BIOMEDICAL ENGINEERING

Undergraduate Study

For undergraduate curriculum in biomedical engineering leading to the degree Bachelor of Science.

engineering.iastate.edu/bme/ (https://www.engineering.iastate.edu/bme/)

Administered as an interdepartmental degree program.

Biomedical engineering seeks to better human health by designing engineered systems that can interface with biomedical systems or by controlling the biomedical systems themselves. Biomedical engineers leverage their deep understanding of fundamental scientific disciplines including physics, chemistry and biology as well as a broad understanding of different traditional engineering disciplines such as chemical, electrical and mechanical engineering. Broad areas of biomedical engineering include medical molecules and materials, biomedical mechanics and manufacturing and biomedical instrumentation that allow for engineering of cells and tissues or delivery of drugs and vaccines or devices that can detect or alleviate disease, regenerate tissue or assist after injury.

Practicing biomedical engineers work in research, uncovering fundamental properties of either biomedical systems or the engineered systems with which they interface. They work as product engineers, bringing innovative technology to bear in a usable product that can pass approval processes by the relevant regulatory organizations or process engineers, developing manufacturing approaches that can produce products economically, safely and under the proper conditions to ensure their use in the human body. Finally, biomedical engineers work in technical sales, intellectual property or governmental regulation.

The curriculum of biomedical engineering includes broad training in math, chemistry, physics, biology as well as engineering sciences such as thermodynamics, materials, fluid and solid mechanics and circuits. The curriculum also provides training in areas such as disease therapeutics and drug delivery, implants and tissue engineering, advanced diagnostics and biosensors, prosthetics and organ mechanics, medical device manufacturing, and medical imaging and equipment electronics. This training will culminate in lab and design courses that will emphasize a synthesis of these topics to design, build and test biomedical systems.

The curriculum will prepare students for a career in serving society through designing and manufacturing biomedical systems that improve human health. The curriculum will also prepare students to navigate difficult ethical questions through training in bioethics and will include broader training in the social sciences and humanities. This prepares graduates to better gauge the impact of biomedical engineering design decisions on broader society. Finally, graduates will be well-trained to communicate both with other technical colleagues as well as the broader public that benefits from the biomedical engineering products.

Student Learning Outcomes

Graduates of the biomedical engineering curriculum should have, at the time of graduation:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Program Educational Objectives

The objectives of the biomedical engineering program at Iowa State University are to produce graduates who:

- Will excel in careers as professional biomedical engineers in the businesses and industries related to biomedical engineering.
- Will successfully pursue research and advanced studies in biomedical engineering or in related professional fields such as medicine, law and business.

A cooperative education program is available to students in biomedical engineering.

Curriculum in Biomedical Engineering

Total credits required: 129

See also basic program and special programs.

The BME Program requires a grade of C or better from any transfer credit course that is applied to the degree program but will not be calculated into the ISU cumulative GPA, Basic Program GPA, or Core GPA.

BASIC PROGRAM: 24 CR.

A minimum GPA of 2.00 required for this set of courses (please note that transfer course grades will not be calculated into the Basic Program GPA). See Basic Program for Engineering Curricula in College of Engineering section.

BME 1600	Biomedical Engineering Problems with Computer Applications Laboratory [3]	3
CHEM 1670	General Chemistry for Engineering Students	4
or CHEM 1770	General Chemistry I	
ENGL 1500	Critical Thinking and Communication	3
ENGR 1010	Engineering Orientation	R
LIB 1600	Introduction to College Level Research	1
MATH 1650	Calculus I	4
MATH 1660	Calculus II	4
PHYS 2310	Introduction to Classical Physics I	4
PHYS 2310L	Introduction to Classical Physics I Laboratory	1
Total Credits		**24**

Social Sciences and Humanities: 12 cr.

Complete a total of 12 cr. with at least 6 cr., but not more than 9 cr., from the same department.

INTERNATIONAL PERSPECTIVES [1]: 3 CR.
U.S. Cultures and Communities [1]: 3 CR.
COMMUNICATION PROFICIENCY:

ENGL 2500	Written, Oral, Visual, and Electronic Composition	3
ENGL 3140	Technical Communication	3

Bioethics: 3 cr.

Choose from PHIL 3310 Moral Problems in Medicine, PHIL 3360 Bioethics and Biotechnology, or PHIL 3430 Philosophy of Technology

Foundational Courses: 34 cr.

BIOL 2120	Principles of Biology II	3
BIOL 2120L	Principles of Biology Laboratory II	1
BIOL 3350	Principles of Human and Other Animal Physiology	3
BIOL 3500	Comprehensive Human Anatomy	4
or BMS 4470	Introduction to Human Gross Anatomy	
or BMS 4480	Principles of Human Gross Anatomy	
CHEM 1670L	Laboratory in General Chemistry for Engineering	1
or CHEM 1770L	Laboratory in General Chemistry I	
MATH 2650	Calculus III	4
MATH 2670	Elementary Differential Equations and Laplace Transforms	4
MATE 2730	Principles of Materials Science and Engineering	3
ME 2310	Engineering Thermodynamics I	3
or MATE 3110	Thermodynamics in Materials Engineering	
PHYS 2320	Introduction to Classical Physics II	4
PHYS 2320L	Introduction to Classical Physics II Laboratory	1
STAT 3050	Engineering Statistics	3
Total Credits		**34**

FOUNDATIONAL ELECTIVES [2]: 14 CR.

