

BIOMEDICAL ENGINEERING (MS)

Offered at: San Luis Obispo Campus

<https://bmed.calpoly.edu/graduate-program/>

Biomedical engineering is an interdisciplinary field in which the principles and tools of traditional engineering fields, such as mechanical, materials, electrical, and chemical engineering, are applied to biomedical problems. By its very nature, biomedical engineering is broad and requires a foundation in engineering, as well as physiology and other biological sciences. The Master of Science degree program in Biomedical Engineering is well-suited for those individuals who desire depth in engineering applications to human health and living systems, with a strong, pragmatic, and rigorous hands-on educational experience. Graduates will be well-equipped to make significant contributions to the biomedical field.

Requirements for Admission

Students apply via Cal State Apply and must submit a transcript, CV/Resume, a personal statement describing their academic background and motivation for graduate study, and three letters of recommendation. No GRE scores required.

International Students must meet all the standard eligibility criteria and demonstrate proficiency in English (English Proficiency Exam Requirements)

Prerequisites: For admission as a classified graduate student, an applicant must possess a bachelor's degree in engineering or a closely related physical science with a minimum grade point average of 3.0 in the last 60 semester units (90 quarter units) attempted. A college level biology course, with laboratory, for engineering majors is highly recommended. Applicants who meet these standards but lack prerequisite coursework may be admitted as conditionally classified students and must make up any deficiencies before advancement to candidacy. Applicants from other academic disciplines, such as biology or chemistry are encouraged to apply and may be admitted to the program conditionally in order to make up deficiencies in prerequisite coursework. Information regarding specific admission requirements and classification as a graduate student may be obtained from the Graduate Coordinator, Biomedical Engineering.

Minimum GPA: 3.0

Application due date: Applications are accepted for Fall enrollment only. Please see Graduate Student Dates and Deadlines (<https://www.calpoly.edu/admissions/graduate-student/dates-and-deadlines/>) for application deadlines.

Advancement to Candidacy

Completion of at least 6 units of graduate coursework with cumulative and higher ed GPA of 3.0 or higher and an approved culminating experience proposal.

Culminating Experience

Thesis Track: Students in the Thesis Track option will work with a faculty advisor on a specific research topic, prepare a written thesis, and present to the public a 30-45-minute defense, after which a three-person committee will have the opportunity to privately ask related questions.

Project Track: Students in the Project Track will work with other students, faculty advisor(s), and industry sponsors on an industry-relevant project. Students will prepare a written report for their faculty advisor(s) and industry sponsors, as well as present an oral defense of the project work. Students must justify that individual contributions satisfy culminating experience expectations.

Specializations

Regenerative Medicine

Offered at: San Luis Obispo Campus

<https://regenmed.calpoly.edu/>

Prepares students for careers in regenerative medicine and related fields. Specifically, our graduates are prepared for immediate employment in cell therapy, tissue engineering, biopharma, or medical technology companies, and as research specialists/laboratory managers at universities or research institutes. Program graduates are also well-prepared to matriculate into bioengineering doctoral programs or graduate programs in the health professions.

Requirements for Admission

Students pursuing the specialization in Regenerative Medicine must satisfy all requirements of the Master of Science in Biomedical Engineering, listed above, as well as the additional requirements specific to the specialization:

- supporting information document providing additional details on the experiences listed in CV/Resume for relevant internships, employment, and volunteer efforts (community, clinical, research, etc.);
- a 1-page personal statement detailing your motivation for applying, experiences that prepared you for the program, and plans upon completing the program;

Prerequisites: For admission as a classified graduate student, an applicant must possess a bachelor's degree in biomedical engineering, bioengineering, or similar, with a minimum grade point average of 3.0 in the last 60 semester units (90 quarter units) attempted. Due to the fixed timeline for each cohort that matriculates into the program, conditional acceptances are not possible, and applicants from other academic disciplines, such as biology, must complete prerequisite coursework before applying. Information regarding specific admission requirements and classification as a graduate student may be obtained from the Graduate Coordinator, Biomedical Engineering.

