

Bulletin of the

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Yale Lab Develops “Deceptively Simple” Device

Silicon Nanowires Key to Revolutionary New Hand-Held Diagnostic Biosensors

Using silicon nanowires one-millionth the diameter of a human hair, Yale University researchers expect to develop a revolutionary array of novel, hand-held sensors that can diagnose diseases, do blood work, find cancer cells, and identify other proteins in minutes by a patient’s bedside.

“This just the tip of the iceberg,” said CASE member Mark A. Reed, Harold Hodgkinson Professor of Engineering and Applied Science at Yale, and one of the lead nano-visionaries. The device developed in Reed’s laboratory is apparently elementary, yet has tremendous potential. About 10 groups of scientists around the world are aggressively pursuing similar technology, according to Reed.

Like the wheel and the inclined plane, the pattern etched into Yale’s silicon crystal is deceptively simple. It consists of 10 “fingers” 1 to 2 microns long and 20 to 30 nanometers in diameter, lined up in parallel like 10 teeth of a very small comb. (A nanometer is one billionth of a meter, or 10^{-9} meters.) To appreciate the dimensions of a nano-world, the smallest virus is around 17 nanometers across and a glucose molecule is 1 nanometer in diameter. Each finger is about 100 times longer than it is wide.

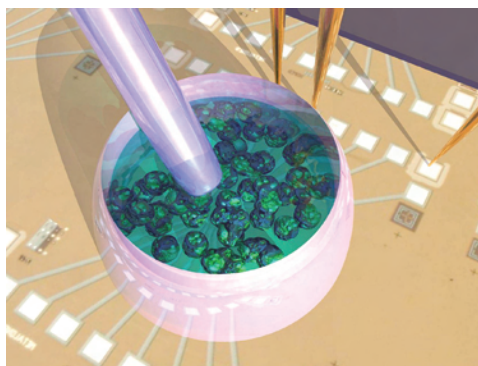
Eric Stern, a former graduate student in Reed’s lab, designed and fabricated the silicon chip, which is compatible with circuitry now used in computers and other contemporary electronic devices. This property is key, because it means that the device can eventually be produced in large numbers and incorporated into equipment by conventional manufacturing methods, Reed said.

The Yale nanowire device was originally invented and produced for detecting biological and chemical weapons on a battlefield, with a grant from the US Defense Advanced Research Projects Agency, or DARPA, and was then adapted to more health-oriented applications.

The key to the device is that the fingers behave like transistors, Reed said. When the array encounters a charged particle, its voltage increases. Using 10 strips, the circuit is also extremely sensitive to minute changes in the acidity, or pH, of a solution.

What makes such an inexpensive and quick pH meter so intriguing for medical applications is the way the human immune system responds to pathogens, said Fahmy, assistant professor of biomedical engineering at Yale, and collaborator on the project.

The body’s complex defenses include cell-mediated immunity and a humoral system that produces antibodies. And it just so happens that when certain white blood cells encounter a microbial foe, the cells start to emit acid. That’s what makes the nano-pH meter so intriguing: infection leads



*An image of a Yale “proof of concept” experiment showing that nanowires can detect a change in pH from acid secreted from T cells.
[Photo courtesy: T. Fahmy]*

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News from the National Academies

The following is excerpted from press releases and other news reports from the National Academies (www.national-academies.org).

◆ America’s Energy Future: Technology and Transformation

A new report from the National Academies’ Committee on America’s Energy Future analyzes the potential of a wide range of technologies for generation, distribution, and conservation of energy. Part of the America’s Energy Future project of the National Academies, the report —“America’s Energy Future: Technology and Transformation”— considers technologies to increase energy efficiency, coal-fired power generation, nuclear power, renewable energy, oil and natural gas, and alternative transportation fuels. It assesses the associated impacts and projected costs of implementing each technology and categorizes them into three time frames for implementation.

The report’s stated aim is to “inform policy-makers about technology options for transforming energy production, distribution, and use to increase sustainability, support long-term economic prosperity, promote energy security, and reduce adverse environmental impacts.” Among the wide variety of technologies under development that might become available in the future, this report focuses on those with the best prospects of fully maturing during the three time periods considered: 2008–2020, 2020–2035, and 2035–2050.

<http://www.nap.edu/catalog/12710.html>

◆ Creative Young Engineers Chosen for NAE Symposium

An engineer from Connecticut’s United Technologies Research Center, Sandor Becz, is one of 88 of the nation’s brightest young engineers selected to take part in the National Academy of Engineering’s (NAE) 15th annual US Frontiers of Engineering symposium in September. The participants—engineers from industry, academia, and government ages 30

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IN MEMORIAM

Edward A. Adelberg, PhD 1920 – 2009

Dr. Adelberg served as Executive Editor for the *Bulletin of the Connecticut Academy of Science and Engineering* (known then as *CASE Reports*) from 1991 to 2001.

