Life Sciences

Biothermal technology for Low-Temperature Application

Carnegie Mellon University's Yoed Rabin has received three grants totaling $1.26 million from the National Institutes of Health (NIH) to develop biothermal technology for low-temperature applications ranging from cryopreservation to cryosurgery. With the support of his NIH grants, Rabin is investigating the effects of combining exotic compounds known as synthetic ice blockers with common glass-promoting materials, in an effort to achieve vitrificative cryopreservation. Additionally, Rabin is leading a team effort to develop wireless, implantable temperature sensors to assist in temperature monitoring and control of the cryosurgical procedure.

Pittsburgh's steel mills may have burned out long ago, but Carnegie Mellon's technology is contributing to the city's new status as a hotbed for biotechnology research and innovation. The university doesn't have a medical school in the traditional sense, but its highly specialized biotechnology and cognitive studies programs are having an impact everywhere, from the operating table to the way we rehabilitate stroke victims.

Collaborations between Carnegie Mellon and other institutions have already resulted in better dyes and modeling for studying cells, a revolutionary approach to hip replacement surgery and a new understanding of how infants think. And, its educational programs are training the researchers that will lead the growth of these sectors into the future.

Molecular Biosensor and Imaging Center: The MBIC's approach to biosensor research promises to yield sophisticated molecular sensors that could be used to detect real-time behavior of the building blocks of life, including a subject's RNA, DNA, protein, peptides, lipids and hormones. Biologist Alan Waggoner leads a team working on fluorescent probes, which use dyes to signal changes in target molecules. These sensors will provide a very powerful tool for detecting a wide range of important biological processes involved in health and disease. Likely applications for the technology are as varied as hospital bed monitoring devices, handheld biohazard scanners for field use and food freshness detectors. *www.mbic.cmu.edu*

Center for Cognitive Brain Imaging: The CCBI investigates high-level cognition — language comprehension, problem-solving, visual thinking and executive processes — through the use of function magnetic resonance imaging (fMRI) and related approaches. Its research goal is to develop a unified theory that explains how thought emerges from brain function. The center uses state-of-the-art scanners at the new Brain Imaging Research Center, as well as behavioral studies, eye fixation studies and therapy studies of people with brain damage. The main applications are to the understanding and treatment of brain damage and to the enhancement of human performance in high-technology environments. *www.ccbi.cmu.edu*

Center for Automated Learning and Discovery: CALD applies machine-learning methods in order to classify the cognitive state of a human subject based on fRMI observations. That is, the project has successfully "trained" artificial-intelligence systems to determine from

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brain images whether a subject is looking at a picture or a sentence, reading a noun or a verb, etc. Eventually, these systems will lead to "virtual sensors" that can detect hidden cognitive states of a subject, providing a key tool for diagnosis of mental processes in patients with brain injuries. *www.cald.cs.cmu.edu*

Center for the Neural Basis of Cognition: A joint endeavor of Carnegie Mellon and the University of Pittsburgh Medical Center (UPMC), the CNBC is dedicated to the investigation of the neural mechanisms that give rise to human cognitive abilities. UPMC serves a large population of patients with functional and/or neurological disorders, including epilepsy, stroke, Parkinson's disease, schizophrenia, affective illness and Alzheimer's disease, and employs state-of-the-art functional imaging techniques for identifying sites of neurological damage. Carnegie Mellon's expertise in cognitive psychology imparts another layer of scientific analysis of the psychological disturbances these patients experience. Using experimental computational models, our researchers can study the neural pathways of normal brains and uncover the effects of structural damage on brain function and human performance. *www.cnbc.cmu.edu*

Bone Tissue Engineering Center: The BTEC is a collaboration between Carnegie Mellon, the University of Pittsburgh Medical Center, Children's Hospital and Duquesne University. Its mission is to develop bone and cartilage therapies to treat developmental deformities, ablative injuries, degenerative changes, tendon/ligament healing, hypoplastic fat and vascular insufficiencies. The center also encourages the transfer of developed technologies and treatments to enable new biotech ventures. *www.btec.cmu.edu*

Laboratory for International Privacy: Carnegie Mellon's "Data Privacy Lab" is dedicated to creating technologies and related policies with provable guarantees of privacy protection while allowing society to collect and share private or sensitive information for many worthy purposes, such as biomedical research. The Lab partners with institutions, agencies and corporations to develop answers to questions such as: What are good and bad privacy practices for sharing DNA sequences? *http://privacy.cs.cmu.edu*

Real-time Outbreak and Disease Surveillance: RODS is a computer-based surveillance, analysis and communication system that monitors public-health data and looks for patterns that suggest an abnormal or hostile occurrence. In this way, it provides early warning of naturally occurring disease outbreaks as well as terrorist attacks employing biological pathogens. The Biomedical Security Institute that runs RODS is a collaboration between Carnegie Mellon, the University of Pittsburgh and the Allegheny County Health Department. *www.rods.pitt.edu*

Quality of Life Technologies Engineering Research Center: June 2006, will see the creation of Carnegie Mellon's newest life-sciences hub: the Quality of Life Technologies Engineering Research Center (QoLT ERC). A joint venture with the University of Pittsburgh, the QoLT ERC will be dedicated to improving and sustaining the quality of life for a large and growing segment of our population: people with reduced functional capabilities due to aging or disability. As families, communities and individuals, we face new challenges to attain, prolong and preserve quality of life. Future QoLT systems will not just be gadgets for convenience, they will be intelligent assistants that fundamentally enhance the lives of both the infirm and their caregivers. Projects include nurse robots, fall-prevention technologies, robotic walkers and remote people-monitoring. *www.qolt.org*

Pittsburgh Mind-Body Center: Increasingly, medical science recognizes the importance of understanding the common pathways — psychological, behavioral, and psychobiological —that connect environmental factors with the onset of and recovery from diverse physical illnesses. That's why Carnegie Mellon and the University of Pittsburgh, supported by the NIH, founded the Pittsburgh Mind-Body Center. Each of the center's four major research initiatives is working toward a better understanding of how the mind influences a person's physical experience with a particular disease. Two of the studies, on osteoarthritis and breast cancer, are designed to serve as interventions, while the other two, on infectious flu and cardiovascular disease, are oriented toward examining risks for disease. *www.wpic.pitt.edu/pmbc*

Carnegie Mellon Engineering Professor Develops new Biomaterials to Improve Drug Delivery

Carnegie Mellon University's Christopher Bettinger is developing new biomaterials for use in a wide range of biomedical applications, including regenerative medicine, neural interfaces and drug delivery. To help make these biomedical devices more efficient, Bettinger's research team is investigating materials and fabrication strategy for the use of organic thin film transistors, which involve the use of organic semiconducting compounds, to assist in biomedical applications. "We found that by combining small-molecular semiconductors and biodegradable polymers it allows for potential electronic functionality in biodegradable medical implants that has previously been unattainable," Bettinger said.