

## Biosciences

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### Biochemistry and Cell Biology

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#### The Wiess School of Natural Sciences

##### Chair

Frederick B. Rudolph

##### Professors

Kathleen Beckingham  
 George N. Bennett  
 Zenaido Camacho  
 Raymon M. Glantz  
 Richard H. Gomer  
 Jordan Konisky  
 Kathleen Shive Matthews  
 John Steven Olson  
 George N. Phillips, Jr.  
 Charles R. Stewart

##### Professors Emeriti

James Wayne Campbell  
 Graham Palmer  
 James B. Walker

##### Associate Professors

Janet Braam  
 Susan L. Gibson  
 Michael C. Gustin  
 Seiichi P.T. Matsuda  
 Edward P. Nikonowicz  
 Michael Stern

##### Assistant Professors

Bonnie Bartel  
 Kevin R. MacKenzie  
 Mary Ellen Lane  
 James A. McNew  
 Yousif Shamoo  
 Scott F. Singleton

##### Lecturers/Laboratory

##### Coordinators

Beth Beason-Armendarez  
 David R. Caprette  
 Alma Novotny

##### Adjunct Professor

Florante A. Quiucho

##### Distinguished Faculty Fellow

Quentin H. Gibson

##### Faculty Fellow

Marian Fabian

## Ecology and Evolutionary Biology

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#### The Wiess School of Natural Sciences

##### Chair

Ronald L. Sass

##### Professors

Frank M. Fisher, Jr.  
 Paul A. Harcombe  
 David C. Queller  
 Joan E. Strassmann  
 Calvin H. Ward

##### Professors Emeriti

Charles Philpott  
 Stephen Subtelny

##### Assistant Professors

Lisa Meffert  
 Evan Siemann

##### Adjunct Assistant Professors

Rosine Hall  
 Nancy Grieg

##### Huxley Fellows

Kevin Foster  
 William Rogers

##### Lecturer/Laboratory

##### Coordinator

Barry Sullender

*Degrees Offered:* B.A., M.A., Ph.D.

The undergraduate curriculum in the biosciences is administered jointly by two departments: the Department of Biochemistry and Cell Biology and the Department of Ecology and Evolutionary Biology. This curriculum offers majors in biochemistry and in biology. Courses in the biosciences include animal behavior, animal biology, biochemistry, biophysics, cell biology, developmental biology, ecology, endocrinology, evolutionary biology, genetics, immunology, microbiology, molecular biology, neurobiology, and plant biology.

The graduate programs in biochemistry and cell biology focus on topics in biochemistry, biophysics, cell biology, development, genetics, molecular biology, and neurobiology. In the ecology and evolutionary biology program, the focus is on behavior, biogeochemistry, molecular evolution, plant community ecology, population biology, sociobiology, and wetland ecosystems.

### **Degree Requirements for B.A. in Biosciences**

For general university requirements, see Graduation Requirements (pages 16–18). Students majoring in biosciences must complete at least 48 semester hours of courses at the 300 level or higher. The total semester hours at graduation should be at least 129 hours (128 hours if students choose the PHYS 101/102 option, and 132 hours if they choose the MATH 111/112 option). All biosciences majors must complete the following:

#### **Mathematics**

MATH 101/102 *Single Variable Calculus I and II*  
MATH 211 *Ordinary Differential Equations and Linear Algebra*

#### **Chemistry**

CHEM 121/122 *General Chemistry with Laboratory*  
CHEM 211/212 *Organic Chemistry*  
CHEM 213/214 *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*  
BIOS 311 *Lab in Protein Purification*

#### **Any 2 of the following advanced laboratory courses:**

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 530 *NMR Spectroscopy and Molecular Modeling*  
BIOS 532 *Spectroscopy*  
BIOS 533 *Computational Biology*  
BIOS 535 *Practical X-Ray Crystallography*