One of the preeminent geneticists of his generation, Dr. Adelberg was a member of the National Academy of Sciences and a founding member of the Connecticut Academy of Science and Engineering. He chaired Yale's Department of Microbiology from 1961 to 1964 and from 1970 to 1972, and was a founding member of its Department of Genetics. He was the university's first Deputy Provost for the Biomedical Sciences, serving from 1983 until his retirement in 1991.

The Academy will always be grateful for his dedication and commitment to the highest standard of scientific discourse.

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Nanodevices (continued from page 1)

to an increase in acid output, which can be detected easily and rapidly.

"The immune system is responsible for all conditions and diseases," Fahmy said, either because it works too well, or not well enough.

When the immune system is too aggressive, it can cause autoimmune diseases such as multiple sclerosis, in which the body attacks its own tissues. The immune response also causes inflammation that leads to conditions such as coronary artery disease. Occasionally the defenses fail to eliminate cancer cells, leading to tumors and potential death. HIV attacks the very cells that congregate to destroy the viral particles.

"Our goal is to identify a malfunctioning immune system, and then 'fix' it by targeting aberrant cells," Fahmy said.

One of the first white blood cells that bacteria, viruses and other pathogens encounter are T cells, so called because they originate in the thymus. One type of T cell is studded with CD-4 complexes. Antigen presenting cells grab the pathogen and present it to the CD-4 protein. The CD-4 signals the T cell to launch a cascade of additional white cells, enzymes and other proteins to destroy the invaders.

The T cells also begin to emit acid in the form of protons. The purpose of these protons is unknown, but they generate a signal that the ultra-sensitive Yale device can detect. An influx of protons near the wires increases the wires' electrical charge. This additional voltage can be measured, making the nanowires work as a proton monitor, or pH detector.

"The release of protons is the first step of the reaction of T cells. It is a very early response, indicative of an early infection," Fahmy said. Between the time the CD-4 latches onto an antigen, until the T cell starts to pump out acid is about 30 seconds.

Stern had found that the bio-sensor designed for DARPA was also an extremely precise pH meter and he started looking for a way to make use of the unanticipated feature. So when Stern asked Fahmy what a microscopic pH meter might be good for, Fahmy had a ready answer: diagnosing infections, judging the effectiveness of inhibitory drugs, and possibly identifying cancer proteins.

So far, the Yale scientists have tested the circuit in solution, using an array of equipment. The circuit is able to detect one proton-producing cell out of 1 billion, making it an astonishingly powerful measuring device.

Fahmy compares the proton affinity of the nanowires to hearing a high-pitched voice among the din at a large, loud party. "If your ear is tuned only to sense high-pitched vibrations, then when somebody speaks at the party with a high pitch, then you'll detect them," he said. "If cells are around and you add specific stimulus that results in only a few reacting and secreting protons, then the wires will sense them, if the wires are small enough. Nanowires are much better pH detectors than larger electrodes," Fahmy said.

"This is just proof of concept. Eventually we should be able to use it with a pinprick of blood," Fahmy said.

Reed imagines an instrument the size of a classic iPod. A drop of blood would be placed in a port, and minutes later, the device would diagnose an infection. Since the circuit is so small, many, perhaps hundreds or thousands, of the chips could fit into the device, Reed said. The resulting portable electronics would be

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Biomedical Research

SECRETS OF LIFE-GIVING AMINO ACID REVEALED. In the July 17 issue of the journal *Science*, Yale University and University of Illinois researchers detail the molecular mechanisms that govern the metabolism of selenium in the human body. Selenium is a trace element crucial to life—too little or too much of it is fatal. It is thought to offer protection from diverse human ailments including adverse mood states, cardiovascular disease, viral infections and cancer. Selenocysteine, the most active metabolite of selenium in humans, is unique among amino acids because it is the only one synthesized directly on a transfer RNA (tRNA) molecule. CASE member and Yale's Sterling Professor of Molecular Biophysics and Biochemistry **Dieter Söll** is co-senior author of the paper. His team captured for the first time images of how selenocysteine is created on a super-sized tRNA molecule.

GE TEAMS UP TO MARKET STEM CELL PRODUCTS. Fairfield-based **General Electric's GE Healthcare** unit and Menlo Park, CA-based Geron Corp. announced an agreement to develop and market embryonic stem cell products for use in drug discovery, development and toxicity screening. The program will use stem cells derived from those listed on the National Institutes of Health's Human Pluripotent Stem Cell Registry. According to the agreement, GE Healthcare will have an exclusive license under Geron's intellectual property portfolio covering the growth and differentiation of human embryonic stem cells. The first products are expected to be available by early 2010.

CT FIRM'S DEVICE IN CLINICAL TRIAL. A pain therapy device developed by Fairfield-based **Competitive Technologies Inc.** (CTT) is being used by clinical investigators at the Virginia Commonwealth University Massey Cancer Center in Richmond. **John B. Nano**, CTT's chairman, president and CEO, says the device is non-invasive and avoids the harmful side effects of narcotic painkillers. The treatment protocol calls for 15 patients with chemotherapy-induced neuropathy to be studied first. The unit, with a biophysical rather than a biochemical approach, uses a multi-processor able to simultaneously treat multiple pain areas by applying surface electrodes to the skin.

