

# Biomedical Engineering, PhD

Graduate study in biomedical engineering prepares students to use contemporary methods at an advanced level during a professional career in engineering design, development, and research.

Each student's course of study is based on individual background, career objectives, and sound academic practice. An individual program for each student may be developed from courses offered by the Roy J. Carver Department of Biomedical Engineering and other departments, particularly mechanical engineering, electrical engineering, physiology, mathematics, and biological sciences. Faculty members in the department have teaching and research expertise in cardiovascular and fluid biomechanics, musculoskeletal biomechanics, biomaterials and tissue engineering, bioinstrumentation, biosystems, biomedical imaging, biological signal analysis, bioinformatics and computational biology, pulmonary engineering, computational neuroscience, and other allied fields.

PhD programs may center on any one of the previously described areas through the choice of appropriate coursework and research topic.

## Learning Outcomes

By completing the graduate curriculum in biomedical engineering, students will be able to:

- demonstrate broad knowledge of the field of biomedical engineering and deep knowledge in their specific area of study;
- communicate complex technical ideas concisely and effectively to both general and specialized audiences through verbal, visual, and written formats;
- formulate research questions, pose testable hypotheses, employ methods that enhance the reproducibility of research, and apply critical thinking skills to produce solutions to complex engineering problems that intersect with biology and human health; and
- operate with professionalism and under standards of ethical conduct.

## Requirements

The Doctor of Philosophy program in biomedical engineering requires a minimum of 72 s.h. of graduate work, including acceptable transfer credit. At least 42 s.h. must be earned in formal coursework taken after the BSE is awarded, and at least 12 s.h. must be earned through research and the thesis. Students who enter with an MS may count a maximum of 30 s.h. of approved transfer credit toward the PhD, but they must earn 39 s.h. of graduate credit at the University of Iowa, including at least 12 s.h. in research and the thesis. Based on a student's research progress, examination results, or other measures, the graduate committee may require additional formal coursework to strengthen perceived areas of weakness.

All PhD students must successfully complete the Graduate Core Courses as part of their graduate curriculum. Students are expected to complete them during their first year of study. Additionally, students must complete 18 s.h. of graduate-level coursework in the College of Engineering over the course of

their studies. Medical scientist training program students are required to complete 12 s.h. of graduate-level coursework in the College of Engineering.

## Graduate Core Courses

| Course #  | Title   | Hours |
|-----------|---|-------|
| ENGR:7270 | Engineering Ethics  | 1     |
| HHP:3500  | Human Physiology  | 3     |
| ME:5113   | Mathematical Methods in Engineering (or equivalent graduate mathematics course; approval of academic advisor required before registering) | 3     |

Depending upon a student's performance in Graduate Core Courses and the nature of their research project, the student's examining committee may specify additional coursework to be completed to satisfy the Graduate Core Courses requirement.

Graduate Core Courses may be substituted by other equivalent courses at the discretion of the student's examining committee. Equivalent coursework taken as part of a student's undergraduate or graduate studies prior to starting the biomedical engineering graduate program at the University of Iowa may satisfy one or more of the Graduate Core Courses requirements. Students who wish to request a substitution or a waiver for HHP:3500 Human Physiology or ME:5113 Mathematical Methods in Engineering must submit a core course substitution or waiver form. Forms may be obtained from the graduate program coordinator.

Admission to the PhD program is conditional until students successfully complete a qualifying examination. The biomedical engineering faculty administers the exam and decides whether a student's performance is adequate for admission to the PhD program.

Admission to PhD candidacy requires a grade-point average (GPA) of at least 3.00 on all graduate work at the University of Iowa. Upon completion of the coursework specified in the plan of study and with the required GPA and the advisor's recommendation, students are admitted to the comprehensive examination by their committee.

After satisfactorily completing the comprehensive examination, students must complete and defend their dissertations at the final examination. Requirements for the PhD generally can be completed in three to four years beyond the master's degree.

## Combined Programs

### PhD/MD

Students may work toward the Doctor of Medicine degree and a PhD in biomedical engineering in a combined degree program offered by the Carver College of Medicine and the College of Engineering. Applicants must be admitted to both programs before they may be admitted to the combined degree program. See the Medical Scientist Training Program (Carver College of Medicine) in the catalog.

## Admission

Applicants must meet the admission requirements of the Graduate College; see the Manual of Rules and Regulations on the Graduate College website.

Reference letters, research interests, previous graduate grade-point average, and other factors may be considered in admission decisions.

Admission to the Doctor of Philosophy in biomedical engineering is conditional until students successfully complete a qualifying examination.

## Career Advancement

Biomedical engineers with PhDs can pursue career opportunities in the health care industry in the fields of biomedical devices, diagnostic equipment, and software. Graduates have started careers in research, design, development, sales, and entrepreneurship, and they have advanced to administrative and leadership positions in their organizations. Graduates also have careers with health care providers, such as in hospitals, or use their biomedical engineering expertise to advance careers in medicine and law. In addition, PhD graduates have careers in academia or at research institutions where they advance the understanding of human health. Faculty mentors assigned to graduate students aid in their professional development. Students are exposed to opportunities through seminar speakers who have relevant expertise and are invited to campus.

