Introduction

What is Biomedical Engineering (BME)? It’s a synthetic heart valve that saves a grandmother’s life. It is a MRI scanner that reduces parents’ worries about their infant’s head injury. It’s an automatic biosensor for rapid gene sequencing. Biomedical engineering is the newest engineering discipline, integrating the basic principles of biology with the tools of engineering. With the rapid advances in biomedical research, and the severe economic pressures to reduce the cost of health care, biomedical engineering will play an important role in the medical environment of the 21st century. Over the last decade, biomedical engineering has evolved into a separate discipline bringing the quantitative concepts of design and optimization to problems in biomedicine.

The 5-year sequential undergraduate/graduate study (SUGS) program in biomedical engineering combines an undergraduate engineering discipline with a graduate program in one of the fastest growing fields in engineering. At the end of the program, a student has a B.S.E. in Chemical Engineering and an M.S.E. in Biomedical Engineering with a concentration in Biotechnology.

Opportunities

The opportunities for a biomedical engineer are wide ranging. The medical device and drug industries are increasingly investing in biomedical engineers. As gene therapies become more sophisticated, biomedical engineers will play an important role in bringing these ideas into real clinical practice. Finally, as technology plays an ever-increasing role in medicine, there will be a larger need for physicians with a solid engineering background. From biotechnology to tissue engineering, from medical imaging to microelectronic prosthesis, from biopolymers to rehabilitation engineering, biomedical engineers are in demand.

Application information

To officially enter the SUGS program a Chemical Engineering student must have obtained senior standing (85+ hours) by the time of entry and have a GPA of 3.2 or above. Students may apply for provisional admission Winter of their Junior year. To apply, first make an appointment with Mrs. Susan Graeber, BME Academic Advisor/Counselor, to discuss this program and ensure that it is a good fit with your career goals and plans. A student may also be referred to a faculty advisor for further services.

Next, fill out a Rackham Graduate School application and attach a statement of purpose, personal statement, and resume online. The application is submitted to the Rackham Graduate School and the Department of BME. The three names and email addresses of the faculty who will be writing letters of reference for you should be noted at the end of your online application. When your application is submitted, the system will send an email to the faculty with instructions on how to complete the form and letter of reference on-line. General Record Exam (GRE) scores are not required. The graduate school application fee must be submitted to Rackham, as well. Admission is not automatic. The BME admissions committee will review your application. Your statement of purpose and letters of recommendation are important parts of the admission decision.
The application deadlines are:

To begin SUGS in Fall term –
U.S. & Canadian students apply by July 1, International students apply by June 1

To begin SUGS in Winter term –
U.S. & Canadian students apply by Nov. 1, International students apply by October 1

To begin SUGS in Spring term –
U.S. and Canadian students apply by March 1, International students apply by March 1

In the spring term, very few course offerings are available. Most students will be better served by entering the program in the Fall or Winter terms.

GRE scores are not required for admission to the SUGS program, but are required for admission to the regular BME master’s and Ph.D. programs. If a student is seriously considering pursuing a Ph.D., the GRE test should be taken during the senior year. This also facilitates applications for major national graduate fellowships from the National Science Foundation, Office of Naval Research, Whitaker Foundation and others. The TOEFL is waived for students who have already taken it.

Students in the SUGS program are not eligible for a Life Sciences concentration in BSE ChE. Students pursuing dual degrees are not eligible to enroll in SUGS programs.

Requirements

1. All 128 credits of Chemical Engineering BSE requirements must be met.
2. All 30 credits of Biomedical Engineering MSE requirements must be met.
3. Up to nine hours of prior-approved coursework may be double-counted towards each of the two degrees, leading to a minimum total of:

   \[128 \text{ (BSE)} + 30 \text{ (MSE)} - 9 \text{ (double-counted)} = 149 \text{ credit hours} \]

Double-counted hours may not include any core courses required for the BSE degree, but may include courses elected to meet technical, biology/life science or free electives required for the BSE degree.

All double-counted hours must be acceptable for Rackham credit (non-core BME 4xx or BME 5xx or BME 6xx courses, or courses in other departments at the 4xx level or above). Check the Rackham approved courses online at www.rackham.umich.edu/Programs/index.html

CONTACTS

Undergraduates:
Dr. Susan Montgomery, 3142 Dow, (734) 936-1890, smontgom@umich.edu
www.engin.umich.edu/che/undergraduate/program/options/sgus

Graduate:
Prof. Andrew Putnam, 2204 Lurie BME Building, (734) 615-1398, putnam@umich.edu
Mrs. Susan Graeber, 1111 Gerstacker Building, (734) 763-5290, sbitzer@umich.edu
www.bme.umich.edu/programs/ SGUS /

Rackham SUGS website
www.rackham.umich.edu/current-students/policies/academic-records/sugs-information

Last updated February 2016
**MSE Biomedical Engineering – Biotechnology Concentration**  
30 total credits minimum

**Biotechnology (one course)**  
* BiomedE 410/MSE 410 Design and Application of Biomaterials (3)

**General**  
* BiomedE 500 Biomedical Engineering Seminar (1)  
* BiomedE 550 Ethics & Enterprise (1)

**Biomedical Research and Design (either 590 or both 599 courses)**  
* BiomedE 590 Directed Research (2)  
* BiomedE 599 – Section 002 Graduate BME Innovative Design Team (3) (Fall) AND  
* BiomedE 599 – Sections 004 Graduate BME Innovative Design Team (4) (Winter)