CURAGEN, CELLDIX & EXPANDED BREAST CANCER DRUG TRIALS. Branford-based **CuraGen Corp.** has been acquired by Celldex Therapeutics Inc. of Needham, MA. The deal, announced in May, is expected to close in September. CuraGen also announced the expansion of clinical trials on its treatment for advanced breast cancer. The company said two of the first four eligible patients in the Phase II trial showed enough progress after 12 weeks on its breast cancer treatment to warrant expanding testing to about 25 patients. Celldex management is currently evaluating whether CuraGen remaining in Connecticut is part of the company's ongoing business plan.



Business & Industry

COMPANY RELOCATING TO CT RECEIVES CI INVESTMENT. **Connecticut Innovations (CI)**, the state's quasi-public authority responsible for technology investing and innovation development,

announced in July its investment of \$750,000 in **Soft Tissue Regeneration, Inc.** (STR) through its Eli Whitney Fund. STR is in the process of relocating its operations from Charlottesville, VA, to Connecticut. The company is advancing a breakthrough technology to treat anterior cruciate ligament (ACL) injuries.

KAMAN TO CONTINUE SUPPLYING FUSES TO USAF. **Kaman Corp.**, based in Bloomfield, reported that the US Air Force has exercised an option worth about \$53 million for the company to continue supplying bomb fuses assembled at its plants in Middletown, CT, and Orlando, FL. Deliveries of the electro-mechanical devices used for de-arming and arming bombs will begin in spring 2010.

EB GETS SUB REPAIR CONTRACT. Groton-based **Electric Boat** was awarded a \$15.8 million Navy contract to repair damage sustained by the *USS Hartford* after the submarine's collision in March with the amphibious transport dock ship *USS New Orleans* in the Persian Gulf. The contract covers repairs to the Los Angeles-class sub's hull patch, its sail, and the port retractable bow plane. Work is expected to be completed by October.

F-135 TESTING COMPLETE, PLANT CLOSINGS WEIGHED. East Hartford-based **Pratt & Whitney Co.** announced that its F-135 engine surpassed 15,600 test hours for service and reliability. The company is preparing to deliver the first engines to the Pentagon later this year. The F-135 is the only engine powering the F-35 Lightning II flight test program. In other news, Pratt is still in the meet and confer process with the machinists union after announcing plans to close its commercial jet engine overhaul in Cheshire and a portion of the East Hartford overhaul operations. A decision is expected in early September.

COVIDIEN BUYS VNUS. **Covidien Ltd.**, which has operations in North Haven, bought medical device maker VNUS Medical Technologies Inc. for \$440 million. VNUS, based in San Jose, CA, makes products that treat varicose veins and venous reflux disease.

EDAC TECHNOLOGIES ACQUIRES MTU FACILITY. Farmington-based aerospace components manufacturer **EDAC Technologies** acquired the Newington facility of Germany-based **MTU Aero Engines**, which employs 120 people. This marks the second acquisition by EDAC of MTU assets. In 2007, EDAC purchased MTU's Newington-based repair unit.

LIFE SCIENCES A DRAW FOR INVESTORS. Venture capitalists invested a total of \$37.3 million in five Connecticut companies in the first quarter of 2009, up sharply from \$15.1 million in eight companies in the fourth quarter of 2008, according to The MoneyTree® Report, issued quarterly by PricewaterhouseCoopers and the National Venture Capital Association, based on data from Thomson Reuters. Of that investment, 94% went into life sciences companies.

GENERAL DYNAMICS TO BUY AXSYS. Defense giant General Dynamics, owner of **Electric Boat** in Groton, will pay \$643 million for **Axsys Technologies Inc.**, a Rocky Hill manufacturer of surveillance gear used primarily in the security and defense industries. Axsys employs 1,000 workers, mainly in Rocky Hill. Awaiting the merger, the company reported a 43% drop in second

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 CASE Bulletin, 179 Allyn St., Suite 512, Hartford, CT 06103-1422, or email us at acad@ctcase.org

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quarter net income to \$3.5 million from \$6.1 million during the same period a year ago, attributing the drop to uncertainty among its customers, who delayed orders as the merger was pending.

GE DEALS IN BAHRAIN. Fairfield-based **General Electric Co.** (GE) this summer announced \$500 million worth of contracts for electricity-generating equipment at what will become the biggest power plant in Bahrain. GE will provide equipment and long-term service to the Al Dur Independent Water and Power Project, which is slated to eventually produce 1,250 megawatts of power—30% of the country's existing power output. The contracts cover two steam turbines and four gas turbines. GE will also maintain the turbines under a 20-year service agreement.



