The interdisciplinary Ph.D. program in bioengineering offered by the College of Engineering at the University of Notre Dame provides training in a wide range of engineering and biological fields, including physical, chemical, and mathematical sciences, as well as engineering principles. The diverse nature of the program, and the fact that it involves each department within the College of Engineering and faculty from the College of Science, will prepare you well for a career in biomedical research or industry.

The logistics are simple: As an entering Ph.D. student, you are admitted to the Graduate School and bioengineering graduate program with simultaneous admission into one of the traditional departments within the College of Engineering. This "home" department serves as your "administrative" location. For example, you will receive a stipend and tuition support from your home department. Faculty adviser(s) from the department will also help you plan a path to best meet your goals. Your coursework will emphasize depth in a traditional engineering discipline (within your home department), while incorporating additional coursework in a specific area of interest.

Bioengineering students at Notre Dame work in state of the art research facilities, such as cell and tissue culture laboratories; biomechanical testing; imaging, including computed tomography, electron microscopy, and light microscopy; microfluidics; micro- and nanofabrication; high-performance computing; material and chemical characterization by FTIR, HPLC, and mass spectrometry.

Coursework Requirements
As a student seeking a degree in bioengineering, you must complete a minimum of 27 credit hours: nine in engineering science, nine in biological science, and nine in bioengineering (encompassing engineering, bioengineering, and biology electives).

Comprehensive Exams and Candidacy Exam
Scheduled exams with written and oral components and your candidacy exam occur throughout the program and conform to Graduate School guidelines.

Dissertation and Defense
The final examination is the defense of the Ph.D. dissertation.

About South Bend
Part of a tri-city area, South Bend, Ind., is home to more than 200,000 people and offers a variety of cultural activities and facilities, as well as a wide selection of public and private schools and three major hospitals.

For more information, visit http://www.exploresouthbend.org

About Notre Dame
The University of Notre Dame is one of a handful of truly national universities with a student body drawn from across the United States and 100 countries. Current enrollment exceeds 11,400, with the graduate population numbering more than 1,600 students.

Visit the Graduate School Web site at http://graduateschool.nd.edu/html/about/index.html for more information.

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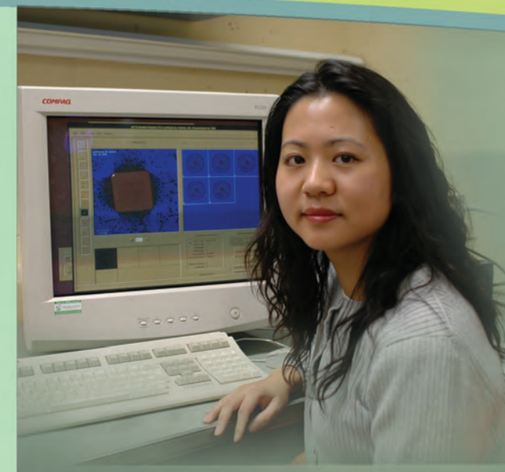

Graduate Studies in BioEngineering at the University of Notre Dame

Orthopedics

From designing implants for minimally invasive surgical procedures and imaging technologies to the development of biomaterials and tissue engineering, orthopedics at Notre Dame offers a wide range of options for a Ph.D. candidate. As with all of the other research areas, students work closely with faculty on campus and with industry researchers on a variety of projects. Courses include biomechanics, cell mechanics, mechanics of solids, cell and molecular biology, computational biophysics, thermodynamics, and fracture of engineering materials.

Diagnostics

Medical diagnostics encompass a variety of areas and technologies. University researchers are developing and incorporating these technologies ... from imaging to transport, nanofabrication to MEMS systems ... into medical devices that combine mechanical insights with biosensor and micromanipulation techniques that may be applied to diagnoses, drug delivery, or environmental sensing. In fact, researchers in the Center for Microfluidics and Medical Diagnostics hold a number of patents for both the method and apparatus for several such devices. Courses include reaction engineering, transport phenomena, molecular biology, applied mathematics, biomaterials engineering, cell biology, molecular biology, and thermodynamics.

Environmental Engineering

Research opportunities in bioengineering, focusing on environmental engineering (specifically protection and restoration of natural systems), range from understanding and tracking the fate of metals and organic molecules in the environment to the control and remediation of contaminants in soils and groundwater, treatment of off-gases and wastewater, and the application of molecular techniques and mathematical modeling to enhance treatment processes. Most recently, researchers have developed an embedded sensor network that detects and diverts overflow in combined sewer systems. The system being installed in South Bend, Ind., is the first city-wide embedded sensor network to monitor sewer overflow. Researchers are also working to develop membrane biofilm reactors and reduce bromate levels in water using microbial ecology. Courses include geochemistry, water-rock interactions, geomicrobiology, environmental and technological aspects of minerals, advanced geostatistics, environmental biotechnology, finite elements in engineering, environmental microbiology, and environmental isotope chemistry.

Modeling and Simulation

Modeling and simulation techniques are used in every department as part of the graduate studies curriculum. Within the Department of Computer Science and Engineering, these techniques provide the basis for scientific computing and specialization in computational biology, algorithms, and theory. Courses include bioinformatics, biostatistics, applied probability, computational biophysics, biochemistry, genetics, numerical methods, mathematical and computational modeling in biology and physics, software engineering, cell biology, and stochastic modeling.

Bioengineering Students at Work

Bioengineering Ph.D. student **Jacqueline Garrison** is studying the role of bone quality in osteoporotic fractures. She uses mechanical testing, histology, and high-resolution imaging to determine the relative importance of bone density, microarchitecture, pre-existing damage, in predicting the fracture susceptibility of bone taken from ovariectomized sheep - a novel animal model for human osteoporosis. Part of a National Institutes of Health study, Garrison's research is being conducted at Notre Dame and in collaboration with the Small Ruminant Comparative Orthopaedic Laboratory at Colorado State University.

Kaifeng Liu is a Ph.D. candidate studying the mechanical behavior of hydrogels – hydrophilic crosslinked polymers – for bioengineering applications, specifically the replacement of diseased or damaged tissue such as cartilage. This is important because approximately 40 million Americans suffer from degenerative joint diseases involving damaged cartilage.

Combining finite element analysis and experimental methods, he is working to address some of the challenges of hydrogels, which include a lack of standardized testing methods and difficult modeling properties. In addition to his work at the University, Liu has interned in the Biomechanical Testing Laboratory at Zimmer Holdings, Inc., in Warsaw, Ind., where he helped develop testing protocols and conduct mechanical testing to support the development of injection molded hydrogels.

Ryan Ross is also pursuing a Ph.D. in bioengineering. He is involved in a U.S. Army supported research project aimed at developing an X-ray contrast agent for quantifying microdamage in bone. He is developing methods to track the diffusion of gold and other metalic nanoparticles in bone and to selectively attach these particles to damage sites within the bone. The nanoparticles will be imaged using microscale computed tomography.