ENVIRONMENTAL SCIENCE

The Bachelor of Science in Environmental Science provides students with a strong background in areas of science related to environmental concerns and with an opportunity to study environmental problems from a scientific point of view that integrates biology, chemistry, Earth science, and physics. The major leads to a Bachelor of Science degree and prepares students for careers in waste management, environmental consultation, teaching, environmental health and resource management.

Dearborn Discovery Core Requirement

The minimum GPA for the program is 2.0. In addition, the DDC permits any approved course to satisfy up to three credit hours within three different categories. Please see the General Education Program: The Dearborn Discovery Core section for additional information.

Foundational Studies

Written and Oral Communication (GEWO) – 6 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gewo)

Upper Level Writing Intensive (GEWI) – 3 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gewi)

Quantitative Thinking and Problem Solving (GEQT) – 3 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#geqt)

Critical and Creative Thinking (GECC) – 3 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gecc)

Areas of Inquiry

Natural Science (GENS) – 7 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gens)

- Lecture/Lab Science Course
- Additional Science Course

Social and Behavioral Analysis (GESB) – 9 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gesb)

Humanities and the Arts (GEHA) – 6 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#geha)

Intersections (GEIN) – 6 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gein)

Capstone

Capstone (GECE) – 3 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gece)

Foreign Language Requirement

Complete a two-semester beginning language sequence.

<table>
<thead>
<tr>
<th>Language</th>
<th>Course Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ancient Greek I and II</td>
<td>MCL 105 and MCL 106</td>
</tr>
<tr>
<td>Arabic I and II</td>
<td>ARBC 101 and ARBC 102</td>
</tr>
<tr>
<td>Armenian I and II</td>
<td>MCL 111 and MCL 112</td>
</tr>
<tr>
<td>French I and II</td>
<td>FREN 101 and FREN 102</td>
</tr>
<tr>
<td>German I and II</td>
<td>GER 101 and GER 102</td>
</tr>
<tr>
<td>Latin I and II</td>
<td>LAT 101 and LAT 102</td>
</tr>
<tr>
<td>Spanish I and II</td>
<td>SPAN 101 and SPAN 102</td>
</tr>
<tr>
<td>Chinese I and II</td>
<td>CHIN 101 and CHIN 102</td>
</tr>
</tbody>
</table>

Prerequisites to the Major

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 130</td>
<td>Intro Org and Environ Biology</td>
</tr>
<tr>
<td>CHEM 134</td>
<td>General Chemistry IA</td>
</tr>
<tr>
<td>or CHEM 144</td>
<td>Gen Chemistry IB</td>
</tr>
<tr>
<td>CHEM 136</td>
<td>General Chemistry IIA</td>
</tr>
<tr>
<td>or CHEM 146</td>
<td>General Chemistry IIB</td>
</tr>
<tr>
<td>GEOG 203</td>
<td>Weather and Climate</td>
</tr>
<tr>
<td>GEOL 118</td>
<td>Physical Geology</td>
</tr>
<tr>
<td>MATH 113</td>
<td>Calc I for Biology &amp; Life Sci</td>
</tr>
<tr>
<td>or MATH 115</td>
<td>Calculus I</td>
</tr>
<tr>
<td>MATH 114</td>
<td>Calc II for Biology &amp; Life Sci</td>
</tr>
<tr>
<td>or MATH 116</td>
<td>Calculus II</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td></td>
</tr>
<tr>
<td>PHYS 100</td>
<td>Perspectives in Physics ¹</td>
</tr>
<tr>
<td>PHYS 125</td>
<td>Introductory Physics I ¹</td>
</tr>
<tr>
<td>PHYS 150</td>
<td>General Physics I ¹</td>
</tr>
</tbody>
</table>

Total Credit Hours: 30-31

¹ Students in the Environmental Chemistry concentration must elect PHYS 125 or PHYS 150.

