

# **Biomedical Engineering Interdisciplinary Studies Program**

## **Graduate Curriculum for the Biomedical Engineering Program Certificate**

The Biomedical Engineering Program (BEP) is an Interdisciplinary Studies Program, which offers a Biomedical Engineering Program Certificate. This certificate is similar to a minor and is open to all majors. The program consists of 21 credit hours and provides an interdisciplinary focus in three areas through education, research and service. The BEP's focus areas are: biomechanics and biomaterials; molecular, cellular, and tissue engineering; medical diagnostics, devices and imaging. A solid foundation in biomedical engineering (and engineering in general which includes chemistry, physics, and calculus), and life sciences (particularly, anatomy and physiology are required to obtain the interdisciplinary studies certificate in biomedical engineering.

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# Biomedical Engineering Program

## Graduate Curriculum for BEP Certificate

### CORE COURSES

**All students must take all 11 credits of the core courses.**

Bioengineering (BE/ME 570)...3

*Physiological and medical systems analysis using engineering methods including mechanics, fluid dynamics, control, electronics, and signal processing.*

Mammalian Physiology I (BS 500)...4

*Nervous, muscular, cardiovascular, and respiratory systems.*

Design and Data Analysis for Researchers I (ST 511)...4

*Statistical methods for experimenters and researchers emphasizing design and analysis of experiments.*

### ENGINEERING COURSES

**Non-Engineering Majors must take at least 3 credits of engineering courses.**

Bioprocess Engineering (BE / BH 306)...4

*Material, energy balances; fluid flow, heat exchange, mass transfer; application to operations in food, fermentation, other bioprocess industries.*

Bioseparation Processes (BE / CH 522)...3

*Analysis of processes used to recover and purify fermentation products.*

Cell and Tissue Engineering (BE / CH 525)...3

*Cell and tissue engineering concepts and techniques with emphasis on cellular response, cell adhesion kinetics, and tissue engineering design.*

Biomechanics (BE / ME 571)...3

*Mathematical approach to analysis of living systems, their function, diseases, and replaceable parts.*

Structure and Function of Biomaterials (BE / ME 573)...3

*Structure-function relationships of natural biomaterials; application to analysis of biomimetic materials and biomaterials used in medical devices.*

Fundamentals of Biochemical Engineering (CH 504)...3

*Application of chemical engineering principles to enzyme kinetics, fermentation and cell culture, product purification, and bioprocess design.*

## ELECTIVE COURSES

**Non-Engineering Majors must also take at least 7 credits from the following. (None of the engineering requirements can double count as an elective requirement.)**

**Engineering Majors must take at least 10 credits from the following.**

\* Interpreting Animal Research (AN 565)...3

*Designing, conducting, analyzing, and reporting of animal science research.*

Molecular Regulation of Cell Function (BC 565)...4

*Molecular regulation of cell organization, membrane formation, organelle biogenesis, cell communication, shape and motility, growth, aging, and death.*

Gene Expression (BC 663)...3

*Eukaryotic transcription mechanisms with emphasis on methods of study and regulatory mechanisms.*

\* Grant Proposal Writing and Review (BC 701)...1

*Didactic and hands-on experience with locating funding sources, writing effective grant proposals and the review process in the bio-molecular sciences.*

Bioprocess Engineering (BE / BH 306)...4

*Material, energy balances; fluid flow, heat exchange, mass transfer; application to operations in food, fermentation, other bioprocess industries. (Non-Engineering students may only count this course as an engineering course and not as an elective course.)*

Bioseparation Processes (BE / CH 522)...3

*Analysis of processes to recover and purify fermentation products. (Non-Engineering students may only count this course as an engineering course and not as an elective course.)*

Cell and Tissue Engineering (BE / CH 525)...3

*Cell and tissue engineering concepts and techniques with emphasis on cellular response, cell adhesion kinetics, and tissue engineering design. (Non-Engineering students may only count this course as an engineering course and not as an elective course.)*

Biomechanics (BE / ME 571)...3

*Mathematical approach to analysis of living systems, their function, diseases, and replaceable parts. (Non-Engineering students may only count this course as an engineering course and not as an elective course.)*

Structure and Function of Biomaterials (BE / ME 573)...3

*Structure-function relationships of natural biomaterials; application to analysis of biomimetic materials and biomaterials used in medical devices. (Non-Engineering students may only count this course as an engineering course and not as an elective course.)*

Biomedical Clinical Practicum (BE 586 A/B)...2 / 4

*Graduate-level activity, such as biomedical research or design of a new medical device, for exposure to the hospital/clinical environment.*

Mammalian Physiology II (BS 501)...5

*Cardiovascular, respiratory, renal, digestive, endocrine, metabolic, and reproductive function.*

- Histology (BS 502)...4  
*Analysis of animal cells, tissues and organs emphasizing light microscopy; reference to ultrastructural details.*
- Electron Microscopy- TEM, SEM, and X-Ray (BS 550)...3  
*Theory and demonstration of transmission and scanning electron microscopy and X-ray microanalysis.*
- Theory and Practice of Animal Biotechnology (BS 560)...3  
*Principles of molecular technology and applications to animal and human populations, including transgenic technology and gene therapy.*
- Human Anatomy Dissection (BS 575)...4  
*Regional approach to human gross anatomy through laboratory dissection of human cadaver.*
- \* Managing a Career in Science (BS 610)...1  
*Survival skills for professionals. How to succeed in science, including improving writing, teaching, speaking; finding the right job.*
- Cardiovascular Physiology (BS 620)...3  
*Physiology and biophysics of the circulatory system.*
- Mechanisms of Hormone Action (BS 631)...2  
*Synthesis, secretion, and mechanisms of action of hormones.*
- Fundamentals of Biochemical Engineering (CH 504)...3  
*Application of chemical engineering principles to enzyme kinetics, fermentation and cell culture, product purification, and bioprocess design. (Non-Engineering students may only count this course as an engineering course and not as an elective course.)*
- Advanced Cell Biology (CM 501)...4  
*Cell structure and organelle function.*
- Proteolytic Regulation of Cellular Processes (CM 520)...3  
*Functions of proteolytic pathways in the regulation of eukaryotic cellular processes, such as mitosis, apoptosis, signal transduction, and gene regulation.*
- Bioinformatics (MB / BI 576)...3  
*Technical computing across platforms using bioinformatics tools in molecular analyses.*
- Immunobiology (MB 651)...3  
*Structure, function, regulation of immunoglobulins and the immune system. Cellular immunity including transplantation and cancer.*
- Neuronal Circuits, Systems, and Behavior (NB 505)...3  
*Anatomical and physiological organization of the nervous system.*
- \* Seminar in Ethical Theory (PL 547)...3  
*Systematic and historical overview of 20<sup>th</sup> century theories of meta-ethics.*
- \* Seminar in Animal Rights (PL 564)...3  
*Contemporary issues concerning nature and moral status of nonhuman animals.*
- Design and Data Analysis for Researchers II (ST 512)...3  
*Model building and decision making; communication of statistical information.*

Most students will be able to count some of the Biomedical Engineering Program requirements toward their specific degree requirements. Substitutions for elective requirements may be allowed if approved by BEP and the student's advisor.

**For all students: a total of 21 credits is required with 12 of the 21 credits being courses 500 level or greater.**

\* Only three credits of non-technical courses may count towards total credit requirement.

Revised 01/05