

# PHD IN BIOMEDICAL ENGINEERING

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## Program Objectives

The goal of the PhD program in Biomedical Engineering at the University of Miami is to train students for independent research and innovation in biomedical engineering. The program is designed to prepare graduates for careers in academia, industrial research and development, or government (FDA, US Patent Office).

PhD students conduct research at the Department of Biomedical Engineering and at clinical departments and research centers at the School of Medicine, including the Bascom Palmer Eye Institute, the Miami Project to Cure Paralysis, the Diabetes Research Institute, the University of Miami Ear Institute, Biomedical Nanotechnology Institute, the Departments of Pathology, Radiology, Radiation Oncology, Otolaryngology, and Surgery, and the Miami Veterans Administration Research Service. Many of our doctoral students work closely with physicians to develop and investigate new therapies, devices, and technologies that address real-world clinical problems.

## Graduation Requirements

The general requirements for award of the Doctor of Philosophy include:

- Completion of a minimum of 72 credits.
- Satisfactory completion of an oral qualifying examination.
- The submission, oral defense, and approval of a dissertation proposal.
- The submission, oral defense and approval of a dissertation.
- Completion of the publication requirements.

All work, including credit transferred from other institutions, must be completed within 8 years of the time of admission to graduate work, and/or within four years of approval of the dissertation proposal. An average of B (3.0) is required for a graduate degree, and no "D" credit may be counted toward the degree. A C- is the lowest passing grade for graduate students.

## Admission Requirements

The qualifications and documentation required for admission to the PhD program in Biomedical Engineering are the same as for the College of Engineering.

In general, the Department admits students with BS or MS degrees in Biomedical Engineering or related science and engineering fields, or students with MD degrees with undergraduate degrees in sciences or engineering.

The PhD program in biomedical engineering is also a degree-granting program of the University of Miami's MD-PhD program.

Internal M.S. students (thesis or non-thesis) who wish to pursue a doctoral degree can transfer from the MS program to the doctoral degree program under the following general requirements:

- Submission of an application for admission to the PhD program.
- Submission of a letter of support by a faculty member who agrees to serve as the student's Ph.D. dissertation advisor.
- Approval of the application by the Department's Graduate Admissions Committee.

## Curriculum Requirements

The PhD curriculum was designed to provide the technical and intellectual skills required to identify and solve complex scientific or technical problems at the interface of engineering and medicine or biology. The curriculum combines advanced coursework which provides depth in a specific area of concentration, with independent original research in one of the laboratories of the faculty from the Department of Biomedical Engineering or the School of Medicine.

There are no formalized graduate curricular tracks in the PhD program. The student's mentor and supervisory committee work with the student to develop a personalized course plan, based on the student's own needs and interests. The personalized course plan is designed to ensure that the student is prepared for advanced independent research and technical innovation in biomedical engineering. The course plan can include any of the graduate course offerings, as long as the student satisfies the course pre-requisites.

The proposed individualized course curriculum must be submitted to the Graduate Program Director for final approval or to the Department Chairperson when the Graduate Program Director is the student's mentor.

## Required Core Courses

There are five core graduate courses: Human Physiology courses (BME 601/BME 602/BME 603, 3 credits each), a Graduate Scholarship course (BME 780, 3 credits), and a graduate biostatistics course (3 credits). Additionally, students are required to register for the Biomedical Engineering

Seminar Series (BME 703, 1 credit) for their first six semesters. All students are required to complete Responsible Conduct of Research training via an online training module and BME 701 (1 credit).

The three human physiology courses are designed to provide a basic understanding of organ-level physiology and anatomy, neurophysiology and cellular and molecular biology. Students admitted to the PhD program with a biomedical background can request to replace one of the three courses with another course of their selection. Students enrolled in the MD-PhD program and students with an MD from a medical school accredited by the World Health Organization are exempted from taking these 3 courses.

The Graduate Scholarship course (BME 780) provides training in grant proposal writing, manuscript preparation and other doctoral-level research and professional skills. The Biomedical Engineering Seminars course (BME 703) is a seminar series on research and professional topics in Biomedical Engineering.