Culminating Experience

Students who obtain a degree in the Master of Science in Biomedical Engineering with a specialization in Regenerative Medicine are not required to complete a "thesis" through BMED 5599. In place of the thesis as a culminating experience, students complete a Project during a 10-month internship at a company or research laboratory¹ (BMED 5598). The Project Report is evaluated by their Cal Poly and Internship Mentor; their Project Presentation is evaluated by their Cal Poly and Internship Mentors, and Program Director.

¹ Students will complete their internship at one of our partner institutions. An updated list of our current partners can be found on our program website (<https://regenmed.calpoly.edu/>).

A blended program provides a potentially accelerated route to a graduate degree, with simultaneous conferring of both Bachelor's and Master's degrees. Students in the blended program are provided with a seamless process whereby they can progress from undergraduate to graduate status. Students are required to complete all requirements for both degrees.

Blended options

- BS Biomedical Engineering + MS Biomedical Engineering
- BS Chemistry + MS Biomedical Engineering
- BS Computer Engineering + MS Biomedical Engineering
- BS Electrical Engineering + MS Biomedical Engineering
- BS Mechanical Engineering + MS Biomedical Engineering
- BS Materials Engineering + MS Biomedical Engineering

Units Double-Counted

6 units of 4000-5000 level graduate program courses can be double counted towards undergraduate degree requirements. Neither undergraduate senior project nor graduate culminating experience may not be applied toward double-counted units.

Requirements for Admission for the Blended Program

Students apply directly to the program and not through Cal State Apply; please contact the department graduate coordinator.

- Prerequisites: must be a current BS student in an approved blended pairing program. Students must have completed all lower division classes and the GWR prior to transitioning to graduate status.
- Minimum GPA: 3.0 major GPA
- Timeline for admission: The Blended MS BMED – Thesis Track admits students to start in both Fall and Spring semesters; applications accepted Fall and Spring. The Blended MS BMED – Project Track admits students ONLY for Fall start; applications accepted in Fall. Students should apply 2 semesters before completing their undergraduate degree requirements. E.g., students interested in the Project Track and scheduled to complete their undergraduate program in Spring should apply the preceding Fall. Please see MS Biomedical Engineering website for specific deadlines and more details.
- Application materials: Students submit a CV/Resume, transcript, and a personal statement. Contact information for a recommender may be included. Thesis Track students are strongly encouraged to obtain a recommendation from their intended faculty thesis advisor.

Program Learning Objectives

1. Analyze contemporary challenges in biomedical engineering, discover knowledge gaps, and assess needs to formulate research and development opportunities.
2. Demonstrate understanding of biomedical engineering practice in a regulated environment.
3. Utilize modern techniques and technologies to generate data of significance to biomedical innovations/challenges.
4. Apply advanced engineering methods – such as theoretical, computational, or manufacturing tools – to the design and/or evaluation of biomedical systems.
5. Employ statistical approaches to design experiments, and analyze & interpret data to form data-driven conclusions.
6. Communicate engineering, biological, and medical concepts in both written and oral forms.
7. Demonstrate independence and initiative in acquiring the knowledge and skills necessary to complete biomedical engineering projects at the interface between biology, medicine, and engineering.

Specialization in Regenerative Medicine

1. Perform fundamental laboratory skills involved in regenerative medicine research & development.
2. Discuss and critically evaluate biomedical primary literature.
3. Effectively communicate technical topics to both peer and lay audiences.
4. Explain the process of biotechnology development & commercialization.
5. Describe how research & development efforts are motivated by and impact physician & patient experiences.
6. Design and execute independent research projects.

