ENVIRONMENTAL BIOLOGY

404 Altschul Hall
212-854-5618
212-854-5760 (fax)
Department Assistant: Catherine Cook

Mission

The mission of the Environmental Biology major is to provide students with an understanding of the structure, function and interrelationships of diverse living systems within the context of earth’s changing environment. It addresses some of the most important issues of our time—climate change and declining biological diversity—and efforts to address these problems. To this end, students take courses in both the Environmental Science and Biology departments, including laboratory and field courses that help them learn how to design and test hypotheses, use modern scientific equipment, interpret data, and evaluate and solve problems. Students learn scientific communication skills by critiquing research articles, writing laboratory reports and research papers, and participating in oral presentations and debates.

Environmental Biology students are encouraged to become involved in research under the guidance of a faculty member at Barnard or elsewhere in New York City. Our urban setting, the proximity to the Hudson River, and the numerous affiliations we maintain with Columbia University through Lamont-Doherty Earth Observatory, the Earth Institute, and the School of Public Health, as well as Black Rock Forest, the American Museum of Natural History, and other institutions, allow us to offer undergraduates unparalleled opportunities for student research and educational experiences. Upon successful completion of our program, our students are well prepared to pursue successful careers in research, teaching or the allied health sciences. The Environmental Biology major is appropriate for students interested in careers as diverse as university-level research and teaching, curatorial work and research in natural history museums and parks, environmental education, and decision-making in environmental policy, law, public health, and government agencies.

Student Learning Outcomes

- Discuss the structure, function, and interrelationships of key environmental systems: climate, earth, life
- Demonstrate an appreciation of the many different life forms on planet Earth
- Design and execute an independent scientific analysis, including the formulation of a testable hypothesis and assembling a logical chain of reasoning ranging from observation to inference
- Locate, integrate, and evaluate information from multiple and disparate sources
- Apply appropriate analytical and quantitative approaches including calculating statistics and displaying data to interpret relationships, trends and make predictions about past and future changes
- Resolve uncertain, complex problems in the lab and field
- Clearly communicate analyses, interpretations and significance through variable media: oral presentation, poster, proposal, research or review article, report

The program in Environmental Biology is jointly administered by the departments of Biology and Environmental Science, and students should maintain contact with the advisers in both departments. A major in Environmental Biology provides a strong background for students interested in the intersection of Biology and Environmental Science. The major is suitable for students who intend to pursue a research career in conservation biology, ecology, or environmental biology as well as for students interested in environmental law or policy. Students who elect the Environmental Biology major will enroll in introductory and advanced courses in Biology and Environmental Science and related fields. All Environmental Biology majors complete a senior essay either in the Biology or Environmental Science departments.

Students may substitute courses taught at Columbia (in the Departments of Biology, E3B, Earth and Environmental Sciences, or Statistics) or at other institutions with the prior approval of both major advisers. Students interested in Environmental Biology often choose to spend a semester abroad in the field. Courses completed in such programs may be accepted in fulfillment of some major requirements.

Students may also pursue an interdisciplinary program by electing a major in either Biology or Environmental Science and a minor in the other discipline, or by planning a double major.

There is no minor in Environmental Biology.

Advisers: Hilary Callahan (Biological Sciences), Paul Hertz (Biological Sciences), Brian Mailoux (Environmental Science), Krista McGuire (Biological Sciences), Martin Stute (Environmental Science)

Requirements for the Major

For requirement details, see Environmental Biology Major Worksheet, envbioworksheet.doc

Introductory Biology, Chemistry, and Environmental Science with Laboratory

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<tr>
<th>Course</th>
<th>Title</th>
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<tr>
<td>BIOL BC1500</td>
<td>Introduction to Organismal and Evolutionary Biology</td>
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<td>Introductory Lab in Organismal and Evolutionary Biology</td>
<td>2</td>
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<tr>
<td>BIOL BC1502</td>
<td>Introduction to Cell and Molecular Biology</td>
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<td>Introductory Lab in Cell and Molecular Biology</td>
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<tr>
<td>EESC UN2100</td>
<td>Earth’s Environmental Systems: The Climate System</td>
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<tr>
<td>EESC UN2200</td>
<td>EARTH’S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH</td>
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<td>or CHEM BC2002</td>
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Ecology Lecture

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<tr>
<td>or BIOL BC3380</td>
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Ecology Laboratory

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<tr>
<td>BIOL BC2873</td>
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Organismal Biology Lecture