## MD-PhD program

Students enrolled in the MD-PhD program start the PhD program after completion of the first two years of medical school.

MD-PhD students who choose BME as their degree-granting program can receive up to 3 credits for each research rotation that they complete during their first two years of medical school, up to a maximum total of 6 credits. To receive credit, students enroll in PIB 731 (<https://bulletin.miami.edu/search/?P=PIB%20731>) - Laboratory Research (1-6 credits) and must submit a report for each rotation, following the guidelines for BME Independent Study reports.

All MD PhD students must complete the core curriculum described above.

## Credit Requirements

The credit requirements are summarized below.

### Standard PhD Track

#### Total of 72 Course & Dissertation Credits

Code	Title	Credit Hours
<b>Required Courses <sup>1</sup></b>		
BME 601	Biochemistry and Cellular Physiology for Engineers	3
BME 602	Human Physiology for Engineers	3
BME 603	Neurophysiology for Engineers	3
BME 780	Graduate Scholarship in Biomedical Engineering	3
<b>A graduate biostatistics course</b>		<b>3</b>
<b>A minimum of 12 credits of additional courses <sup>2</sup></b>		<b>12</b>
<b>Seminar Series</b>		<b>6</b>
BME 703	Biomedical Engineering Seminar Series	
<b>Teaching Requirement</b>		<b>3</b>
BME 704	Mentored Teaching Experience	
<b>Responsible Conduct of Research Training <sup>3</sup></b>		
Responsible Conduct of Research		0
BME 701	Professionalism and Ethics for Engineers and Medical Physicists	1
<b>Dissertation Credits <sup>4</sup></b>		<b>12-35</b>
BME 830	Pre-candidacy Doctoral Dissertation	
BME 840	Post-Candidacy Doctoral Dissertation	
<b>Total Credit Hours</b>		<b>72</b>

<sup>1</sup> Students with a biomedical background only need to take 2 of the physiology courses, and replace the 3rd with another course of their selection. Students in the MD/PhD program can waive the 601/602/603 requirement completely.

<sup>2</sup> A minimum of 12 credits of additional courses to be selected by the student in consultation with his/her mentor and the supervisory committee. Students with an M.S. degree in engineering will be able to waive up to 12 credits of coursework. Students in the MD/PhD program can count up to 6 credits of PIB 731 towards this coursework requirement.

<sup>3</sup> More information about these courses can be found on the CoE website (<http://www.coe.miami.edu/>) and the UM RCR website (<https://bioethics.miami.edu/clinical-and-research-ethics/responsible-conduct-of-research/>).

<sup>4</sup> A minimum of 12 credits of dissertation work must be completed. Students should enroll into BME 830 before admission to candidacy and BME 840 after admission to candidacy.

## MD-PhD Joint Degree Program

### Total of 72 Course & Dissertation Credits

Code	Title	Credit Hours
<b>MD DEGREE REQUIREMENTS</b>		<b>136</b>
Refer to the link below for more information on the MD Dual/Joint Degree Program requirements. <a href="https://bulletin.miami.edu/graduate-academic-programs/medicine/md/">https://bulletin.miami.edu/graduate-academic-programs/medicine/md/</a> ( <a href="http://bulletin.miami.edu/graduate-academic-programs/engineering/biomedical-engineering/curriculumtext/">http://bulletin.miami.edu/graduate-academic-programs/engineering/biomedical-engineering/curriculumtext/</a> )		
<b>PHD REQUIREMENTS (72 CREDIT HOURS)</b>		
<b>Required Courses</b>		
BME 780	Graduate Scholarship in Biomedical Engineering	3
PIB 700	Journal Club	1
Graduate Biostatistics Course		3
<b>A minimum of 15 credits of additional courses <sup>1</sup></b>		<b>15</b>
<b>Seminar Series</b>		<b>6</b>
BME 703	Biomedical Engineering Seminar Series	
<b>Teaching Requirement</b>		<b>3</b>
BME 704	Mentored Teaching Experience	
<b>Responsibility Conduct of Research Training <sup>2</sup></b>		
Responsible Conduct of Research		0
BME 701	Professionalism and Ethics for Engineers and Medical Physicists	1
<b>Dissertation Credits <sup>3</sup></b>		<b>12-40</b>
BME 830	Pre-candidacy Doctoral Dissertation	
BME 840	Post-Candidacy Doctoral Dissertation	
<b>Total Credit Hours</b>		<b>208</b>

