Biomedical Engineering Graduate Concentration – Fall 2016
Biotechnology
Advisor: Jan Stegemann, Ph.D.

**BIOTECHNOLOGY:**
- BIOMEDE 410: Design and Applications of Biomaterials (3) (I)
- BIOMEDE 504: Cellular Biotechnology (3) (II)
- BIOMEDE 584: Advances in Tissue Engineering (3) (II)
- BIOPHYS 440: Biophysics of Diseases (3) (I)
- CHE 517: Biochemical Engineering (3) (I)

**GENERAL (both courses are required):**
- BIOMEDE 500: Biomedical Engineering Seminar (1) (I,II)
- BIOMEDE 550: Ethics and Enterprise (1) (I)

**BIOMEDICAL RESEARCH AND DESIGN (select one – BIOMEDE 590 or BIOMEDE 599.002 and BIOMEDE 599.004):**
- BIOMEDE 590: Directed Research (2-3) (I,II,III)
- BIOMEDE 599.002: Graduate BME Innovative Design Team (3) (I)
- BIOMEDE 599.004: Graduate BME Innovative Design Team (4) (II)

**NOTE:** In order for BIOMEDE 599.002 and BIOMEDE 599.004 to count toward their degree in BME, students must register for these courses in both the fall and winter terms, and they must adhere to the following rules:

a) this course can be counted as a SUGS, terminal MS, or MS/PhD student's 2 credit hour technical elective (fall term) and Biomedical Research and Design requirement (winter term),
b) this course, taken in both terms, can be counted as a technical elective for a student that has already taken BIOMEDE 590,
c) this course can be counted as PhD coursework providing that it has not already been counted as the student's Biomedical Research and Design requirement or technical elective in their MS program, and the student's advisor approves.

**MATHEMATICS (select one course):**
- MATH 450: Advanced Mathematics for Engineers I (4) (I,II,IIIb)
- MATH 454: Boundary Value Problems for Partial Differential Equations (3) (I,II,IIIa)
- MATH 462: Mathematical Models (3) (II)
- MATH 463: Mathematical Modeling in Biology (3) (I)
- MATH 471: Introduction to Numerical Methods (3) (I,II,IIIb)
- MATH 540: Mathematics of Biological Networks (3) (I)
- MATH 550: Introduction to Adaptive Systems (3) (I)
- MATH 555: Introduction to Functions of a Complex Variable with Applications (3) (I,II)
- MATH 556: Applied Functional Analysis (3) (I)
- MATH 557: Applied Asymptotic Analysis (3) (II)
- MATH 558: Applied Nonlinear Dynamics (3) (I)
- MATH 559: Topics in Applied Mathematics (3)
- MATH 561: Linear Programming I (3) (I,II)
- MATH 562: Continuous Optimization Methods (3) (II)
- MATH 563: Advanced Mathematical Methods in Biology (3) (II)
- MATH 564: Topics Math Biology (3)
- MATH 571: Numerical Linear Algebra (3) (I,II)
- MATH 572: Numerical Methods for Differential Equations (3) (II)
- MATH 651: Topics in Applied Mathematics I (3)
- MATH 656: Introduction to Partial and Differential Equations (3) (I)
- MATH 657: Nonlinear Partial Differential Equations (3)
- MATH 756: Advanced Topics in Partial Differential Equations (3)
- MECHENG 501: Math Methods in Mechanics (3) (II)
MECHENG 564  Linear Systems Theory (4) (I)

**BIOINSTRUMENTATION (select one course):**

BIOLCHEM 516  Intro Biochemistry Lab (3) (I)
BIOMEDE 458  Biomedical Instrumentation and Design (4) (I, II)
BIOMEDE 510  Medical Imaging Laboratory (3) (II)
IOE 432  Industrial Engineering Instrumentation Methods (3) (I)
MCDB 429  Cellular & Molecular Biology Lab (3) (II)

**STATISTICS (select one course):**

BIOMEDE 503  Statistical Methods for Biomedical Engineering (3) (II)
BIOSTAT 602  Biostatistical Inference (4) (II)
BIOSTAT 650  Applied Statistics I: Linear Regression (4) (I)
BIOSTAT 651  Applied Statistics II: Extensions for Linear Regression (3) (II)
EECS 501  Probability and Random Processes (4) (I,II)
IOE 461  Quality Engineering Principles and Analysis (3) (I)
STATS 470  Introduction to the Design of Experiments (4) (I)
STATS 500  Applied Statistics I (3) (I)
STATS 525  Probability Theory (3) (I)

