

PENNSTATE



# Bioengineering

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## CAREERS

Graduates with a bachelor's degree in bioengineering may be employed in the healthcare industry and work on product research and development, design, production, testing, quality assurance, clinical trials, sales, and technical service. To succeed at these tasks the bioengineering program provides graduates with a broad base of mathematics, physics, chemistry, and the biological sciences, as well as an understanding of the principles of engineering analysis and design. The program develops the skills needed to work in multidisciplinary teams, communicate effectively, and appreciate the ethical and regulatory constraints governing development, manufacture, and distribution of healthcare products.

Research in the biophysical sciences is a major force driving world social and economic development. Bioengineers bring the unique perspective of engineering analysis to experiment design and data interpretation and are at the forefront in the development of new instrumentation and devices for biophysical research and technologies to advance medical care. The bioengineering bachelor of science degree program prepares students for work in this rapidly changing field by instilling an appreciation for the current state-of-the-art and anticipated trends in biophysical and applied research. The bioengineering program also prepares its graduates for careers as physicians, dentists, and physician-scientists by providing the broad science base needed for medical training.

All students obtain the engineering fundamentals needed to develop and apply new diagnostic and therapeutic procedures, including new developments in medical imaging, artificial organs, and biomaterials. Students are trained to recognize the need to maintain and expand this knowledge base through graduate studies and lifelong learning activities.

## CURRICULUM

The undergraduate curriculum consists of a core of common courses taken by all bioengineering students. In the first year, students receive their first exposure to the world of bioengineering through a seminar course designed to

**T**he bioengineering bachelor of science degree program provides the knowledge base and design skills needed for graduates to advance the biophysical sciences and develop technologies for health-care delivery. Consistent with the mission of Penn State and the College of Engineering, the program aims to create world-class engineers who will, after graduation, contribute to social and economic development through applications of engineering to the solution of problems in medicine and biology. The educational objectives for the undergraduate program in bioengineering are described online at [www.bioe.psu.edu/navigate/undergraduate.html](http://www.bioe.psu.edu/navigate/undergraduate.html).

explore the foundations of bioengineering. In the sophomore year, in addition to completing math and physics courses, students take an entry-level course in physiology and an associated lab course to gain hands-on experience with living organs, tissues, and cells. In addition, students take a molecular and cell biology course similar in nature to that taken by life science students, but with a quantitative focus and informative mathematical examples.

The junior year begins with the foundations of continuum mechanics as applied to solid and fluid systems to gain an understanding of the mechanical properties of tissues, such as muscle and bone, and the viscous properties of fluids, such as blood. This course is paralleled by courses in thermodynamics and analysis of physiological systems which cover control and regulation at the molecular, cellular and tissue level. These courses are followed by an exposure to fundamentals of the design of medical instrumentation and further studies on the physical properties of tissues and their functions.

During the senior year, students integrate many of their engineering and life science experiences into a study of the design of medical devices. A first-hand exposure to the application of medical devices to treat various disease processes is given in collaboration with clinical faculty at the Milton S. Hershey Medical Center. This experience is followed by a senior year design course that aims to integrate much of the student's prior educational experiences.

Throughout the curriculum, students are expected to strengthen their engineering and physical science skills by selecting one of four options within which specialized advanced courses, and their prerequisites, are taken. The option areas are:

- **Electrical Engineering:** for students wishing to study the design and development of medical devices, signal processing, and medical imaging
- **Chemical Engineering:** for studies of transport within physiological systems, drug delivery, and development of engineered tissues

- **Mechanical Engineering:** for studies of the mechanics of the human body in health and disease and applications to medical devices and orthopedics
- **Materials Science:** for studies of biomaterials that are designed to interact with living tissues at the cellular and molecular level and tailored to affect tissues in a prescribed manner

## OPPORTUNITIES

The job market for students with a bachelor's degree in bioengineering is growing rapidly as advances in the biomedical sciences impact health care. With a health-care industry that constitutes almost 15 percent of our gross national product, there are many opportunities for graduates with the specialized training offered at Penn State. It is anticipated that with the unique concentration of engineering and life science courses offered in the curriculum, graduates will have an advantage in rising through the engineering ranks to positions of leadership in an industrial setting. With a readily recognizable concentration in a traditional engineering area, as embodied by one of the four options, students will be well prepared to answer the specific needs of an employer, as well as to go on to pursue graduate study in a related area.