Communication

BROADBAND STIMULUS FUNDS. Connecticut is applying for more than \$90 million in federal stimulus funds for broadband programs. The **Department of Public Utility Control (DPUC)** has applied for funds under the **State Broadband Data and Development Grant Program** (see DPUC Docket No. 09-08-04) to develop statewide broadband mapping. Under the project, named CT-Muni-Net, a group of 17 Connecticut municipalities is applying for funds through the Broadband Technology Opportunities Program (BTOP) to create new opportunities for shared services among municipalities. The state **Department of Information Technology** is also applying for a BTOP grant to cover infrastructure projects. Governor Rell's **CT Recovery Act Broadband Review Panel** is expected to consult with the **Connecticut Broadband Internet Coordinating Council** to coordinate state agencies in receiving and disbursing funds and reviewing further Recovery Act applications from public or private entities. Grant awards will be announced sometime this fall.

STAMFORD FIRM BUYING VERIZON LINES. Stamford-based **Frontier Communications Corp.** reached a deal to acquire the scattered phone service areas outside Verizon's main Northeastern and Californian territories for \$5.3 billion in stock. Frontier focuses on serving small towns and rural areas and will triple in size with the deal, which gives it 4.8 million phone lines to residential and small business customers and 1 million broadband connections.

BROADBAND ADOPTION GROWS. Broadband adoption continues to grow in the United States, with the greatest levels of high-speed broadband Internet connections found on the East Coast, according to Akamai Technologies Inc.'s "State of the Internet Report" for the first quarter of 2009. An April 2009 survey by the Pew Research Center's Internet & American Life Project shows 63% of adult Americans now have broadband internet connections at home, a 15% increase from a year earlier. The growth in home broadband adoption occurred even though respondents reported paying more for broadband compared to May 2008.



Education & Cognition

CT'S BRODEN, LAURENCIN WIN PRESIDENTIAL AWARDS. **Stacie Broden**, a second-grade teacher at **Pomperaug Elementary School** in Southbury, will receive the Presidential Award for Excellence in Mathematics and Science Teaching at a White House ceremony this fall. Broden is the Instructional Teacher Leader (ITL) for mathematics at her school and works with colleagues and administrators to improve mathematics teaching and learning. From Connecticut higher education, CASE member

Cato T. Laurencin, vice president for health affairs at the **University of Connecticut Health Center** and dean of the **University of Connecticut School of Medicine**, will receive the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. Broden and Laurencin are among 100 science, math, and engineering teachers and mentors from around the country to be honored. Winners are selected by a panel of distinguished scientists, mathematicians, and educators following an initial selection process done at the state level.

UCONN ENGINEERING CAPTURES FOUR GAANN GRANTS.

The **School of Engineering** at the **University of Connecticut** has captured four US Department of Education grants from the agency's Graduate Assistance in Areas of National Need (GAANN) program. The highly competitive three-year grants are aimed at enhancing the nation's technological competitiveness. The grant, paired with additional matching funds, totals nearly \$1 million per year and will support approximately 30 to 35 graduate students annually. Students from traditionally under-represented populations, including women and minority populations, are a particular focus of the GAANN program. The support will go to students in the following areas: biomaterials for tissue regeneration; energy and environmental technologies; advanced computing research targeting biomedical informatics and underwater sensor networks; and advanced computing security.

CURE ROLLS OUT SECOND MOBILE LAB.

Connecticut United for Research Excellence, Inc. (CURE) rolls out a second BioBus—a mobile science laboratory—this school year. **Boehringer Ingelheim Pharmaceuticals, Inc.** contributed \$1.1 million to the \$2 million project, with the state contributing \$500,000. The new laboratory will initially target grades 3-5 in 13 state-designated priority school districts, but will eventually serve grades K-5; the current BioBus will shift focus to grades 6-12. CURE, a statewide coalition of over 100 members, began its educational initiative—now called Bioscience Explorations—in 2001. The initiative includes three other components: an equipment loan program called BioConnection, curriculum development, and teacher workshops.

CCAT TO GRANT CEUS TO TEACHERS.

The **Connecticut Center for Advanced Technology, Inc. (CCAT)** announced in June that the state **Department of Education** named CCAT an approved provider of continuing education credits (CEUs) for public school teachers in the state. CCAT operates a number of professional development training programs for teachers, including the NASA-PLAN Teachers Academy, a summer program focused on equipping high school teachers with skills in high technology content areas. CCAT is also working with **The Children's Museum** in West Hartford and the **University of Hartford** to offer professional development to upper elementary teachers in Central Connecticut.

CHANGES URGED IN EDUCATION OF FUTURE MDS.

Dean of the **Yale School of Medicine** and CASE member **Robert J. Alpern** co-chaired a committee of scientists and physicians calling for a major overhaul of undergraduate premedical and medical school curricula. Their report, "Scientific Foundations for Future Physicians," issued in June by the Association of American Medical Colleges (AAMC) and the Howard Hughes Medical Institute (HHMI), recommends that premedical education change from a static list of mandated courses to a curriculum that focuses on acquiring core science competencies. It also suggests that premed students need to be better prepared in certain scientific competencies not currently required, like statistics and biochemistry. The report's findings will be considered in the AAMC's comprehensive review of the Medical College Admissions Test (MCAT).