**Options.** One of the advanced laboratory course requirements may be satisfied by taking any of the following: (1) STAT 305 (if used to satisfy a lab requirement, this may not also be used to satisfy a lecture course requirement); or (2) BIOS 310, if taken for at least 2 credits; or (3) 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 adviser; or (4) BIOS 401/402, one semester may be used to meet an advanced

laboratory course requirement, and the other semester may be used to meet the requirement for a group A or B course, as discussed below). Students may substitute MATH 111 Fundamental Theorem of Calculus and MATH 112 Calculus and its Applications for MATH 101. They may substitute CHEM 151/152 Principles of Chemistry for CHEM 121/122. Although PHYS 125 and 126 are the preferred physics courses for biosciences majors, students who want to keep open the option of a different major may satisfy the physics requirement by taking PHYS 101 or 111 Mechanics and PHYS 102 or 112 Electricity and Magnetism (with their respective labs).

**Course Sequence.** Students should take the 100-level mathematics and chemistry courses in their freshman year, the 100-level physics courses and the 200-level biosciences courses in either their freshman or their sophomore year, and the 200-level chemistry courses in their sophomore year. Those with a limited background in chemistry should complete CHEM 121/122 before taking BIOS 201/202. Taking BIOS 201/202 while freshmen gives students earlier access to upper-level courses, and is recommended for students with sufficient chemistry preparation.

**Undergraduate Research.** Undergraduate majors are encouraged, but not required, to pursue independent supervised research in BIOS 401/402 Undergraduate Honors Research; those who do must register concurrently in BIOS 411/412 Undergraduate Research Seminar and complete a thesis. Students may also undertake research projects in BIOS 310 Undergraduate Independent Study and HONS 470/471. See Honors Programs (page 33).

**Biochemistry Major.** Students majoring in biochemistry must take the following in addition to those required of all biosciences majors. See listings in the Courses of Instruction section for Group A and B designations.

- BIOS 352 *Physical Chemistry for Biosciences*  
or CHEM 311/312 *Physical Chemistry*
- BIOS 302 *Biochemistry*
- BIOS 341 *Cell Biology*
- BIOS 344 *Molecular Biology and Genetics*.
- 1 additional bioscience course from Group A

Students may substitute 1 semester of honors research, BIOS 401 or 402, for 1 of the elective courses from Group A if their faculty supervisor is from the Department of Biochemistry and Cell Biology. Biochemistry majors are assigned an adviser from the biochemistry and cell biology department.

**Biology Major.** Students majoring in biology must take the following in addition to the courses that are required of all biosciences majors (see listings in the Courses of Instruction section for Group A and B designations):

- 2 biosciences courses from Group A
- 1 biosciences course from Group B
- 4 additional biosciences courses from Groups A and/or B

Students may substitute STAT 305 Introduction to Statistics for Biosciences for one of the last 4 courses provided that STAT 305 has not been used to satisfy a lab requirement.

Students may also substitute 1 semester of honors research, BIOS 401 or 402, for one of the courses from Group A, if their faculty supervisor is from the Department of Biochemistry and Cell Biology, or from Group B, if their supervisor is from the Department of Ecology and Evolutionary Biology. The recommended courses for those taking a limited number of Group A courses are BIOS 302 Biochemistry, BIOS 341 Cell Biology, BIOS 344 Molecular Biology and Genetics, and BIOS 352 Physical Chemistry for Biosciences.

Students may specialize in ecology and evolutionary biology or in cell and molecular biology by choosing the 4 additional biosciences courses from Group B or from Group A, respectively. Specialization is not required, and students may switch from one to another if they wish. Biology majors are assigned an adviser from one of the two biosciences departments according to their specialization; those electing a general biology program may request advisers from either department. Students interested in environmental careers should consult with the ecology and evolutionary biology department for a list of recommended courses. See also Environmental Program listings (pages 162–173) and Environmental Science Double Major (pages 121–122).

