Bulletin of the

Connecticut Academy of Science and Engineering

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Activities of the Academy

Following is a list of major recent reports of the Academy. Reports are available for a nominal fee from the Academy office or website; executive summaries of the most recent reports are available on the Academy website at www.ctcase.org.

"Study of Radiation Exposure from the Connecticut Yankee Nuclear Power Plant" (2001)

"A Study of Bus Propulsion Technologies Applicable in Connecticut" (2001)

"Efficacy of the Connecticut Motor Vehicle Emissions Testing Program" (2000)

"Indoor Air Quality in Connecticut Schools" (2000)

"Efficacy of MTBE Use in Connecticut" (1999)

"Radon in Connecticut: Quantitative Perspectives about Effects on Public Health" (1998)

"Building Agricultural Biotechnology in Connecticut" (1997)

"Status of Connecticut Critical Technologies" (1997)

"Evaluation of Critical Technology Centers" (1996)

"Science and Technology Policy: Lessons from Six American States" (1994)

"A State Science and Technology" Policy" (1992)

"Electromagnetic Field Health Effects" (1992)

"Economic Impact of AIDS Health Care in Connecticut" (1990)

'Moletronics' May Hold Key to Faster, Cheaper Computing Power

A longer version of this article appears on our website at www.ctcase.org

Yale engineering professor and Academy member Mark Reed, working with colleagues at Yale and elsewhere, has developed molecules that could replace the silicon devices at the heart of your computer. What's more, these molecular devices show promise of performing more efficiently, more powerfully, and more economically than the silicon structures that are now in use.

Reed's field of molecular electronics, or moletronics, was made possible in the1980s with the development of tools

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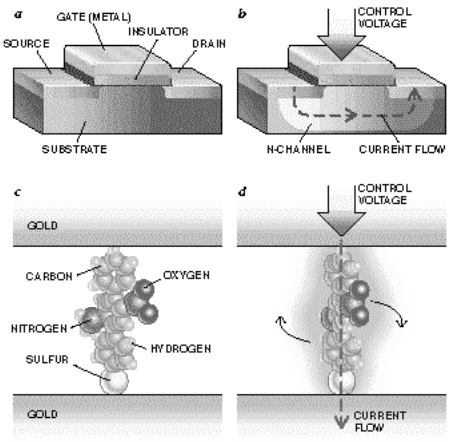

The conduction path in a conventional microelectronics transistor is turned on using an applied voltage at the gate electrode. Similarly, the conduction path through a molecular switch is turned on by an applied voltage. The applied voltage is believed to cause a conformational shift which, in concert with the charging of the molecule, opens the conduction pathway. (Photo: Mark Reed)

News from the National Academies

The following is excerpted from press releases of the National Academies and from *Infocus Magazine,* a news resource of the National Academies which can be found at *www.infocusmagazine.org*

◆ A Biological Terrorism Strategy

Epidemiologist Donald Henderson, former director of the Center for Civilian Biodefense Studies at Johns Hopkins University who was recently appointed director of the Department of Health and Human Services' new Office of Public Health Preparedness, urges the United States to develop a national strategy for dealing with bioterrorism in an editorial in the Spring 2001 issue of the National Academies' *Infocus* magazine. Noting that biological weapons such as smallpox and plague are now thought to pose large-scale threats comparable to those from nuclear weapons, he says that "policy-makers have only begun to appreciate that the release of a biological agent would result in an epidemic and that physicians, nurses, and public health officials would be the first to respond to the needs of acutely ill patients."

He warns that planning and research activities related to bioterrorism have been "heavily dominated by those with little knowledge of infectious diseases and no experience in epidemic control," and that "unless bioterrorism is tackled with a much greater sense of urgency, the right practical expertise, and far more funding, the nation will continue to remain perilously vulnerable."

See http://www.infocusmagazine.org/1.1/opinion.html

(See National Academies, page 7)

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Moletronics *(continued from page 1)*

that allow scientists to perceive and manipulate individual atoms. It's a field that could boost computer technology right past the increasingly onerous limitations of silicon. Currently, computers based on silicon are continuing to grow in power and, at the same time, they're dropping in cost. But designers increase chip ability by miniaturizing the devices that computers use to remember and calculate. The smaller these devices get, the more designers can squeeze onto a chip, increasing its computing power.

As these devices crowd closer together, the chips become far more expensive to produce. Right now, a chip can hold about 42 million transistors, and a chip fabrication plant ("fab") costs over $1.5 billion to build. Both amounts will certainly grow, and many estimate that by about 2015, new fabs will be too expensive to justify.