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QUINNIPIAC OFFERING ONLINE MBA IN HEALTHCARE MANAGEMENT. This fall, **Quinnipiac University Online** will offer an MBA in health care management, through its **School of Business**. **Cynthia Gallatin**, associate vice president and chief operating officer of Quinnipiac University Online, said the key strengths of Quinnipiac's MBA program are content, flexibility and Association to Advance Collegiate Schools of Business (AACSB) accreditation.

TRINITY PROFESSOR CREATES BRAIN MUSIC. **Dan Lloyd**, Brownell Professor of Philosophy at **Trinity College**, took MRI data from brain scans and assigned different musical notes to different regions of the brain. Lloyd created software that translated the data to a Musical Instrument Digital Interface (MIDI), enabling him to apply the information to a mainstream synthesizer, which in turn produced melodies composed by nothing more than data from the brain. Lloyd compared brain scans of people with dementia and schizophrenia to healthy subjects and found a noticeable difference in the music they created. The technology may give new insights into the differences between normal and dysfunctional brains.

SAINT JOSEPH'S ANNOUNCES PHARMACY SCHOOL. In its continuing effort to address the evolving educational and workforce needs of the community, **Saint Joseph College** in West Hartford announced plans to establish a **School of Pharmacy** with a first-year class enrolled as early as fall of 2010, pending approvals. The school will offer a three-year, co-educational doctoral degree program in Pharmacy (Pharm.D.). It is the college's first doctoral program. Saint Joseph's undergraduate program now offers a pre-pharmacy option where the prerequisite courses can be completed. **Joseph R. Ofosu**, associate dean for academic affairs in the College of Pharmacy, Nursing & Allied Health Sciences at Howard University, will serve as the school's first dean.



Energy

WASTE-TO-ENERGY PLANT PROPOSED. Massachusetts-based Chestnut Hill BioEnergy is proposing to build a plant in **Waterbury** to transform garbage into electricity. The company has signed an agreement to buy the site of a former factory and convert it into what it says would be the country's largest food-waste-to-energy plant. The company says the plant would be able to produce electricity for 10,000 homes. The plant would accept 625 tons of garbage a day and generate 12 megawatts of electricity, which it would sell to **Connecticut Light & Power**.

FERC APPROVES QUEBEC-NEW ENGLAND LINE. The US Federal Energy Regulatory Commission (FERC) approved a funding plan for a major transmission project. Berlin-based **Northeast Utilities**, Massachusetts-based NSTAR and Quebec province-owned Hydro-Quebec are negotiating a joint development agreement for the design, planning and construction of the high-voltage, direct-current line which will connect the Des Cantons substation in Quebec with a point to be determined in southern New Hampshire. The project is expected to reduce greenhouse gas emissions by about 4-6 million short tons of carbon dioxide per year by displacing natural gas-fired generation in New England.

PROTON ENERGY EARNS KEY PATENT. Wallingford-based **Proton Energy Systems** announced in July that it earned a patent for its StableFlow system. The StableFlow system allows electric-power generators that rely on hydrogen to monitor the fuel's purity, dew point and pressure. Proton says that StableFlow system can save most plants an average of one megawatt per hour per generator in losses by reducing friction.

SMALL SOLAR REBATES RETURN. The **Connecticut Clean Energy Fund** (CCEF) announced the reopening of its Small Solar PV Rebate Program (SSPRP) this summer. Since November 2008, the program was unable to accept new applications because budgeted funding was fully committed. The CCEF board's recent approval of a new, \$3.1 million funding allocation for the program means the SSPRP can now support new rebates for residential solar installations.

BIODIESEL OPERATION IN NEW HAVEN. Innovation Fuels, a Newark-based biodiesel company, began construction in June on a distribution operation at the **New Haven Terminal**. The company produces and distributes fuel created from waste fat, recycled grease, and new advanced non-food plant oil. The New Haven location, expected to begin operations this winter, allows the company to deliver its product by barge from Newark, then ship it by rail, vessel, or truck. Innovation expects to move 13-18 million gallons of biodiesel through the terminal in the first year.

CCAT GRANTS FOR ENERGY BACKUP. The state **Department of Public Utility Control** recently approved **Connecticut Center for Advanced Technology Inc.'s (CCAT)** application to distribute \$10.8 million in capital grants to develop customer-side distributed generation systems at 30 mission-critical facilities in Fairfield County. The plan, devised under a contract from the US Department of Energy, would generate enough electricity to power more than 20,000 homes. These power-generation systems would supply electricity during emergencies or during periods of peak demand to stabilize the electrical energy grid and reduce prices in the region, CCAT said. The program is intended to expand to other regions of Connecticut and the nation.