Select one of the following: 3

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<td>BIOL BC2240</td>
<td>Plant Evolution and Diversity</td>
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<tr>
<td>BIOL BC2262</td>
<td>Vertebrate Biology</td>
<td></td>
</tr>
<tr>
<td>BIOL BC3320</td>
<td>Microbiology</td>
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Biology Lecture
Select one additional lecture course in Biology (not including those listed above under organismal biology)

**Environmental Methodology**
Select one of the following: 3

- EESC BC3014 Field Methods in Environmental Science
- EESC BC3016 Environmental Measurements
- EESC BC3025 Hydrology
- EESC GU4050 Global Assessment and Monitoring Using Remote Sensing
- EAEE E4009 Geographic information systems (GIS) for resource, environmental and infrastructure management

- SDEV UN3390 GIS for Sustainable Development
- SDEV UN3450 SPATIAL ANALYSIS FOR SDEV

**Environmental Science**
Select one additional course in Environmental Science.

**Data Handling**
Select one of the following: 3

- BIOL BC2286 Statistics and Research Design
- EESC BC3017 Environmental Data Analysis
- EEEB UN3005 Introduction to Statistics for Ecology and Evolutionary Biology

**Senior Essay**
Select one of the following:

- BIOL BC3590 Senior Seminar
- BIOL BC3593 Senior Thesis Research & Seminar
- - BIOL BC3594 and Senior Research Seminar & Seminar
- EESC BC3800 Senior Research Seminar
- - EESC BC3801 and Senior Research Seminar (x,y)

Note: Calculus, Physics, and a second year of Chemistry are recommended for students planning advanced study in Environmental Biology.

**Advice for the Environmental Biology Major**

**Adviser:** Co-Chair, Brian Mailoux

Students may substitute courses taught at Columbia (in the Departments of Biology, Earth and Environmental Sciences, or Statistics) or at other institutions with the prior approval of both major advisers. Calculus, Physics, and a second year of Chemistry are recommended for students planning graduate study in Environmental Biology.

Students interested in Environmental Biology often choose to spend a semester “abroad”, at the School for Field Studies program, the Organization for Tropical Studies, or at comparable programs offered by other institutions. We encourage students to take advantage of such opportunities, and we expect that most of the courses they complete in these programs will be accepted in lieu of some of the major requirements. In addition, we recommend that those students planning to go abroad in the junior year elect to do so in the Fall Semester rather than the Spring Semester in order to take best advantage of senior seminar research planning and programming.

Students who elect a major in Environmental Biology will have a major adviser in each department. Although one member of the faculty will serve as the primary adviser, requests to substitute courses from Columbia or other institutions must be approved by both major advisers. Internships or some type of work or field experience are extremely valuable in preparing students for careers in the environment. Go to the Environmental Science website for Opportunities & Affiliations for listings or see Beyond Barnard. Studies have shown that students who have had related work experience are more attractive to employers and graduate schools.

Students should check the catalogue and the department for additional information on the major and courses offered by Barnard and Columbia. Classes with grades less than C- or taken pass/fail can not be counted towards the major.

See also Senior Research Seminar for information on senior thesis requirements completed in Environmental Science Department.

**Cross-Listed Courses**

**Biological Sciences (Barnard)**

**BIOL BC1500 Introduction to Organismal and Evolutionary Biology. 3 points.**

Prerequisites: This course is suitable for majors & fulfillment of pre-health requirements. A high school biology background or equivalent preparation is highly recommended. For those without this background seeking to major in biology, BIOL BC1002 & BIOL BC1012 are recommended in the fall of their freshmen year, followed by the year-long 1500-level lecture & lab sequence. BIOL BC1500 & BIOL BC1502 do not have to be taken in a fall to spring sequence.

Detailed introduction to biological phenomena above the cellular level; development, anatomy, and physiology of plants and animals; physiological, population, behavioral, and community ecology; evolutionary theory; analysis of micro-evolutionary events; and systematics.

**Fall 2021: BIOL BC1500**

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Note: Cross-listed with Biological Sciences (Barnard) BIOL BC1500 Introduction to Organismal and Evolutionary Biology. 3 points.
BIOL BC1501 Introductory Lab in Organismal and Evolutionary Biology. 2 points.
Prerequisites: BIOL BC1500 lecture is a pre- or co-requisite (preferred). Students must also enroll for a section of BIOL BC1511 recitation. A high school biology background or equivalent preparation is highly recommended. This course is suitable for fulfillment of biology major and pre-health requirements. Enrollment is limited to 16 students per section. A laboratory-based introduction to the major groups of living organisms; anatomy, physiology, evolution, and systematics; and laboratory techniques for studying and comparing functional adaptations.

