ECOLOGY AND EVOLUTIONARY BIOLOGY

THE WiESS SCHOOL OF NATURAL SCIENCES

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DEGREES OFFERED: minor, BA, BS, MA, PhD

Undergraduate Programs—The Department of Ecology and Evolutionary Biology offers a broad range of courses in the biosciences: animal behavior, animal biology, bioinformatics, conservation biology, diseases, ecology, evolutionary biology, field ecology, genetics, genomics, immunology, molecular biology, natural history, plant biology, and advanced courses in these and related areas. Students may elect a BA in biological sciences, BA in ecology and evolutionary biology, BS in ecology and evolutionary biology, or a departmental minor in ecology and evolutionary biology.

BA Biological Sciences

This degree path is intended 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 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.

Nonbiology 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 335 Evolution Bioinformatics 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 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 preapproved by the student's advisor; (iii) BIOC 412/EBIO 412; or (iv) EBIO 393.
BA Ecology and Evolutionary Biology

This degree path is intended 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. This degree is well suited for students with an additional major that is not in the sciences. Course work is designed to emphasize a broad understanding of basic biology together with an in-depth knowledge of ecology and evolutionary biology that culminates in a required capstone 400-level course that incorporates primary scientific literature, presentations and writing in an advanced topic. Students are strongly encouraged to take advantage of study abroad opportunities.

Nonbiology courses:
- MATH 101/102 *Single Variable Calculus I and II*
- STAT course or EBIO 338 *Design and Analysis of Biological Experiments*
- CHEM 121/123 *General Chemistry* (with lab)
- PHYS 125 *General Physics I*

One natural sciences or engineering course at the 300 level or above

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

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

Two 300 or 400 level labs in EBIO or BIOC

Non-EEB biology course:
- 300 or 400 level BIOC lecture course

Advanced EEB courses:
- EBIO 334 *Evolution*

Three EBIO lecture courses at 300 or 400 level (12 credits)

SR scientific communication course:
- EBIO 412 *Scientific Communication in the Biosciences*

BS Ecology and Evolutionary Biology

This degree path is intended for students pursuing a wide range of careers in the life sciences with required research in organismal biology. Students graduating from this degree path typically go on to graduate or professional school or enter the workforce with this as their terminal degree. Course work is designed to emphasize a broad understanding of basic biology together with an in-depth knowledge of ecology and evolutionary biology that culminates in a required capstone 400-level course that incorporates primary scientific literature, presentations and writing in a advanced topic. Additionally, students in this degree program are required to conduct independent research under the supervision or co-supervision of an EEB faculty member (though the research can take place in other locations or institutions such as the Texas Medical Center or at field sites throughout the world). Students are strongly encouraged to take advantage of study abroad opportunities.
In addition to the requirements for the BA in ecology and evolutionary biology, the BS requires the following courses:

EBIO 306 *Independent Research* (for at least 2 credits)

EBIO 403/404 *Senior Research*

**Course Requirements for a Minor in Ecology and Evolutionary Biology**

The ecology and evolutionary biology minor is intended for the large number of students with an avid interest in ecology and evolutionary biology but whose major interests are in other departments.

**Required classes:**

**Introductory Biology:**

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

**Biology Lab:**

EBIO 213 *Introductory Lab in Ecology and Evolutionary Biology* (1 credit)

**Advanced EEB lecture courses:**

Four EBIO lecture courses at the 300 or 400 level

**EEB Major Tracks**

These tracks within the ecology and evolutionary biology majors serve to guide students in their choice of courses such that they are well prepared for further study or careers in different areas within ecology and evolutionary biology. No additional designation will appear on the diploma and students do not have to complete a track if they choose to design their own individualized course of study.

**Conservation Biology/Environmental Biology Track**

This track is appropriate for students interested in gaining in-depth training in the areas of conservation biology and environmental biology. For such students, useful courses include:

**EEB lecture courses:**

EBIO 323 *Conservation Biology*

EBIO 325 *Ecology*

EBIO 326 *Insect Biology*

EBIO 336 *Plant Diversity*

EBIO 340 *Global Biogeochemical Cycles*

**EEB lab courses:**

EBIO 204 *Environmental Sustainability (Community Agriculture)*

EBIO 316 *Field Ecology Lab*

EBIO 327 *Biological Diversity Lab*

EBIO 330 *Insect Biology Lab*

EBIO 337 *Field Bird Biology Lab*

**Non-EEB courses:**

CEVE 306 *Global Environmental Law*
Evolutionary Biology Track

Students considering graduate work in evolutionary biology will typically need a full year of physics and a full year of chemistry, and sometimes organic chemistry or biochemistry. Statistics and computer skills are desirable. Other useful courses include:

**EEB lecture courses:**
- EBIO 321 Animal Behavior
- EBIO 326 Insect Biology
- EBIO 328 Evolution of Genes and Genomes
- EBIO 333 Evolutionary Bioinformatics
- EBIO 334 Evolution (required of all EEB majors)
- EBIO 336 Plant Diversity

**EEB labs:**
- EBIO 317 Lab Module in Behavior
- EBIO 327 Biological Diversity Lab
- EBIO 330 Insect Biology Lab
- EBIO 337 Field Biology Bird Lab

**Other lecture courses:**
- BIOC 344 Molecular Biology and Genetics
- COMP 571 Bioinformatics: Sequence Analysis
- ECON 340 Introduction to Game Theory
- ANTH 203 Human Antiquity: An Introduction to Physical Anthropology and Prehistory

Evolutionary Genetics and Genomics Track

**Synopsis:** The Evolutionary Genetics and Genomics (EGG) Track is a model course of study that (i) satisfies the degree requirements for a BS in ecology and evolutionary biology at Rice, and (ii) emphasizes the knowledge and skills most important for pursuing a successful career in bioinformatics, evolutionary genetics/genomics, medicine, and related fields.

While the track overlaps with other courses of study at Rice (and elsewhere) in that it is designed to train students to apply a “genomic toolkit” of concepts, skills and techniques, including computational analyses and molecular lab techniques, our track is unique in its emphasis on evolutionary biology. For example, comparative genomics is a perspective adopted in bioinformatics to
identify genomic regions that are conserved between distantly related species. By inference, such conserved genomic regions are thought to be of functional significance. In addition to such pattern-oriented and applied perspectives adopted in many bioinformatics programs, students who pursue the EGG Track will understand the processes leading to the evolution of genomic sequences (e.g. the relative roles of selection and genetic drift), and their relationship to important scientific problems in evolutionary biology.

The track consists of a set of core courses, plus a list of suggested courses from which students can choose.

Core EGG EEB lecture courses:
EBIO 328 Evolution of Genes and Genomes
EBIO 333 Evolutionary Bioinformatics
EBIO 334 Evolution (required of all EEB majors)

Other Bioscience Courses of interest:
This set of courses has been compiled from a variety of course offerings at Rice to provide the students with the ability to broaden their knowledge in areas the post-genome era is beginning to leave its mark. Students are encouraged to choose courses from the following compilation.
BIOC 307 Genetics: Science and Society
EBIO 323 Conservation Biology
EBIO 321 Behavior
EBIO 325 Ecology
EBIO 326 Insect Biology
EBIO 336 Plant Diversity
ENST/ESCI 102 Evolution of the Earth
KINE 300 Human Anatomy
KINE 301 Human Physiology
PHIL 313 Philosophy of Science
HUMA 260 Genomics and Social Transformation
STAT 305 Introduction to Statistics for Biosciences (required)

Suggested for quantitative/computational focus: This set of courses is meant as guide to inform the choice of courses for students who are interested primarily in the applications of computational biology in evolutionary research. This will enable the choice of courses that will be prerequisites (by other departments) when opting for the quantitative/computational focus.
BIOC 533 Bioinformatics and Computational Biology
BIOE 391 Numerical Methods
COMP 100 Introduction to Computing and Information Systems
COMP 571 Bioinformatics: Sequence Analysis
COMP 572 Bioinformatics: Network Analysis
MATH 111/112 Fundamental Theorem Calculus/Calculus and Its Applications
MATH 212 Multivariable Calculus
STAT 100 *Data, Models, and Reality*
STAT 423 *Probability in Bioinformatics and Genetics*
STAT 453 *Biostatistics*
STAT 670 *Statistical Genetics*

Suggested for molecular genetics focus: This set of courses is meant as guide to inform the choice of courses for students who are interested primarily in the molecular genetic and genomic techniques conducted in evolutionary research laboratories. This will enable the choice of courses that will be prerequisites (by other departments) when opting for the molecular genetics focus.

