Biomedical Engineering has emerged as one of NJIT’s strongest departments with nationally recognized research programs in such areas as tissue engineering and rehabilitation medicine. An emphasis on the health sciences has become an intrinsic part of education and research throughout the university, encompassing health care, life sciences, and pharmaceuticals.
Glucose-Driven Nanomachines

The development of neural prostheses — devices and technologies for interfacing with the central nervous system — is the focus of research by Mesut Sahin, (above) associate professor of biomedical engineering. He has a new grant from the National Institute of Neurological Disorders and Stroke to develop an interface between a patient’s brain and a computer so that the paralyzed individual can control his own wheelchair and other equipment without help from a caregiver. He hopes to extract the volitional motor signals from the proximal spinal cord that is still intact above the site of injury. His ongoing project, also NIH funded, is to develop and test a technology called floating light activated micro-electrical stimulators (FLAMES) (above left) for wireless activation of the central nervous system. Implanted in the spinal cord and energized by an infrared light beam through an optical fiber located outside the dura mater, FLAMES can allow victims of spinal cord injuries to regain the control of paralyzed muscles.

Research Professors Reginald Farrow and Zafar Iqbal are leading a team that has created new engineering that can scale down bio-fuel cells to the size of transistors, allowing the development of devices that are much lighter and contain less toxic material than the typical battery. The bio-fuel cell could lead to minimally invasive physiological monitoring, targeted drug delivery, brain and spinal stimulation, and other medical applications using nanoscale devices powered by the body’s own glucose and oxygen. The conceptual drawing above, created by Alokik Kanwal (photo left), a research assistant professor in physics, shows how a series of nanoscale bio-fuel cells would power an integrated circuit.

Physics Professors Reginald Farrow (below standing), research professor, and Gordon Thomas, (below seated) professor, are two of NJIT’s most prolific inventors. They recently received a patent for their NJIT SmartShunt, a device that enables the non-invasive wireless monitoring of a shunt that drains fluid out of the brain for patients suffering from severe excess pressure in the brain due to hydrocephalus or brain injury. They received a $3 million grant from the National Institutes of Health for work on the SmartShunt with the Harvard Medical School and a Boston company. Farrow also received a patent, with Research Professor of Chemistry Zafar Iqbal, for an improved method of fabricating arrays of nanoscale electrical probes that may lead to improved diagnostic tools for measuring the spatial variation of electrical activity inside biological cells. Thomas has a patent pending with Associate Professor Tara Alvarez for an improved personal tonometer for diagnosing glaucoma by measuring eye pressure. He also received a grant from the William G. and Helen C. Hoffman Foundation for this project.

Hans Chaudhry, (above) research professor of biomedical engineering, has developed the Automated Anatomic Torsion Monitor (AATM), a device to reduce low back dysfunction by giving oscillations to the pelvis. This device can also be used to find the effectiveness of a specific treatment by evaluating the low back dysfunction.
Laurent Simon, (right) associate professor of chemical, biological and pharmaceutical engineering, develops mathematical models to evaluate the effectiveness of various methods of drug delivery. He recently published findings of several studies evaluating different types of controlled-release systems as well as drug release from microspheres.

Treena Arinzeh, (right) professor of biomedical engineering, is widely recognized for her pioneering work in regrowing bones using adult stem cells. She and former graduate student Yee-Shuan Lee ’10, (below) now a fellow at the Miami Project to Cure Paralysis at the University of Miami School of Medicine, published a study evaluating human neural/stem progenitor cells for neural tissue engineering using piezoelectric fibrous scaffolds. Arinzeh recently received an NSF grant to investigate a biologically-inspired, semi-synthetic derivative of cellulose as a tissue engineering scaffold for cartilage repair. Research Professor George Collins is co-investigator.

Pushpendra Singh and Ian S. Fischer, professors of mechanical engineering, are investigating the physics of particle adsorption, and the spontaneous dispersion of particles that occurs when particles come in contact with a fluid. The NSF-funded study will provide insights into biological processes occurring over the surface of water, and allow improved estimates for the rate at which small particles, including microbes and viruses, spread on interfaces. This understanding will improve the modeling of processes in the pharmaceutical and food industries that involve breakup and spreading of powders on liquid surfaces. The research team includes (above, left to right): Daniel Codjoe, Naga Musunuri and Mdshahadat Hossain, all mechanical engineering students, Singh, and Fischer.

Associate Professor Tara Alvarez (left) of Biomedical Engineering and Associate Professor Sunil Dhar (below) of Mathematical Sciences received an NSF Major Research Instrumentation grant to design an integrated, portable neurovisual assessment system that will allow basic and clinical research scientists to assess neurovisual functions in normal and impaired individuals. This interdisciplinary project also explores the application of different statistical multivariate analyses to evaluate biomedical data collected from the neurovisual assessment system. The first application of the system will be to evaluate biomarkers to aid in the diagnosis of mild traumatic brain injury. This project builds on their recent publication that appeared in the Optometry and Visual Science December 2012 issue studying concurrent vision dysfunctions in patients with traumatic brain injury from a civilian population.