Mark Reed began working on the project in 1991, along with chemist James Tour, currently at Rice University. By 1997, Reed was able to hold a single molecule between two tips of a specially designed scanning tunneling microscope, and measure the current it carried.

But that was only the beginning. To make moletronic computers a reality, the devices had to do more than merely let electrons flow through them. They had to control that flow.

The researchers found that by changing the structure of the molecule, they were able to alter its behavior. They added molecular fragments which distorted the way electrons moved around the molecule. This made it easier to change the molecule's shape. Applying a voltage to the molecule twisted it, disrupting the flow of electrons. Removing the voltage returned the molecule to its original shape, allowing current flow to resume. In other words, the molecule could act as a switch. It turned electricity on and off—a basic ability that a computer needs to process information in bits of 1 and 0.

The researchers have also been able to design a molecule that stores those bits—a molecular device that is able to act as a memory and in fact, it is this device that may become the first moletronic device to be incorporated into everyday life. It will be developed into a commercial product by the Molecular Electronics Corporation, a company founded in 1999 by Reed, Tour, Dave Allara and Tom Mallouk at Penn State University, and Brosl Hasslacher at Los Alamos National Laboratory.

Molecular memory devices, explains Reed, offer many advantages over conventional silicon devices. In a notable improvement over silicon memory, they are able to store information for about 15 minutes. The ability to hold memory longer is clearly significant. Silicon memory devices retain charged bits for only milliseconds before the charge leaks away. That means that each piece of information must

(See Moletronics, page 8)

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Communication

ALPHABET EXCHANGE. **Hartford** is home to an Internet startup that allows users to exchange email in both English and Arabic. Previously, sending email in Arabic required that both correspondents have compatible operating systems configured the same way; it also meant downloading Arabic language programs. Now, **Alawy LLC**, started by Norwich resident **Ahmed Alawy**, has developed a system that runs independent of the user's computer. The Java-based technology was originally written by Alawy so that he could communicate with his own friends and family. But the need for such a system, he believes, is widespread. Most of the world's 225 million Arabs are spread around the globe and they are increasingly interested in using the Internet to stay in touch.

BETTER RECEPTION. A technology recently launched by **Radio Frequency Systems (RFS)** of Meriden offers improved cell phone reception for users inside buildings and under tunnels. ClearFill is a broadband coverage network that is able to handle radio frequencies that range widely from 800 to 2000 MHz. This enables the system to handle cellular (800 MHz), Special Mobile Radio (900 MHz), and PCS (1900 MHz) services. "It is a way of distributing wireless signals in a closed space that is very cost effective and very easy to deploy," said **Alan Wulff**, a marketing manager at RFS. The need for in-building wireless capabilities is expected to increase as more users begin to take advantage of advanced technologies such as wireless data services.

DIAGNOSTICS. With a customized laptop able to perform 15 tests in 15 seconds, technicians for **Southern New England Telephone (SNET)** are able to gain access to important diagnostic information without going through the home office. The "Intelligent Field Device," part of a Technician of the Future initiative started by SNET's parent company, SBC Communications, provides information that includes line testings, cable routings, readings, and circuit history. The devices enable workers to make more service calls, as well as increasing their speed, time, and efficiency, according to SNET officials. The next generation of the device will provide wireless access to even more detailed information.

DUAL PURPOSE STEEPLES. So far, more than 20 Connecticut churches have allowed cell phone companies to mount microwave antennae on their steeples, and more such agreements are expected. Using steeples allows the phone companies to extend their services without erecting metal cell phone towers. In return, in addition to paying rent, they often restore or rebuild the church structures. "We always replicate the original design," said one company spokesman. In **Farmington**, for example, **Verizon Wireless** erected a new steeple atop the **First Church of Christ**. Although the new structure retained the shape of the original stone spire, the replacement was made of steel and fiberglass.

Education & Cognition

MULTIPLE INTELLIGENCES. After more than ten years, and $21.5 million dollars, **Hartford**'s latest magnet school opened in September on the campus of the **University of Hartford**. Designed with a curriculum that embraces Howard Gardner's theories of multiple intelligences, the building is capable of handling the latest technologies; it also offers special rooms for music, art, dance and body movement. Gardner believes that schools should nurture interpersonal and intrapersonal awareness, and physical and other abilities as well as the traditional math and verbal skills. The school is believed to be the first in the nation that focuses on his ideas. Currently, the school has enrolled nearly 300 pre-school through third-grade students from Hartford and six surrounding suburbs; eventually it will add fourth and fifth grade classes.

