

BIOCHEMISTRY AND CELL BIOLOGY

THE WIESS SCHOOL OF NATURAL SCIENCES

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DEGREES OFFERED: BA, BS, PHD

Undergraduate Programs—The Department of Biochemistry and Cell Biology offers a broad range of courses in the biosciences biochemistry, biophysics, cell biology, developmental biology, endocrinology, genetics, immunology, microbiology, molecular biology, neurobiology, and plant biology and advanced courses in these and related areas. Students may elect a BA in biochemistry and cell biology, a BA in biological sciences, or a BS in biochemistry and cell biology. Students may select courses from the range of topics listed above.

Course requirements for each degree path:

BA BIOCHEMISTRY AND CELL BIOLOGY

This degree path is designed for students pursuing a wide range of careers in the life sciences. Students graduating from this degree path typically go on

to graduate, medical, or other professional school. Course work is designed to emphasize a broad understanding of cell biology and biochemistry that culminates in a required capstone 400-level course that incorporates primary scientific literature, presentations, and writing in an advanced topic.

Non-Biology Courses

- MATH 101/102 *Single Variable Calculus I and II*
- MATH 211 *Ordinary Differential Equations and Linear Algebra* or MATH 213 *Basic Mathematical Biology*
- PHYS 101/102 *Mechanics and Electricity and Magnetism* (with labs) or PHYS 125/126 *General Physics I and II* (with labs) or PHYS 111/112 *Mechanics and Electricity and Magnetism* (with labs)
- CHEM 121/122/123/124 *General Chemistry* (with lab)
- CHEM 211/212/215 *Organic Chemistry* (with lab)

Core Lecture Courses

- BIOC 201 *Introductory Biology*
- BIOC 301 *Biochemistry I*
- BIOC 341 *Cell Biology*
- Two of these three courses:
 - BIOC 302 *Biochemistry II*
 - BIOC 344 *Molecular Biology and Genetics*
 - BIOC 352 *Physical Chemistry for the Biosciences*

Laboratory Courses

- BIOC 211 *Introductory Experimental Biosciences*
- BIOC 311 *Advanced Experimental Biosciences*
- Two labs at 300 level or higher*:
 - BIOC 313 *Introductory Synthetic Biology*
 - BIOC 318 *Lab in Applied Microbiology*
 - BIOC 320/BIOE 342 *Lab in Tissue Culture*
 - BIOC 413 *Experimental Molecular Biology*
 - BIOC 415 *Experimental Physiology*
 - BIOC 530 *NMR Spectroscopy and Molecular Modeling*
 - BIOC 532 *Lab in Optical Spectroscopy and Kinetics*
 - BIOC 533 *Bioinformatics and Computational Biology*
 - BIOC 535 *Practical X-Ray Crystallography*

Capstone Course

- 1 BIOC 400 level course ** (3 credit hours or more per course)

Natural Sciences/Engineering Electives

- Two natural sciences or engineering*** 300-level or higher courses (3 credit hours or more)
- * If taken for 3 or more credits, BIOC 310 OR HONS 471/472 may be used to substitute for one 300-level or greater lab. This substitution may be used only once regardless of the number of semesters of BIOC 310 or HONS 471/472 taken.
- ** BIOC 401/402/412 is considered a single BIOC 400 level course and a single lab at 300 level or higher.

***Natural sciences/engineering includes any 300-level or greater course of at least 3 credit hours from any department in the Wiess School of Natural Sciences or George R. Brown School of Engineering (including biochemistry and cell biology) except independent research courses, such as BIOC 310 or BIOE 400/401, which cannot be used to fulfill this requirement.

CHEM 310 or CHEM 311 and 312 may be substituted for BIOC 352. Students may receive credit toward the major for a maximum of 3 credits of BIOC 390 (transfer credit in biochemistry and cell biology).

BS BIOCHEMISTRY AND CELL BIOLOGY

This degree path is designed for students pursuing a wide range of careers in the life sciences with an emphasis on research. Students graduating from this degree path typically go on to graduate, medical, or other professional school. Course work is designed to build a deeper understanding of cell biology and biochemistry through additional upper level course work in topics that can include biochemistry, biophysics, cell biology, genetics and developmental biology. The BS culminates in two required capstone 400-level courses that incorporate primary scientific literature, presentations, and writing in advanced topics. Students in this degree program are strongly encouraged to pursue their research interests by including independent research courses in their coursework.

