

DOCTOR OF PHILOSOPHY WITH A MAJOR IN BIOMEDICAL ENGINEERING

The Joint Biomedical Engineering PhD program is offered through the Wallace H. Coulter (WHC) Department of Biomedical Engineering at Georgia Tech and Emory University. The degree is conferred jointly by Georgia Tech and Emory. The curriculum is based on an integration of life sciences, engineering, and mathematics. The goal is to enable students to postulate and solve biomedical problems quantitatively and with a systems perspective. Both Georgia Tech and Emory faculty provide an integrative teaching medium for students by team teaching courses.

The curriculum will facilitate individual flexibility and depth of study through coursework selected by the student (and thesis advisor) in specific categories: BME Integrative Core, Bioscience/Data Science/Engineering Fundamentals, and BME Advanced Graduate Seminar. Other requirements include a bioethics course, a teaching course, a teaching practicum, and a nine-hour minor program of study outside the student’s thesis research area. The resulting total minimum number of required hours is 35. It is anticipated (although not required) that students may take other elective coursework to fulfill the requirements of their individual research projects and/or training grants.

Soon after enrollment, students are matched with a thesis advisor based upon mutual interest. After successfully passing the qualifying examination, students submit a request for approval of their Thesis Reading Committee. Upon successful completion of all degree requirements, students will be awarded the PhD degree by the graduate schools of Georgia Tech and Emory.

Minimum Prerequisites

- BS in Engineering or Life Sciences
- One year of calculus-based physics
- One semester of organic chemistry (two semesters recommended)
- Calculus through differential equations

Biomedical Information

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All PhD programs must incorporate a standard set of Requirements for the Doctoral Degree.

The below table provides an overview of the BME curriculum by category and hours required.

Code	Title	Credit Hours
Integrative Core Series (select one):		3
BMED 7011	Integrative Core: Introduction to Modeling and Experimentation in Biomedical Engineering	
BMED 7012	Integrative Core: Experimental Design-Measurements at the Right Spatial and Temporal Scales	
BMED 7013	Integrative Core: Problem Solving with Computational Models	
Bioscience/Engineering/Data Science Fundamentals		21

Advanced Graduate Seminar		3
Ethics, Teaching, and Professional Development Training Courses		3
ETHICS		
JPE 600	Jones Program in Ethics (Emory Course)	
JPE 610	Jones Program in Ethics (Emory Course)	
BMED 7004	Teaching & Research Practicum I	1
PROFESSIONAL DEVELOPMENT TRAINING		
TATTO (Emory) or Georgia Tech TA Orientation		
BMED 7001	Biomedical Engineering Seminar	1
BMED 7004	Teaching & Research Practicum I	1
BMED 7005	Teaching & Research Practicum II	1
Teaching Assistantship		
Seminar Attendance		

BIOSCIENCE AND ENGINEERING TRAINING

Integrative Core Series (BMED 7011/BMED 7012/BMED 7013)

Integrative core courses introduce students to an open-ended, problem-solving environment central to their success in a PhD program. The courses may be co-taught (i.e., “engineer” and “bioscientist”) and focus on a particular topic area. Students will—in the context of that topic area—address fundamental technical issues, critically read and evaluate literature, pose well-developed research questions that can be addressed by either experimental or modeling approaches (or both), and understand the importance and limitations of these approaches. In the course, one hour will be dedicated to ethical issues in the topic area related to science and engineering in society. As a group, the three integrative core courses offered span research areas of our program and the organizational hierarchy from molecular to organismic. Each student will select the integrative core course that fits her/his interests, and he/she should complete the course in the first year in the program prior to taking the qualifying exam.

Bioscience/Engineering/Data Science Fundamentals (Course numbers vary)

Engineering/bioscience fundamental courses focus on fundamental knowledge in engineering, in bioscience, and at the intersection of the two. These courses may be offered by the Wallace H. Coulter Department of Biomedical Engineering or by other units at Georgia Tech and Emory.

Students must complete 21 semester hours in this category, with a minimum of one bioscience, one data science, and one engineering course. The overall balance of bioscience, data science, and engineering courses is determined by the student and his/her advisor and should factor the student’s prior knowledge and research. Courses must be documented on the Program of Study form and must be approved by the Graduate Program Committee.

Advanced Graduate Seminar (Course numbers vary)

The Advanced Graduate Seminar course is designed to teach students how to develop breadth and depth of knowledge in a specific topic area. All Advanced Seminars achieve the following objectives: 1) Understanding of fundamental principles, approaches, and tools; 2) Identification of leading edge questions; 3) Identification of gaps in knowledge; and 4) Identification of technical challenges faced.

ETHICS TRAINING

Online Training

All students are required to complete online RCR training within the first 90 days of enrollment. This training is offered through the Collaborative Institutional Training Initiative (CITI).