MATH WHIZZES. Connecticut students outscore those in other states in mathematics, according to the National Assessment of Educational Progress (NEAP), a nationally-administered series of tests also known as the Nation's Report Card. For fourth graders, Connecticut ranked highest in the country, and for eighth graders, only Minnesota's scores were better; state scores have increased by eight points since the tests were first given in 1990, in line with improvements nationwide. However, of the 5,000 state youngsters who took the exam, two-thirds failed to achieve the level considered proficient. (Nationally, only 1 in 4 reached proficiency.) And Connecticut youngsters still lag behind those in other countries. The NEAP tests abilities to use logic, understand geometry, and analyze real-word situations. The tests show that while Connecticut students are skilled in computation, they still must improve their abilities to think, reason, and problem-solve, according to **Department of Education** consultant **Mari Muri**.

DEVELOPMENT DIFFERENCE. In humans, some fetal brain cells migrate to a particular part of the brain, but no similar movement has been found in mice or monkeys, according to a study done at **Yale.** Using dyes, the researchers found that human cells that give rise to the frontal cortex can also be tracked to a portion of the thalamus, a part of the brain that works with the cortex. No evidence of this was seen in the tissue of the other animals, even though the early development of their brains is similar to humans in other ways. Both the thalamus and cortex are much larger in humans than in other primates, and this research may help explain how these two brain structures developed in tandem to help create the human brain. The experiments were conducted by Yale neurobiologist and Academy member **Pasko Rakic** and his colleagues.

RITALIN ALTERNATIVE. The drug guanfacine may be preferable to Ritalin in treating youngsters who suffer from both tics and attention deficit hyperactivity disorder (ADHD), according to research done at **Yale**. In the first controlled study of guanfacine in children with ADHD, conducted on 34 boys and girls, researchers found an average 37% improvement in total score on the ADHD Rating Scale, compared to 8% improvement for the placebo. While ADHD has been treated effectively with Ritalin, methylphenidate, and d-amphetamine, these drugs all have side effects; Ritalin, for example, is known to worsen tics. Guanfacine has shown fewer side effects in animals, improves tics, and strengthens functioning in the brain's prefrontal cortex.

LISTENING SKILLS. About 3% of school-age children suffer from central auditory processing disorder (CAPD), an auditory version of dyslexia that prevents sufferers with normal hearing from making sense of what they hear. "It's hard for them to distinguish foreground signals from background noise," explains **University of Connecticut (UConn)** audiologist **Frank Musiek**. Such children struggle in classrooms when teachers use complex language, speak rapidly, or present lengthy information. The disorder, which includes symptoms like hyperactivity and an inability to pay attention, is often mistaken for ADHD. It may be caused by brain

Items that appear in the In Brief section are compiled from previously published sources including newspaper accounts and press releases. For more information about any In Brief item, please call the Academy at (860) 527-2161, write the editors at 179 Allyn St., Suite 512, Hartford, CT 06103-1422, or e-mail us at acad@ix.netcom.com

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lesions, traumatic brain injury, a history of chronic ear infections, learning disabilities, delays in maturing, and, in older adults, neurological changes due to aging.

Energy

GO WITH THE FLOW. When fish prefer cold water, the **Northeast Generation Services Company (NGSC)** is willing to help. During summer's heat waves, brook trout and brown trout in the **Housatonic River** seek refuge from rising water temperatures by fleeing to the cool mouths of the river's tributary streams, explains **Ed Parker**, Chief of the **Department of Environmental Protection's Bureau of Natural Resources**. The NGSC, which operates a hydropower plant at **Falls Village**, typically releases varying amounts of water as needed; this fluctuating pattern allows for maximum power generation. But the larger releases of warm river water can cause massive trout die-offs by overwhelming the cold water in the fishes' tributary refuges. With the guidance of a statistical model that assesses trout stress, the NGSC chose to switch to a steady release pattern during hot weather, thus stabilizing water flow and temperature in the trout habitats.

LESSONS IN FUEL CELLS. The first fuel cell to be installed in a Connecticut public school will be used to provide emergency power as part of local disaster relief plan; it will also serve as a teaching tool for students. Approved for the high school in **South Windsor**, the project will be financed by a $2 million grant from **Connecticut Innovations Inc (CII)**, and it will be built, installed and maintained by South Windsor-based **International Fuel Cells**. The fuel cell will be located outside the school. Town officials estimate that the device will reduce the cost of backup power at the school by about $79,000 annually.