<sup>1</sup> A minimum of 15 credits of additional courses to be selected by the student in consultation with his/her mentor and the supervisory committee. Of these credits, up to 6 credits can be satisfied by PIB 731. Beyond the minimum requirement of 22 course credits, the supervisory committee shall decide which additional courses, if any, will be required to ensure that the student is prepared for advanced independent research and technical innovation in biomedical engineering.

<sup>2</sup> More information about these courses can be found on the CoE website (<http://www.coe.miami.edu/>) and the UM RCR website (<https://bioethics.miami.edu/clinical-and-research-ethics/responsible-conduct-of-research/>).

<sup>3</sup> A minimum of 12 credits of dissertation work must be completed. Students should enroll into BME 830 before admission to candidacy and BME 840 after admission to candidacy.

## Research in Residence

Once a student has completed all required course and dissertation credits, he or she must enroll in Research in Residence status (BME 850, 0 credit) until the degree has been granted. Research in Residence status is considered full time enrollment. Credit is not granted for research in residence, but a fee is charged for each enrollment.

## Qualifying Examination

### Schedule

The examination will be administered at the beginning of the third semester that a student is enrolled in the PhD program.

### Qualifying Examination Committee

The oral qualifying examination will be administered by a qualifying examination committee, to be nominated by the Graduate Program Director or Department Chair, with input from the research mentor. The committee will consist of 3 tenured or tenure-track primary faculty in the Department of Biomedical Engineering. The committee members will be selected based on the student's research area. The research mentor cannot be a member of the qualifying examination committee for his/her students. At least one additional tenured, primary BME faculty member who is not part of the committee will serve as neutral observer. The observer will moderate the examination and will ensure that the examination follows the required standards and will help resolve any conflicts that may arise.

### Format

The committee will provide the student with a list of topics to study at least 3 months before the exam, including fundamental knowledge of physiological and engineering principles, data analysis, and experimental methods. At the start of the exam, the student will provide a brief overview of his/her research topic. During the exam, the committee will assess the student's grasp of the topics as well as critical thinking and problem-solving skills. The oral qualifying examination will be closed to the public. The examination should last approximately 1 hour, and will be followed by

a deliberation period of the qualifying examination committee. The entire examination will be recorded and the recording will be stored in a secured database until the student graduates from the program.

### **Evaluation and Repeat Rule**

After the oral examination, the student's qualifying examination committee will deliberate and determine if the student passed the examination. The findings of the qualifying examination committee will be summarized in a letter to the student from the Graduate Program Director. A student who fails will be given an opportunity to retake the examination. The letter will include a list of topics where the student needs improvement that will be included in the second examination. The second examination must be scheduled within 3 months and will be given by the same committee. A student who fails the examination at the second trial will be dismissed from the program.

### **Supervisory Committee**

Following the successful completion of the oral qualifying examination, a Ph.D. Supervisory Committee is appointed by the Chairperson of the Department of Biomedical Engineering. Usually, the student consults with his/her research mentor and with the Chairperson to select the Committee members. In the Department of Biomedical Engineering, the members of the Supervisory Committee usually also eventually serve on the Dissertation Committee. The role of the Supervisory Committee is to administer the dissertation proposal, and to make up any additional written or oral examination deemed necessary to complete the qualifying examination.

In the Department of Biomedical Engineering, the Supervisory Committee must be comprised of at least five members. The minimum requirements of the committee composition are given below:

- At least three primary BME faculty members
- At least one external member. The external member is either a University of Miami faculty member who holds a primary appointment outside of BME, a faculty member from another University or from outside of academia. If the external member is from outside of academia, he/she must be a recognized expert in the field holding a leadership position.

The five members include the committee chair, who is a Graduate Faculty member of the Department of Biomedical Engineering. If the committee chair is not a Primary Faculty member of the Department of Biomedical Engineering, a second Co-Chair who is a Primary Faculty of the Department of Biomedical Engineering is required.