Non-Biology Courses

- MATH 101/102 *Single Variable Calculus I and II*
- MATH 211 *Ordinary Differential Equations and Linear Algebra* or
MATH 213 *Basic Mathematical Biology*
- PHYS 101/102 *Mechanics and Electricity and Magnetism* (with labs) or
PHYS 125/126 *General Physics I and II* (with labs) or
PHYS 111/112 *Mechanics and Electricity and Magnetism* (with labs)
- CHEM 121/122/123/124 *General Chemistry* (with labs)
- CHEM 211/212/215 *Organic Chemistry* (with labs)

Core Lecture Courses

- BIOC 201 *Introductory Biology*
- BIOC 211 *Introductory Experimental Biosciences*
- BIOC 301 *Biochemistry*
- BIOC 302 *Biochemistry*
- BIOC 341 *Cell Biology*
- BIOC 344 *Molecular Biology and Genetics*
- BIOC 352 *Physical Chemistry for the Biosciences*

Laboratory Courses

- BIOC 211 *Introductory Experimental Biosciences*
- BIOC 311 *Advanced Experimental Biosciences*
- Two labs at 300 level or higher*:
BIOC 313 *Introductory Synthetic Biology*
BIOC 318 *Lab in Applied Microbiology*
BIOC 320/BIOE 342 *Lab in Tissue Culture*
BIOC 413 *Experimental Molecular Biology*
BIOC 415 *Experimental Physiology*

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BIOC 530 *NMR Spectroscopy and Molecular Modeling*

BIOC 532 *Lab in Optical Spectroscopy and Kinetics*

BIOC 533 *Bioinformatics and Computational Biology*

BIOC 535 *Practical X-Ray Crystallography*

Capstone Course

- 1 BIOC 400 level course ** (3 credit hours or more per course)

Natural Sciences/Engineering Electives

- Two natural sciences or engineering*** 300-level or higher courses (3 credit hours or more)

* If taken for 3 or more credits, BIOC 310 or HONS 471/472 may be used to substitute for one 300-level or greater lab. This substitution may be used only once regardless of the number of semesters of BIOC 310 or HONS 471/472 taken.

** BIOC 401/402/412 is considered a single BIOC 400 level course and a single lab at 300 level or higher.

*** Natural sciences/engineering includes any 300-level or greater course of at least 3 credit hours from any department in the Wiess School of Natural Sciences or George R. Brown School of Engineering (including biochemistry and cell biology), except independent research courses such as BIOC 310 or BIOE 400/401, which cannot be used to fulfill this requirement.

CHEM 310 or CHEM 311 and 312 may be substituted for BIOC 352. Students may receive credit toward the major for a maximum of 3 credits of BIOC 390 (transfer credit in biochemistry and cell biology).

BA BIOLOGICAL SCIENCES

This degree path is designed for students pursuing a wide range of careers in the life sciences. Students graduating from this degree path typically go on to graduate or professional school. Course work is designed to emphasize a broad understanding of the full range of biological disciplines. The BA in biological sciences may not be combined with any other biosciences degree (i.e. BA biochemistry and cell biology, BA ecology and evolutionary biology, BS biochemistry and cell biology, BS ecology and evolutionary biology, Minor in biochemistry and cell biology, or minor in ecology and evolutionary biology). This degree is jointly managed by the Department of Ecology and Evolutionary Biology and the Department of Biochemistry and Cell Biology.

Non-biology Courses

- MATH 101/102 *Single Variable Calculus I and II*
- MATH 211, MATH 213, STAT 305, or EBIO 338 *Differential Equations or Biological Statistics* course
- CHEM 121/122/123/124 *General Chemistry* (with labs)
- CHEM 211/212/215 *Organic Chemistry* (with labs)
- PHYS 125/126 *General Physics I and II*

Introductory Biology

- BIOC 201/EBIO 202 *Introductory Biology I and II*

Introductory Biology Labs

- BIOC 211 *Introductory Experimental Biosciences*
- EBIO 213 *Introductory Lab in Ecology and Evolutionary Biology*

Advanced Biology Labs

Three biology labs from the following list:

- BIOC 311 *Advanced Experimental Biosciences*
- BIOC 313 *Introductory Synthetic Biology*
- BIOC 318 *Lab in Applied Microbiology*
- BIOC 320/BIOE 342 *Lab in Tissue Culture*
- BIOC 413 *Experimental Molecular Biology*
- BIOC 415 *Experimental Physiology*
- BIOC 530 *NMR Spectroscopy and Molecular Modeling*
- BIOC 532 *Lab in Optical Spectroscopy and Kinetics*
- BIOC 533 *Bioinformatics and Computational Biology*
- BIOC 535 *Practical X-Ray Crystallography*
- EBIO 316 *Lab in Ecology*
- EBIO 317 *Lab in Behavior*
- EBIO 327 *Biological Diversity Lab*
- EBIO 330 *Insect Biology Lab*
- EBIO 337 *Field Bird Biology Lab*
- EBIO 393 *Laboratory Transfer Credit in Biosciences*

Upper level Biology courses

- BIOC 301 *Biochemistry*
- Three EBIO 300 or 400 level lecture courses
- One BIOC 300 or 400 level lecture course
- BIOC 302, 341, 344, or 352
- One BIOC or EBIO 300 or 400 level lecture course

MATH 111 and 112 may be substituted for MATH 101; CHEM 151 and 152 may be substituted for CHEM 121 and 122; CHEM 251 and 252 may be substituted for CHEM 211 and 212; PHYS 101 and 102 or PHYS 111 and 112 and their labs may be substituted for PHYS 125 and 126.

