

## BIOSCIENCES

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### BIOCHEMISTRY AND CELL BIOLOGY

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## ECOLOGY AND EVOLUTIONARY BIOLOGY

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**DEGREES OFFERED: BA, BS, MA, PHD**

**Undergraduate Programs**—The Departments of Biochemistry and Cell Biology and Ecology and Evolutionary Biology offer a broad range of courses in the biosciences: animal behavior, animal biology, biochemistry, biophysics, cell biology, developmental biology, ecology, endocrinology, evolutionary biology, genetics, immunology, microbiology, molecular biology, neurobiology, plant biology, and advanced courses in these and related areas. Students may elect a BA in Biochemistry and Cell Biology, BA in Biological Sciences, BS in Biochemistry and Cell Biology, or BS in Ecology and Evolutionary Biology; and may select courses from the range of topics listed above.

**Core courses required of all biosciences majors:****Mathematics**MATH 101/102 *Single Variable Calculus I and II***Chemistry**CHEM 121/122 *General Chemistry with Laboratory*CHEM 211/212 *Organic Chemistry*CHEM 215 *Organic Chemistry Lab***Physics**PHYS 125/126 *General Physics I and II***Biosciences**BIOS 201/202 *Introductory Biology*BIOS 301 *Biochemistry*BIOS 211 *Introductory Lab in Biological Sciences* (2 credit hours)BIOS 213 *Introductory Lab in Ecology and Evolutionary Biology***One Group B BIOS course****2 of the following advanced laboratory courses:**BIOS 311 *Lab in Protein Purification*BIOS 312 *Lab Module in Molecular Biology I*BIOS 313 *Lab Module in Molecular Biology II*BIOS 314 *Lab in Cell and Developmental Biology*BIOS 315 *Lab in Physiology*BIOS 316 *Lab in Ecology*BIOS 317 *Lab in Behavior*BIOS 318 *Lab in Microbiology*BIOS 319 *Tropical Field Biology*BIOS 320 *Lab in Tissue Culture*BIOE 342 *Lab in Tissue Culture*BIOS 530 *NMR Spectroscopy and Molecular Modeling*BIOS 532 *Spectroscopy*BIOS 533 *Computational Biology*BIOS 535 *Practical X-Ray Crystallography*

Math 111 and 112 may be substituted for Math 101; Chem 151, 152 may be substituted for Chem 121, 122; Phys 101 and 102 or Phys 111 and 112 and their labs may be substituted for Phys 125, 126. See listings in the Courses of Instruction for Group A and B designations. No course may be counted more than once toward any of the major requirements.

One of the advanced laboratory course requirements can be satisfied by taking any of the following: (i) Bios 310 if taken for at least two 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 pre-approved by the student's advisor; or (iii) Bios 412.

**BA IN BIOCHEMISTRY AND CELL BIOLOGY**

In addition to the core courses required of all biosciences majors, BA majors within this option must also take:

- MATH 211 or MATH 213
- BIOS 311

- BIOS 341
- Two of the following courses: BIOS 302, BIOS 344, BIOS 352
- Two additional Group A biosciences courses, only one of which may be BIOS 401 or 402

Chem 311 and 312 may be substituted for BIOS 352. Neur 511 and 512 may be substituted for one Group A course. Students may receive credit toward the major for a maximum of 3 credits of BIOS 390.

### **BA IN BIOLOGICAL SCIENCES**

In addition to the core courses that are required of all biosciences majors, BA majors within this option must take:

- MATH 211 or MATH 213 or STAT 305
- One of the following advanced lab courses: BIOS 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 530, 532, 533, 535, or BIOE 342
- One of the following Group A courses: BIOS 302, 341, 344, 352
- One additional Group A course
- Two Group B courses
- One additional Group A or Group B course

Only one of the courses used to satisfy these group A and group B requirements may be BIOS 401, 402, 403, or 404. NEUR 511 and 512 may be substituted for one Group A course. Students may receive credit toward the major for a maximum of 3 credits of BIOS 390 and 3 credits of BIOS 391. Students desiring to specialize in ecology and evolutionary biology can choose a group B course for the group A or B course and their advanced lab can be BIOS 316, 317, or 319.