For more information about the Supervisory Committee, please also see the Graduate Student Handbook, which can be found on the Graduate Student Handbook, which can be found on the Graduate School website ([www.grad.miami.edu](http://www.grad.miami.edu) (<https://www.grad.miami.edu/>)). The Graduate School website also provides a list of Faculty who are members of the University of Miami Graduate Faculty.

### **Dissertation Proposal**

#### **Format**

Each student must submit an original written proposal describing the goals of the dissertation research project, the significance of the work, preliminary studies, and the research plan. The proposal must be submitted to the Supervisory Committee and orally defended before the end of the fourth semester for students admitted with an MS degree and before the end of the first semester of the third year for students admitted with a BS degree. The student's knowledge of the proposed research topic will be tested during the oral defense. If any deficiencies are discovered during the defense of the proposal, an additional written or oral examination may be required by the Ph.D. Supervisory Committee.

#### **Evaluation Forms**

The candidate is responsible for distributing dissertation proposal evaluation forms ([http://bulletin.miami.edu/graduate-academic-programs/engineering/biomedical-engineering/biomedical-engineering-phd/SACS\\_Graduate\\_Rating\\_Grid\\_Rubric\\_2016.pdf](http://bulletin.miami.edu/graduate-academic-programs/engineering/biomedical-engineering/biomedical-engineering-phd/SACS_Graduate_Rating_Grid_Rubric_2016.pdf)) to the members of the Supervisory Committee. The evaluation forms are used to assess the overall quality of the graduate program at the Department, College, and University level. The evaluation forms are available on the Graduate School and Department of Biomedical Engineering websites. The forms must be completed by the Committee members after the dissertation defense. The completed forms must be collected by the Dissertation mentor and forwarded to the Office Manager at the Department of Biomedical Engineering.

#### **Admission to Candidacy**

A student who has passed the written qualifying examination, and successfully defended the dissertation proposal must:

- submit a signed "Approval of the Dissertation Proposal ([http://bulletin.miami.edu/graduate-academic-programs/engineering/biomedical-engineering/biomedical-engineering-phd/Department\\_Dissertation\\_Proposal\\_Approval.pdf](http://bulletin.miami.edu/graduate-academic-programs/engineering/biomedical-engineering/biomedical-engineering-phd/Department_Dissertation_Proposal_Approval.pdf))" form to the Graduate Program Director of the Department of Biomedical Engineering.
- form a Dissertation Committee (see below)
- submit an Application for Admission to Candidacy (<https://grad.miami.edu/policies-and-forms/forms/>) for the Ph.D./Ed.D./D.M.A. to the Graduate School to be granted admission to candidacy.

Admission to candidacy recognizes the fact that a student enrolled in the PhD program has completed all doctoral degree requirements except completion of an acceptable dissertation project and defense of the dissertation. Completion of the required course credits and dissertation credits (BME 830 and/or BME 840) is not a requirement for admission to candidacy in the Department of Biomedical Engineering.

No student may receive the degree in the same semester or summer session in which he or she is admitted to candidacy. The student must be admitted to candidacy before the dissertation defense is scheduled.

## Dissertation Committee

In the Department of Biomedical Engineering, the Dissertation Committee is generally the same as the Supervisory Committee, but it may also be a committee formed anew to undertake the duties of advising and passing upon the dissertation. The Dissertation Committee is nominated by the Department, and is approved and appointed by the Dean of the Graduate School.

As with the Supervisory Committee, the Dissertation Committee must be comprised of at least five members, including the committee chair. The minimum requirements of the committee composition are given below:

- At least three primary BME faculty members
- At least one external member. The external member is either a University of Miami faculty member who holds a primary appointment outside of BME, a faculty member from another University or from outside of academia. If the external member is from outside of academia, he/she must be a recognized expert in the field holding a leadership position.

The five members include the committee chair, who is a Graduate Faculty member of the Department of Biomedical Engineering. If the committee chair is not a Primary Faculty member of the Department of Biomedical Engineering, a second Co-Chair who is a Primary Faculty member of the Department of Biomedical Engineering is required.

