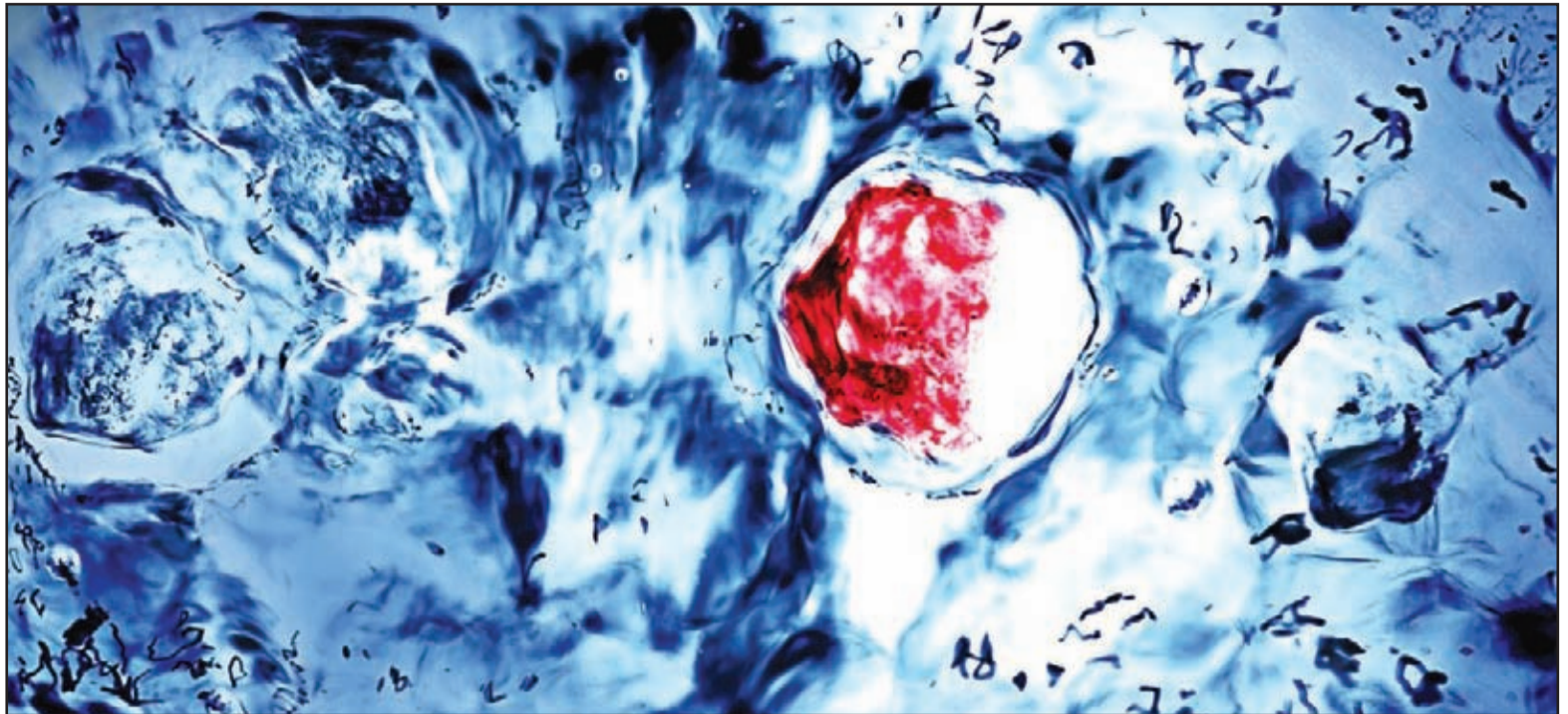
In 2003, researcher Didier Raoult from Universite de la Mediterranee in Marseille, France, and his associates isolated *Acanthamoeba polyphaga* mimivirus in amoebae, collected more than a decade earlier from a U.K. cooling tower. Initially, the virus was overlooked, left frozen in storage, mistakenly identified as a bacterium because of its large size. Detailed study revealed the microbe to be a "giant" virus with a genome carrying more than 900 protein-coding genes—three times more than that of the largest previously known viruses. Mimivirus was, in fact, large enough to be visible under the optical microscope.

According to Eugene Koonin at the National Center for Biotechnology Information in Bethesda, Maryland, the discovery of this "giant" virus caused a great deal of excitement in virology as it seemed to cross the imaginary boundary between viruses and cellular organisms.

Raoult and his colleagues continued to study mimivirus and recently discovered a new larger strain. Because of its slightly larger size, they named it mamavirus.

The Discovery of "Sputnik"

Detailed examination of the mamavirus using electron microscopy showed a surprising passenger—second virus—just as if the Mamavirus had caught the "flu." The tiny passenger virus, composed of just 21 genes, was named Sputnik—a term best known for the first man-made satellite.



The closest homologues of four of the 21 predicted protein-coding genes of Sputnik were found in the Global Ocean Survey environmental set. This led researchers to speculate that Sputnik may represent a yet-to-be-discovered family of viruses.

Sputnik is incapable of multiplying by itself in a host amoeba, but it takes advantage of its association with mamavirus. Once Sputnik co-infects an amoeba along with mamavirus, it grows rapidly using the giant mamavirus's "virus factory." Sputnik takes over the genetic machinery of mamavirus and produces its own replica, along with some malformed versions of the mamavirus.

Since Sputnik functionally resembles a bacteriophage—a virus that infects bacteria—scientists have termed it as a "virophage."

Gene Mixing and Matching

Upon sequencing, researchers found that the Sputnik genome, which is a small circular double-stranded DNA of approximately 18 kilobases, contains genes that are related to three different viral families.

Sputnik was found to possess genes common to the mamavirus also. It is likely that these genes have been transferred to Sputnik by the association of mamavirus with the amoeba host and then the subsequent interaction between the virophage and the viral host. It is also believed that recombination inside the viral factory might have led to the gene exchange.

These findings indicate that Sputnik attacks more than one group of viruses and can transfer genetic material from one giant virus to another. According to Raoult, this novel means of gene transmission could be driving evolution of a new species in currently unknown ways.

Sputnik thus provides one of the most compelling pieces of evidence for gene mixing and matching between viruses and suggests that one virus may have a role in the evolution of other viruses.