Environment

MERCURY LEVELS IN FISH DECLINING. A study by **University of Connecticut** (UConn) researchers found that mercury contamination levels in the meat of largemouth bass caught in the state's lakes were significantly lower in 2005-2006 than levels documented a decade earlier. However, enough mercury is still present, the study reports, to merit a continuation of the statewide fish consumption advisory. "Formal inference about any trend of mercury contamination in fish tissue through time will require more data to create a proper time-series," says **Jason Vokoun**, an assistant professor of natural resources and the environment in the **College of Agriculture and Natural Resources**, and co-author of the new study with **Christopher Perkins**, laboratory co-director at UConn's **Center for Environmental Sciences and Engineering**.



Food & Agriculture

LATE BLIGHT IN TOMATOES. A widespread outbreak of late blight of tomato and potato occurred in gardens and in both conventional and organic commercial fields and greenhouses throughout Connecticut and the Northeast, reports **The Connecticut Agricultural Experiment Station**. Known for its association with the Irish potato famine of the 1840s, this devastating disease, caused by the pathogen *Phytophthora infestans*, rapidly kills plants under favorable conditions such as cool, cloudy, windy, and wet weather. The sale and distribution of infected tomato transplants by big box stores throughout the Northeast and continued favorable weather for disease aided the unprecedented outbreak. Visit www.ct.gov/caes to learn more.

ASIAN LONG-HORNED BEETLE STILL A THREAT. The Asian Longhorned Beetle (ALB) was discovered attacking trees as

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nearby as Worcester, MA, in August 2008. Since then, over 26,000 trees have been found to be infested. Over 700,000 trees in a 64 sq. mile quarantine area still need to be surveyed. The adult ALB is 3/4 to 1-1/2 inches long, glossy black with white spots on the back. It has distinctive black and white bands on each segment of the long antennae. The ALB can be confused with the native Whitespotted Sawyer, which is bronzy-black with smaller or no white spots and no distinctive white bands on the antennae. The wood-boring ALB eats healthy maples, birches, elms, willows, and horsechestnuts, among others. If residents find the beetle or its damage in trees (exit holes, egg sites, running sap) they should call **The Connecticut Agricultural Experiment Station** at 1-203-974-8485; photos can be sent to CAES.StateEntomologist@ct.gov.

CODING FOR SCHOOL LUNCH POLICIES. In an effort to help families and school administrators fight the epidemic of childhood obesity, a **Yale**-led team of researchers has developed a practical coding system to evaluate school wellness policies, which are required of all schools participating in the National School Lunch Program. This coding system was introduced in the July 2009 issue of the *Journal of the American Dietetic Association*. The Child Nutrition and Women, Infants and Children Reauthorization Act of 2004 required all local education agencies participating in the National School Lunch Program to create a school wellness policy by the 2006-2007 school year. Until now no quantitative method existed to measure their effectiveness.



Health

DPH UPDATE ON H1N1 VACCINATION. As of Sept. 2, 2009, there were 1,977 Connecticut residents who had tested positive for the novel H1N1 virus. Experts believe this is only a fraction of the likely number of cases in the state, as many people with mild symptoms do not seek medical care. A vaccine for the H1N1 virus is anticipated for mid-fall of 2009 and will be made available first to priority groups such as pregnant women, caregivers of young children, children, and healthcare workers. On August 16, 2009, **Governor M. Jodi Rell** announced that the **Department of Public Health** will be recruiting healthcare providers to administer the vaccine to residents. A **Yale** study published in the August 20 online issue of *Science* by **Alison P. Galvani**, an associate professor in the division of epidemiology of microbial diseases, suggests that vaccines targeted at groups more likely to transmit flu viruses, rather than those at highest risk of complications, would result in fewer infections and improved survival rates.

OBESITY, DIABETES RESEARCH. Scientists at the **Yale School of Medicine** found that reducing levels the enzyme prolylcarboxypeptidase (PRCP) in the brain led to weight loss and a decreased risk of Type 2 diabetes in mice. The study, reported in *The Journal of Clinical Investigation*, found that PRCP is located in the hypothalamus and regulates levels of a peptide known for inhibiting food intake and stimulating energy. Senior author **Sabrina Diano** says the research “provides the first evidence that breaking down molecules in the brain that regulate metabolism is an important component of weight control.” In another Yale study, researchers found that suppressing a liver enzyme that induces glucose production helped diminish the symptoms of Type 2 diabetes in a rat model—reducing blood glucose concentrations, decreasing rates of glucose production in the liver, and improving insulin sensitivity. Senior author and CASE Member **Gerald Shulman** said the results indicate that inhibiting Sirtuin 1 in the liver may be an attractive approach for the treatment of Type 2 diabetes. The research appears in the *Proceedings of the National Academy of Sciences*.

GENE'S ROLE IN PROMOTING ATHEROSCLEROSIS. **Yale University** researchers found that a single gene plays a key role in the development of atherosclerosis in mice. The research provides insight into the causes of atherosclerosis, or the hardening of the arteries, caused by a buildup of plaque. The research appears in the July 8 issue of the journal *Cell Metabolism*. Accumulation of low-density lipoprotein (LDL) cholesterol in the artery wall is the initial event in atherosclerosis, but the mechanism by which the LDL infiltrates vascular lining to reach the arterial wall has been unclear. The Yale team discovered that, when active, the caveolin-1 (Cav-1) gene, which is essential for orchestrating certain intracellular trafficking, promoted atherosclerotic lesions.



