

ENVIRONMENTAL SCIENCES (BS)

Director of Undergraduate Studies:
Dominic Chaloner

Program in Environmental Sciences

All life, including humans, directly depends on the functioning of Earth's ecosystems. Further, it has become apparent that human activities have altered Earth's environments. Factors such as pollution, invasive species introductions, anti-biotic resistance, and global climate change can all be traced to human activity. Increasing the knowledge and awareness of the link between humans and the environment is one of the most important endeavors of the twenty-first century.

The environmental sciences major stresses interdisciplinary knowledge and logic. The curriculum is designed to expose students to a scientific understanding of our environment from biological, chemical, and physical perspectives. Particular emphasis is placed on understanding how humans interact chemically and biologically with the environment. Material and energy resource limitations, chemical and thermal pollution, and effects of environmental pollution on public health are major considerations within the environmental sciences curriculum. Emphasis is also placed on understanding interactions between human societies and the environment from social, ethical, economic, anthropological, and governmental points of view. Students are also encouraged to strengthen their mathematical and computational skills and to participate voluntarily in environmentally oriented research projects or summer internships.

The First Major

College of Science students who major in Environmental Sciences will earn the degree of bachelor of science. Students following the Environmental Sciences first major program complete a total of 69 credits of science.

Environmental Sciences majors may pursue a supplementary major within or outside the College of Science so long as this is permitted by the program, and with the permission of the director and the dean or dean's designate.

Concentrations in Earth Science

With this collaboration students will explore how geologic processes affect humans and how human activity is changing earth systems, studying a range of topics including earthquakes, volcanic activity, global climate change, subsurface transport of toxic heavy metals, carbon sequestration, and safe disposal of nuclear waste. The Earth Science concentration program combines classroom, laboratory and field studies, and all students are encouraged to conduct independent research under faculty supervision. The flexibility of the undergraduate program allows students to switch to this concentration if they have followed either an engineering or science track during their first or even their second years.

An undergraduate major in Environmental Sciences with a concentration in Earth Science prepares a student for graduate study (M.S., Ph.D.) in many aspects of geological and environmental science, as well as for admission to a variety of professions. Graduates with a B.S. degree may enter careers in diverse areas such as state geological offices,

the National Park Service, oil and mining industries, environmental consulting, and government national research laboratories or policy offices. Another option is the minor in environmental Earth sciences which requires only 14 credits. The minor provides a foundation in the physical, chemical, and biological processes at Earth's surface, and how they are influenced by human activities.

Relationship with Other Programs

The Environmental Sciences Major Program has a special collaborative relationship with the Science, Technology, and Values (STV) Concentration program housed in the Reilly Center in O'Shaughnessy Hall. Select courses required of environmental sciences first majors are also cross-listed as STV courses. Thus, students in the STV program from across the university are expected to benefit in the curricular endeavors of the Environmental Sciences Program. Environmental sciences first majors often enroll in the STV program. (Environmental science students with flexibility in their program often have room to complete an STV concentration by taking STV courses beyond those required by the first major or university requirements.) However, arts and letters students with second majors in environmental science will be encouraged to participate in further interdisciplinary course work through the STV concentration. Second majors are especially encouraged to take the capstone course, Current Topics in Environmental Science (BIOS 40491), *provided it completes that second program.*

All environmental sciences first majors take the following courses in science:

Code	Title	Hours
Science Courses		
BIOS 10171 & BIOS 11173	Biology I :Big Questions and Biological Investigations Laboratory	4
BIOS 10172 & BIOS 11174	Biology II: Molecules to Ecosystems and Research Experience in Biology Laboratory	4
CHEM 10171 & CHEM 11171	Introduction to Chemical Principles and Introduction to Chemical Principles Laboratory	4
CHEM 10172 & CHEM 11172	Organic Structure and Reactivity and Organic Structure and Reactivity Laboratory	4
MATH 10350 & MATH 10360	Calculus A and Calculus B ^{1, 2, 3}	8
SC 20110 & SC 21110	Planet Earth and Planet Earth Laboratory	4
PHYS 20210 & PHYS 21210	Physics for Life Sciences I and Physics for Life Sciences I Lab	4
PHYS 20220 & PHYS 21220	Physics for Life Sciences II and Physics for Life Sciences II Lab	4
BIOS 40411	Biostatistics ⁴	4
BIOS 30312 & BIOS 31312	General Ecology and Practical Ecology Laboratory	5
Chemistry Elective ⁵		3-4
BIOS 40491	Current Topics in Environmental Science	3
Science Electives (chosen from an approved list, completing a required minimum total of 69 credits in science) ⁶		18
BIOS 30305	Evolution	
BIOS 30310	The History of Life	
BIOS 20250	Classical and Molecular Genetics	
or BIOS 20303	Fundamentals of Genetics	