—Daisy Rani Devi

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Human Kidney

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AC/DC Dynamo Demonstration Model	S96358	\$56.65
Van De Graff Generator, Motor Driven	S96531	\$225.00
Multi-output Quad Regulated DC Power Supply	S96532	\$251.35
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THE LITTLE GREEN SCHOOLHOUSE

Faster progression in math and in reading, improved performance, fewer sick days, better moods ... even less dental decay! Studies show that abundant natural light, comfortable temperatures, clean air and first-rate acoustics—some of the characteristics of a green building—can make a difference in how students learn.



Let the Sunshine In

We all feel better and do better when the sun is shining. Filling the classroom with natural instead of artificial light can have a huge impact. In one study of more than 21,000 students, those with window views demonstrated 20 percent faster progress in math, 26 percent faster progress in reading, and a 5–10 percent increase in performance, overall.

Another study found that full-spectrum light encouraged more positive moods and improved health. Students missed fewer school days. And, because they had more exposure to vitamin D via natural light, they had nine times less dental decay and grew more in height than those in schools with average light.

Take in Clean Air

Breathing good air helps us concentrate; however, according to the American Federation of Teachers, the General Accounting Office found that the air is unfit to breathe in nearly 15,000 schools. Such an environment impacts not only the ability to concentrate, but the health and well-being of students, teachers, administrators, and support staff. It affects operating costs, too, resulting in higher absenteeism, staff turnover, and insurance expenses.

The 2006 report "Greening America's Schools: Costs and Benefits" documented a 38.5 percent reduction in asthma in schools with improved indoor air quality. The report also noted that "17 separate studies all found positive health impacts from improved indoor air quality, ranging from 13.5 percent up to 87 percent improvement."

Create a Comfort Zone

Temperate temperatures let us focus on our task, not our discomfort. Many teachers believe that temperature control is related and important to student performance. Studies of the impact of temperature on productivity showed an improvement of up to 15 percent when the working environment was comfortable.

Lower Costs

On average, green schools use 30 percent less water and 30–50 percent less energy than conventional facilities. And, because green buildings are healthy buildings, expenses associated with absenteeism, turnover, and healthcare decrease.

Go Certifiably Green

There are plenty of reasons to go green, and there is plenty of help to get us there. Certification programs and rating systems abound that set green standards and help us achieve them.

The U.S. Green Building Council developed the "LEED (Leadership in Energy and Environmental Design) for Schools" green-building rating system for K-12 and higher education buildings. LEED certification indicates a building meets the highest green building and performance measures. The program evaluates the design and construction of new facilities, focusing on acoustics, indoor air quality, mold prevention, energy efficiency, and water conservation. Ratings ("platinum," "gold," "silver" and "certified") are based on the level of environmentally friendly elements incorporated.

The "Green Globes" rating system originated in Canada but has migrated to the United States. The system was developed by the Green Building Initiative organization, which identifies sustainably designed facilities. Originally, the group addressed existing buildings. It now offers an online "Green Globes for Existing Buildings" assessment and rating tool.

Today, LEED and Green Globes are the most widely recognized rating systems. While there are similarities between the two, there are also differences. For example, both use the Energy Star® Portfolio Manager, and both regularly evaluate and enhance their certification tools based on user feedback. LEED requires detailed documentation at every step, but Green Globes does not. While it may not be easier to earn Green Globes certification, their process is simpler and less expensive than LEEDS.

A third rating system, the Collaborative for High Performance Schools (CHPS), defines design criteria required for a high-performance facility. This rating program is specifically designed for K-12 schools. Its mission is to "facilitate the design, construction, and operation of high performance schools: environments that are not only energy and resource efficient, but also healthy, comfortable, well lit, and containing the amenities for a quality education."

Although these certification programs focus for the most part on new construction, older buildings can go green too. Some suggestions would be to convert school buses to alternative fuels, encourage biking and walking by students and faculty, reduce water consumption and recycle! Schools can also buy local, use green cleaning products and take advantage of natural light. All of us can do something to improve our learning and living environments.

If you have further interest in this topic, consider reviewing the following:

Greening America's Schools. Costs and Benefits. Gregory Kats. October 2006. A Capital E Report. www.cape.com.

—Alida Cataldo

New Icons Denote Green Products and Curricula

Look for these icons! You'll find them on products that highlight our commitment to promoting and teaching sustainability practices in our schools.



Our "Teach Green" icon identifies products that support teaching green chemistry or green technology.



Our eco-friendly products icon illustrates the role of science in protecting our environment. It identifies products built using sustainable, low waste, low energy processes.

You'll find these alerting you to green products in the new Fisher Scientific Education 2009 catalog and other Fisher Scientific Education product advertisements.



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- Renewable-plant-derived formulation, phosphate free, no glycol ether, ozone safe, phthalate free

ALL-PURPOSE CLEANER	32 OZ	1/EA & 12/CS	CAT NO S95747	8.50 EA	102.40 12/CS
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ALL-PURPOSE CLEANER	5 GAL	1/EA	CAT NO S95765	153.80 EA	



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GREEN GAZETTE SOLAR CAR COMPLETES TRIP AROUND WORLD

In December 2008, Swiss teacher-turned-inventor Louis Palmer made history as he became the first person to drive a solar-powered car around the world.

Mr. Palmer's trek covered 32,000 miles through 38 countries and took 11 months to complete—without using a single drop of gasoline. Only two days were lost to breakdowns.

Similar to a race car, Mr. Palmer's solar car is a three-wheeled, two-seater made from aluminum, fiberglass and plastic, with some components, like its Renault-made steering wheel, borrowed from European automobiles. Its electric engine is powered by solar cells hauled on a trailer.

Mr. Palmer showed off his invention at the United Nations' climate conference in Poznan, Poland as proof that solar-powered automobiles are a viable commercial option. Prior to his global ride, Mr. Palmer commuted to work in his solar car every day for a year.

"These new technologies are ready," he said. "[They are] ecological, economical and absolutely reliable."

SAVINGS MADE IN THE SHADE?

We all know it's cooler under a shade tree in the summer heat, but can a tree cut your electric bill?

A California study showed that shade trees planted on the west and south sides of a house can save up to \$25 annually. Researchers measured the impact of tree placement on energy use in Sacramento, a city known for its hot summers and high use of air conditioning. They determined that tree placement was critical to saving energy; a tree planted on the east side of a house had no effect on energy use, but one planted on the west side can reduce net carbon emissions by 30% over a 100-year period.