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<th>Instructor</th>
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BIOL BC1502 Introduction to Cell and Molecular Biology. 3 points.
Prerequisites: BIOL BC1002 or equivalent preparation. Course suitable for fulfillment of premedical requirements. Together with BIOL BC1500 this course is part of a yearlong introductory sequence. BIOL BC1500 and BIOL BC1502 do not need to be taken in sequence. Detailed introduction to cellular and subcellular biology: cell structures and functions, energy metabolism, biogenesis of cell components, biology of inheritance, molecular genetics, regulation of gene expression, and genes in development.

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<td>002/00125</td>
<td>M W F 7:00pm - 7:50pm Online Only</td>
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A laboratory-based introduction to cell and molecular biology. Both classic and modern approaches are used to investigate principles of heredity as well as the structure and function of cells and their molecular components. Lab exercises introduce practical techniques and data analysis.

BIOL BC1503 Introductory Lab in Cell and Molecular Biology. 2 points.
Prerequisites: BIOL BC1502 lecture is a pre- or co-requisite (preferred). Students must also enroll for a section of BIOL BC1513 recitation. A high school biology background or equivalent preparation (such as BIOL BC1002 & BIOL BC1012) is highly recommended. This course is suitable for fulfillment of biology major and pre-health requirements. Enrollment is limited to 16 students per section; must attend first lab to hold place. A laboratory-based introduction to cell and molecular biology. Both classic and modern approaches are used to investigate principles of heredity as well as the structure and function of cells and their molecular components. Lab exercises introduce practical techniques and data analysis.

BIOL BC2240 Plant Evolution and Diversity. 3 points.
Prerequisites: BIOL BC1500, BIOL BC1501, BIOL BC1502, BIOL BC1503 or the equivalent. Survey of plant biology emphasizing evolutionary and ecological perspectives on mating and reproduction, physiology, anatomy, and morphology.

BIOL BC2262 Vertebrate Biology. 3 points.
Prerequisites: BIOL BC1500, BIOL BC1501, BIOL BC1502, and BIOL BC1503 or the equivalent. Systematic survey of the Phylum Chordata: fossil history, biogeography, systematics, natural history, body architecture, energetics, locomotion, feeding, and behavior.

BIOL BC2272 Ecology. 3 points.
Not offered during 2021-22 academic year.
Prerequisites: BIOL BC1500, BIOL BC1501, BIOL BC1502, BIOL BC1503 or the equivalent. This course is a pre- or co-requisite for BIOL BC2873 Laboratory in Ecology. Introduction to evolutionary ecology; life history strategies, population growth, competition, predator-prey interactions, population regulation, species diversity, community organization, and biogeography. Lectures integrate theory with empirical studies.

BIOL BC2286 Statistics and Research Design. 3 points.
Not offered during 2021-22 academic year.
Prerequisites: BIOL BC1500, BIOL BC1501, BIOL BC1502, BIOL BC1503 or the equivalent, college-level algebra or the equivalent. General Educational Requirement: Quantitative and Deductive Reasoning (QUA) Introduction to basic principles of statistics and experimental design. Topics include common statistical procedure, analysis of data, sampling populations, power analysis, and the design of experiments. This course differs from traditional statistics courses by explicitly integrating statistics into research process.

BIOL BC2873 Laboratory in Ecology. 3 points.
Not offered during 2021-22 academic year.
Prerequisites: BIOL BC2272 (which can be taken as a pre- or co-requisite). Enrollment is limited to 16; must attend first lab to hold place. The definition of ecological problems in experimentally tractable ways; the design of experiments and analysis of ecological data; class projects on population ecology. Students conduct individual projects during last month of term.

BIOL BC3320 Microbiology. 3 points.
Prerequisites: BIOL BC1500, BIOL BC1501, BIOL BC1502, BIOL BC1503, and BIOL BC2100 or the equivalent. This course is a pre-requisite for BIOL BC3321 Laboratory in Microbiology. Survey of the diversity, cellular organization, physiology, and genetics of the major microbial groups. Also includes aspects of applied microbiology and biotechnology, the function of microorganisms in the environment, and the role of microbes in human diseases.
BIOL BC3591 Guided Research and Seminar. *4 points.*

Per Semester

An independent research project in Biology under the guidance of a faculty member and suiting the needs of the individual student. A Barnard research mentor (if your lab is at Barnard) or internal adviser in the Biology Department (if your lab is elsewhere) must approve your planned research before you enroll in this year-long course. A *Project Approval Form* must be submitted to the department in the fall.