INCREASING ENERGY. Its first proposal to build a high voltage electric transmission line across **Long Island Sound** was rejected because of fears that the project might damage shellfish beds. Now, **TransEnergieUS**, the company that proposed the line, has developed a plan designed to preserve the beds by making use of existing shipping channels. The company has also begun to investigate the feasibility of building two more such cables. While the current proposal links Long Island to **New Haven**, the exploratory projects would bring cables to Connecticut at **Bridgeport** and **Norwalk**. In addition to the three projects generated by TransEnergieUS, at least half a dozen other proposals to build electric transmission cables and natural gas pipelines are being considered.

STAR LIGHT, STAR BRIGHT. **Connecticut Light and Power (CL&P)** hopes to increase energy efficiency. Some state residents hope to reduce light pollution. The solution? Replace old incandescent street lights with metal halide instead of high-pressure sodium fixtures. CL&P, which is in the midst of a four-year project to replace street lights in 144 Connecticut cities and towns, had intended to use the sodium fixtures, which are less expensive, more efficient, and more durable. Some, though, in towns that include **Salisbury, Hebron, Newtown, Kent** and **Simsbury**, dislike the lights, which produce a distinctive orange glow, and which are so bright that they can obscure the night sky. The metal halide lights, while slightly less efficient, produce a softer, more natural-looking light.

Environment

QUICKSILVER. The state has exceeded its goal of removing 2001 pounds of mercury from the environment during the current year: it collected 1170 pounds of the metal from household hazardous waste, 412 pounds from dentists, 380 pounds from school cleanouts, and 58 pounds through mercury thermometer exchanges. More ambitious measures are expected; in a meeting last August, governors of six New England states and the premiers of five eastern Canadian provinces adopted a resolution calling for mercury emissions to be cut by 75% by 2010. Mercury can damage brains, kidneys, and developing fetuses, and is a possible carcinogen.

LEAF EATERS. While gypsy moths are decimating trees in surrounding states, Connecticut has remained largely free of the scourge. A caterpillar-killing fungus known as *Entomophaga maimaiga* may be what's keeping the insects in check. The fungus, which consumes only gypsy moth caterpillars, is carried in spores that lie on the forest floor. Dampness reactivates the fungus, which germinates, emitting a second, pear-shaped spore. When this spore lands on a gypsy moth caterpillar, it burrows inside, and then grows from the inside out, destroying its host. The fungus can reduce gypsy moths by 60–70%. **Ronald M. Weseloh**, an entomologist at the **Connecticut Agricultural Experiment Station** in New Haven, is developing a method to simulate the distribution cycles of the fungus. This work will help predict gypsy moth infestations across the country.

BUG TRAP. In an attempt to improve its mosquito trapping technology, the **Connecticut Agricultural Experiment Station (CAES)** has been testing new types of traps. All trapping sites use both a CO_2-baited CDC Light Trap, which is designed to trap host-seeking female mosquitoes, and a Gravid Mosquito Trap, which attracts previously blood-fed adult female mosquitoes. At research sites, two additional traps have been set up. Both use CO_2 without lights as bait: one emits CO_2, heat, and moisture, and the other simply uses CO_2 from a tank. "By comparing trapping numbers and species, we will know which trap attracts the mosquito species we're most interested in," said CAES director and Academy member John Anderson. The new traps are being tested in **Stratford, Milford**, and **Stonington**, which are areas with high mosquito populations, multiple mosquito species and mosquito-borne diseases.

Food & Agriculture

CLONING ADVANCE. In an important advance for agricultural and therapeutic cloning, a team of **University of Connecticut (UConn)** researchers have shown that a clone produced from an aged cow can give normal birth. "The normal birth of 'Norm' provides evidence that when you clone from an aged cow, you do not get an aged copy," says **Jerry Yang,** head of **UConn's Transgenic Animal Facility**. Norm is a 90-pound male calf born to "Daisy," a Holstein heifer cloned two years ago from an aged cow. This adds strength to earlier results suggesting that calves cloned from aged animals do not inherit the cellular genetic age of their donors, and do not have cells that are abnormally old. It's a step toward realizing therapeutic cloning, says Yang. Therapeutic cloning is a promising technique in which cells from diseased individuals could be cloned to provide embryonic stem cells, which would then be differentiated into any needed cell or tissue types.

HIGH TECH BAGGERS. Within six-story high steel towers in the **Nutrena** plant in **Franklin**, animal feed mix is managed, not by hand, but through a keyboard in a computerized control room. The Franklin plant, which produces 90,000 tons of feed a year, is the first automated mill for Nutrena, which has 180 plants in 27 countries. The fully automated plant allows for great efficiency and accuracy, says plant manager **Rod Cheney**: the bagged feed comes

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within .05 pounds, or a couple of pellets, of its weight. The automation also aids preparation of the company's nearly 500 customized formulas, which are designed for specialty animals, such as the pee-wee horses on a Newtown farm. Machinery at the plant is able to fill 17 bags of chicken feed a minute.