In 2006 the Sacramento Municipal Utility District gave away 16,000 free trees to residents at a cost of \$1.36 million. The district expects to recover its investment over 26 years if homeowners place their trees correctly.

MAINE'S WILD HIGHWAY

Balancing the needs of both motorists and wildlife, the new Gorham, Maine, Bypass is not your typical highway. Opened in 2008, the 3.4 mile road features design elements that allow animals to cross it without risk to themselves, or to drivers.

Oversized culverts double as drainage pipes and wildlife tunnels for salamanders, turtles and raccoons. Extra-wide bridge spans create natural underpasses for moose and deer. Fences and vegetation act as funnels to herd the animals through the manmade crossings. The network reconnects animals to important habitat areas such as seasonal breeding or feeding grounds.

Wildlife crossings such as the Gorham Bypass are part of a global initiative called "roadway ecology" which seeks to

minimize the impact of highways on habitat and to lower the number of highway accidents involving animals and motorists. The Maine Department of Transportation incorporated the animal-friendly features into the Gorham project at little cost to the \$28 million project. A federal grant will allow state officials to monitor animal movements and gauge the design's effectiveness.

CAR PARTS FROM... COCONUTS?

Baylor University researchers have identified low-cost automotive components that can be made from coconuts. Tests show that coconut husk fibers have properties as good or better than synthetic polyesters in the manufacture of compression-molded composites such as door covers, panels and trunk liners.

If automakers accept coconut-made parts as a cost-effective, viable option, the researchers estimate that it could be an economic boon for the world's 11 million coconut farmers, most of whom live in poor Equatorial regions.

Algae-powered flight?

In January 2009, Continental Airlines tested a prototype aviation fuel derived from algae and jatropha, a tropical shrub.

Continental's test in Houston, TX, was the first in North America to use an alternative fuel and the first to use a twin-engine aircraft, a Boeing 737-800. The flight lasted two hours.

Airlines around the world are seeking sustainable replacements for today's Jet-A1 kerosene fuel. According to Paul Steele, executive director of the Air Transport Action Group, "Algae has been identified as a promising alternative, so we are eager to see how it performs under normal operating conditions."

GOOD NEWS, BAD NEWS FROM WWF

The World Wildlife Federation (WWF) released its 2009 list of the planet's nine most at-risk species. The iconic polar bear and giant panda appear on the list. Poaching, habitat loss and climate change-related factors imperil these species, WWF says.

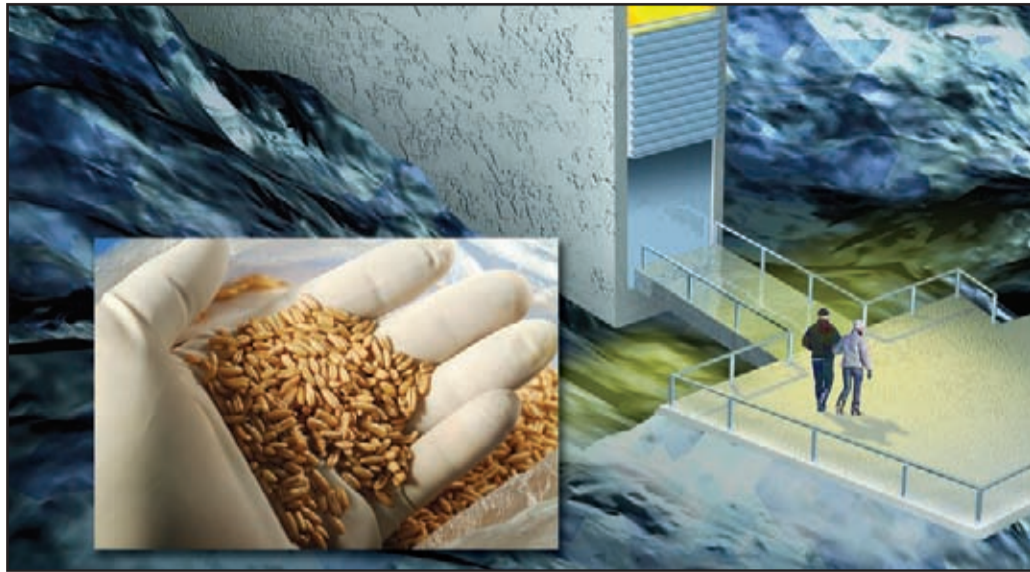
On a brighter note, WWF released a list of more than 1000 new species discovered or newly identified in the Greater Mekong Region of Southeast Asia in the decade spanning 1997-2007. Among the new discoveries were the Laotian Rock Rat—thought to have been extinct for 11 million years—a pink dragon millipede, and the Siamese Peninsula Pit Viper. The list contained 519 plants, 279 fish, 88 frogs, 88 spiders, 46 lizards, 22 snakes, 15 mammals, four birds, two turtles, two salamanders and a toad.

WWF cautioned that economic development and environmental protection must be balanced to provide for the welfare of human communities as well as to sustain wildlife and natural habitats.

—Dan Skantar

THE DOOMSDAY VAULT

Nuclear war. An asteroid. Severe climate change. Human beings might survive such catastrophic events, but not for long—if there's nothing to eat.



In February 2008, doors opened to the "Doomsday Vault," a fortress designed to safeguard the world's agriculture from disaster. Built into a mountainside on a remote island near the North Pole, the Svalbard Global Seed Vault can house two billion seeds. Its high walls of fortified concrete, armored air-locked doors, and sensor alarm enable it to withstand a nuclear missile attack, a plummeting plane or an unauthorized intrusion.

Seed banks are necessary not only to stave off starvation, but to preserve crop biodiversity—the biological base of agriculture. Only about 150 crops are cultivated on any significant scale worldwide, but each comes in a vast range of different forms. Height, color, fruiting time, seed size, or flavor may vary. Ability to withstand cold, heat, or drought or tolerate pests and diseases may differ. Even nutritional qualities can range from variety to variety. Farmers and scientists use these differences to ensure productive harvests.

Approximately 100 countries maintain their own seed banks, which hold a total of about 6.5 million samples in 1400 facilities. But a typhoon wiped out the rice bank in the Philippines. The Taliban destroyed Afghanistan's seed store. A power failure ruined the seed bank in Cameroon. Iraq's bank was demolished during the war. And pathogens, pests and natural disasters demolish entire crops—and their seeds—all too frequently.