**Mathematics (one course)**  
* Math 450 Advanced Mathematics for Engineers I (4)  
* Math 454 Boundary Value Problems for Partial Differential Equations (3)  
* Math 462 Mathematical Models (3)  
* Math 463 Math Modeling in Biology (3)  
* Math 471 Introduction to Numerical Methods (3)  
* Math 513 Introduction to Linear Algebra (3)  
* Math 550 Introduction to Adaptive Systems (3)  
* Math 555 Introduction to Complex Variables (3)  
* Math 556 Methods of Applied Math I (3)  
* Math 557 Methods ofApplied Math II (3)  
* Math 558 Applied Nonlinear Dynamics (3)  
* Math 559 Topics in Applied Mathematics (3)  
* Math 561 Linear Programming (3)  
* Math 562 Continuous Optimization Methods (3)  
* Math 563 Advanced Mathematical Methods for the Biological Sciences (3)  
* Math 564 Topics Math Biology (3)  
* Math 571 Numerical Methods for Scientific Computing I (3)  
* Math 572 Numerical Methods for Scientific Computing II (3)  
* Math 651 Topics in Applied Mathematics I (3)  
* Math 652 Topics in Applied Mathematics II (3)  
* Math 656 Introduction to Partial Differential Equations (3)  
* Math 657 Nonlinear Partial Differential Equations (3)  
* Math 756 Advanced Topics in Partial Differential Equations (3)  
* MechEng 501 Math Methods in Mechanics (3)  
* MechEng 564 Linear Systems Theory (4)

**Bioinstrumentation (one course)**  
* Biol. Chem. 516 Intro Biochem Lab (3)  
* BiomedE 458 Biomedical Instrumentation and Design (4)  
* BiomedE 510 Medical Imaging Laboratory (3)  
* IOE 432 Industrial Engineering Instrumentation Methods (3)
**Statistics (one course)**

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

**Life Science (two courses)**

*Required one from this list*

- BiomedE 519/Physiology 519 Bioengineering Physiology (4)

*And one of the following*

- ANAT 403 Human Anatomy (5)
- ANAT 541 Mammal Reprod (4)
- BiolChem 451 Introductory Biochemistry I (4)
- BiolChem 515 Introductory Biochemistry (3)
- BiolChem 550 Macromol Struc and Function (3)
- BioPhys 520 Biophys Chem I (3)
- CANCBIO 553 Cancer Biology (3)
- CDB 516 Histol Allied Scien (4)
- CDB 530 Cell Biology (3)
- CDB 550 Histology (4)
- CDB 581 Developmental Genetics (3)
- CDB 583 Stem Cells Regen Bio (3)
- KINESLGY 522 Clin Neurophys Image (3)
- KINESLGY 545 Metab Respon to Exer (3)
- MCDB 422 Cellular and Molecular Neurobiology (3)
- MCDB 423 Neurology Lab (3)
- MCDB 427 Molecular Biology (4)
- MCDB 428 Cell Biology (4)
- MCDB 429 Laboratory in Cell and Molecular Biology (3)
- MCDB 435 Intracellular Trafficking (3)
- MCDB 530 Cell Biology (3)
- MicroBio 440 Immunology (3)
- Neurosci 570 Human Neuroanatomy (3)
- Neurosci 601 Principles Neuro I (4)
- Neurosci 602 Principles Neuro II (4)
- Path 581 Tissue, Cellular and Molecular Basis of Disease (4)
- Physiol 592 Integrative Neuroscience (4)
- Physiol 600 Pathophysiology (3)

**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 faculty advisor.

Technical Electives with biotechnology content

- Bioinf 527 Introduction to Bioinformatics and Computational Biology (4)
- Biolchem 504 Cell Biotech (3)
- Biolchem 550 Protein Structures and Function (3)
- BiomedE 410/MSE 410 Design and Application of Biomaterials (3)
- BiomedE 456 Tissue Mechanics (3)
- BiomedE 476 Biofluid Mechanics (4)
- BiomedE 479 Biotransport (4)
- BiomedE 522 Biomembranes: Structure, Transport, and Disease (3)
- BiomedE 556 Cellular and Molecular Biomechanics (3)
- BiomedE 599 Special Topics (1-6)
- CANCBIO 553 Cancer Biology (3)
- CDB 550 Through the Looking Glass – From Stem Cells to Tissues and Organs (4)
- CDB 683-685 Organogenesis of Complex Tissues (3)
- ChemE 519 Pharmaceutical Engineering (3)
- ChemE 528 Chemical Reactor Engineering (3)
- ChemE 530 Intro Bioinfo Sys Bio (3)
- ChemE 538 Statistical and Irreversible Thermodynamics (3)
- ChemE 542 Intermediate Transport Phenomena (3)
- ChemE 696 Selected Topics (2)
- EECS 414 Intro to MEMS (4)
- EHS 583 Radiation Biology (3)
- MCDB 611 Excitable Membranes (1)
- Mecheng 553 Microele Sys (3)
- Mecheng 599 Special Topics in ME (1-6)
- Medchem 409 Drug Assay (3)