### **BS IN BIOCHEMISTRY AND CELL BIOLOGY**

In addition to the core courses required of all biosciences majors, BS majors must also take:

- MATH 211 or MATH 213
- BIOS 311
- BIOS 302
- BIOS 341
- BIOS 344
- BIOS 352
- Three additional Group A bioscience courses

BIOS 401 and 402 are recommended Group A courses in the BS degree program. NEUR 511 and 512 may be substituted for one Group A course. Students may receive credit toward the major for a maximum of 3 credits of BIOS 390.

### **BS IN ECOLOGY AND EVOLUTIONARY BIOLOGY**

In addition to the core courses required of all biosciences majors, BS majors must also take:

- MATH 211 or MATH 213 or Stat 305
- One of the following advanced laboratory courses: BIOS 316, 317, 319
- One Group A biosciences course
- BIOS 403 and BIOS 404
- Two additional Group B biosciences courses
- One additional biosciences course from Group A or B

NEUR 511 and 512 may be substituted for one Group A course. Students may receive credit toward the major for a maximum of 3 credits of BIOS 390 and 3 credits of BIOS 391.

**Advising**—Students should contact the appropriate departmental office to be assigned to an advisor. Those pursuing a BS or BA in Biochemistry and Cell Biology should contact that department office. Those pursuing a BS in Ecology and Evolutionary Biology should contact that department office. Those electing a BA in Biological Sciences may choose the department that most closely corresponds to their interests, and that choice may be changed at any time. Students interested in environmental careers should consult with the Ecology and Evolutionary Biology Department for a list of recommended courses. See also Environmental Studies listings and Environmental Science Double Major.

It is recommended that the 100-level mathematics and chemistry courses be taken in the freshman year; that the 100-level physics courses and the 200-level biosciences courses be taken in either the freshman or sophomore year; and that CHEM 211, 212, 215 be taken in the sophomore year. Those with a limited background in chemistry should complete CHEM 121, 122 before taking BIOS 201, 202. Others are urged to take BIOS 201, 202 as freshmen, to permit earlier access to advanced level BIOS courses. PHYS 125 and 126 are the preferred physics courses for biosciences majors. However, PHYS 101 and 102 or PHYS 111 and 112 and their labs may be taken instead by those wishing to preserve the option of majoring in a subject for which PHYS 101 and 102 are required.

An undergraduate major in biosciences must have 48 semester hours in courses numbered 300 or higher to obtain a BA or BS degree. Students must also complete no fewer than 60 semester hours outside the departmental requirements. These must include the courses needed to satisfy the university distribution requirements.

### **ACCELERATED RICE BA-BS/PHD PROGRAM IN BIOCHEMISTRY AND CELL BIOLOGY**

Qualified undergraduate students at Rice can apply to enroll in the biochemistry and cell biology graduate program in their senior year. The course requirements for graduate studies are therefore completed at the same time as the upper-level undergraduate degree requirements; laboratory research performed as part of the undergraduate thesis project can serve as the initial phases of the PhD thesis work. As a result, the graduate careers of these students will be accelerated by at least one full year, and, in principle, such students should be able to obtain their PhD degrees approximately three years after obtaining their BA or BS degree.

Criteria for selection include academic performance (GPA  $\geq 3.3$ ), GRE scores, motivation, previous research experience, and personal qualities. Selection is made by the department admissions committee.

### **MECHANICS OF THE PROGRAM**

The program requires the completion of two and one-half years (or their equivalent) of undergraduate studies at Rice before a student can be considered for enrollment in the accelerated PhD program. To continue in the program, the following requirements must be fulfilled: (1) The student must take the GRE before receiving the BA or BS degree and receive scores greater than 80 percent in the Analytical and Quantitative Tests; (2) students must also maintain at least a B average in all courses in their senior year; and (3) the usual graduate requirements will apply for continuation in the program.