HARDY STOCK. The Jaltomata, a distant relative of the tomato, thrives in habitats as varied as the humid forests of Central America and the arid, frigid heights of the Peruvian Andes. "An evolutionary biologist looks at this, and is in awe," says **Thomas Mione**, a biology professor at **Central Connecticut State University**. Mione, and colleague **Leon Yacher**, chairman of geography at **Southern Connecticut State University**, are trying to determine how the plant manages to achieve success in such a diversity of conditions. The plant produces a marble-to-ping-pong ball sized fruit, with colors that range from light orange to dark purple. Growing at 12,000 feet, it is able to survive frost without damage. Yacher believes that the plant's capabilities could offer agricultural benefits. Frost-resistant Jaltomata genes might, for example, produce tomato plants with a longer growing season.

REVERSE OSMOSIS. Through a process known as reverse osmosis, **PureTech Waters of America** transforms tap water into a liquid that's purer than spring water, and tastes just as good. The **Glastonbury** company uses a method that begins by softening and filtering water that it buys from the **Metropolitan District Commission**. Then it removes impurities by forcing the water through a membrane with pores so small that only water molecules can pass through. The company then injects calcium, potassium, and magnesium into the water: these are taste-enhancing minerals that give it a spring-like flavor, says PureTech official **Tom DiMarco**. The company sells the final product, known as **Vital H2O**, to corporate clients.

Health

LYME DISEASE RISK LOW. The risk of Lyme Disease is much lower than most people believe, according to **Yale** researcher **Eugene D. Shapiro**. Even in the most highly endemic areas, he says, the risk for any individual is only 3.2%. According to Shapiro, the only people who developed Lyme Disease had been infected by a nymphal-stage deer tick that had fed for at least 72 hours. Research done elsewhere found that a single dose of 200 mg of the antibiotic doxycycline was 87% effective in preventing Lyme Disease if administered within three days of a bite. Yale researcher **Durland Fish**, though, points out that 80% of Lyme Disease patients never realize that they've been bitten, even though the ticks had to have been attached for at least three days.

AIDS VACCINE MADE EASY. Researchers at **Yale** have developed an easy-to-deliver AIDS vaccine that has so far proved effective in monkeys. A team led by **Yale School of Medicine** professor **John K. Rose** showed that the vaccine, which uses AIDS virus proteins and relies on a common livestock virus (VSV) as a delivery system, can protect against AIDS caused by a hybrid human/monkey AIDS virus. While vaccines using DNA provide equal protection, they may not be as practical to use, says Rose. With the VSV delivery system, the vaccine can be administered as nose drops—both less expensive and easier than injections. This feature would be particularly important in developing countries.

GLUCOSE CONTROL. To help diabetics monitor their glucose levels, **University of Connecticut** professor **Francis Moussy** is working on an implantable glucose sensor. Precise management of glucose levels prevents many of diabetes' complications, but currently such control requires monitoring through finger pricks. Sometimes, the finger pricks must be done as frequently as every two hours, even at night. An implantable sensor could check levels continuously and unobtrusively; results would be transmitted to a wrist-band receiver that would sound an alarm if glucose levels went too high or too low. Moussy and his colleagues have already developed a sensor smaller than a grain of rice; currently, they are researching ways to keep it working inside the body.

HEADACHE CURE. Feverfew, an herb that's commonly used as an alternative medicine for migraine, works because it contains an anti-inflammatory component called parthenolide. Using a derivative of the substance, scientists at **Yale** have discovered how parthenolide works: it binds to a protein called IkappaB Kinase, which is responsible for inflammation. "We showed that the binding disrupted the protein's ability to function and we also were able to identify the part of the protein to which the compound binds," said Yale professor **Craig Crews**, who headed the research team. The discovery could enable scientists to develop additional ways to block the protein, possibly producing new anti-inflammatory drugs that could treat a variety of illnesses.

IF YOU DON'T USE SUNBLOCK. A special kind of white blood cell helps defend the body against skin cancer, **Yale** researchers have found. Using genetically engineered mice, the scientists showed that the blood cells fought cancer by producing a protein which engages a molecule, Rae-1, that is produced by the tumor cells. Once that happens, the T-cells are able to kill the defective cells. While Rae-1 is not produced by normal skin, it is generated by skin cells that have been exposed to chemical carcinogens. "This is an initial and important distress signal to local T-cells," said Yale dermatology professor **Michael Girardi**, the study's lead author. Gamma-delta T cells are likely crucial, he says, to an early defense against skin cells that have recently transformed to a pre-malignant or malignant state.