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Adjunct Professor Allyn Luke (above), manager of laboratories in civil and environmental engineering, is helping to advance research involving dental implants and biomaterials at New Jersey Dental School’s Department of Restorative Dentistry. An expert in materials testing, he coaches dental researchers in using their unique closed-loop servohydraulic multiaxial testing system to duplicate chewing motions.
Marguerite Schneider (above), associate professor of management, earned the 2012 Best Paper Award from the Organization Development and Change Division of the Academy of Management for her study of leadership in a hospital setting. The paper was authored with Curt Lindberg of Complexity Partners. She studied the results of a long-term project to reduce the MRSA staph infection at Maine Medical Center through "Positive Deviance" (PD), an organizational change technique based on the application of complexity theory to organizational leadership. Behavioral change is encouraged through revealing and tapping into “positive deviants” or notable individuals who come to lead the change process from within based on their own behaviors that deviate from the organization’s norms and accomplish extraordinary results using ordinary resources.

Chairs that can help musicians feel better and play better are the goal of David Brothers, (above) assistant professor of interior design at NJIT’s School of Art + Design. He has created a chair designed to reduce the back pain that is an occupational hazard for musicians who are required to sit for long periods of time, most often on a seat not designed for their needs. He said that the chair is also designed to promote good playing posture and correct breathing techniques. He hopes to design, fabricate and test a series of chairs with working musicians to assess the viability of the proposed strategies in a real-world application. He was named a finalist in the International 2012 SparkAwards program celebrating design excellence and innovation for his chair design.

Jason Wang, (above) professor of computer science and director of the Data and Knowledge Engineering Laboratory, develops software tools and search engines to simplify — by analysis and classification — huge amounts of biological data. The project is part of a long-term initiative in collaboration with researchers from the National Cancer Institute to build a cyber infrastructure for RNA data analysis and mining that would allow researchers to uncover patterns with potential applications in the detection of genetic diseases, the classification of DNA sequences, the prediction of RNA and protein secondary and tertiary structures, the investigation of structure-function relationships, the understanding of protein evolution, and rational drug design.

Associate Professor Stephen Pemberton (above) is the author of The Bleeding Disease: Hemophilia and the Unintended Consequences of Medical Progress. He explores both the success in transforming the disease to a manageable bleeding disorder and the unintended consequences in the 1980s when people with the disease contracted HIV/AIDS and Hepatitis C in staggering numbers.

The systems studied are the Unified Medical Language System, a terminological knowledge base of 2.6 million concepts taken from 160 specialized medical terminologies, and SNOMED CT, an international clinical terminology of over 300,000 concepts used for coding in Electronic Health Records.

Geller and his doctoral student, Xiang Ji, collaborated with Soon Ae Chun of CUNY-Staten Island to develop the Epidemics Outbreak and Spread Detection System, which gathers information in real time from Twitter as the basis for a user-friendly method for visualizing the outbreak and spread of an epidemic.

Associate Professor Yehoshua Perl (above) is a member of the Computer Science Department focusing on research on large terminological databases — how to efficiently store and retrieve knowledge in huge repositories, and to develop new approaches to extract the meaning and assure the integrity of stored knowledge. They have been involved in developing a simplified, compact semantic network to organize the large, complex clinical databases used in hospitals. Perl and Geller recently completed two studies supported by the National Library of Medicine with over $2.5 million, to track down and correct incorrect or misplaced medical terms.
Doctoral student **Syamala Pillai** (right) collaborated with researchers from UMDNJ’s Department of Microbiology and Molecular Genetics to develop a new, non-invasive technique for diagnosing fungal infections, a serious health threat for immune-compromised patients. The team synthesized highly fluorescent derivatives of antifungal drugs that bind themselves to fungal cells, rendering them fluorescent and allowing diagnostic imaging.

**Lev Krasnoperov**, professor of chemistry and environmental science, is her advisor.

**Frandy Dort** (above left), biomedical engineering major, and **Bemin Ghobreal ’12** both worked on **Associate Professor Tara Alvarez**’s research team in the Vision and Neural Engineering Laboratory. Dort worked on a study to identify biomarkers of mild traumatic brain injury and provide an understanding of the neural basis of oculomotor rehabilitation. Ghobreal developed custom software for the **NJIT** flexible visual stimulator, a tool used to facilitate rehabilitation of the visual system.

Students from universities across the country came to **NJIT**’s Department of Biomedical Engineering last summer to perform research in neural engineering with faculty experts in the NSF-funded Research Experiences for Undergraduates (REU) in Neural Engineering, led by **Associate Professor Bryan Pfister** and **Assistant Professor Raquel Perez-Castillejos**.

Above, the REU team that investigated the collective behavior of neurons under micrometric cues: (left to right): **Stacy Willett** of Arkansas Tech University; **Perez-Castillejos**; **Nikhil Chavali** from Johns Hopkins; **Brandey Anderson** from University of Florida; and Assistant Professor **Cheul Cho**. The project was a collaboration of the Tissue Models and the Stem Cells and Tissue Engineering Laboratories directed by Perez-Castillejos and Cho, respectively. All four teams in the program submitted an abstract of their research to the national annual meeting of the biomedical society that was accepted for a presentation at the conference.

**Ali Mustafa** (above), an applied physics major, took first prize in the Dana Knox Student Research Showcase for his project with Assistant Professor **Camilia Prodan** to develop a device to perform single-cell dielectric spectroscopy, an improved method by which pharmaceutical companies and industrial research labs can measure the effects of drugs on the health of cells.

Doctoral student **Qinyin Qiu** (above right) works with **Associate Professor Sergei Adamovich** (above left) on the research team developing RAVR – robot assisted virtual rehabilitation – to help restore hand and arm function in stroke victims and children with cerebral palsy. She led a study comparing the responses of the two groups of patients during and after intensive RAVR training, and found that while both groups showed improvement in clinical measurements of upper extremity functions, the robotic system required adjustment to accommodate the rehabilitation needs of the children.

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