

Introducing

# BIOMEDICAL ENGINEERING

At Northwestern University

## CAREERS FOR BIOMEDICAL ENGINEERS

A biomedical engineer is a fully qualified engineer who, in addition to his/her technical education, has acquired an interdisciplinary background in the life or medical sciences. There are three principal paths a biomedical engineer can follow after graduation: (1) graduate school in engineering or in the life sciences, (2) medical or dental school, or (3) positions in industry or in a hospital. Some graduates continue to study biomedical engineering, at Northwestern or at another university, to obtain the Master of Science or Doctor of Philosophy in biomedical engineering or in an engineering specialty with a biomedical engineering option. Graduate schools train biomedical engineers to apply engineering research techniques to unravel the mysteries of living systems and lead research laboratories in industry or universities. A large number of students find that undergraduate biomedical engineering programs at Northwestern give excellent pre-professional training. With the increasingly technical nature of health care delivery, such students find relatively easy access to medical and dental schools. Many graduates choose jobs in biomedical industries or hospitals, to satisfy the demand for technically skilled people who

understand the special problems of living systems. Industry offers the possibility of developing, testing and marketing products ranging from prosthetic joints to medical lasers to cardiac pacemakers to pharmaceuticals and beyond.

## UNDERGRADUATE BIOMEDICAL ENGINEERING CURRICULA

Northwestern University was among the first schools to recognize the value of an education in biomedical engineering, and today the McCormick school offers, at both the undergraduate and graduate levels, one of the largest and broadest programs in the country. The primary path that undergraduates follow is the program offered by the Biomedical Engineering Department, which provides full integration of biology and engineering. Alternative curricula are the "options" that exist in other engineering departments. In such "option" programs, a student follows the specified sequence of courses for that departmental major and then selects a few elective courses in the bioscience and bioengineering areas. During the sophomore year, students usually indicate the curriculum of their choice and are assigned a faculty advisor who is actively involved in biomedical engineering. The Cooperative Engineering Education program is

a popular option for those who wish to gain industry work experience during the course of their studies. Most students decide on this option at the end of their freshman year.

## THE BIOMEDICAL ENGINEERING DEPARTMENT PROGRAM

This curriculum has been created to enable engineering students to receive biomedical training that is quantitative and emphasizes the application of engineering techniques to the analysis of biological systems. Required courses start with four courses in mathematics, a year of chemistry, two courses in physics, a four-course engineering analysis sequence, two courses in engineering design and communication, and a basic engineering background of five courses. The biomedical engineering component of this curriculum entails sixteen courses: two courses from a three-quarter sequence in systems physiology, a course in biochemistry and molecular biology, two in organic chemistry, and one course each in biomedical engineering laboratory and design; the remaining courses are chosen by the student with the help of his/her faculty advisor from one of five areas of specialization. The courses in each area of specialization provide depth in the applications of

engineering and mathematics to a particular subset of biomedical problems. Thus, specializations in electronic instrumentation, biomechanics and rehabilitation, transport processes and tissue engineering, biological materials and biotechnology, and biomedical signals and images can be achieved. These prepare the student for specific industrial opportunities. All areas of specialization provide excellent premedical preparation. Finally, this program requires the same course work in the humanities and social sciences as is required in all other engineering curricula at Northwestern University. Many biomedical engineering courses have been strongly influenced by the department's involvement in a National Science Foundation Engineering Research Center (VaNTH) whose goal is to develop new teaching materials and methods in bioengineering based on the latest advances in cognitive psychology, neuroscience and educational research into the ways people learn most effectively. As a complement to coursework, many students choose to broaden their skills and add depth to their content knowledge through involvement in undergraduate research.

## **BIOMEDICAL ENGINEERING DEPARTMENT PROGRAM SPECIALIZATIONS**

### **DEFINITIONS**

- 1. Electronic Instrumentation:** This option deals with biomedical and clinical data analysis methodologies, medical information systems, and special hardware and software for on-line patient analysis.
- 2. Biomechanics and Rehabilitation:** This option deals with applications of mechanics to the musculoskeletal system as well as to soft tissues such as the heart.
- 3. Transport Processes and Tissue Engineering:** This option deals with fluid flow and mass transfer in the body, as well as applications to biosensors, artificial organs and engineered tissues.
- 4. Biological Materials and Biotechnology:** This option deals with the application of chemical and molecular biological techniques to develop biomaterials and solve bioengineering problems.
- 5. Biomedical Signals and Imaging:** This option deals with the collection and analysis of biomedical signals (e.g., the electrocardiogram, the electroencephalogram) and images (e.g., magnetic resonance images).

## **PREPARATION FOR THE FUTURE**

Graduates with Biomedical Engineering degrees are attractive candidates for medical school, or for advanced study in biomedical science or engineering leading to the M.S. or Ph.D. degrees. Today, many graduates choose to pursue challenging careers in the large biomedical industry where the breadth and depth of training received by students in biomedical engineering is rapidly gaining appreciation. A small number of graduates pursue careers in fields ranging from law to veterinary medicine and the public sector. The Biomedical Engineering degree is the gateway to many career possibilities.

### **Website:**

<http://www.bme.northwestern.edu>

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