One additional requirement is that the Dissertation Committee of students enrolled in the M.D.-Ph.D. program must include one member of the M.D.-Ph.D. program committee.

If a student and his/her mentor decide to change the members of the Dissertation Committee after being admitted to candidacy, a Committee Composition Change Request Form must be completed. This form can be completed electronically via Dynamic Forms on the Graduate School's website.

## Bi-Annual Progress Review

The student must schedule a bi-annual meeting with the dissertation committee. The purpose of the meeting is to give the student an opportunity to present his/her doctoral research progress to the committee and to receive the committee's feedback and recommendations. The student must submit a brief progress report to the dissertation committee at least seven days before the meeting. During the meeting, the student will present his/her doctoral research progress to the committee. The presentation will be followed by a discussion session. At the end of the discussion session, the committee will meet alone to discuss the student's progress and provide recommendations to the mentor. The mentor will provide a written summary of the discussion and committee recommendations to the student and to the Graduate Program Director. Students who are not making adequate progress may be terminated from the program.

## Doctoral Dissertation

### General Description

The doctoral dissertation is a monograph which describes the significance of the research and summarizes the research activities completed as part of the doctoral degree requirements. The objective of the dissertation is to evaluate the candidate's competence in the area of the Ph.D. research. The dissertation must demonstrate that the research is original and that it makes a significant contribution to the field of study.

A final public oral defense of the dissertation is required. However, none but the members of the dissertation committee may interrogate the candidate. The defense must be held before the deadline published on the Graduate School website (<https://grad.miami.edu/>), generally at least two weeks prior to the last day of class in the semester the student wishes to graduate. The student must submit the Defense Notice Form (<https://grad.miami.edu/policies-and-forms/forms/>) available on the Graduate School website (<https://grad.miami.edu/>) and provide a copy to the Department of Biomedical Engineering.

The candidate is well advised to have a final, acceptable typescript of the dissertation in the hands of each member of his/her committee at a time reasonably in advance of the final defense of the work a minimum of two weeks prior to the defense.

### Dissertation Format and Deadlines

It is the duty of the student to ensure that the dissertation defense is scheduled and that a final version of the dissertation approved by the Dissertation Editor is submitted to the Dissertation Editor by the required deadlines set by the Graduate School. All information pertaining to the formatting and electronic guidelines for electronic thesis and dissertation submission can be found on the Graduate School website (<https://grad.miami.edu/>). The Graduate School also encourages students to contact the Dissertation Editor at the Graduate School when they start preparing their dissertation.

Students must inform the Department of Biomedical Engineering of their intent to defend at least 2 weeks in advance of the defense date, by email to the Department staff. The email must include the dissertation title and the date, time and location of the defense. The information will be posted in the Department's physical and online bulletin boards.

Each dissertation must be accompanied by Certificate of Defense Approval for Doctoral Dissertation signed by all members of the Committee. Forms can be downloaded from the Graduate School website (<https://www.grad.miami.edu/>).

### Evaluation Forms

The candidate is responsible for distributing dissertation evaluation forms ([http://bulletin.miami.edu/graduate-academic-programs/engineering/biomedical-engineering/biomedical-engineering-phd/SACS\\_Graduate\\_Rating\\_Grid\\_Rubric\\_2016.pdf](http://bulletin.miami.edu/graduate-academic-programs/engineering/biomedical-engineering/biomedical-engineering-phd/SACS_Graduate_Rating_Grid_Rubric_2016.pdf)) to the members of the Dissertation Committee. The evaluation forms are used to assess the overall quality of the graduate program at the Department, College, and University level. The evaluation forms are available on the Graduate School and Department of Biomedical Engineering websites. The forms must be completed by the Committee members after the dissertation defense. The completed forms must be collected by the Dissertation mentor and forwarded to the Office Manager at the Department of Biomedical Engineering.

### Publication Requirements

As a requirement for graduation, all PhD Candidates at the University of Miami Department of Biomedical Engineering are expected to have published, or have in press (i.e., the manuscript must have received final acceptance), in high quality peer-reviewed journals, a minimum of 2 publications describing work related to the dissertation. The candidate must be the first author on at least one of these two publications. In addition, the candidate must have been the presenting author of at least 2 oral or poster presentations describing the dissertation work at major peer-reviewed international conferences.