BIOC 344 *Molecular Biology and Genetics* (required)
BIOC 301 *Biochemistry*
BIOC 302 *Biochemistry*
BIOC 443 *Development*

STAT 675 *Gene Expression and Proteomics*

*Labs:*

Students should acquire a basic understanding of organismal and molecular biology, should be able to approach computational and mathematical problems from an applied perspective, and understand scientific publications where analytical and/or computational developments are presented.

We suggest that students need to take at least one intro lab course covering organisms and/or biological diversity (EEB), we require EBIO 333L, one introductory molecular biology lab (BCB), and one introductory lab in computational biology, computer science, statistics or applied mathematics (EBIO, COMP, STA, MATH, CAAM).

**EEB lab courses in Biology:**

Required for EEG-EBIO 333L *Evolutionary Bioinformatics Lab*

One lab that covers organismal biology and/or diversity (EBIO 316, EBIO 317, EBIO 337).

**Non-EEB lab courses in Biology:**

We suggest lab modules in *Molecular Biology I and II* or lab in *Cell and Developmental Biology*

BIOC 311 and 312 *Advanced Experimental Biosciences* and *Experimental Molecular Biology*

BIOC 313 *Advanced Molecular Biology*

BIOC 318 *Laboratory Studies in Applied Microbiology*

**Non-EEB lab courses in computation, mathematics and statistics:**

COMP 110 *Computation in Science and Engineering*

CAAM 210 *Introduction to Engineering Computation* (equivalent to COMP 110)

**Human Biology Track**

This track is targeted towards students with an interest in human biology.

**EEB lecture courses:**

EBIO 328 *Evolution of Genes and Genomes*
EBIO 329 Animal Biology and Physiology
EBIO 331 Biology of Infectious Diseases
EBIO 333 Evolutionary Bioinformatics

**EEB labs:**
EBIO 333L Bioinformatics Lab
EBIO 328L Genomics Lab
EBIO 306 Independent Research (conducted at Texas Medical Center)

**Non-EEB courses:**
BIOC 344 Molecular Biology and Genetics
BIOE 260 Introduction to Global Health Issues
BIOE 320 Systems Physiology Lab Module
BIOE 362 Bioengineering for Global Health Environment

**Advising**
Students pursuing an EEB degree (BA, BS or minor) should contact the EEB departmental office to be assigned to an advisor. Those electing a BA in biological sciences may choose the department (BCB or EEB) that most closely corresponds to their interests, and that choice may be changed at any time.

**Graduate Degrees**
Degree requirements For MS, MA, and PhD in ecology and evolutionary biology:

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

- BA or BS degree or equivalent that provides a strong background in biology
- Strong ability and motivation, as indicated by academic record, Graduate Record Examination (GRE) scores, and recommendations
- Scores from the GRE biology subject exam are optional but can be helpful, particularly for students with nontraditional backgrounds in biology

These requirements do not preclude admission of qualified applicants who have majored in areas other than biology. Although the department offers MA and MS degrees, only on rare occasions are students who do not intend to pursue the PhD admitted to the graduate program.

Students should have completed course work in physics, mathematics (including calculus), and chemistry (including organic chemistry) prior to admission. Deficiencies in these subject areas or in specific areas of biology should be made up during the first year of residence; some may be waived at the discretion of the student's advisory committee and the department chair.

Entering students will meet with a faculty advisor to form a course of study of the first year. All first year students will complete the core course in ecology and evolutionary biology (EBIO 569) in their first semester. All graduate students are required to complete EBIO 585/586 Graduate Seminar in Ecology and Evolutionary Biology and two semesters of EBIO 591 Graduate Teaching. Students must maintain a grade average of B in courses taken in the department and satisfactory grades in courses taken outside the department.
Students must demonstrate satisfactory progress in their degree program in annual reviews by a departmental committee. The review process requires that each student present a public seminar on their research, prepare a written report on their progress, and participate in an interview with the departmental committee. For general university requirements, see Graduate Degrees (in General Announcements).

**MS Program**—In addition to the general university requirements and those listed above, the master of science in ecology and evolutionary biology requires at least 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, the PhD degree in ecology and evolutionary biology requires:

- Passing the admission to candidacy examination given by the Graduate Thesis Committee. (The committee will be composed of at least four members. At least three must be members of the EEB graduate faculty.)
- Complete an original investigation and a doctoral thesis with the potential to produce publications in reputable, peer-reviewed scientific journals
- Present a departmental seminar on the research
- Publicly defend the doctoral thesis