BIOS 30318	Introduction to Biocomputing
BIOS 30401	Principles of Microbiology
BIOS 30407	Animal Behavior
BIOS 30420	Aquatic Ecology
BIOS 40527	Stream Ecology
Numerous other BIOS courses as designated by the ES director, including 60000-level graduate courses are accepted	
CHEM 20204	Environmental Chemistry
CHEM 20274	Chemistry across the Periodic Table
CHEM 40420	Principles of Biochemistry
MATH 20550	Calculus III
MATH 20580	Introduction to Linear Algebra and Differential Equations
SC 40300	Geochemistry
SC 30500	Geomorphology for Engineers and Scientists

- ¹ Equivalent or higher-level sequences in mathematics may be substituted, e.g., Honors Mathematics I (MATH 10850)–Honors Mathematics II (MATH 10860) for Calculus A (MATH 10350)–Calculus B (MATH 10360).
- ² Students interested in the area of ecological modeling are strongly urged to take Calculus I (MATH 10550)–Calculus II (MATH 10560) for their mathematics requirement. Other mathematics courses should be taken as science electives.
- ³ Students who have completed only six hours of mathematics in their first year may transfer into the program, but they will be required to complete a mathematics sequence equivalent to MATH 10350–MATH 10360 or MATH 10550–MATH 10560. Students having taken Elements of Calculus (MATH 10250), (or MATH 10260 or MATH 10270) may do this by taking Calculus B (MATH 10360), while those who have taken only one semester of lower-level calculus should take both Calculus A (MATH 10350), Calculus B (MATH 10360). (See also the discussion on science degree credit found later in this section.)
- ⁴ Students transferring into the major, or transfer students who have previously taken a statistics course equivalent to Statistics for Life Sciences (ACMS 20340), **may be** allowed to have this course count for Biostatistics (BIOS 40411) with the permission of the ES Director. Students will be allowed to substitute Statistics for Life Sciences (ACMS 20340), or an equivalent statistics course (e.g., Statistics for Behavioral Sciences (PSY 30100)) in exceptional cases with the permission of the director of their major and the associate dean of the College of Science.
- ⁵ The 4-credit chemistry elective requirement is satisfied by either one additional course in organic chemistry (CHEM 20273) or Inorganic Chemistry (CHEM 20274) or by Analytical Chemistry (CHEM 30333, CHEM 31333) or by an alternative 4-credit CHEM course as approved by the director of their major and by the associate dean of the College of Science. Students are also allowed to take the 3-credit CHEM 10122 lecture or CHEM 20204 with the understanding that if/when a laboratory is established for that course, they will be required to take that lab prior to graduation.
- ⁶ Select CE courses may be allowed with the approval of the associate dean, College of Science. Other SC courses as approved by the ES director may be included as they become available. Select courses offered in Study Abroad (UC-Dublin, UWA-Perth) also may be counted toward the ES science electives as well as select CE courses not cross-listed with SC, with permission of the ES director.

Students interested in attending graduate school in environmental sciences should consider taking science electives beyond requirements of this major. For example, for admission into some graduate programs, a year of organic chemistry would be a requirement. Deviations from the approved list of science electives must be approved by the advisor for the major.

Non-science Courses

Also required are the following non-science courses:

Code	Title	Hours
Non-Science Courses		
One philosophy or theology University requirement must be in the area of ethics. An ethics course with emphasis on environmental biology or life science issues, i.e., Environmental Ethics or Science, Technology, and Society, or other approved arts and letters courses.		
ECON 10010	Principles of Microeconomics ^{1, 2}	
	or ECON 20010 Principles of Microeconomics	
Students are also urged to choose their electives from a recommended list of arts and letters courses ³		

- ¹ The economics requirement for this major is fulfilled by taking Principles of Microeconomics either in the first year (ECON 10010) or in the second through fourth years (ECON 20010). Note, the course Social Science University Seminar (ECON 13181) will not fulfill the economics requirement for this major
- ² For this major, the University social science requirement will be fulfilled by the required microeconomics course.
- ³ Numerous STV courses are recommended as electives as approved by the ES director. The STV courses may be taken either under the STV label or from the primary departmental cross-list

Sample Curriculum (B.S. Degree Majors):

Course	Title	Hours
First Year		
First Semester		
Biology I lecture and lab ¹		4
Calculus I (or A)		4
General Chemistry I lecture and lab		4
Theology or Philosophy		3
Writing Requirement		3
Moreau First Year Experience		1
Hours		19
Second Semester		
Biology II lecture and lab		4
Calculus II (or B)		4
Organic Chemistry I lecture and lab		4
Theology or Philosophy		3
Writing Requirement		3
Hours		18
Sophomore Year		
First Semester		
Planet Earth lecture and lab		4
General Ecology lecture		3
Practical Ecology lab		2
Language I		4
Microeconomics		3
Hours		16

Second Semester	
CHEM Elective lecture ²	3
Biostatistics	4
Language II	3
Theology or Philosophy	3
Hours	13
Junior Year	
First Semester	
Physics I lecture and lab	4
Theology or Philosophy	3
Language III	3
Ways of Knowing IV	3
SCI Elective I	3
Hours	16
Second Semester	
Physics II lecture and lab	4
SCI Elective II	3
SCI Elective III	3
Ways of Knowing V	3
Hours	13
Senior Year	
First Semester	
Current Topics	3
SCI Elective IV	3
SCI Elective V	3
Ways of Knowing VI	3
Free Elective ³	3
Hours	15
Second Semester	
SCI Elective VI	3
Free Elective ³	4
Free Elective ³	3
Free Elective ³	3
Moreau Senior Capstone	1
Hours	14
Total Hours	124

¹ Ideally, students who decide to major in environmental sciences before beginning their first year should take Biology I :Big Questions (BIOS 10171)–Biology II: Molecules to Ecosystems (BIOS 10172). This will allow for an additional year of relevant science and other electives to be included in their total curriculum.