Svalbard serves as a backup for farmers and researchers who look to seed banks for plant varieties and traits that they need. Should a seed bank lose its inventory for any reason, the collection could be replenished from Svalbard.

A fortress for foods

The Svalbard vault consists of three rooms built about 394 feet into a mountain on Norway's Svalbard archipelago. Svalbard was chosen for several reasons. Radiation

levels are low, the area's geological structure is sound, and vulnerability to potentially high water levels is absent. Its cold climate and permafrost are ideal for underground cold storage. The vault is refrigerated; but if the mechanical system fails, vault rooms will remain naturally frozen for up to 200 years, even in the worst-case scenarios of global warming.

Security is tight. Motion detectors are set up around the site. Polar bears, which roam freely and frequently, are an effective deterrent. If a visitor gets past the external security, they'll then have to pass through four locked doors. Keys are coded to allow access—not all keys will unlock all doors. To further protect Svalbard's treasure, each box of seeds is scanned before it is placed in the vault.

How are they preserved—and how long can they last?

Seeds are stored at -18°C (-0.4°F) and sealed in specially designed four-ply foil packages. The packages are then sealed inside boxes and placed on shelves inside the vault. Each vault is surrounded by frozen arctic permafrost, ensuring the continued viability of the seeds, should the electricity supply fail. The low temperature and moisture level inside the vaults keeps metabolic activity low, lengthening the seeds' "shelf life."

The length of time that frozen seeds maintain their ability to germinate depends on the species. Some seeds may survive for only 20 to 30 years. But, when properly stored and maintained at -20°C (about -4°F), others will remain viable for a millennium or more. For example, barley can last 2000 years, wheat 1700 years, and sorghum almost 20,000 years. When seeds approach the end of viability, they're taken from storage and planted. Fresh, new seed is then harvested and placed in storage, perpetuating the original variety.

A global resource

The Svalbard Global Seed Vault was funded and built by Norway as a service to the world. On opening day, 100 million seeds from more than 100 countries were deposited. The seeds ranged from unique varieties of major African and Asian food staples such as maize, rice, wheat, cowpea,

and sorghum to European and South American varieties of eggplant, lettuce, barley, and potato. That first deposit—which took 70 years to collect—represented the most comprehensive and diverse collection of food crop seeds held anywhere in the world.

The Global Crop Diversity Trust is responsible for collecting and maintaining inventory. Priority is given to crops that are important for food production and sustainable agriculture; genetically altered seeds are not accepted. There is no charge for depositing seeds, and the countries that deposit seeds own them. Seed boxes are sealed by the depositors and not accessible to anyone other than the depositor. And a seed cannot be removed unless it's replaced by a fresh sample or is needed to plant a crop that's been wiped off the Earth.

A hedge against disaster

According to the United Nations Food and Agriculture Organization, hundreds of thousands of plant varieties representing as much as 75% of genetic diversity have been lost during the last century. And we lose another one every day. In the 1800s, for example, Americans were growing 8100 varieties of apples. Today, about 7100, or 86%, of those varieties are extinct. In 1903, U.S. farmers used 578 varieties of beans. Eighty years later, just 32 still existed, protected in gene banks.

Scientists help prevent famines by examining the genes of tens of thousands of plants, looking for those that can fight disease, drought or other problems. A particular strain of wheat that had been grown for thousands of years was deemed useless for food, but it had a "superhero" gene that fought wheat disease. Today, that gene is bred into much of the wheat that's in our bread.

The "Doomsday Vault" could become our last best hope. Impervious to most natural and manmade catastrophes, the vault provides a measure of insurance that food production can be restarted anywhere on the planet.

For more information about the Svalbard Global Seed Vault, visit www.croptrust.org or www.seedvault.no.

—Alida Cataldo



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feed the mind, body and spirit. They bring science to life and healthy food to the table. Teachers with students of different ages, in differing circumstances, with diverse goals and objectives, plant seeds in the sustainable EarthBox to harvest knowledge, health and hope. Numerous studies show that students in garden-based programs score higher than their peers across all standardized tests and have higher grade point averages. Research also shows that children who plant their own fruits and vegetables are more likely to eat them and to increase overall consumption.

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Middle School Site Package	S93896	\$215.25
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200mm (8")							
-10° to $+110^{\circ}\text{C}$	1°	1°	50mm	20591-1	S95796	\$10.95	\$265.80
-10° to $+110^{\circ}\text{C}$	1°	1°	Total	20592-1	S95797	\$10.95	\$265.80
-10° to $+150^{\circ}\text{C}$	1°	1°†	50mm	20593-1	S95798	\$11.45	\$279.55
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20° to 230°F	2°	2°	50mm	20597-1	S95800	\$10.95	\$267.00
20° to 230°F	2°	2°	Total	20596-1	S95801	\$10.95	\$267.90
20° to 300°F	2°	2°	50mm	20599-1	S95802	\$11.25	\$271.60
20° to 300°F	2°	2°	Total	20598-1	S95803	\$11.25	\$271.60
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-20° to $+110^{\circ}\text{C}$	1°	1°	76mm	20505-1	S95804	\$12.95	\$317.00
-20° to $+110^{\circ}\text{C}$	1°	1°	Total	20500-1	S95805	\$12.95	\$317.00
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-20° to $+150^{\circ}\text{C}$	1°	1°†	Total	20510-1	S95807	\$12.95	\$317.00
0° to 230°F	2°	2°	76mm	20535-1	S95808	\$12.80	\$313.00
0° to 230°F	2°	2°	Total	20530-1	S95809	\$12.80	\$313.00
0° to 300°F	2°	2°‡	76mm	20545-1	S95810	\$12.95	\$317.00
0° to 300°F	2°	2°‡	Total	20540-1	S95811	\$12.95	\$317.00

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A CLOSER LOOK AT THE BITE IN CRIME

In the forensics community, a raging debate continues over whether bite marks alone are enough to warrant a conviction in a criminal case. In the past, comparisons of what was once thought to be unique bite impressions on victims were used to convict suspects of violent crimes.

Today, those convictions are being called into question.

Many scientists feel that not enough research has yet been applied to the science of dental forensics to warrant convictions based exclusively on bite-mark evidence.



How Bite Marks Are Used As Criminal Proof

Teeth are often used as weapons when one person attacks another or when a victim tries to ward off an assailant. When this happens, the impressions left on the victim are recorded as evidence, so that a possible comparison can be made with the shape, size, and patterns present in the mouth of the alleged attacker.