High Technology

FIRST ELECTRONIC QUANTUM PROCESSOR. A team of theoretical physicists at **Yale University**, led by CASE Member **Steven Girvin** and **Robert Schoelkopf**, has created the first rudimentary solid-state quantum processor. The team manufactured two artificial atoms, or qubits (“quantum bits”). The two-qubit superconducting chip successfully ran elementary algorithms, demonstrating quantum information processing with a solid-state device for the first time. Their findings appeared in a June 28 advanced online issue of *Nature*. The research is another step toward the ultimate goal of building a quantum computer which could potentially solve problems much faster than a classical computer.

LIGHT WITH THE POWER TO PUSH. A team led by **Hong Tang**, assistant professor at **Yale's School of Engineering & Applied Science**, discovered a “repulsive” light force that can be used to manipulate components on silicon microchips, meaning future nanodevices could be controlled by light rather than electricity. The team previously discovered an “attractive” force of light and showed how it could be manipulated to move components in semiconducting micro- and nanoelectrical systems—tiny mechanical switches on a chip. These light forces may one day control telecommunications devices that would require far less power but would be much faster than today's conventional counterparts. Light, as opposed to electricity, can be routed through a circuit with almost no interference in signal, and would eliminate the need to lay down large numbers of electrical wires. The team reports its findings in the July 13 edition of *Nature Photonics's* advanced online publication.



Transportation

CONNDOT SEEKS STIMULUS FUNDS FOR RAIL UPGRADES, HIGH-SPEED SERVICE. The **Connecticut Department of Transportation (ConnDOT)** has applied for \$80 million of the stimulus funds available for high-speed rail projects with the ultimate goal of establishing high-speed service between **New Haven** and **Springfield**. The Federal Railroad Administration (FRA) grant process requires that projects be part of regional high speed rail plans. Connecticut officials are meeting regularly with Amtrak and the **Coalition of Northeastern Governors (CONEG)** to assure that the respective projects being considered fit into a larger, coordinated plan for the Northeast. The Phase 1 funding request, submitted Aug. 24, is to cover the shovel-ready project of building ten miles of double-tracking between Berlin and Newington.

—Compiled and edited by **Ann G. Bertini, Asst. Dir. for Programs**

From the National Academies (from page 1)

to 45 who are performing exceptional engineering research and technical work in a variety of disciplines—were nominated by fellow engineers or organizations and chosen from approximately 240 applicants.

The symposium, held at the National Academies' Beckman Center at the University of California, Irvine, examined engineering tools for scientific discovery; engineering the health care delivery system; nano/micro photonics and new applications; and resilient and sustainable infrastructures.

<http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=06252009b>

◆ Report Faults US Plan for Research on Potential Health, Environmental Risks from Nanomaterials

A new report from the National Research Council finds serious weaknesses in the government's plan for research on the potential health and environmental risks posed by nanomaterials, which are increasingly being used in consumer goods and industry. An effective national plan for identifying and managing potential risks is essential to the successful development and public acceptance of nanotechnology-enabled products, stressed the committee that wrote the report. The panel did not evaluate whether current uses of nanomaterials represent unreasonable risks to the public, but instead focused on what would constitute an effective national research strategy for ensuring that current and future uses of nanomaterials are without significant impacts on human health or the environment.

The study urges a robust US strategic plan for addressing nanotechnology-related environmental health and safety risks, which will focus on promoting research that can assist all stakeholders, including federal agencies, in planning, controlling, and optimizing the use of engineered nanomaterials while minimizing effects of concern to society.

http://books.nap.edu/catalog.php?record_id=12559

◆ FreedomCAR, Fuel Partnership Strategy Assessed

At the request of the US Department of Energy, the National Research Council's Board on Energy and Environmental Systems has issued a letter report summarizing its review of the strategy and structure of the FreedomCAR and Fuel Partnership.

Although the current focus on nearer-term technologies is on the right track, according to the report, there remains a need for continued investment in longer-term, higher-risk, higher-payoff vehicle technologies that could be highly transformational with regard to reduced use of petroleum and reduced emissions. Such technologies include advanced batteries, technologies for hydrogen storage, and hydrogen/fuel cells. For researchers, contractors, and investors to be willing to make long-term commitments to these and other potentially important developing technologies, a consistent year-to-year level of support must be provided.

http://www.nap.edu/catalog.php?record_id=12711

Elected to the National Academy of Sciences:

G. Shirleen Roeder, PhD

Eugene Higgins Professor of Molecular, Cellular and Developmental Biology and Professor of Genetics,
Yale School of Medicine

For her work on genetic shuffling during the formation of sex cells

A CASE FOR CAPTURING CT'S WASTE HEAT

A new study by the Connecticut Academy of Science and Engineering entitled *The Feasibility of Utilizing Waste Heat from Central Electric Power Generating Stations and Potential Applications* finds that the heat currently being rejected from Connecticut's power plants is an untapped resource that is roughly equal in value to all of the fossil fuels used for the state's residential, commercial, and industrial sectors for process and space heating. CASE presented its findings at a Sept. 4th meeting of the Connecticut Energy Advisory Board (CEAB), which commissioned the study.