### Teaching Requirements

Students enrolled in the PhD program in Biomedical Engineering who passed their qualifying examination are required to complete two semesters of mentored teaching experience. Students will assist faculty by holding office hours for undergraduate courses, prepare laboratory sessions, and/or cover lectures for the faculty. Fulfilment of this requirement will be tracked by a 1-credit course taken two different semesters (BME 704, Mentored Teaching Experience). Students will also take a 1-credit teaching training workshop the semester before starting the teaching experience.

### Suggested Plan of Study

Year One		Credit Hours
<b>Fall</b>		
Responsible Conduct of Research		0
BME 703	Biomedical Engineering Seminar Series	1
BME 602	Human Physiology for Engineers	3
BME 603	Neurophysiology for Engineers	3
Elective Course		3
<b>Credit Hours</b>		<b>10</b>
<b>Spring</b>		
BME 701	Professionalism and Ethics for Engineers and Medical Physicists	1
BME 703	Biomedical Engineering Seminar Series	1
BME 601	Biochemistry and Cellular Physiology for Engineers	3
Biostatistics Course		3
Elective Course		3
<b>Credit Hours</b>		<b>11</b>
<b>Summer</b>		
Oral Qualifying Examination (August)		
<b>Credit Hours</b>		<b>0</b>
<b>Year Two</b>		
<b>Fall</b>		
BME 703	Biomedical Engineering Seminar Series	1
BME 780	Graduate Scholarship in Biomedical Engineering	3
Elective Courses		6
<b>Credit Hours</b>		<b>10</b>
<b>Spring</b>		
BME 703	Biomedical Engineering Seminar Series	1
BME 704	Mentored Teaching Experience	1
BME 830	Pre-candidacy Doctoral Dissertation	5
<b>Credit Hours</b>		<b>7</b>

<b>Summer</b>		
Research		
	<b>Credit Hours</b>	<b>0</b>
<b>Year Three</b>		
<b>Fall</b>		
BME 703	Biomedical Engineering Seminar Series	1
BME 704	Mentored Teaching Experience	1
BME 830	Pre-candidacy Doctoral Dissertation	6
Dissertation Proposal (Admission to Candidacy)		
	<b>Credit Hours</b>	<b>8</b>
<b>Spring</b>		
BME 703	Biomedical Engineering Seminar Series	1
BME 704	Mentored Teaching Experience	1
BME 840	Post-Candidacy Doctoral Dissertation	6
	<b>Credit Hours</b>	<b>8</b>
<b>Summer</b>		
Research		
	<b>Credit Hours</b>	<b>0</b>
<b>Year Four</b>		
<b>Fall</b>		
BME 840	Post-Candidacy Doctoral Dissertation	6
	<b>Credit Hours</b>	<b>6</b>
<b>Spring</b>		
BME 840	Post-Candidacy Doctoral Dissertation	6
	<b>Credit Hours</b>	<b>6</b>
<b>Summer</b>		
Research		
	<b>Credit Hours</b>	<b>0</b>
<b>Year Five</b>		
<b>Fall</b>		
BME 840	Post-Candidacy Doctoral Dissertation	6
Dissertation Defense		
	<b>Credit Hours</b>	<b>6</b>
	<b>Total Credit Hours</b>	<b>72</b>

## Mission

The mission of the Biomedical Engineering Program is to prepare future leaders in biomedical engineering who are motivated to create a positive impact on human health, medicine, and industry.

## Goals

The goal of the PhD program in Biomedical Engineering at the University of Miami is to train students for independent research and innovation in biomedical engineering. The program is designed to prepare graduates for careers in academia, industrial research and development, or government (FDA, US Patent Office).

## Student Learning Outcomes

- Advanced ability to apply knowledge in mathematics, science and engineering to formulate and solve relevant biomedical engineering problems and conduct research.
- An ability to communicate the scientific and technical research effectively in writing and oral presentations.
- Ability to conduct independent research and contribute to existing knowledge.