This comparative analysis is often difficult, however, since human skin is curved and elastic, and has frequently undergone extensive bruising and trauma from the attack. Conclusions can still be reached about the role a suspect may have played in the crime, even if the bite marks cannot be matched conclusively.

Casting Doubt on the Reliability of Imprint Evidence

In recent years, several cases relying heavily on bite marks have been overturned with the introduction of new evidence based on DNA results from saliva retrieved from the same victims.

A 2004 Chicago Tribune series, "Forensics Under the Microscope," showed DNA tests have proved wrong many of the leading bite-mark experts.

The series examined 154 cases involving bite-mark comparison (most of which were murders and rapes) that reached appeals courts around the country. Their research found that, in more than one-quarter of these cases, forensic dentists for the prosecution and for the defense gave diametrically opposed opinions.

In the case of Robert Stinson, who was convicted in 1984 for murder, new DNA tests proved he was not the source of saliva found on the victim. A 63-year-old man had been beaten to death and bitten eight times. Stinson was subsequently sentenced to life in prison for this murder. Stinson has always maintained his innocence and now has renewed hope this evidence will eventually win back his freedom.

One of the premier scientists in this field, Dr. Raymond Rawson, helped send two men to death row in Arizona. In both of these cases, his work was later undermined, much as the evidence was in the Stinson case, resulting in one of these men being set free.

Making a Case for the Future of Forensic Dentistry

While dental forensics may have redeemable value in the law-enforcement arena, many feel it is too early in the life of the science to offer indisputable proof.

Dr. L. Thomas Johnson and law professor Daniel Blinka, part of the team that worked to convict Stinson, defended the validity of bite-mark evidence, and stand behind their argument in 1984 that led to Stinson's conviction.

"What we want to show," said Johnson, "is that it's not a faulty science if it's done properly, and there is a solid statistical basis behind it."

In his research, Johnson gathered dental molds from more than 400 Air National Guard members and scanned them into a computer. He then established six identifying characteristics for those bite patterns.

Johnson's goal is to build a significant database for bite patterns, similar to the system in place worldwide for fingerprints. He believes if a sufficient number of bite patterns are gathered using specific and consistent marking points, much like the direction, flow, and patterns currently identified in fingerprints, forensic dentists could establish the frequency of dental patterns and produce more reliable identifications.

"This is only a starting point," Johnson said. "This isn't the Rosetta stone that's going to solve all the problems. We're not ready for prime time yet. But what it has done is answered the question of whether there is any science behind this."

David Sweet, a professor of odontology (the science that deals with the study of the teeth) at the University of British Columbia who has been working on a similar study, said Johnson's research is much needed.

"Right now it's a discipline based on an opinion," Sweet said. "But in order to express that opinion in real terms, what we need to know is if anybody in the population has the same dental traits as the suspect."

Gregory Golden, a member of the American Board of Forensic Odontology, oversees the guidelines for the use of digital imaging in bite-mark analysis—a tool that has improved the ability of odontologists to comprehensively compare bite marks.

Although not quite ready to stand alone in court, as new methods continue to be developed and incorporated, dental forensics could soon be included as a reliable and definitive form of criminal investigation and conviction.

—Valinda Huckaby

THE NINTENDO® Wii Fit™

You Probably Won't Get Ripped, But It Might Help Your Health a Wee Bit

In the mood to dodge flying cleats and panda bear heads? (And no, this isn't Kung Fu Panda 2 or a bad reaction to the cafeteria food that hits you at soccer practice.) Perhaps you'd like to increase your Spider-Man flexibility with some human pretzel-inducing yoga poses? Best of all, what if you could do these things from the privacy of your very own room, with no guy built like the Rock snickering at you by the free weights.

Welcome to the exciting universe of Nintendo's Wii Fit, where the fitness craze meets the video gaming world. Unlike the pleasures of rocking out with Aerosmith in the Guitar Hero series or blowing things up in Call of Duty 4, Wii Fit offers the potential for more concrete real-world benefits, such as improved physical fitness, or at the very least, an improved awareness of health and fitness.

Wii WILL ROCK YOU! The Lowdown on the Wii Workout

The Wii Fit package offers approximately 40 games in four basic categories (Aerobics, Yoga, Strength Training, and Balance Games) and comes with an array of physical fitness measurement tools. The Balance Board, for instance, is the first game component and can perform weight and body balance readings. Special features include a health pre-assessment, incorporating such factors as your height and age, along with a balance test. The Wii Fit gives you your Body Mass Index (BMI) and your Wii Fit Age, the game's interpretation of how old you are fitness-wise vs. your actual age.

Just Say "Oui" to Wii

Robert Dothard, a fitness training expert, believes the game will catch on with people who might be reluctant to go to a gym and work out in front of people. For Dothard, the

game's biggest strength is giving users the opportunity to see where their core balance actually is, allowing them to exercise more effectively.

David Dziewaltowski, a researcher at Kansas State University, thinks "there is a big future in games that use emerging technologies and require movement because the games will be enjoyed by children and also be more healthy than existing games."

In the October 2008 issue of *Exercise and Sport Sciences Reviews*, Dziewaltowski points out game systems like Wii are beneficial because "anything that gets people to move more than they have in the past is positive." For Dziewaltowski, one of the strengths of the Wii Fit is that, like more traditional fitness programs, it offers a system for creating and monitoring health goals and activities.

Ben Sawyer, one of the founders of the Games for Health Project, thinks fitness platforms like the Wii Fit are a step in the right direction. But the degree of their impact will be dependent on their use in schools and gyms. Some similar full-body movement games, such as Dance Dance Revolution, for example, have already been utilized as part of some school curriculums.

"HOUSTON, Wii HAVE A PROBLEM": Some Weaknesses of the Wii

Even with all the potential health benefits of the Wii Fit, however, there are still some concerns. Games tend to be rather short (less than ten minutes) with an explanation of scoring after each game. There is currently no way to create a customized, longer workout made up of the various games without interruptions.



Some game testers for *Consumer Reports* did not find the aerobics games particularly difficult, though they were fun. According to testers, the yoga activities were also not the best introduction to the basics of breathing and form. Someone serious about learning yoga would be better off perhaps with an experienced, real-world yoga instructor.