## 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 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 entitled “Graduate Requirements for Biochemistry and Cell Biology” which is updated annually. For general university requirements, see Graduate Degrees (in the 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 (current composition: Stern, Bartel, Braam, Gustin, Olson). 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:

BIOS 301 *Biochemistry*

BIOS 302 *Biochemistry*

BIOS 311, 312 and 313 *Laboratories for the Biosciences*

BIOS 341 *Cell Biology*

BIOS 344 *Molecular Biology and Genetics*

BIOS 352 *Physical Chemistry for the Biosciences*

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

BIOS 575 *Introduction to Research*

BIOS 581, 582 *Graduate Research Seminars*

BIOS 583 *Molecular Interactions*

BIOS 587 *Research Design, Proposal Writing, and Professional Development*

BIOS 594 *The Ethics of Bioscience and Bioengineering*

BIOS 599 *Graduate Teaching*

BIOS 800 *Graduate Research* (rotations in first year)

**Students must also take 2 units from the following set of advanced courses:**

BIOS 525 *Plant Molecular Biology* (1 unit)

BIOS 530, 532, 533, 535 *Graduate Laboratory Modules in Molecular Biophysics* (1/2 unit each)

BIOS 545 *Advanced Molecular Biology and Genetics* (1 unit)

BIOS 551 *Molecular Biophysics*

BIOS 588 *Advanced Cell and Developmental Biology* (1 unit)

Students should complete BIOS 583 and BIOS 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 identifies any deficiencies to be corrected (usually in the first year). Thesis advisors may require additional course work of a more specialized nature. Students must complete all additional courses before taking the admission to candidacy examination.

At the end of each semester, the department chair, in consultation with the committee and faculty, reviews student performance in the formal course work; after students complete two semesters at Rice, the faculty conducts a review. Students must maintain at least a B average and demonstrate outstanding motivation and potential for research.

Evaluation after the first year includes:

- Ongoing review of research progress by the thesis research 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 after the second 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.

## DEGREE REQUIREMENTS FOR MA AND PHD IN ECOLOGY AND EVOLUTIONARY BIOLOGY

**Admission**—Applicants for graduate study in the Department of Ecology and Evolutionary Biology must have:

- BA degree or equivalent
- Scores from the Graduate Record Examination (GRE), including the advanced examination in biology
- A strong background in biology
- Completed course work in physics, mathematics (including calculus), and chemistry (including organic chemistry)

These requirements do not preclude admission of qualified applicants who have majored in areas other than biology. Deficiencies should be made up during the first year of residence; some may be waived at the discretion of the student's faculty advisor and the department chair.

Entering students will meet with a faculty advisor to form a course of study for the first year. All first-year students will demonstrate basic proficiency in ecology and evolutionary biology either by completing one ecology course from the following choices: BIOS 322, BIOS 324, BIOS 325, BIOS 329, or BIOS 336 and one evolutionary biology course from the following choices: BIOS 321 or BIOS 334 or by performing satisfactorily on a written examination that tests basic knowledge in both ecology and evolutionary biology.

All graduate students are required to complete the following graduate-level courses: BIOS 561 Topics in Evolution, BIOS 562 Topics in Behavioral Biology, BIOS 563 Topics in Ecology, BIOS 568 Topics in Biological Diversity, BIOS 585/586 Graduate Seminar in Ecology and Evolutionary Biology. Students may substitute BIOS 432 Advanced Evolutionary Biology for BIOS 561 or BIOS 562. Students are required to complete

two semesters of BIOS 591 Graduate Teaching. Students typically complete a PhD in no fewer than 3 and no more than 5 years.

**MS Program**—In addition to the general university requirements and those listed above, the Master of Science in Ecology and Evolutionary Biology requires 10 hours of research credit.

**MA Program**—In addition to the general university requirements and those listed above, the Master of Arts in Ecology and Evolutionary Biology requires the completion and public defense of a thesis embodying the results of an original investigation.

**PhD Program**—In addition to the general university requirements and those listed above, applicants for the PhD degree in Ecology and Evolutionary Biology must:

- Maintain a grade average of B or better in courses taken in the department and satisfactory grades in courses taken outside the department
- Pass the admission to candidacy examination given by the Graduate Advisory Committee (this examination may be oral and/or written)
- Complete an original investigation and a doctoral thesis worthy of publication in a scientific journal
- Present a departmental seminar on the research
- Publicly defend the doctoral thesis