Attendance at a weekly seminar is required. By the end of the year, students enrolled in BIOL BC3591-BIOL BC3592 will write a scientific paper and give a poster presentation of their work at the Barnard Biology Research Symposium. Completion of this year-long course fulfills two upper-level laboratory requirements for the major. Must be taken in sequence, beginning in the fall.

### Fall 2021: BIOL BC3591

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### BIOL BC3592 Guided Research and Seminar. *4 points.*

Per Semester

An independent research project in Biology under the guidance of a faculty member and suiting the needs of the individual student. A Barnard research mentor (if your lab is at Barnard) or internal adviser in the Biology Department (if your lab is elsewhere) must approve your planned research before you enroll in this year-long course. A *Project Approval Form* must be submitted to the department in the fall.

Attendance at a weekly seminar is required. By the end of the year, students enrolled in BIOL BC3591-BIOL BC3592 will write a scientific paper and give a poster presentation of their work at the Barnard Biology Research Symposium. Completion of this year-long course fulfills two upper-level laboratory requirements for the major. Must be taken in sequence, beginning in the fall.

### Spring 2021: BIOL BC3592

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BIOL BC3593 Senior Thesis Research & Seminar. *4 points.*

Per Semester

Prerequisites: Permission of a faculty sponsor and the department. Cannot be taken concurrently with BIOL BC3591 or BIOL BC3592. Same as BIOL BC3591-BIOL BC3592, including attendance at a weekly seminar. By the end of the year, students enrolled in BIOL BC3593-BIOL BC3594 will write a scientific paper and orally present their work at the Barnard Biology Research Symposium.

A Barnard research mentor (if your lab is at Barnard) or internal adviser in the Biology Department (if your lab is elsewhere) must approve your planned research before you enroll in this year-long course. A *Project Approval Form* must be submitted to the department in the fall. Completion of this year-long course fulfills the senior capstone requirement for the major; it cannot be taken at the same time as BIOL BC3591-BIOL BC3592. Must be taken in sequence, beginning in the fall.

### Fall 2021: BIOL BC3593

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### BIOL BC3594 Senior Thesis Research & Seminar. *4 points.*

Prerequisites: Permission of a faculty sponsor and the department. Cannot be taken concurrently with BIOL BC3591 or BIOL BC3592. Same as BIOL BC3591-BIOL BC3592, including attendance at a weekly seminar. By the end of the year, students enrolled in BIOL BC3593-BIOL BC3594 will write a scientific paper and orally present their work at the Barnard Biology Research Symposium.

A Barnard research mentor (if your lab is at Barnard) or internal adviser in the Biology Department (if your lab is elsewhere) must approve your planned research before you enroll in this year-long course. A *Project Approval Form* must be submitted to the department in the fall. Completion of this year-long course fulfills the senior capstone requirement for the major; it cannot be taken at the same time as BIOL BC3591-BIOL BC3592. Must be taken in sequence, beginning in the fall.

### Spring 2021: BIOL BC3594

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Chemistry (Barnard)

CHEM BC2001 GENERAL CHEMISTRY I. 5.00 points.
Students enrolled in CHEM BC2001 must also register for a section of CHEM BC2012.
Corequisites: CHEM BC2012
Atoms; elements and compounds; gases; solutions; equilibrium; acid-base, precipitation, and oxidation-reduction reactions; thermochemistry. Laboratory one day a week. Laboratory experience with both qualitative and quantitative techniques. Counts towards Lab Science Requirement.

CHEM BC2002 General Chemistry II. 5 points.
Not offered during 2021-22 academic year.
Prerequisites: CHEM BC2001 or permission of the instructor. Students who have completed CHEM BC3230 or its equivalent may not subsequently receive credit toward the degree for CHEM BC2002.
Lecture: TuTh 8:40-9:55; Lab lecture and laboratory: M 1:10-5:00. Corequisites: Counts towards Lab Science requirement.
Kinetics and mechanisms of chemical reactions; nuclear chemistry and radioactivity; atomic and molecular structure; selected topics in environmental chemistry, organic chemistry, and biochemistry.

CHEM BC3230 ORGANIC CHEMISTRY I-LEC. 3.00 points.
Prerequisites: CHEM BC2001 or equivalent. Credit will not be given for any course below the 3000 level after completing CHEM BC3230 or its equivalent. Lecture: MWF 10:00 - 10:50 AM
Corequisites: With lab, counts towards Lab Science requirement.
Prerequisites: CHEM BC2001 or equivalent. Credit will not be given for any course below the 3000 level after completing CHEM BC3230 or its equivalent. Corequisites: With lab, counts towards Lab Science requirement. Atomic and molecular structure; stereochemistry of organic molecules; introduction to organic reactions, reaction mechanisms, and synthesis.