Another area of concern, which is also true for many other Wii games, is injuries from repetitive strain, such as carpal tunnel syndrome and tennis elbow (elbow strain). If you are just starting out with no recent history of physical activity, it is best to begin slow and limit your time to 20 to 30 minutes on the Wii Fit. A warm-up of some type, such as stretching, is also recommended.

For Dziewaltowski and others, the potential problem of the Wii Fit is in people's attitudes. If they are trying to use the Wii as a substitute for outside activities that require more effort and movement, then that could become a negative factor for their health.

So Where Do Wii Go From Here?

Because of the growing popularity and strong sales of video games that incorporate body movement like Wii Fit, experts have started to do studies to evaluate their health effect. Last fall, Scott Owens, a researcher from the University of Mississippi, began a study monitoring eight families using the Nintendo Wii to see if the games have any overall impact on their health.

While there are some definite issues, the positive potential health benefits of the Wii Fit appear clear. As the creator of the Wii Fit, Shigeru Miyamoto, said, "I don't think Wii Fit's purpose is to make you fit; what it's actually aiming to do is make you aware of your body." But that key understanding could in turn lead many to a healthier lifestyle and an overall habit of fitness.

—Jason Akerman



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LEAPING PTEROSAURS TAKE TO THE AIR

Pterosaurs (based on the Greek, "winged lizard") have been part of many a child's imaginary visit to the land of the dinosaurs. Also referred to as pterodactyls ("winged fingers"), these unforgettable creatures are actually not dinosaurs—surprising news to many of pterosaur's young fans—but rather, flying reptiles.

Almost always shown by the popular press as soaring through the air, the impression we have is that the pterosaur had no problem getting airborne. To the contrary, the process by which a pterosaur takes to the skies has been the subject of much debate among paleontologists.

Inhabiting the Earth 220 to 65.5 million years ago during the late Triassic period to the end of the Cretaceous period, pterosaurs have been shown through the fossil record to have been creatures of widely varying size and weight, from bird-size to a colossus with a 30-foot wingspan. Viewing its puzzling anatomy, the discoverer of the first pterosaur fossil in 1784, Cosimo Collini, believed this extinct creature to be aquatic, using its long front limbs as paddles. This aquatic view was later replaced by the vision of the flying reptile soaring over giant ferns and *Tyrannosaurus rex*.

The fossil record on the pterosaurs is limited, and the reptile's hollow bones do not preserve well. Nonetheless, fossils for more than 60 genera have been found, spanning every continent except for Antarctica. Fossils suggest that the pterosaurs' most characteristic feature, their wings, were not bird-like. Fibrous skin and other tissues formed a membrane that stretched between a highly elongated fourth finger and the side of the body.

Just because pterosaurs were believed to take flight, they were often associated with birds, at least a bird-like approach to take-off. Birds characteristically use their strong back legs to launch themselves into the air, at which time their flapping wings take over to complete their ascent. But birds are not pterosaurs, and the bird model of flight, with much reliance on their light weight and strong back legs, just doesn't work, as confirmed by computer models



generated by Michael Habib of the Center for Functional Anatomy and Evolution at the Johns-Hopkins University School of Medicine. They would simply not be able to get their bulk off the ground and into the skies.

But other factors were working to assist these reptile to fly. Rather than scrawny and fragile like they appear in many illustrations, these creatures are thought to have been very strong. As Habib, author of the recent study on pterosaur flight, said, "They're actually built a lot more like Arnold Schwarzenegger than Urkel."

Moreover, their specialized anatomy gives them (literally) a real boost. Two limbs were not enough to do the trick, but the use of four limbs, especially with strong front limbs/wings, made all the difference to these reptiles' get-away time, comparing running away from predators to flying out of their reach. From a resting position with the knuckles of the front wings, these creatures are thought to have used a "leap-frogging, long jump" motion to launch themselves into the air. Considering the size of these pterosaurs was comparable to our modern-day giraffes,

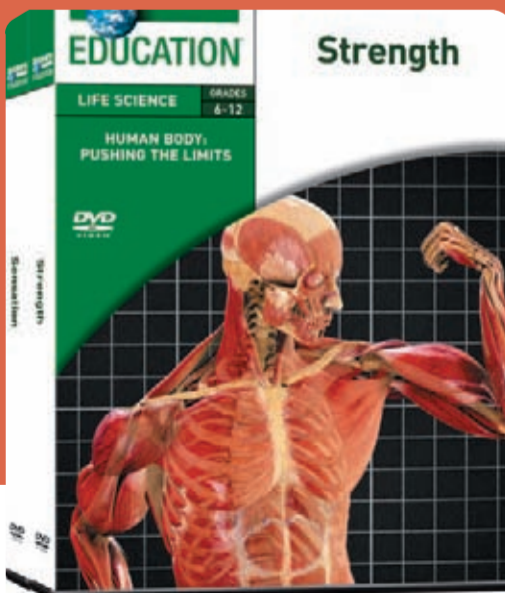
their leap into flight must have been a sight to behold. But Habib, using estimated strength of pterosaur bones and computer modeling, has confirmed that the four-legged approach could have gotten them off the ground in less than a second. Quite an achievement, and one that must have left even the *Tyrannosaurus rex* in the dust.

—Merry Morris

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2007 TIMSS PROVIDES INTERNATIONAL VIEW OF KNOWLEDGE AND SKILL IN MATH AND SCIENCE

How are U.S. students performing in mathematics and science relative to the rest of the world? Not an easily answered question, but the results of the 2007 Trends in International Mathematics and Science Study (TIMSS) are giving educators an idea how well our students are doing and how they compare to students in other countries.

The 2007 version of the study is the fourth of its kind since 1995. Designed to generally parallel mathematics and science curricula in the 58 countries that participated, this recent study highlights for educators how well students have learned their math and science lessons at school. It samples students in the equivalent of fourth and eighth grades. Comparisons over time, say between 1995 and 2007, can also be made among those countries that participated in both studies. For example, in science testing for the fourth graders, 16 countries were part of the evaluation in both years, and for eighth graders, 19 countries.

Science Results

TIMSS looks at “knowing, applying and reasoning” skills over four broad areas of science: physics, chemistry, life science and earth science, plus a dimension called “scientific inquiry.”

According to the 2007 study figures, the average U.S. fourth-grade science score was higher than those of students in 25 of the 35 other participating countries. At eighth grade, the average U.S. science score was higher than the average scores of students in 35 of the 47 other participating countries.