The Graduate College offers numerous career advancement opportunities and professional development programs for graduate students. Ongoing program offerings, news, and announcements can be found under Grad Success Center on the Graduate College website.

## Academic Plans

### Sample Plan of Study

Sample plans represent one way to complete a program of study. Actual course selection and sequence will vary and should be discussed with an academic advisor. For additional sample plans, see MyUI.

### Biomedical Engineering, PhD

| Course  | Title                             | Hours    |
|---|-----------------------------------|----------|
| <b>Academic Career</b>  |                                   |          |
| <b>Any Semester</b>   |                                   |          |
| 72 s.h. must be graduate level coursework; graduate transfer credits allowed upon approval. More information is included in the General Catalog and on department website. <sup>a</sup> |                                   |          |
| Graduate College program GPA of at least 3.00 is required. <sup>b</sup>   |                                   |          |
| <b>Hours</b>  |                                   | <b>0</b> |
| <b>First Year</b>   |                                   |          |
| <b>Any Semester</b>   |                                   |          |
| Exam: Doctoral Qualifying Exam  |                                   |          |
| <b>Hours</b>  |                                   | <b>0</b> |
| <b>Fall</b>   |                                   |          |
| BME:5010  | Seminar in Biomedical Engineering | 0        |

|                                    |  |   |
|------------------------------------|--|---|
| ENGR:7270                          | Engineering Ethics <sup>c</sup>                  | 1 |
| HHP:3500                           | Human Physiology <sup>d</sup>                    | 3 |
| ME:5113                            | Mathematical Methods in Engineering <sup>e</sup> | 3 |
| Other required course <sup>f</sup> |  | 3 |

**Hours 10**

#### Spring

|                                    |                                   |   |
|------------------------------------|-----------------------------------|---|
| BME:5010                           | Seminar in Biomedical Engineering | 0 |
| Other required course <sup>f</sup> |                                   | 3 |
| Other required course <sup>f</sup> |                                   | 3 |
| Other required course <sup>f</sup> |                                   | 3 |

**Hours 9**

#### Second Year

##### Fall

|                                    |                                   |   |
|------------------------------------|-----------------------------------|---|
| BME:5010                           | Seminar in Biomedical Engineering | 0 |
| Other required course <sup>f</sup> |                                   | 3 |
| Other required course <sup>f</sup> |                                   | 3 |
| Other required course <sup>f</sup> |                                   | 3 |

**Hours 9**

##### Spring

|                                    |                                   |   |
|------------------------------------|-----------------------------------|---|
| BME:5010                           | Seminar in Biomedical Engineering | 0 |
| Other required course <sup>f</sup> |                                   | 3 |
| Other required course <sup>f</sup> |                                   | 3 |
| Other required course <sup>f</sup> |                                   | 3 |

**Hours 9**

#### Third Year

##### Fall

|  |                                   |   |
|--|-----------------------------------|---|
| BME:5010   | Seminar in Biomedical Engineering | 0 |
| Optional coursework or additional research hours |                                   | 3 |
| Other required course <sup>f</sup>               |                                   | 3 |
| Other required course <sup>f</sup>               |                                   | 3 |

**Hours 9**

##### Spring

Exam: Doctoral Comprehensive Exam

Dissertation Prospectus

|  |                                   |   |
|--|-----------------------------------|---|
| BME:5010   | Seminar in Biomedical Engineering | 0 |
| Optional coursework or additional research hours |                                   | 3 |
| Optional coursework or additional research hours |                                   | 3 |
| Optional coursework or additional research hours |                                   | 3 |

**Hours 9**

#### Fourth Year

##### Fall

|  |   |   |
|--|---|---|
| BME:5010   | Seminar in Biomedical Engineering                 | 0 |
| BME:7999   | Research: Biomedical Engineering PhD Dissertation | 6 |
| Optional coursework or additional research hours |   | 3 |

**Hours 9**

##### Spring

|  |   |   |
|--|---|---|
| BME:5010   | Seminar in Biomedical Engineering                 | 0 |
| BME:7999   | Research: Biomedical Engineering PhD Dissertation | 6 |
| Optional coursework or additional research hours |   | 3 |
| Exam: Doctoral Final Exam <sup>g</sup>           |   |   |

**Hours 9**

**Total Hours 73**

- a Students must complete specific requirements in the University of Iowa Graduate College after program admission. Refer to the Graduate College website and the Manual of Rules and Regulations for more information.
- b Graduate College program GPA is comprised of all courses that are approved degree requirements. If a student takes more than the minimum required number of semester hours to complete the degree, but all courses taken are eligible to count toward the degree, those courses will be included in the Graduate College program GPA.
- c Does not count toward the total hours required for the degree.
- d Course substitution or waiver allowed upon approval.
- e Or equivalent graduate level mathematics course; advisor approval required prior to registration.
- f 18 s.h. must be graduate coursework at the 5000 level or above from the College of Engineering or courses from the approved elective list; work with faculty advisor to determine appropriate graduate coursework and sequence.
- g Dissertation defense.