BME 3600	Biotransport	3
BBMB 3030	General Biochemistry	3
CE 2740	Engineering Statics	3
CHEM 1780 & 1780L	General Chemistry II and Laboratory in College Chemistry II	4
CHEM 2310 & 2310L	Elementary Organic Chemistry and Laboratory in Elementary Organic Chemistry	4
or CHEM 3310 & 3310L	Organic Chemistry I and Laboratory in Organic Chemistry I	
EE 2850	Problem Solving Methods and Tools for Electrical Engineering	4
EE 3140	Electromagnetics for non Electrical Engineers	3
EE 4420	Introduction to Circuits and Instruments	2
EE 4480	Introduction to AC Circuits and Motors	2
ME 3240L & ME 3240	Manufacturing Engineering Laboratory and Manufacturing Engineering	4
ME 3450	Engineering Dynamics	3
ME 3700	Engineering Measurements	3

BME Core: 24 cr.

A minimum GPA of 2.00 is required for this set of courses (please note that transfer course grades will not be calculated into the Core Program GPA).

BME 1040	Biomedical Engineering First-Year Learning Community	R
BME 2010	Faculty-guided Professional Development in Biomedical Engineering	R
BME 2200	Introduction to Biomedical Engineering	3
BME 2700	Introduction to Biomedical Engineering Design	2
BME 3400	Numerical Analysis in Biomedical Engineering	3
BME 3500	Bioinstrumentation	4
BME 3520	Cellular and Tissue Biomechanics	3
BME 3520L	Molecular, Cellular and Tissue Biomechanics Lab	1
BME 3540	Introduction to Biomaterials	3
BME 3540L	Survey of Biomaterials Lab	1
BME 4200	Biomedical Engineering Design I	2
BME 4300	Biomedical Engineering Design II	2
Total Credits		**24**

Note: Students with transfer credits in Biomedical Engineering core courses must earn at least 18 semester credits, as well as complete all Biomedical Engineering design courses, at ISU in this category to qualify for the B.S. degree in Biomedical Engineering.

ELECTIVES [2]: 12 CR.

Complete 6 credits of BME Electives from approved list	6
Complete 3 credits of Engineering Electives from approved list	3
Complete 3 credits of Bioscience Electives from approved list	3
Total Credits	**12**

[1] These university requirements will add to the minimum credits of the program unless the university-approved courses are also approved by the department to meet other course requirements within the degree program. U.S. Cultures and Communities and International Perspectives courses may not be taken Pass-Not Pass.

[2] Electives used to meet graduation requirements may not be taken Pass-Not Pass.

[3] See Basic Program for Engineering Curricula for accepted substitutions for curriculum designated courses in the Basic Program.

Four-Year Plans

Medical Molecules and Materials Emphasis

Freshman

Fall	Credits	Spring	Credits
MATH 1650	4	MATH 1660	4
ENGL 1500	3	CHEM 1780	3
CHEM 1770	4	CHEM 1780L	1
CHEM 1770L	1	PHYS 2310	4
BME 1600	3	PHYS 2310L	1
BME 1040	R	BIOL 2120	3
LIB 1600	1	BIOL 2120L	1
ENGR 1010	R		
	16		**17**

Sophomore

Fall	Credits	Spring	Credits
ENGL 2500	3	BIOL 3350	3
PHYS 2320	4	BME 2200	3
PHYS 2320L	1	BME 2700	2
CHEM 2310 or 3310	3	MATH 2650	4
CHEM 2310L or 3310L	1	MATE 2730	3
MATH 2670	4	PHIL 3310, 3360, or 3430	3
		BME 2010	R
	16		**18**

Junior

Fall	Credits	Spring	Credits
BBMB 3030	3	BME 3500	4
MATE 3110	3	BME 3540	3
BME 3520	3	BME 3540L	1
BME 3520L	1	STAT 3050	3
BME 3400	3	BME 3600	3
EE 4420	2	ENGL 3140	3
	15		**17**

Senior

Fall	Credits	Spring	Credits
BME 4200	2	BME 4300	2
BIOL 3500, BMS 4470, or BMS 4480	4	SSH Elective	3
BME Elective	3	Engineering Elective	3
SSH Elective	3	BME Elective	3
SSH Elective	3	Bioscience Elective	3
		SSH Elective	3
	15		**17**

Total Credits: 131

BioMedical Mechanics and Manufacturing Emphasis

Freshman

Fall	Credits	Spring	Credits
MATH 1650	4	MATH 1660	4
ENGL 1500	3	SSH Elective	3
CHEM 1670	4	PHYS 2310	4
CHEM 1670L	1	PHYS 2310L	1
BME 1600	3	BIOL 2120	3
BME 1040	R	BIOL 2120L	1
LIB 1600	1		
ENGR 1010	R		
	16		**16**