## DEPARTMENT STATISTICS

The Department of Bioengineering consists of 12 faculty members at University Park. The department also oversees an Intercollege Graduate Degree Granting Program that offers M.S. and Ph.D. degrees in bioengineering. The intercollege graduate faculty consists of an additional 25 members with primary appointments in other engineering departments and colleges within the University, including the Hershey Medical Center College of Medicine.

## ADMISSION REQUIREMENTS

Prospective students are encouraged to plan their entry to bioengineering in their first year since the second-year life science courses are not part of the common engineering curriculum. No prior experience in biology is required.

**ELECTRICAL ENGINEERING OPTION (133 credits)**

First Semester		Second Semester		Third Semester		Fourth Semester	
	CR		CR		CR		CR
BIOE 100S First-Year Seminar	1	CHEM 112 Chemical Principles	3	BIOL 141 Physiology	3	BIOE 201 Cell & Molecular Bioengineering	3
CHEM 110 Chemical Principles	3	CHEM 113 Experimental Chemistry	1	BIOL 142 Physiology Lab	1	ECON 002, 004, or 014 Economics	3
CHEM 111 Experimental Chemistry	1	CMPSC 200 or 201 Computer Programming	3	E MCH 210 Statics & Strength of Materials	5	E E 210 Circuits & Devices	4
EDSGN 100 Engineering Design	3	Health & Physical Activity	1.5	MATH 251 Differential Equations	4	Humanities & Arts Elective (GA/GH/GS)	3
ENGL 015 Rhetoric & Composition	3	MATH 141 Calculus II	4	PHYS 212 General Physics: Electricity & Magnetism	4	MATH 230 Calculus & Vector Analysis	4
MATH 140 Calculus I	4	PHYS 211 General Physics: Mechanics	4		4	Total	17
Total	15	Total	16.5	Total	17		
Fifth Semester		Sixth Semester		Seventh Semester		Eighth Semester	
	CR		CR		CR		CR
BIOE 301 Analysis of Physiological Systems	3	BIOE 401 Intro to Bioe Res & Design	3	BIOE 406 Medical Imaging	3	BIOE 450W Bioengineering Senior Design	3
BIOE 302 Physiological Simulation Lab	1	BIOE 402 Medical Instrumentation	3	BIOE 440 Clinical Correlations	1	BIOE Elective	3
BIOE 303 Bio-Continuum Mechanics	3	BIOE 403 Medical Instrumentation Lab	1	BIOE Elective	3	EE Option Elective	3
BIOE 313 Biothermodynamics	3	BIOE 404 Data Analysis & Experiment Design	1	CAS 100A or B Effective Speech	3	Humanities & Arts Elective (GA/GH/GS)	3
E E 310 Electronic Circuit Design I	4	EE 330 Engineering Electromagnetics or CMPEN 270 Digital Systems	4	EE Option Elective	3	Science & Engineering Elective	3
Humanities & Arts Elective (GA/GH/GS)	3	ENGL 202C Technical Writing	3	Health & Physical Activity	1.5	Total	15
Total	17	Humanities & Arts Elective (GA/GH/GS)	3	Humanities & Arts Elective (GA/GH/GS)	3		
		Total	18	Total	17.5		