### **Admission Requirements for Accelerated B.A./Ph.D. Program in Biochemistry and Cell Biology**

Qualified undergraduates at Rice may apply for admission to the biochemistry and cell biology graduate program in their senior year. This allows them to complete certain course requirements for graduate studies at the same time as their upper-level undergraduate degree requirements; laboratory research performed as part of their undergraduate thesis project can serve as the initial phases of their Ph.D. thesis work. Students thus should be able to obtain their Ph.D. degree more quickly—approximately three years after earning their B.A. degree.

Criteria for admission include academic performance (grade point average of 3.30 or higher), high scores on the Graduate Record Examination (GRE), motivation, previous research experience, and personal qualities. The department Graduate Admissions Committee makes the selection.

Interested students must complete two and one-half years (or their equivalent) of undergraduate studies at Rice before applying for enrollment in the accelerated B.A./Ph.D. program. To continue in the program, they must:

- Take the GRE before receiving the B.A. degree and earn scores greater than 80 percent in the analytical and quantitative tests
- Maintain a B average in all courses in their senior year

The usual graduate requirements will apply for continuation in the program.

### **Degree Requirements for M.A. and Ph.D. in Biochemistry and Cell Biology**

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

- B.A. 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 M.A. degree in biochemistry and cell biology, only on rare occasions are students who do not intend to pursue the Ph.D. degree admitted to the graduate program. The department provides a program guide titled “Graduate Program for Biochemistry and Cell Biology,” which is updated annually. For general university requirements, see Graduate Degrees (pages 60–65).

**Both Ph.D. and M.A. 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: Braam, Gustin, Shamoo, and Stern). 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, 313 *Laboratories for the Biosciences*  
 BIOS 341 *Cell Biology*  
 BIOS 344 *Molecular Biology and Genetics*  
 BIOS 352 *Physical Chemistry for the Biosciences*

**All Ph.D. 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 800 *Graduate Research* (rotations in first year)  
 UTHSC GS210051 *Ethical Dimensions of the Biomedical Sciences*

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

Students should complete BIOS 583 and BIOS 587 in their first and second years, respectively, and they will be responsible for the content of those course programs in their admission to candidacy examination (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 advisers 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 entire 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:

- Continual review of research progress by the thesis research adviser
- 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 beginning of the student's sixth semester
- Defense of the Ph.D. thesis research and text in a final public seminar presentation and oral examination attended by the student's Thesis Committee

**M.A. Program.** All the above requirements and evaluation procedures apply to M.A. candidates with the following exceptions. The research progress review examination held during the M.A. student's second full year, which is identical in format to that for Ph.D. students, replaces the admission to candidacy examination; no other preliminary examination is held before the final oral defense of the master's thesis. M.A. 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 M.A. and Ph.D. in Ecology and Evolutionary Biology**

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

- B.A. degree or equivalent
- Scores from the Graduate Record Examination (GRE), including the advanced examination in biology
- Strong background in biology
- Completed course work in physics (one year), mathematics (including calculus), chemistry (including organic chemistry), and biochemistry

These requirements do not preclude admission of qualified applicants who have majored in areas other than biology.

Students should make up any deficiencies no later than their first year of residence (including the subsequent summer) but preferably during the summer preceding the first semester of residence. Students must pass an examination during the first year; those entering with an M.A. degree are normally exempt from this exam.

**M.A. Program.** For the M.A. degree, applicants must complete 30 semester hours of graduate study, including the completion and public defense of a thesis embodying the results of an original investigation.

**Ph.D. Program.** In addition to the general university requirements for Graduate Degrees (see pages 60–65), applicants for the Ph.D. degree must:

- Complete three or more years of graduate study in ecology and evolutionary biology, with at least two years in residence at Rice
- Maintain a grade average of B or better in courses taken in the department and satisfactory grades in courses taken outside the department
- Perform satisfactorily in teaching assignments for at least two semesters
- Pass the admission to candidacy examination given by the Graduate Advisory Committee (this examination may be oral and/or written)
- Complete an original investigation worthy of publication in a scientific journal and a doctoral thesis
- Publicly defend the doctoral thesis
- Present a departmental seminar on the research

**See BIOS (pages 271–278) in the Courses of Instruction section.**