² The 4-credit chemistry elective requirement is satisfied by either one additional course in organic chemistry (CHEM 20273) or Inorganic Chemistry (CHEM 20274) or by Analytical Chemistry (CHEM 30333/CHEM 31333) or by an alternative 4-credit CHEM course as approved by the director of their major and by the associate dean of the College of Science. Students are also allowed to take the 3-credit CHEM 10122 lecture or CHEM 20204 with the understanding that if/when a laboratory is established for that course, they will be required to take that lab prior to graduation.

³ As is the case for science first majors, six credits of the science course work in this program may also be counted toward the student's university science requirement.

Summary of Requirements for Graduation for Environmental Sciences Major

Code	Title	Hours
Biological Sciences		16
Chemistry		12
Geology		4
Mathematics		8
Physics		8
Current Topics		3
Science Electives		18
Total Science		69
Language Intermediate-Level Competency		3
University Requirement		3
Philosophy ¹		6
Theology ¹		6
University Requirement		3
University Requirement		3
University Requirement		3
Free Electives ²		26
Moreau First Year Experience ³		2
Total Hours		124

¹ One of these courses must be a University Seminar 13180–13189

² Assumes intermediate-level competency in language was achieved by taking a minimum of one three-credit course

³ Students will take a 1-credit Moreau First-Year Seminar course during their first year and complete their 1-credit Moreau experience in their final year

Environmental Sciences Major with a Concentration in Earth Science

The following outlines the course requirements (totaling 34 credits) for Earth Sciences concentration:

Code	Title	Hours
CE 20520	Environmental Mineralogy	4
CE 20320	Environmental Aquatic Chemistry	3
CE 20300	Global Change, Water and Energy	3
CE 30530	Sedimentology and Stratigraphy	3
CE 30300	Introduction to Environmental Engineering	3
CE 30540	Petrology/Earth Materials	3
CE 30560	Dynamic Earth and Natural Disasters	3
CE 40300	Geochemistry	3
CE 40350	Environmental Microbiology	3
CE 40381	Environmental Isotope Geochemistry	3
CE 45200	Geology Field Trip	1
CE 45340	Fall Geology Field Trip	1
CE 47600	Special Studies (Earth Sciences Reading Course)	0-10

Sample Curriculum with a Concentration in Earth Sciences

Course	Title	Hours
First Year		
First Semester		
Biology I lecture and lab		4
Calculus I (or A)		4
General Chemistry I lecture and lab		4
Theology or Philosophy		3
Writing Requirement		3
Moreau First Year Experience		1
Hours		19
Second Semester		
Biology II lecture and lab		4
Calculus II (or B)		4
Organic Chemistry I lecture and lab		4
Theology or Philosophy		3
Writing Requirement		3
Hours		18
Sophomore Year		
First Semester		
Planet Earth lecture and lab		4
General Ecology lecture		3
Practical Ecology lab		2
Language I		4
Microeconomics		3
Hours		16
Second Semester		
Global Change, Water and Energy		3
Environmental Aquatic Chemistry		3
CHEM Elective lecture and lab ¹		4
Language II		3
Theology or Philosophy		3
Hours		16
Junior Year		
First Semester		
Environmental Mineralogy		3
Geomorphology		3
Physics I lecture and lab		4
Theology or Philosophy		3
Fall Field Trip		1
Language III		3
Hours		17
Second Semester		
Petrology of Earth Materials and Lab		4
Sedimentation and Stratigraphy		3
Physics II lecture and lab		4
Spring Field Trip		1
Ways of Knowing IV		3
Hours		15
Senior Year		
First Semester		
Environmental Isotope Geochemistry		3
Geochemistry		3
Current Topics		3
Ways of Knowing V		3
Ways of Knowing VI		3
Hours		15
Second Semester		
Dynamic Earth		3

Biostatistics	4
Environmental Microbiology	3
Free Elective ²	3
Free Elective ²	3
Moreau Senior Capstone	1
Hours	17
Total Hours	133

¹ The 4-credit chemistry elective requirement is satisfied by either one additional course in organic chemistry (CHEM 20273) or Inorganic Chemistry (CHEM 20274) or by Analytical Chemistry (CHEM 30333/CHEM 31333) or by an alternative 4-credit CHEM course as approved by the director of their major and by the associate dean of the College of Science. Students are also allowed to take the 3-credit CHEM 10122 lecture or CHEM 20204 with the understanding that if/when a laboratory is established for that course, they will be required to take that lab prior to graduation.

² As is the case for science first majors, six credits of the science course work in this program may also be counted toward the student's university science requirement.