Major Requirements

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 344</td>
<td>Quantitative Analysis</td>
</tr>
<tr>
<td>ENST/STS 301</td>
<td>Concepts of Environmentalism</td>
</tr>
<tr>
<td>ESCI 301</td>
<td>Environmental Science ¹</td>
</tr>
<tr>
<td>ESCI/BIOl 304</td>
<td>Ecology</td>
</tr>
<tr>
<td>ESCI/ENST 395</td>
<td>Sem on Environmental Issues</td>
</tr>
<tr>
<td>Select at least three upper-level credit hours in Geology (GEOL) ²</td>
<td></td>
</tr>
<tr>
<td>Select at least three upper-level credit hours in Environmental Science (ESCI) ²</td>
<td></td>
</tr>
</tbody>
</table>

Research/Internship/Capstone

Select 3 credit hours from the following:

- At least three credit hours in ESCI 498 and/or ESCI 499 culminating in a public seminar presentation of research results
- ENST 385 | Environmental Internship
- & ENST 485 | and Seminar in Environ Topics
ESCI 492  Capstone Research Experience

Total Credit Hours  25

1  Credit cannot be earned for both ESCI 275 and ESCI 301. ESCI 275 cannot be used in the environmental science major. However, when students already have credit for ESCI 275, it is possible to substitute ESCI 275 for the ESCI 301 lectures, but must complete the ESCI 301 lab. This may be accomplished with approval to take ESCI 499 (independent study, contract required) where the required work is the ESCI 301 lab. See the Environmental Science faculty advisor to discuss.

2  Beyond courses applied to other portions of the major requirements

Note: LIBS 395 may be substituted by Petition for ENST 385 if the cooperative education work assignment is environmentally oriented.

Concentration (16-24 hrs)
Must select one of the following concentrations:

Environmental Biology Concentration

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 140</td>
<td>Intro Molec &amp; Cellular Biology</td>
<td>4</td>
</tr>
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</table>

Select twelve credit hours in upper-level (300+) Biological Sciences (BIOL) courses (other than BIOL 304) including at least seven credit hours selected from:

| BIOL/ESCI 315 | Aquatic Ecosystems                        |              |
| BIOL/ESCI 320 | Field Biology                             |              |
| BIOL/ESCI 337 | Plant Ecology                             |              |
| BIOL 360     | Population Genetics & Evolutn             |              |
| BIOL 361     | Population Genetics & Evol Lab            |              |
| BIOL/ESCI 414| Limnology                                 |              |
| BIOL/ESCI 420| Advanced Field Ecology                    |              |
| BIOL 390, BIOL 490, BIOL 497 by Petition only |              |

Total Credit Hours  16

1  Acceptable by Petition when topic is environmentally oriented.

Earth Science Concentration

<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td>BIOL 140</td>
<td>Intro Molec &amp; Cellular Biology</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 126</td>
<td>Introductory Physics II</td>
<td></td>
</tr>
<tr>
<td>PHYS 151</td>
<td>General Physics II</td>
<td></td>
</tr>
<tr>
<td>GEOL 377</td>
<td>Field Methods</td>
<td>1</td>
</tr>
</tbody>
</table>

At least eleven additional credit hours in upper-level (300+) Geology (GEOL) and Physical Geography (GEOG) courses.

Total Credit Hours  16

1  Physical Geography (GEOG) offerings include GEOG 302, GEOG 310 and ESCI 330.

Individualized Concentration

This concentration is a highly selective program for qualified students with well-conceived academic goals.

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<td>Introductory Physics II</td>
<td></td>
</tr>
<tr>
<td>PHYS 151</td>
<td>General Physics II</td>
<td></td>
</tr>
</tbody>
</table>

A minimum of 12 upper-level (300+) credit hours in natural sciences courses that address a common theme.

Total Credit Hours  16
Individualized concentration must be developed in consultation with the Environmental Science program advisor, and the proposed coursework must be approved by the Environmental Science Program Committee by Petition before the student achieves senior standing.