Code	Title	Units
REQUIRED COURSES		
BMED 5505	Biomedical Signal Transduction and Data Acquisition	3
or BMED 5515	Biomedical Imaging	
Select from the following:		3
BMED 5520	Modeling of Biomedical Systems	
BMED 5530	Advanced Issues in Biomaterials	
BMED 5535	Bioseparations and Clinical Diagnostics	
BMED 5563	Biomedical Engineering Graduate Seminar	1
STAT 5120	Intermediate Statistics for Graduate Students	3-4
or STAT 5440	Statistical Methods for Study Design and Analysis	
Select from the following:		6
BMED 5591	Project Seminar I	
& BMED 5592	and Project Seminar II	
& BMED 5598	and Project	
BMED 5599	Thesis	
Approved Engineering, Science, and Mathematics Electives		
Select from the following: ¹		13-14
AERO 5507	Computational Aerodynamics	
ASCI 4403	Applied Biotechnology in Animal Science	
BIO 4451	Bioinformatics Applications	
BIO 4457	Molecular Biology Laboratory	
BIO 5501	Molecular and Cellular Biology	
BIO 5528	Principles of Stem Cell Biology	
BMED 4404	Applied Finite Element Analysis	
BMED 4409	Interdisciplinary Projects in Biomechanics	
BMED 4422	Medical Device Evaluation and FDA Regulatory Processes	
BMED 4432	Microfluidics/MEMS Design	
BMED 4433	Microfluidics/MEMS Design and Fabrication Laboratory	
BMED 4434	Micro/Nano Fabrication	
BMED 4435	Micro/Nano Fabrication Laboratory	
BMED 4445	Biopotential Instrumentation	
BMED 4480	Drug Discovery and Development	
BMED 5510	Principles of Tissue Engineering	
BMED 5525	Skeletal Tissue Mechanics	
BMED 5550	Current and Evolving Topics in Biomedical Engineering	
BMED 5555	Introduction to Computational Neuroscience	
BMED 5560	Cell Transplantation and Biotherapeutics	
BMED 5561	Cell Transplantation and Biotherapeutics Laboratory	
CE 5504	Finite Element Analysis of Continua	
CHEM 4432	Advanced Techniques in Chemical Analysis	
CHEM 4440	Advanced Organic Chemistry - Mechanisms	
CHEM 4442	Advanced Organic Chemistry - Synthesis	
CHEM 4444	Advanced Organic Chemistry Laboratory	
CHEM 4452	Physical Biochemistry Methods and Applications	

CHEM 4454	Protein Techniques	
CHEM 4480	Polymer Synthesis and Characterization	
CHEM 4481	Polymer Synthesis and Characterization Laboratory	
CHEM 4484	Functional Polymeric Materials	
CHEM 4486	Surface Chemistry of Materials	
CHEM 4490	Computational Chemistry	
CHEM 5580	Advanced Polymer Synthesis and Characterization	
CHEM 5581	Advanced Polymer Synthesis and Characterization Laboratory	
CPE 5350	Digital Systems Design	
CSC 5666	Advanced Machine Learning	
EE 5428	Computer Vision	
ENVE 5581	Biochemical Engineering	
IME 5503	Applied Statistical Methods in Engineering	
MATE 4402	Materials Characterization Theory	
MATH 5053	Discrete Mathematics	
MCRO 4433	Microbial Biotechnology	
ME 5501	Continuum Mechanics and Elasticity	
PHYS 4408	Electromagnetic Fields and Waves I	
STAT 5740	Advanced Design and Analysis of Experiments	
Total Units		30

¹ Minimum number of elective units needed will depend on which statistics course was taken to fulfill the requirement.

Specialization in Regenerative Medicine

Code	Title	Units
REQUIRED COURSES		
BMED 5510	Principles of Tissue Engineering	3
BMED 5511	Advanced Cell Culture Techniques	1
BMED 5515	Biomedical Imaging	3
Select from the following:		3
BMED 5520	Modeling of Biomedical Systems	
BMED 5530	Advanced Issues in Biomaterials	
BMED 5535	Bioseparations and Clinical Diagnostics	
BMED 5561	Cell Transplantation and Biotherapeutics Laboratory	2
BMED 5563	Biomedical Engineering Graduate Seminar	1
BMED 5598	Project	6
BIO 4457	Molecular Biology Laboratory	3
or ASCI 4403	Applied Biotechnology in Animal Science	
BIO 5509	Communicating Biology to Various Audiences	1
BIO/ASCI 5528	Principles of Stem Cell Biology	2
BIO/ASCI/BMED 5583	Research and Professional Development for Regenerative Medicine Students	2
STAT 5120	Intermediate Statistics for Graduate Students	3
Total Units		30