One of the advanced laboratory course requirements can be satisfied by taking any of the following: (i) BIOC 310 or EBIO 306 if taken for at least 2 credits; or (ii) HONS 470/471, if the research supervisor is from one of the biosciences departments or if the research is biological in nature and preapproved by the student's advisor; (iii) BIOC 412; or (iv) BIOC 393 (laboratory transfer credit in biochemistry and cell biology).

MINOR IN BIOCHEMISTRY AND CELL BIOLOGY

The biochemistry and cell biology minor is intended for students with an interest in the life sciences but majoring in other areas. The biochemistry and cell biology minor incorporates many of the life science core requirements required for the health professions. The minor may be combined with any major except those offered by the Department of Biochemistry and Cell Biology.

MATH 101/102 *Single Variable Calculus I and II*

PHYS 101/102 *Mechanics and Electricity and Magnetism* (with labs) or

PHYS 125/126 *General Physics I and II* (with labs) or

PHYS 111/112 *Mechanics and Electricity and Magnetism* (with labs)

CHEM 121/122/123/124 *General Chemistry* (with labs)

CHEM 211/212/215 *Organic Chemistry* (with labs)

BIOC 201 *Introductory Biology*

BIOC 211 *Introductory Experimental Biosciences*

BIOC 301 *Biochemistry*

BIOC 341 *Cell Biology*

1 BIOC higher than 300-level course ** (more than 3 credit hours)

RESEARCH IN THE DEPARTMENT OF BIOCHEMISTRY AND CELL BIOLOGY

Research is highly encouraged for all interested majors, and there are many opportunities for independent research, including BIOC 310 for on-campus research or with an off-campus laboratory at the Texas Medical Center.

BIOC 310—Section 1 is research in Rice University BCB faculty laboratories. Section 2 is research in other Texas Medical Center laboratories. Students are required to spend at least three hours per week in the laboratory for each semester hour of credit. BIOC 310 requires a research proposal, weekly reports, and a final project (either a research paper in the fall semester or a poster presentation in the spring semester). The prerequisite is either BIOC 111 or BIOC 211, and instructor permission is required. To receive credit, a student must be participating in a laboratory-based biosciences research project. Credit cannot be received for physician shadowing or other clinical or hospital activities. Students will not receive course credit if they are being paid for their work. It is strongly recommended that all students register for 3 credit hours their first semester of BIOC 310. Fewer hours will leave insufficient time for meaningful research, and more might be unsustainable with a busy academic schedule. Students in section 2 must register for at least 3 credits (www.bioc.rice.edu/bios310/).

HONORS RESEARCH

The Biochemistry and Cell Biology Honors Research Program is a suite of courses (BIOC 401/402/412) offering our seniors and advanced juniors the opportunity to perform a two-semester individual research project in a research laboratory in biochemistry and cell biology*. This immersive program is intended to give students a first-hand experience of what a career in research would entail. Students interested in graduate school are strongly encouraged to apply for consideration for honors research.

Please note that Honors Research Program courses function as a set and must all be taken in the same academic year. Registration for any of the courses requires a commitment to register for all three.

Criteria for participation in honors research:

- Strong performance in BIOC 211 and either BIOC 301 or BIOC 341 and other BIOC degree courses taken to date
- A grade of A in independent research (BIOC 310, HONS 470/471, or other approved research course)
- Research professor recommendation
- Research proposal (previous accomplishments in research area, abstract, specific aims, timeline)

Requirements for individual honors research course components:**BIOC 401**—Fall semester, 5 credit hours

Requires at least 15 hours of laboratory research per week, a proposal (revised from application), monthly reports, and a formal progress report (abstract, aims, progress toward aims, discussion of results, plans for the spring semester). Coordinating instructor: Janet Braam

BIOC 402—Spring semester, 5 credit hours

Requires at least 15 hours of laboratory research per week, monthly reports, a thesis (substantial research paper) and a poster presentation at the Rice Undergraduate Research Symposium. Coordinating instructor: Janet Braam

BIOC 412—Spring semester, 1 credit hour

This companion seminar requires attendance at course meetings and a formal scientific presentation of research performed while enrolled in the Honors Research Program. Instructors: [TBA]

*Students having performed BIOC 310 research in an off-campus laboratory in the Texas Medical Center will be eligible to apply to perform honors research in that laboratory.