Within the U.S., science achievement for both fourth- and eighth-graders showed no marked change over time, with the fourth-graders’ 1995 score of 549 being closely matched by the 2007 score of 539. The comparable eighth-graders’ scores were 513 in 1995 and 520 in 2007.

However, looking internationally, the percent of U.S. fourth-graders exceeding the advanced international benchmark dropped as compared to the 1995 level. (19 percent compared to 15 percent). That downward trend was reversed among the eighth-graders between 1999 and 2007, where 12 percent of the students achieved at or above the advanced international benchmark compared to the earlier 10 percent. That trend was not evident between 1995 and 2007.

Across all the participating countries, the picture was mixed. For fourth-graders, an improvement in average science scores (7 of 16 countries) was more prevalent than declines (5 of 16 countries) from 1995 to 2007. For eighth-graders, roughly one quarter of the countries improved their scores, with only three of the 19 countries experiencing a decline.

Fourth- and eighth-graders in Singapore achieved the highest science scores.

Math Results

The mathematics content areas covered by TIMSS include number, measurement, geometry, data and algebra, and the test investigates “knowing, applying and reasoning” skills, as for science assessments.

In the mathematics area, 16 countries collected data for the fourth-graders and 20 for the eighth-graders in both 1995 and 2007.

Overall, the average U.S. fourth-grade mathematics score was higher than those for students in 23 of the 35 other countries tested. For eighth-graders, the average U.S. score was higher than 37 of the 47 other countries.

Within the U.S., a clear improvement in fourth- and eighth-graders’ score points was observed between 1995 and 2007: 11 points for the younger students and 16 for the older ones.

The comparison of student performance against the advanced international benchmark in math showed no change between 1995 and 2007 for either fourth- or eighth-graders.

For the participating countries, one-half of the fourth-graders improved their average math scores from 1995 to 2007, with one-quarter declining. Comparable evaluations for eighth-graders showed the reverse: one-quarter of the countries improved their scores and one-half lost ground.

In mathematics, the highest scores among fourth-graders were achieved by students in Hong Kong. For eighth-graders, the highest achievers were from Chinese Taipei.

Other Evaluation Statistics

TIMSS is not the only tool educators can use to evaluate performance. The National Assessment of Educational Progress (NAEP) provides data for fourth-, eighth- and twelfth-graders in a number of subjects. Similarly, the Program for International Assessment provides data for performance of 15-year-old students internationally.

No matter which assessment is used, having precise data on student performance can only help the development of future educational programs in both the U.S. and abroad.

—Merry Morris



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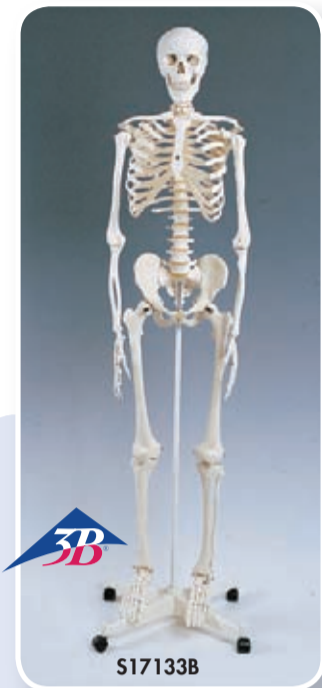
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CD REVIEW



S&SCS CHEMICAL MANAGEMENT SYSTEM

LINDA STROUD

A companion piece to the Science Laboratory Safety Manual, Second Edition, 2008 (see below left), this CD can be a valuable resource for schools intent on promoting chemical safety and careful management of chemicals.

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Also included on the CD for the convenience of the user are a chemical justification form, chemical substitution list, special hazards information and more.

—Merry Morris

BOOK REVIEW

SCIENCE LABORATORY SAFETY MANUAL, SECOND EDITION, 2008

LINDA STROUD

COMING SOON! from FISHER SCIENCE EDUCATION ORDER S98168

This spring-bound manual covers a multitude of topics of direct use in making science classes, labs and demonstrations safer and more compliant with the pertinent laws, codes, regulations and standards.

In addition to an information-packed introduction, Dr. Stroud presents chapters on Legal Concerns; Student Involvement; Biohazards and Radiation; Chemical Management; Safety Facilities; First Aid; Laboratory Glassware, Hardware and Equipment; Personal Protective Equipment; and Elementary Science Safety. The Legal Concerns section includes discussions of various types of negligence, important reading in order to understand the nuances of a teacher's or administrator's responsibilities. In the Student Involvement section, the author presents a discussion of student safety "contracts" (also referred to as agreements or acknowledgements) and provides an example of a safety contract.

Counteracting the misbelief that safety concerns are limited to the chem lab, Dr. Stroud presents in the Biohazard and Radiation section essential information related to biohazards, including a discussion of Methicillin-resistant *Staphylococcus aureus* (MRSA). In Chemical Management, topics range from toxicology, classification, and labeling systems through prevention and cleanup of spills. For the teacher seeking to reduce some of the risks inherent in certain chemical reactions, the section includes suggestions

for substitution of less hazardous chemicals in labs and demonstrations.

Need to design lab space with safety in mind? The Facilities section includes a planning system for the design of a safe workspace as well as ventilation, electrical and fire hazards and more. Considering the many types of injuries that can occur in the lab, first aid issues are broad, and this section provides clear instructions on what actions should be taken in the event that mishaps should occur. For the nitty-gritty precautions to take working with glassware and other lab apparatus, you can refer to the Laboratory Glassware, Hardware and Equipment section. A highly effective set of photographs in the PPE section portrays graphically the need for chemical splash goggles for wet labs.

Because science is not just for "big kids" these days, the Elementary Science Safety section is well worth reading. Precautions for child-friendly activities with plants or animals, chicken embryos, culturing microorganisms, chemical labs and field trips are outlined along with discussions of facilities, electrical hazards and first aid.

The broad range of topics covered and their concise presentation make this manual a great resource for both teachers and administrators alike.