High Technology

TIME MACHINE. Time travel may be possible, according to **University of Connecticut** physics professor **Ronald Mallet**. According to Einstein's theories, gravity amounts to a curvature of time and space, which implies that in a really strong gravitational field, like that of a black hole, time would slow, or stop. Mallet believes that he can produce a region of slowed time by creating circles of light with lasers, bending the circles back into a loop, perhaps using fiber optics, and then intensifying or slowing the light to strengthen the gravitational field. You could reach the past by entering the slowed region inside the loop, although you could only go back as far as the time that the machine was first turned on. Mallet hopes to develop a machine that can transport subatomic particles through time. He believes that this can be done within the next ten years.

SIMULATED CELLS. Researchers at the **University of Connecticut** have developed a simulated cell program that can predict how cells will respond to potential medications. The model, known as **Virtual Cell**, calculates how ions travel in and out of cells, motions of RNA, workings of mitochondria, and other factors. It can show whether particular chemical reactions are possible, and how rapidly they would occur. It can be adjusted to represent different cell types, for example, from males or females. The program allows pharmaceutical companies to test new compounds quickly and relatively cheaply. "Improving drug design processes has

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always been one of the objectives of the Virtual Cell technology," said **Leslie Loew**, director of the **Center for Biomedical Imaging Technology**.

PROTEIN ANALYSIS. A unique way to determine the structure of an important class of cell membrane proteins has been developed by a **University of Connecticut** research team. These proteins, known an G-protein coupled receptors (GPCRs), often serve as the targets to which drugs bind. Analyzing the surface structure of these proteins enables scientists to better understand the target that the drug is trying to reach. The researchers, led by molecular and cell biology professors **Philip Yeagle** and **Arlene Albert**, worked on the protein rhodopsin, which is the receptor for light in the eye. They disassembled the protein into smaller pieces whose structure could more readily be determined, and then reassembled the pieces into a completed three-dimensional structure. The rebuilt protein possessed structural details that agreed with rhodopsin's known biochemistry; it also provided new information about how the receptor communicates with the cell. More than 60% of all prescription drugs currently on the market target GPCRs.

ATOMIC SCOPE. Using an atomic force microscope, **Christine Caragianis-Broadbridge**, a physics professor at **Southern Connecticut State University (SCSU),** and her students are able to "see" atomic surface structure. The image is created when a probe just a few molecules thick is dragged across the surface of a material. The atoms in the probe are first attracted and then repelled by the electrons in the surface below. As a result, the probe bounces up and down, and a computer turns this movement into an image. This device, which, along with three other atomic scopes, is funded in part by the National Science Foundation, and SCSU, is intended to discover the surface structure of experimental materials.

Industry & Business

IDENTIFYING GENES. In research that documented an unexpected variability among genes, scientists at New Haven's **Genaissance Pharmaceuticals** found that there are fourteen versions of each human gene. This research could lead to a new generation of "personalized" drugs able to attack disease on a molecular level, says company founder **Gualberto Ruano**: it is these variations, known as halotypes, that determine which patients will benefit from a particular medication, and which may be harmed by it. Researchers may be able to use these variations to design drugs that cure a disease by affecting the genes that cause it. The study looked at 313 genes in 82 unrelated individuals; it was, according to **J. Claiborne Stephens**, the lead author of the article describing the work, the most extensive study of gene variation in diverse populations.

ANALYZING PROTEINS. With a device known as **ProtoWell,** New Haven biotech company **ProtoMetrix** hopes to better understand proteins, and the way that they interact. ProtoWell, which was developed by company co-founder and **Yale** scientist **Mike Snyder**, is a chip containing many tiny wells. Proteins are poured into the wells, chemically tagged, and assayed. The device enables researchers to analyze many proteins simultaneously, speeding up the analysis process. Snyder believes it will give the company an advantage over those who study proteins with conventional methods. Proteins are involved in causing and treating a number of diseases, and the analysis of proteins, known as proteomics, is a growing field that builds on the success of the human genome project.

CHLORINE CLEANUP. A technique developed at the **University of Connecticut's (UConn's) Environmental Research Institute** will be evaluated in an experiment conducted at **Roosevelt Mills** in **Vernon**. The new method can be used to clean up chlorinated solvents, which are used, for example, on machinery. Known as Duox, it involves injecting two oxidants, usually potassium permanganate and sodium persulfate, into the contaminated site. The oxidants neutralize the chlorine, and then are themselves broken down by the soil into harmless substances. The process is expected to take about a year, and to be both quicker and less expensive than traditional clean-up methods: such methods had been estimated to cost $1.3 million at that site. Duox can be used to clean up sites that had been used industrially, freeing them for other uses.