**CHEMICAL ENGINEERING OPTION (132 credits)**

First Semester		Second Semester		Third Semester		Fourth Semester	
	CR		CR		CR		CR
BIOE 100S First-Year Seminar	1	CHEM 112 Chemical Principles	3	BIOL 141 Physiology	3	BIOE 201 Cell & Molecular Bioengineering	3
CHEM 110 Chemical Principles	3	CHEM 113 Experimental Chemistry	1	BIOL 142 Physiology Lab	1	CHEM 210 Organic Chemistry	3
CHEM 111 Experimental Chemistry	1	CMPSC 200 or 201 Computer Programming	3	E MCH 210 Statics & Strength of Materials	5	ECON 002, 004, or 014 Economics	3
EDSGN 100 Engineering Design	3	Health & Physical Activity	1.5	MATH 251 Differential Equations	4	Humanities & Arts Elective (GA/GH/GS)	3
ENGL 015 Rhetoric & Composition	3	MATH 141 Calculus II	4	PHYS 212 General Physics: Electricity & Magnetism	4	MATH 230 Calculus & Vector Analysis	4
MATH 140 Calculus I	4	PHYS 211 General Physics: Mechanics	4		4	Total	16
Total	15	Total	16.5	Total	17		
Fifth Semester		Sixth Semester		Seventh Semester		Eighth Semester	
	CR		CR		CR		CR
BIOE 301 Analysis of Physiological Systems	3	BIOE 401 Introduction to Bioengineering	3	BIOE 440 Clinical Correlations	1	BIOE 423 Reaction Kinetics	3
BIOE 302 Physiological Simulation Lab	1	BIOE 402 Medical Instrumentation	3	BIOE Elective	3	BIOE 450W Bioengineering Senior Design	3
BIOE 303 Bio-Continuum Mechanics	3	BIOE 403 Medical Instrumentation Lab	1	CAS 100A or B Effective Speech	3	BIOE Elective	3
BIOE 313 Biothermodynamics	3	BIOE 404 Data Analysis & Experiment Design	1	CH E Option Elective	3	Humanities & Arts Elective (GA/GH/GS)	3
CH E Option Elective	3	BIOE 409 Biofluid Mechanics	3	Health & Physical Activity	1.5	Science & Engineering Elective	3
CH E Option Elective	2	BIOE 413 Transport Phenomena	3	Humanities & Arts Elective (GA/GH/GS)	3	Total	15
Humanities & Arts Elective (GA/GH/GS)	3	ENGL 202C Technical Writing	3	Humanities & Arts Elective (GA/GH/GS)	3		
Total	18	Total	17	Total	17.5		

**MECHANICAL ENGINEERING OPTION (132 credits)**

First Semester		Second Semester		Third Semester		Fourth Semester	
	CR		CR		CR		CR
BIOE 100S First-Year Seminar	1	CHEM 112 Chemical Principles	3	BIOL 141 Physiology	3	BIOE 201 Cell & Molecular Bioengineering	3
CHEM 110 Chemical Principles	3	CHEM 113 Experimental Chemistry	1	BIOL 142 Physiology Lab	1	E MCH 212 Dynamics	3
CHEM 111 Experimental Chemistry	1	CMPSC 200 or 201 Computer Programming	3	E MCH 210 Statics & Strength of Materials	5	E MCH 315 Mechanical Response of Engineering Materials	2
EDSGN 100 Engineering Design	3	Health & Physical Activity	1.5	MATH 251 Differential Equations	4	E MCH 316 Experimental Determination of Mechanical Response of Materials	1
ENGL 015 Rhetoric & Composition	3	MATH 141 Calculus II	4	PHYS 212 General Physics: Electricity & Magnetism	4	Humanities & Arts Elective (GA/GH/GS)	3
MATH 140 Calculus I	4	PHYS 211 General Physics: Mechanics	4		4	MATH 220 Matrices	2
Total	15	Total	16.5	Total	17	MATH 230 Calculus & Vector Analysis	4
						Total	18
Fifth Semester		Sixth Semester		Seventh Semester		Eighth Semester	
	CR		CR		CR		CR
BIOE 301 Analysis of Physiological Systems	3	BIOE 401 Introduction to Bioengineering	3	BIOE 440 Clinical Correlations	1	BIOE 450W Bioengineering Senior Design	3
BIOE 302 Physiological Simulation Lab	1	BIOE 402 Medical Instrumentation	3	BIOE Elective	3	BIOE Elective	3
BIOE 303 Bio-Continuum Mechanics	3	BIOE 403 Medical Instrumentation Lab	1	CAS 100A or B Effective Speech	3	Humanities & Arts Elective (GA/GH/GS)	3
BIOE 313 Biothermodynamics	3	BIOE 404 Data Analysis & Experiment Design	1	ECON 002, 004, or 014 Economics	3	ME Option Elective	3
Humanities & Arts Elective (GA/GH/GS)	3	BIOE 409 Biofluid Mechanics	3	Health & Physical Activity	1.5	Science & Engineering Elective	3
ME 360, ME 370, BIOE 443 or BIOE 444 IL	3	ENGL 202C Technical Writing	3	Humanities & Arts Elective (GA/GH/GS)	3	Total	15
Total	16	ME Option Elective	3	Humanities & Arts Elective (GA/GH/GS)	3		
		Total	17	Total	17.5		