—Merry Morris

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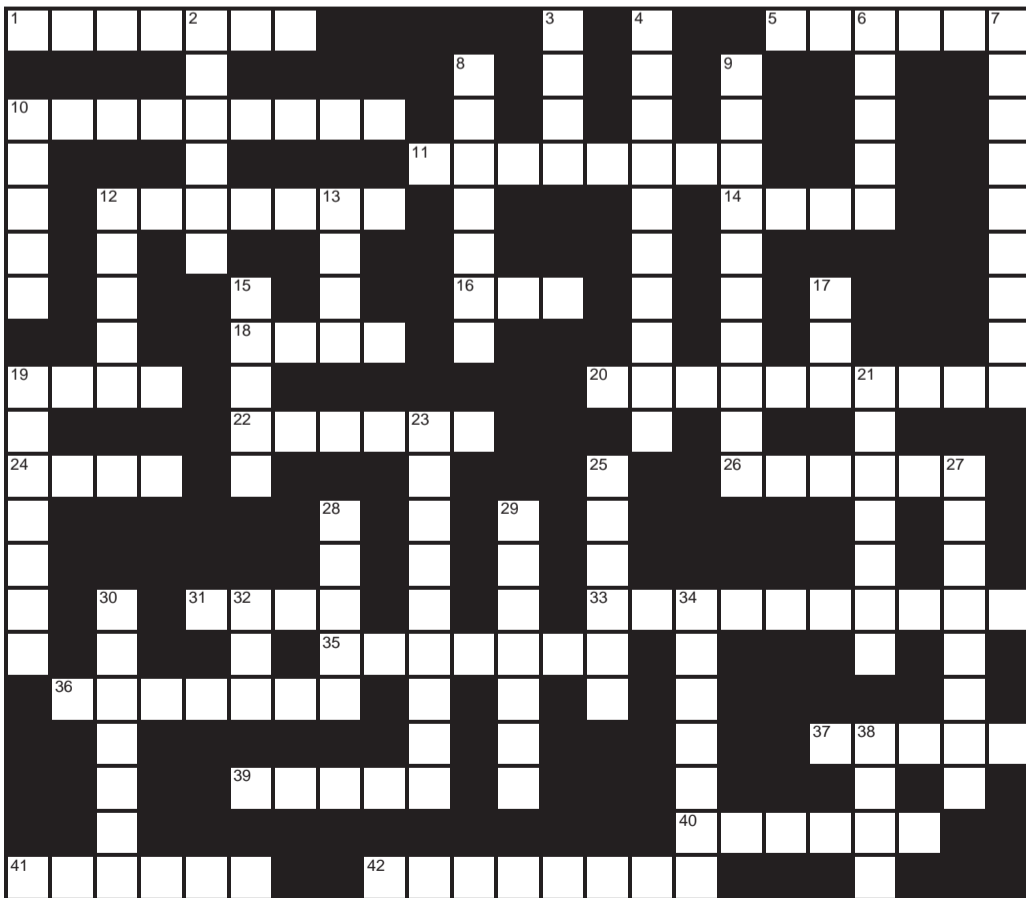
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ACROSS

- Infrared light and radio waves give better views of the center of the Milky Way than does _____ light. (p. 7)
- Coconut husk _____ have properties as good as or better than synthetic polyesters. (p. 15)
- Fourth- and eight-grade students in this country scored highest in the science portion of the TIMS Study. (p. 21)
- To find a replica of Stonehenge, go to _____ in Washington state. (p. 4)
- Using the Wii Fit®, you can play Aerobics, Yoga, Strength Training or _____ Games. (p. 18)
- The _____ program recognizes leadership in developing green buildings. (p. 14)
- PET scans may be used to gain a better understanding of brain diseases such as Alzheimer's, Parkinson's and _____. (p. 11)
- To become airborne, pterosaurs needed the use of both their strong front and _____ legs. (p. 20)
- The Wii Fit® can calculate your Body _____ Index (BMI). (p. 18)
- Molecules making up resealing rubber. [two words] (p. 3)
- Students at _____ University in the Netherlands discovered an extrasolar planet. (p. 6)
- Student who have more natural light in their classrooms have made better progress in reading and _____ classes. (p. 14)
- Emergency response personnel travel to Disaster City to learn _____-and-rescue techniques. (p. 2)
- Trees planted on this side of a house can reduce net carbon emissions. (p. 15)
- The study of teeth. (p. 17)
- The star associated with the new extrasolar planet is the _____ star ever found to have a planet. (p. 6)
- The pterosaurs' wings were made of fibrous membranes that stretched from their fourth _____ to their sides. (p. 20)
- In a recent study using PET, study volunteers were injected with this marker to make plaques and tangles easier to spot. (p. 11)
- PET scans have been called "windows into the _____." (p. 11)
- Researchers are looking for ways to use oxytocin in patients with schizophrenia and _____. (p. 9)
- The "Doomsday Vault" was funded and built by _____. (p. 16)
- Bite impressions have been used to convict defendants in _____ cases. (p. 17)

DOWN

- Darwin set sail on the H.M.S. _____ as a naturalist. (p. 10)
- One goal of the Wii Fit® is to increase _____ awareness. (p. 18)
- New _____ drilling techniques extract natural gas from shale rock. (p. 1)
- Charles Drew set up the first _____ banks in the U.S. and U.K. (p. 2)
- These may be able to stave off famine in the event of global agricultural disaster. [two words] (p. 16)
- Wildlife crossings as built in Gorham, Maine, are part of program called "_____ ecology." (p. 15)
- We can now measure time to about 30 _____ of a second per year. (p. 5)
- Louis Palmer drove this kind of car around the world. (p. 15)
- Over 20,000 years ago, Ice Age hunters marked _____ to measure the time between phases of the moon. (p. 5)
- Ethanol, when used as a biofuel, is made from this crop. (p. 1)
- Oxytocin is important for parent-_____ relationships. (p. 9)
- Recent studies have pointed out cases in which bite analysis and saliva _____ conflicted. (p. 17)
- Monkey-see, monkey-do. (p. 10)
- A team from this university developed a means to control when and for how long future insect spies flap their wings. (p. 8)
- The Sputnik virus may have a role in the _____ of other viruses. (p. 13)
- The new technology introduced to Disaster City was the use of rescue _____. (p. 2)
- Fourth graders in this city scored highest in the math portion of the TIMS Study. [two words] (p. 21)
- These are excellent candidates for insect super spies. (p. 8)
- Windmills used to generate energy capture _____ energy and convert it to electricity. (p. 1)
- The _____ Space Telescope is helping astronomers better understand the star formation process. (p. 7)
- Doses of oxytocin increase _____ contact. (p. 9)
- Mimivirus is large enough to be seen with an _____ microscope. (p. 13)
- The birth of a star begins within a cloud of _____ and gas. (p. 7)



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