EASIER CHEMO. A Stamford-based company, **Delcath Systems**, has developed a patented system that allows for a potent cancer-fighting drug to be sent to the liver without circulating through the rest of the body. It includes a catheter that sends the medication, Doxorubicin, directly to the liver; a pair of balloons inserted into an artery to block the medicated blood from flowing to the heart, and a system that draws the medicated blood from the body, filters out the Doxorubicin, and returns the cleansed blood back to the body. The system allows the drug, which can destroy the heart, to be administered in doses up to ten times higher than the amount currently used. Delcath's system could cut the cost of chemotherapy from about $160,000 to $48,000, and reduce the time of treatment, say company officials. It will also minimize side effects.

Transportation

MINI-SUB. The **Groton**-based submarine ***USS Hartford*** will be the first in the Atlantic fleet to be equipped with a special mini-submarine designed to carry teams of Navy Seals into harbors for covert operations. Two Pacific-based subs have already been modified to carry the small commando subs; the *USS Hartford* is the next in line to be outfitted with the special collar and pylon that will allow it to transport the sub. Currently Navy Seal forces are delivered to their operations sites in craft that are open to the water.

WEIGHTY SPAN. New Haven's new **Tomlinson Bridge** scheduled to open in 2002, will rank as the heaviest lift bridge on the eastern seaboard. The structure will carry four lanes of motor traffic, one rail line and a 10-foot walkway. The center span weighing 6 million pounds will be counterweighted by 6 million pounds of concrete and can be raised 60 feet to pass river traffic. The counter balance pullies and concrete weights are housed in towers at both ends of the span are 92 feet wide straddling the roadway and about the height of a 14-story building. As the span is raised, the concrete weights go down leaving only the changing weight of the connecting cables to be overcome by the drive motors. Massive pins will support the span when in a lowered position and subjected to traffic loading.

FIGHTER POWER. **Pratt and Whitney's** new F119 engine, which will power the Air Force's newly authorized F-22 fighter planes, offers maintenance costs that are about half those associated with other fighter planes. It also provides more power: 35,000 pounds of thrust per engine, compared to the 20,000 pounds of thrust typical of an F-16. In addition to powering the F-22's, the engines will be aboard Lockheed Martin's new Joint Strike Fighter. The F-22's, which will replace the Air Force's older F-15's, can take off and land vertically. With 295 of the fighters currently authorized for production, the first squadron of F-22's is expected to be ready for service in 2005.

— Compiled and edited by Karen Miller

National Academies *(continued from page 1)*

◆ The Nation's Uninsured

At a recent workshop held by an Institute of Medicine (IOM) committee to review what is known about the 42 million people in the United States who have no health insurance, experts reported surprising findings. For example, although many of the uninsured are poor, the majority who are of working-age are employed, and a large proportion of them work for businesses with more than 500 employees. Eight out of every 10 people without health coverage either work or are children of working parents, according to one expert. Many small businesses do not offer health insurance at all, and those where at least a third of their workers make less than $20,000 a year are far less likely to offer it than firms that pay higher wages. Only 64% of workers at larger businesses employing 200 or more receive coverage through their employers.

The workshop was the first step in a three-year IOM project, sponsored by the Robert Wood Johnson Foundation, to assess the health, economic, and social consequences of uninsurance. The project will generate six reports on the subject; the first is expected in the fall and will present an overview of who the uninsured are, where they live, and which population subgroups are disproportionately likely to be uninsured. This initial report will offer a conceptual framework for assessing the impact of uninsurance that will be used in the subsequent reports. For more information, see http://www.infocusmagazine.org/1.1/meetings.html.

◆ Eat Your (Fruit) and Veggies

The Institute of Medicine's Food and Nutrition Board, in its latest report on Dietary Reference Intakes (DRIs), says recent studies show that it takes twice as many carotenoids to yield the same amount of vitamin A that researchers believed were needed in 1989, when the board last issued recommendations for vitamin A.

Darkly colored fruits and vegetables, such as carrots, sweet potatoes, and broccoli, contain carotenoids that are converted to an active form of vitamin A in the body. The new findings mean people need to make sure they eat enough orange, red, green, and dark-yellow fruits and vegetables such as these to meet their daily requirement for vitamin A, particularly if they are strict vegetarians. Meat eaters and vegetarians who eat egg and dairy products typically get plenty of vitamin A, since it is abundant in animal-derived foods.

The report also examines the nutritional value of vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc, noting that the daily requirements of these nutrients can, in almost all instances, be met without taking supplements.