The study examines operational and rejected heat characteristics of base load power plants of 65 MW or larger and provides several examples of uses for reject heat. Potential uses in Connecticut include district energy (heating and cooling) systems; waste heat enterprise zones to encourage economic development; and algae farms for generating biofuel. Another key recommendation of the report is that new plants being sited be required to integrate electricity with thermal generation into their design.

http://www.ctcase.org/reports/waste_heat.pdf



*The newly opened KidSpace features water play and creative play areas.
[Photo courtesy: CT Science Center]*

News from the CT Science Center ...

The new Connecticut Science Center in Hartford has reached several significant milestones since opening on June 12 of this year. By the end of August, visitors exceeded 100,000. Residents from all 169 Connecticut towns have visited, along with tourists from dozens of other states and countries.

KidSpace, a creative exhibit gallery targeting children ages 2-6 and featuring water play and creative activities, opened in August. The water play area combines five water-based interactive exhibits including a giant water vortex, water fountain designer, and LEGO block, dam building stream table for up-and-coming hydro-engineers. The creative play area includes a build-your-own roller coaster, reading nook, and a 55-foot pneumatic ball transporter.

Two 3D movies — "Dinosaurs Alive!" and "3D Sun" — are currently showing at the 3D digital Hoffman Foundation Theater. "Wild Oceans" will replace the dinosaurs film on December 20. The current traveling exhibit, SPEED, will remain until December 13. In January, a new traveling exhibit, Ends of the Earth, will open. On October 3, the Science Center will host a LEGO Invent: the Future Contest event. This and many other events are listed at <http://ctsciencecenter.org/things-to-do/calendar.aspx>.

Nanodevices (continued from page 2)

able to diagnose dozens of infectious diseases or conditions, or perhaps could be designed to run blood work.

Usually, blood chemistry tests are done in a laboratory and results are not immediately available. Many underdeveloped countries do not have the resources or infrastructure to conduct blood tests or diagnose diseases in rural areas, Reed said. The envisioned small, multi-chipped diagnostic device could be used to test for HIV or any other pathogen, without the need for a laboratory, and produce results on the spot.

The technology also holds great promise in the most modern medical settings. A surgeon removing a cancerous lesion would also benefit from such a device. Instead of sending tissue samples to a pathologist for testing, the oncologist could check the margins around the tumor for lingering cancerous cells and receive data without leaving the operating room. These immediate results could spare the patient additional surgery and ensure that virtually all the cancer is removed. Fahmy said that the device would be sensitive to cancer cells because these rogue cells tend to carry an overall negative charge.

Eric Stern worked in Yale's clean room and said the nanowires were made conventionally using an electron beam to "sculpt" a perfect silicon crystal. "The real trick is that you need high-quality silicon with a perfect crystal structure," he said. The chip had to be etched in such a way that the sides of the nanowires were "perfectly" smooth. "The big challenge was making it integratable with standard circuits," he said. That's the difference between a small printed circuit or an ungainly, impractical assemblage of lab equipment.

"There's no limit as to what can be sensed—proteins, DNA, antigens—as long as it's charged," Reed said.

The nanowires can be used in two ways. "Naked" nanowires are able to detect changes in pH in a liquid. Otherwise, the nanowires can be made chemically "sticky" so that receptors, antibodies, or other proteins can be fixed to the silicon.

"We were doing basic science on tiny devices," Reed said. "We found we could use these small devices for biosensing. The nano device acts like a transistor. Stuff sticks to the surface and changes the current."

The Yale group published a paper in the journal *Nature* in 2007, grabbing the attention of nano labs around the world. Did it not occur to other scientists to make parallel nanowires?

Reed smiled and shrugged. "People are jumping on this all over the world. There are immediate applications in different areas. Products will emerge soon. These chips can be made cheaply," he said.

"We could put multiple sensors in a device. I hope this will have an impact on the developing world. And this is an area of great importance to Connecticut" and its growing biotechnology industry, Reed said. "Eventually we'll be able to see a single cell emitting protons. There are many modes in which to use these devices. We're opening up a whole new system to look at."

Fahmy has already started to produce hollow nanoparticles with which to deliver drugs to cells infected with HIV or other pathogens. Or the nanoparticles could carry pieces of antigen, a virus perhaps, and work like a vaccine.

These advances in biosensing and therapy using nanomaterials promise a revolution in the way diseases of all kinds are diagnosed and treated, the Yale scientists said ... and soon. — **Abram Katz is a freelance science writer.**

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