Environmental Science (Barnard)

EESC V2100 Earth's Environmental Systems: Climate. 4.5 points.
BC: Partial Fulfillment of General Education Requirement: Laboratory Science (SCI)., BC: Fulfillment of General Education Requirement: Quantitative and Deductive Reasoning (QUA), Lab Required
Prerequisites: High school algebra. Recommended preparation: High school chemistry/physics, and one semester college science. Enrollment limited.
Studies formation of winds, storms, and ocean currents. Recent influence of human activity: global warming, and climate change. Laboratory exploration of topics through demonstrations, experimentation, computer data analysis, and modeling.

EESC V2200 Earth's Environmental Systems: Solid Earth. 4.5 points.
BC: Partial Fulfillment of General Education Requirement: Laboratory Science (SCI), Lab Required
Studies plate tectonics: Origin and development of continents, ocean basins, mountain systems on land and sea. Earthquakes, landslides, volcanoes, diamonds, oil. Land-use planning for resource development and conservation. Laboratory exploration of topics through demonstrations, experimentation, computer data analysis, and modeling.

EESC BC3014 Field Methods in Environmental Science. 3 points.
Prerequisites: Enrollment limited. Five required field trips that take a substantial portion of the day. Problem-oriented, hands-on approach emphasizing the tools, techniques, and observational skills necessary for the understanding of forest ecology and deer management. Field and laboratory work as well as data analysis and interpretation. Field Methods utilizes the outdoor resources of the Hudson River Valley, especially the forest environment at Black Rock Forest, a 4,000-acre preserve near Cornwall, N.Y.
EESC BC3016 Environmental Measurements. 3 points.
Prerequisites: Enrollment limited. Required field trip on first Friday of the semester.
Hands-on approach to learning environmental methods. Students take a one-day cruise on the Hudson River to collect environmental samples. These samples are then analyzed throughout the semester to characterize the Hudson River estuary. Standard and advanced techniques to analyze water and sediment samples for nutrients and contaminants are taught.

Spring 2021: EESC BC3016
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
EESC 3016  001/00290  M W 2:10pm - 4:00pm Room TBA  Brian Mailloux  3  0/16

Fall 2021: EESC BC3016
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
EESC 3016  001/00290  M W 2:10pm - 4:00pm Room TBA  Brian Mailloux  3  0/16

EESC BC3017 Environmental Data Analysis. 3 points.
Prerequisites: One year of college science or EESC V2100 or permission of the instructor.
Acquisition, analysis, interpretation, and presentation of environmental data, assessment of spatial and temporal variability. Focus on water quality issues and storm surges. Uses existing and student-generated data sets. Basic principles of statistics and GIS, uses standard software packages including EXCEL and ArcGIS. Includes a half-day field trip on a Saturday or Sunday. General Education Requirement: Quantitative and Deductive Reasoning (QUA).

Fall 2021: EESC BC3017
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
EESC 3017  001/00281  T Th 2:10pm - 4:00pm Room TBA  Elizabeth Cook  3  12/15

EESC BC3025 Hydrology. 3 points.
Prerequisites: EESC V2100, physics, or permission of instructor. Includes a weekend field trip. Alternate years.
Hands-on study and discussion of the basic physical principles of the water cycle (evaporation, condensation, precipitation, runoff, and subsurface flow), as well as environmentally relevant applications based on case studies. Special focus on the New York City area, the arid Southwest, and the developing world. Coverage of contemporary global water resources issues, including pollution control, sustainable development, and climate change. General Education Requirement: Quantitative and Deductive Reasoning (QUA).

EESC BC3800 Senior Research Seminar. 3 points.
Enrollment limited to senior majors (juniors with the instructor’s permission). Provides credit for the senior thesis. The Senior Research Seminar can be taken Spring/Fall or Fall/Spring sequence.
Guided, independent, in-depth research culminating in the senior thesis in the spring. Includes discussion about scientific presentations and posters, data analysis, library research methods and scientific writing. Students review work in progress and share results through oral reports. Weekly seminar to review work in progress and share results through oral and written reports. Prerequisite to EESC W3901.

Fall 2021: EESC BC3800
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
EESC 3800  001/00292  Th 4:10pm - 6:00pm Room TBA  Martin Stute, Jacqueline Austermann, Roisin Commane, Elizabeth Cook  3  33/50