**MATERIALS SCIENCE OPTION (132 credits)**

First Semester		Second Semester		Third Semester		Fourth Semester	
	CR		CR		CR		CR
BIOE 100S First-Year Seminar	1	CHEM 112 Chemical Principles	3	BIOL 141 Physiology	3	BIOE 201 Cell & Molecular Bioengineering	3
CHEM 110 Chemical Principles	3	CHEM 113 Experimental Chemistry	1	BIOL 142 Physiology Lab	1	CHEM 210 Organic Chemistry	3
CHEM 111 Experimental Chemistry	1	CMPSC 200 or 201 Computer Programming	3	E MCH 210 Statics & Strength of Materials	5	ECON 002, 004, or 014 Economics	3
EDSGN 100 Engineering Design	3	Health & Physical Activity	1.5	MATH 251 Differential Equations	4	Humanities & Arts Elective (GA/GH/GS)	3
ENGL 015 Rhetoric & Composition	3	MATH 141 Calculus II	4	PHYS 212 General Physics: Electricity & Magnetism	4	MATH 230 Calculus & Vector Analysis	4
MATH 140 Calculus I	4	PHYS 211 General Physics: Mechanics	4		4	PHYS 214 General Physics: Wave Motion & Quantum Physics	2
Total	15	Total	16.5	Total	17	Total	18
Fifth Semester		Sixth Semester		Seventh Semester		Eighth Semester	
	CR		CR		CR		CR
BIOE 301 Analysis of Physiological Systems	3	BIOE 401 Introduction to Bioengineering	3	BIOE 440 Clinical Correlations	1	BIOE 444 IL Surfaces & the Biological Response to Materials	3
BIOE 302 Physiological Simulation Lab	1	BIOE 402 Medical Instrumentation	3	BIOE 443 Biomedical Materials	3	BIOE 450W Bioengineering Senior Design	3
BIOE 303 Bio-Continuum Mechanics	3	BIOE 403 Medical Instrumentation Lab	1	BIOE Elective	3	BIOE Elective	3
BIOE 313 Biothermodynamics	3	BIOE 404 Data Analysis & Experiment Design	1	CAS 100A or B Effective Speech	3	Humanities & Arts Elective (GA/GH/GS)	3
Humanities & Arts Elective (GA/GH/GS)	3	ENGL 202C Technical Writing	3	Health & Physical Activity	1.5	Science & Engineering Elective	3
MATSE 201 Introduction to Materials Science	3	Humanities & Arts Elective (GA/GH/GS)	3	Humanities & Arts Elective (GA/GH/GS)	3	Total	15
Total	16	MATSE 443 Introduction to the Materials Science of Polymers	3	MATSE 430 Materials Characterization	3		
		Total	17	Total	17.5		

This publication is available in alternative media on request.

Penn State is committed to affirmative action, equal opportunity, and the diversity of its workforce.  
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