Sophomore

Fall	Credits	Spring	Credits
ENGL 2500	3	BIOL 3350	3
PHYS 2320	4	BME 2200	3
PHYS 2320L	1	BME 2700	2
CE 2740	3	MATH 2650	4
MATH 2670	4	MATE 2730	3
		PHIL 3310, 3360, or 3430	3
		BME 2010	R
	15		**18**

Junior

Fall	Credits	Spring	Credits
BIOL 3500, BMS 4470, or BMS 4480	4	BME 3500	4
ME 2310	3	BME 3540	3
BME 3520	3	BME 3540L	1
BME 3520L	1	STAT 3050	3
BME 3400	3	BME 3600	3
EE 4420	2	ENGL 3140	3
ME 3240L	1		
	17		**17**

Senior

Fall	Credits	Spring	Credits
BME 4200	2	BME 4300	2
ME 3240	3	SSH Elective	3
BME Elective	3	Engineering Elective	3
SSH Elective	3	BME Elective	3
ME 3450	3	Bioscience Elective	3
		SSH Elective	3
	14		**17**

Total Credits: 130

BioMedical Instrumentation Emphasis

Freshman

Fall	Credits	Spring	Credits
MATH 1650	4	MATH 1660	4
ENGL 1500	3	EE 2850	4
CHEM 1670	4	PHYS 2310	4
CHEM 1670L	1	PHYS 2310L	1
BME 1600	3	BIOL 2120	3
BME 1040	R	BIOL 2120L	1
LIB 1600	1		
ENGR 1010	R		
	16		**17**

Sophomore

Fall	Credits	Spring	Credits
ENGL 2500	3	BIOL 3350	3
PHYS 2320	4	BME 2200	3
PHYS 2320L	1	BME 2700	2
SSH Elective	3	MATH 2650	4
MATH 2670	4	MATE 2730	3
		BME 2700	2
		PHIL 3310, 3360, or 3430	3
		BME 2010	R
	15		**20**

Junior

Fall	Credits	Spring	Credits
BIOL 3500, BMS 4470, or BMS 4480	4	BME 3500	4
ME 2310	3	BME 3540	3
BME 3520	3	BME 3540L	1
BME 3520L	1	STAT 3050	3
BME 3400	3	ENGL 3140	3
EE 4420	2		
	16		**14**

Senior

Fall	Credits	Spring	Credits
BME 4200	2	BME 4300	2
EE 4480	2	SSH Elective	3
EE 3140	3	Engineering Elective	3
BME Elective	3	BME Elective	3
SSH Elective	3	Bioscience Elective	3
ME 3700	3	SSH Elective	3
	16		**17**

Total Credits: 131

Biomedical Engineering Minor

Minor supervised by an interdisciplinary faculty committee, administered by the Chemical and Biological Engineering Department. The Biomedical Engineering minor is a unique opportunity for students to acquire a multi-disciplinary engineering and life sciences background for entering the field of biomedical engineering.

The program is open to all undergraduate students at Iowa State University who meet the course prerequisites. This minor will provide students with a foundation of core biology and engineering relevant to further study in biomedical engineering along with an introduction to the application of engineering principles to biomedical problems from a multidisciplinary perspective as well as the applications within the majors of the participating departments.

A minimum of 17 cr. meeting the six requirements below with a minimum of 3 of those credits not being used to meet any other department, college, or university requirement and a minimum of 6 cr. at the 3000 level or above. No more than 3 cr. of 4900 credit may be applied to this minor. At least 3 credits must be taken at Iowa State University.

BIOL 2120	Principles of Biology II	3
BME 2200	Introduction to Biomedical Engineering	3

BIOL 2560	Fundamentals of Human Physiology	3
or BIOL 3350	Principles of Human and Other Animal Physiology	
Introductory Engineering Elective *		3
Advanced Engineering Elective **		3
Professional Elective ***		2-3
Total Credits		**17-18**

*A second (Introductory) engineering course from a department other than that of your major. The topic of the course should have ready application to later BME-related electives in that discipline (ABE 3780; CE 2740; CHE 2100; CPRE 2810; EE 2010, EE 3140, or EE 4420 and EE 4480; EM 3240; IE 2710; MATE 2730; ME 2310; or other courses approved by the Biomedical Engineering curriculum committee).

** 3000-5000 level engineering course with clear biomedical engineering application (BME 4900, BME 3410, EE 4500; CHE 4400; MATE 4560; IE 4470; IE 5710; ME 5500 or other courses approved by Biomedical Engineering curriculum committee).

*** 3000-5000 level engineering or life sciences course with clear biomedical engineering application OR BME 4900 OR departmental 4900 with biomedical engineering topic OR 2000+-level life sciences laboratory course (If a 2000-level course is chosen here, the student will need to meet the required 6 cr. of 3000+ courses by substitution of a higher-level course for the other requirements or by taking an additional course.), OR 3000-5000 level BME course.