DRIs include not only Recommended Dietary Allowances (RDAs), but also adequate intakes (AIs), which are recommended when not enough evidence exists to set an RDA, and tolerable upper intake levels (ULs). The report establishes ULs for vitamin A, boron, copper, iodine, iron, manganese, molybdenum, nickel, vanadium, and zinc to help people avoid harm from taking too much of a nutrient. The report also includes either RDAs or AIs for vitamin K, chromium, copper, iodine, iron, manganese, molybdenum, and zinc. Whenever the data allows, recommendations are made for all age groups as well as for pregnant and lactating women. The full report is available at: http://www.nap.edu/books/0309072794/html/.

◆ Pain on the Job

According to a new report from the National Research Council and the Institute of Medicine, scientific evidence shows that musculoskeletal disorders (MSDs) such as lower backache, tendonitis, and carpal tunnel syndrome can be attributed to particular jobs and working conditions. Known as MSDs, these and other health problems affecting muscles, nerves, spinal disks, joints, cartilage, tendons, and ligaments affect about 1 million workers each year, costing the nation between $45 billion and $54 billion in compensation expenditures and decreased productivity.

MSDs can affect many types of workers. Workers' individual characteristics, such as gender and age, as well as stressful, fast-paced job settings can make employees more vulnerable to MSDs, noted the report. And risks may be compounded if workers feel powerless in such environments. However, properly implemented strategies to reduce the incidence, severity, and consequences of work-related musculoskeletal disorders can be effective, according to the report

To do a better job of tracking the disorders nationwide, federal agencies should create a broad surveillance system to more accurately quantify the problems and pinpoint risk factors both on and off the job, the panel said. For the full report, see http://www.nap.edu/books/0309072840/html/

◆ Making it Count: Mathematics Education

The nation's efforts in the area of mathematics education have been inconsistent and marked by an emphasis on routine arithmetic, says a new report from the National Research Council, which concludes that a more coordinated and systematic approach from pre-kindergarten through eighth grade is urgently needed.

The report urges that all students be "mathematically proficient," comprehending more than disconnected facts and procedures. The committee defines mathematical proficiency as the ability to understand and apply important concepts, to compute with ease, to formulate and solve problems, and to explain their reasoning. Finally, they should have confidence in their abilities and regard mathematics as a sensible and worthwhile subject.

Teacher educators and school administrators must rethink their work, too. Colleges and universities should create programs that emphasize in-depth knowledge of mathematics and processes through which schoolchildren come to comprehend the subject, the committee said. And schools should give teachers more time as well as high-quality training to acquire a solid understanding of math. The full report is available at: http://www.nap.edu/books/0309069955/html/index.html

Moletronics *(continued from page 2)*

be restored ten to a hundred times a second, which requires substantial amounts of power.

Because Reed's device retains its electrons for nearly fifteen minutes, it has, he explains, the ability to get information in and out using significantly less power. Compared to, say, current equipment, which only runs for a few hours before the batteries wear out, Reed says, machines using molecular memory could run for a week.

Reed and his colleagues hope to synthesize molecules that can serve as even stronger electron traps. But even the memory that they have in hand will serve many uses, believes Reed. It will, he says, dramatically reduce power requirements, and he believes that it could have applications in virtually all portable electronic systems.

But there's another advantage. The fabrication technologies for this are potentially very attractive from a cost standpoint, says Reed. Unlike silicon, these nanodevices do not require costly manufacturing facilities. Instead, they rely on a process called "self-assembly." The molecules are designed so that one end will stick to a metal surface. When the metal is dipped into a beaker of the molecules, the devices automatically adhere to it, in their proper position. The process bypasses the need for fabs, and, between the ease of self-assembly and the drop in power requirements, these molecular devices, says Reed, have the potential of generating electronics too cheap to meter.

Reed expects his company to have a prototype ready in a year or two. It will, he says, integrate the molecular memory devices into a standard silicon chip. They'll manufacture chips in the standard way, up to the point where the molecules must be absorbed. "Then we stick them in a beaker, and they self-assemble, just where we need them to be."

Designing a system that incorporates molecular devices as working memory will be impressive enough. Yet that's probably only the beginning. Eventually, nanodevices could free computing from the constraints of silicon. They could, for example, be put into clothes. "Imagine," says Reed, "wearing flexible computers that constantly fine-tune your environment for you: when you walk into a room, they'll automatically communicate and interact with the room: you will become part of the web of the room."

Fanciful? Maybe. But the field is advancing faster than anyone predicted. Who would ever have believed that individual molecules could be designed to work as devices? Like so much else, it's not science fiction any more. ◆ ***Karen Miller***

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