

Biosciences

Biochemistry and Cell Biology

The Wiess School of Natural Sciences

Chair

George N. Bennett

Professors

Kathleen Beckingham
 George N. Bennett
 Zenaido Camacho
 Raymon M. Glantz
 Richard H. Gomer
 Jordan Konisky
 Kathleen Shive Matthews
 John Steven Olson

Ronald J. Parry
 Frederick B. Rudolph
 Charles R. Stewart

Professors Emeriti

James Wayne Campbell
 Graham Palmer
 James B. Walker

Associate Professors

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

Assistant Professors

Mary Ellen Lane
 Kevin R. MacKenzie
 James A. McNew
 Yousif Shamoo
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Lecturers/Laboratory

Coordinators

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Adjunct Professors

James Armstrong
 Richard Dixon
 Daniel Feeback
 Robert O. Fox
 Susan Gibson
 Kendal Hirschi
 Neal Pellis
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 Florante A. Quiocho

Clarence Sams
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Ecology and Evolutionary Biology

The Wiess School of Natural Sciences

Chair

Ronald L. Sass

Professors

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 David C. Queller
 Joan E. Strassmann
 Calvin H. Ward

Professors Emeriti

Frank M. Fisher, Jr.
 Charles Philpott

Stephen Subtelny

Assistant Professors

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 Lisa Meffert
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Adjunct Assistant Professors

Nancy Grieg
 Rosine Hall

Steven Pennings

Huxley Fellows

Saara DeWalt

Kevin Foster

Lecturer/Laboratory**Coordinator**

Barry Sullender

Faculty Fellow

William Rogers

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, plant biology, and structural biology.

The graduate programs in biochemistry and cell biology focus on topics in biochemistry, biophysics, cell biology, development, genetics, molecular biology, neurobiology, and enzymology. 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 20–23). 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 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*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 320/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

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. 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 the freshman year, the 100-level physics courses and the 200-level biosciences courses in either the freshman or the sophomore year, and the 200-level chemistry courses in the sophomore year. Those with a limited background in chemistry should complete CHEM 121/122 before taking BIOS 201/202. Taking BIOS 201/202 in the freshman year 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 34).

Biochemistry Major. Students majoring in biochemistry must take the following in addition to those required of all biosciences majors.

- 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
- 1 additional course for 3 or more hours at the 200 level or higher in mathematics, physics, computer science, statistics, or computational and applied mathematics; or BIOS 322, BIOS 325, or BIOS 334
- 1 additional course for 3 or more hours at the 300 level or higher in chemistry or Group A biosciences

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. NEUR 511 and 512 may be substituted for one Group A course. 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:

- 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. NEUR 511 and 512 may be substituted for one Group A course. 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 who choose to specialize in ecology and evolutionary biology should choose their 4 additional biosciences courses from Group B. Students who choose cell and molecular biology for their specialization should choose their 4 additional biosciences courses from Group A. Specialization is not required, and students may switch from one to the other 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 Studies listings and Environmental Science Double Major.

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 65–70).

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, MacKenzie, 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 lack 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 594 *The Ethics of Bioscience and Bioengineering*
 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 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 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 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.S., M.A., and Ph.D. in Ecology and Evolutionary Biology

Admission. 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, 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 adviser and the department chair.

Entering students will meet with a faculty adviser 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 Ph.D. in no less than 3 and no more than 5 years.

M.S. 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.

M.A. 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.

Ph.D. Program. In addition to the general university requirements and those listed above, applicants for the Ph.D. 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

See BIOS in the Courses of Instruction section.