Jones Program of Ethics (JPE 600, 610)

Emory's Laney Graduate School requires that all BME students complete JPE 600 and 610. JPE 600 is a one-day session at Emory University prior to the start of each fall term. The course provides 6 hours of content covering a broad historical and philosophical overview of ethics, identifies key ethical issues students are likely to face throughout their careers, presents the role of ethics in research and professional practice, and through case studies helps students develop a process for evaluating ethical issues. Students must attend the entire course in their first year to receive credit. JPE 610 is a series of educational sessions.

Students must attend four sessions, and approved sessions may be offered at Georgia Tech or Emory. Confirmation of course completion of both courses is recorded on the student's Emory transcript and is required for graduation.

Program-Specific Courses (BMED 7004, Integrative Core, Advanced Graduate Seminar) BME graduate students must complete the ethics training module in BMED 7004 Teaching and Research Practicum I, which includes eight hours of in-person training. Topics include authorship and publication, collaborative research, conflict of interest, data management, peer review, policies regarding the use of human subjects and vertebrate animals in research, research misconduct, and the responsibilities of mentors and mentees.

All students in interdisciplinary programs may submit a transcript record of a Georgia Tech- approved RCR training course to the Director of Graduate Training to waive the requirement of completing the ethics training module of BMED 7004.

Integrative Core and Advanced Seminar courses include 1.5 hours each of in-person RCR training in appropriate topic areas for a total of three additional hours of RCR training. This is required only of BME students.

PROFESSIONAL DEVELOPMENT TRAINING

TATTO (Emory) or TA Orientation (Georgia Tech)

All BME students must complete TATT 600, a 2-day workshop just prior to the start of the Fall term. All BME students with only a Georgia Tech affiliation (i.e., interdisciplinary program students) must attend Georgia Tech's TA Orientation.

Program-Specific Courses (BMED 7001, BMED 7004, BMED 7005)

BME students are required to complete four terms of the BMED 7001 seminar course. When enrolled, students attend a minimum of five research seminars and two professional/career development seminars per term. Georgia Tech and Emory University host seminars that fulfill the attendance requirement. A Seminar Participation Form documenting the seminar titles, dates, and host institutions for seminars attended must be completed, signed, and submitted by the student, to the course management site in order for the students to receive a Satisfactory (S) grade in the BMED 7001 course. A student who fails to register for the course will not be able to apply attendance from one term to a future term's registration. A student who registers but fails to submit the completed and approved Participation Form will receive an Unsatisfactory (U) grade for the course.

All BME students must register for BMED 7004 and BMED 7005 during their first and second terms as TA, respectively. This series of classes provides students with instructional and application- oriented teaching

training, as well as provide information relevant to academic life. In addition, BMED 7005 Teaching & Research Practicum II course contains topics relevant for academic life and career preparation (i.e., a professional development training module, which provides, training in the areas of mentorship, project management, career exploration, and communications).

Teaching Assistantship

Teaching is considered an integral part of the educational experience and is a requirement of the program. Doctoral students serve as a Teaching Assistant (TA) for two semesters, whereas master's students serve as a TA for one semester. The Director of Graduate Training finalizes TA assignments during the semester prior to the start of the TA position. Students enroll in training courses concurrently with their TA position, typically the Fall and Spring semesters of the second year in the program.

PKU PROGRAM

Students enrolled in the PKU program are subject to language and ethics training requirements that differ from those outlined for BME students. All policies are approved by a joint Atlanta-Beijing PKU Graduate Committee. Questions may be directed to the Director of the PKU program.

Global Perspectives Requirement

Students enrolled in the PKU program may enroll in one required optional global perspectives course on each campus (i.e., Georgia Tech/Emory and PKU). Courses must be approved by the BME Graduate Program Committee.

Language Requirement

PKU students who matriculate first on the Beijing campus must demonstrate English proficiency via the TOEFL requirement during the admission process. PKU students who matriculate first on the Atlanta campus must complete the Chinese language requirement by completing the Georgia Tech CHIN 1001 course by end of second year with a minimum grade of B. PKU students are encouraged to take further CHIN courses to improve Chinese proficiency. Students may exempt the course requirement by contacting the Georgia Tech Modern Languages department for an assessment early in the first term of enrollment. Results of the assessment will be sent via e-mail to the Graduate Program Manager. All course(s) (exempt or for-credit) must be noted on the Program of Study.

Ethics Series

Students that matriculate first on the Beijing campus must complete the JPE 600, JPE 610, the ethics training module of BMED 7004 and ethics training within the integrative core and advanced seminar courses upon enrollment at the Atlanta campus

Foreign Study Programs

An additional option for the joint biomedical engineering degree is offered between the WHC Department of Biomedical Engineering at Georgia Tech & Emory University and Peking University in Beijing, China. The curriculum is the same with the addition of global perspectives courses. Students spend the majority of their time in the program on the "home" campus (either Atlanta or Beijing) with one year abroad for research with a faculty co-advisor. This partnership provides the opportunity to create a new paradigm for global biomedical engineering education and research. The program offers a unique means for U.S. and Chinese students who want to learn and work in a global economy and in global health settings. Program graduates will be prepared to become global

leaders of innovation who can contribute to cultural, political, economic and health concerns in their home countries and around the world.