**NOTE:** BME graduate students can only take EECS 501 in the winter term.

**LIFE SCIENCE (two courses are required – at least one course must be outside of the College of Engineering):**

**Required:**

BIOMEDE 519  Quantitative Physiology (4) (I)

**Select one course:**

ANAT 403  Human Anatomy (5) (I,II)
ANAT 541  Mammalian Reproductive Physiology (4) (II)
BIOLCHEM 451  Advanced Biochemistry I (4) (I)
BIOLCHEM 515  Introductory Biochemistry (3) (I, II)
BIOLCHEM 550  Macromolecular Structure and Function (3) (I)
BIOPHYS 520  Methods of Biophysical Chemistry (3) (I)
CANCBIOL 553  Molecular Biology of Cancer (3) (I)
CANCBIOL 554  Cancer Pathogenesis and Treatment (3) (II)
CDB 530  Cell Biology (3) (I)
CDB 550  Histology (4) (II)
CDB 581  Development Genetics (3) (I)
CDB 583  Organogenesis: Stem Cells to Regenerative Biology (3) (II)
KINESLGY 522  Clinical Neurophysiology and Neuroimaging (3)
KINESLGY 545  Metabolic Responses to Exercise (3)
MCDB 422  Brain Development, Plasticity, and Circuits (3) (I)
MCDB 423  Introduction to Research in Cellular and Molecular Neurobiology (3) (I) (II)
MCDB 427  Molecular Biology (4) (I) (II)
MCDB 428  Cell Biology (4) (I) (II)
MCDB 429  Cellular and Molecular Biology Laboratory (3) (II)
MCDB 435  Intracellular Trafficking (3) (II)
MICRBIOL 540  Human Immunology (3) (II)
NEUROSCI 570  Human Neuroanatomy I (3) (I)
NEUROSCI 601  Principles Neuro I (3) (I)
NEUROSCI 602  Princ Neurosc II (3) (II)
PATH 581  Tissue, Cellular and Molecular Disease (4) (II)
PHYSIOL 592  Integrated Neuroscience (2-4) (II)
**TECHNICAL ELECTIVES:**
At least one graduate level engineering and biology course. For technical electives outside of those listed, you must obtain approval from the biotechnology advisor.

Sample Course Sequence:

<table>
<thead>
<tr>
<th>Term</th>
<th>Courses</th>
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<tbody>
<tr>
<td>Fall</td>
<td>BIOLCHEM 515 or BIOMEDE 519, BIOMEDE 500, BIOMEDE 550, STATS 500, Technical Elective</td>
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<tr>
<td>Winter</td>
<td>BIOMEDE 418, MCDB 429, Biotechnology</td>
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<tr>
<td>Fall</td>
<td>CHE 508, BIOMEDE 590, Technical Elective</td>
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Technical Electives with biotechnology content:

- BIOINF 527 Introduction to Bioinformatics and Computational Biology (4) (I)
- BIOLCHEM 504 Cellular Biotechnology (3) (II)
- BIOLCHEM 550 Macromolecular Structure and Function (3) (I)
- BIOMEDE 410 Biomaterials (3) (I)
- BIOMEDE 456 Tissue Mechanics (3) (I)
- BIOMEDE 476 Biofluid Mechanics (4) (II)
- BIOMEDE 479 Biotransport (4) (II)
- BIOMEDE 599 Special Topics (1-7) (I,II)
- CANCBIO 553 Molecular Biology of Cancer (3) (I)
- CDB 550 Histology (4) (II)
- CDB 683 Organogenesis: Stem Cells to Regenerative Biology (3) (II)
- CHE 519 Pharmaceutical Engineering (3) (II)
- CHE 528 Reactor Engineering (3) (II)
- CHE 538 Statistical and Irreversible Thermodynamics (3) (I)
- CHE 542 Intermediate Transport Phenomena (3) (II)
- CHE 696 Selected Topics (3) (I,II)
- EECS 414 Introduction to MEMS (4) (I)
- MCDB 611 Neurochemistry/Neuropharmacology (1) (I)
- MECHENG 553 Microelectromechanical Systems (3) (I)
- MECHENG 599.002 Cellular Engineering (3) (I)

**KEY AND ADDITIONAL NOTES:**

Course Department and Number Course Name (# of credits) (term offered)

Terms: I - fall, II - winter, III - spring-summer, IIIa - spring half, IIIb - summer half

If a term is not listed after the course, please contact the department for course offering information.

Every effort is made to make sure that the course offering information listed on the concentration is correct. Students can also refer to the Schedule of Classes or the department for the current offering.