Applications accepted February 1–May 1. Students are encouraged to apply early. Applications received by April 1 will be reviewed by the committee in time for spring registration. Applications may be obtained from the BCB Honors Research Program website.

DEGREE REQUIREMENTS FOR MA AND PHD IN BIOCHEMISTRY AND CELL BIOLOGY

Admission—Applicants for graduate study in the Department of Biochemistry and Cell Biology must have:

- BA or BS degree in biochemistry, biology, chemistry, chemical engineering, physics, or some equivalent
- Strong ability and motivation, as indicated by academic record, Graduate Record Examination (GRE) scores, and recommendations

Although the department offers an MA degree in biochemistry and cell biology, only on rare occasions are students who do not intend to pursue the PhD degree admitted to the graduate program. The department provides a program guide titled “Graduate Requirements for Biochemistry and Cell Biology” that is updated annually. For general university requirements, see Graduate Degrees in *General Announcements*.

Both PhD and MA Programs—Most of the formal course studies will be completed in the first year of residence to allow the students to commence thesis research at the end of their second semester at Rice. During the first year, all graduate students will be advised by the Graduate Advisory Committee. This committee will determine the formal course program to be taken during the first year in residence. Students are required to have training in biochemistry, cell biology, genetics, and physical chemistry or biophysics. If students are missing formal training in these subjects, they are required to take the equivalent background courses during their first year. The corresponding courses at Rice include the following:

BIOC 301 *Biochemistry*
 BIOC 341 *Cell Biology*
 BIOC 344 *Molecular Biology and Genetics*
 BIOC 352 *Physical Chemistry for the Biosciences*

All PhD students are required to take the following graduate-level courses:

BIOC 575 *Introduction to Research*
 BIOC 581/582 *Graduate Research Seminars*
 BIOC 583 *Molecular Interactions*
 BIOC 587 *Graduate Seminar for 1st Year Graduate Students: Research Design, Proposal Writing, and Professional Development*
 BIOC 594 *Training in the Responsible Conduct of Research*
 BIOC 599 *Graduate Teaching*
 BIOC 701/702 *Graduate Lab Research* (laboratory rotations in first year)

Students also must take two units from the following set of advanced courses:

BIOC 525 *Plant Molecular Genetics and Development* (1 unit)
 BIOC 530/535 *Graduate Laboratory Modules in Molecular Biophysics* (1/2 unit each)
 BIOC 540 *Metabolic Engineering* (1 unit)
 BIOC 544 *Developmental Biology* (1 unit)
 BIOC 545 *Advanced Molecular Biology and Genetics* (1 unit)
 BIOC 550 *Virology* (1 unit)
 BIOC 551 *Molecular Biophysics I* (1 unit)
 BIOC 560 *Cancer Biology* (1 unit)
 BIOC 580 *Protein Engineering* (1 unit)
 BIOC 588 *Advanced Cell and Developmental Biology* (1 unit)

All students are required to attend BIOC 581 and 582 during all years of residency. Students should complete BIOC 583 and BIOC 587 in their first year, and they will be responsible for the content of those course programs in their admission to candidacy examinations (see below). Students also gain teaching experience by serving as discussion leaders and graders in undergraduate sections during their second year. Safety and ethics presentations are provided for first-year students.

Evaluation of Progress in Graduate Study—The Graduate Advisory Committee evaluates each student's undergraduate record and recommends course work based on the requirements. Thesis advisors may require additional courses before taking the admission to candidacy examination.

At the end of each semester, the department chair, in consultation with the faculty, reviews student performance in the formal course work. Students must maintain at least a B average, perform satisfactorily in BIOC 701/702, and demonstrate outstanding motivation and potential for research. Thesis lab assignments are made based on student and faculty preferences following research rotations.

Evaluation after the first year includes:

- Ongoing review of research progress by the thesis advisor
- A research progress review examination given each year by the student's Research Progress Review Committee
- Presentation of research progress at least once a year until submission of a complete doctoral thesis
- Completion of an oral admission to candidacy examination before the end of the student's fourth semester
- Defense of the PhD thesis research and text in a final public seminar presentation and oral examination attended by the student's Thesis Committee

MA Program—All the above requirements and evaluation procedures apply to MA candidates, with the following exceptions. The research progress review examination held during the MA student's second full year, which is identical in format to that for PhD students, replaces the admission to candidacy examination; no other preliminary examination is held before the final oral defense of the master's thesis. MA candidates must complete a thesis and make a public oral defense of their research work to their Thesis Committee and other interested parties.