

# 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

## 2 DEPARTMENTS / Ecology and Evolutionary Biology

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 a 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*

### **MINOR ECOLOGY AND EVOLUTIONARY BIOLOGY**

The EEB 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.

#### ***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*

CEVE 307 *Energy and the Environment*

ENGL 368 *Literature and the Environment*

ENST 312 *Environmental Battles in the 21st Century: Houston as Microcosm*

ENST 313 *Sustainable Design*

ENST 314 *Environmental Health*

ESCI 450 *Remote Sensing*

HIST 425 *U.S. Conservation Movement*

SOCI 367 *Environmental Sociology*

### **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 student 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