Notes:
1. A maximum of 72 credit hours in courses offered by the Department of Natural Sciences (ASTR, BCHM, BIOL, CHEM, ESCI, ENST, GEOL, MICR, NSCI, PHYS) may count in the 120 hrs. required for graduation.
2. At least 12 of the 41 upper level hours in the major must be elected at UM-D.
3. Students cannot take both CHEM 370 and CHEM 470 and/or CHEM 471 for any combination of major or minor requirements.
4. A maximum of 6 hrs. of independent study/research in any Dept. of Natural Sciences discipline may count towards the 120 hours required to graduate.

Minor or Integrative Studies
Concentration Requirements

A minor or concentration consists of 12 credit hours of upper-level courses in Environmental Science (ESCI).

ESCI 275 Intro to Environmental Science 3 Credit Hours
A distribution course which surveys major environmental problems. Concepts discussed are ecology, environmental chemistry, methods of investigating the environment, and possible solutions to environmental problems. Three hours lecture. (YR).

ESCI 301 Environmental Science 4 Credit Hours
A survey of historical and current environmental problems, with emphasis on understanding causes, consequences, and control. Topics include human population growth, air pollution, water pollution, and waste disposal. Laboratory emphasizes an experimental approach to environmental problems, including data collection, analysis, and interpretation. Lecture and laboratory/recitation.
Prerequisite(s): CHEM 124 or CHEM 134 or CHEM 144 and GEOL 118 and BIOL 130

ESCI 304 Ecology 4 Credit Hours
Relationships between organisms and their environments. Patterns in the physical environment, physiological and behavioral adaptations, population dynamics, energy flow, nutrient cycling, succession. Three hours lecture, four hours laboratory (with field trips). (F).
Prerequisite(s): BIOL 130 and (MATH 104 or MATH 105 or MATH 113 or MATH 115 or Mathematics Placement with a score of 116)
Corequisite(s): ESCI 304L

ESCI 305 Intro to GIS 4 Credit Hours
An introductory course that examines the digital representation, manipulation, and analysis of geographic data, with emphasis on the analytical capabilities that GIS brings solutions to geographic problems. Students will explore and learn GIS principles using ESRI’s mapping software, as well as complete a major GIS project.
Prerequisite(s): GEOG 302
Corequisite(s): ESCI 305L

ESCI 305D Intro to GIS & Cartography Dis 0 Credit Hours
Required discussion session for ESCI 305.
Corequisite(s): ESCI 305

ESCI 315 Aquatic Ecosystems 4 Credit Hours
An introduction to the physical, chemical, and biological characteristics of lakes, rivers, and wetlands emphasizing a comparison of ecosystem structure and function. Laboratory emphasizes data collection and analysis to characterize a representative lake, river, and wetland. Lecture and laboratory. (AY,F).
Prerequisite(s): BIOL 130 and (CHEM 124 or GEOL 118)

ESCI 320 Field Biology 4 Credit Hours
Adaptations, taxonomy, systematics, ecology, and behavior of southeastern Michigan flora and fauna. Techniques of field observation and recording are emphasized. Skills in the use of identification keys and guides are developed. The campus Environmental Study Area is used intensively. Three hours lecture, four hours laboratory (with field trips). (S).
Prerequisite(s): NSCI 120 or NSCI 233

ESCI 330 Land Use Planning and Mgmt 4 Credit Hours
Environmental aspects of land use planning, park planning, and site planning. Consideration of soils, groundwater, topography, and sensitive natural features and their role in determining land-use suitability. Examination of the mechanics and effectiveness of the planning process. Lecture and recitation. (AY,W).
Prerequisite(s): BIOL 130 and GEOL 118 or ESCI 275

ESCI 331 Hazardous Waste Management 3 Credit Hours
Environmental problems associated with solid and hazardous waste. Regulations governing the generation, transport, and disposal of hazardous waste. Waste management techniques, including reduction, reuse, recycling, treatment, incineration, and land disposal. Three hours lecture. (AY,W).
Prerequisite(s): GEOL 118 or ESCI 275

ESCI 332 Plant Ecology 3 Credit Hours
This course focuses on different aspects of the relationship between plants and their environment. Topics include: a) interactions of plants with the physical environment; b) ways in which the environment acts to shape plant populations through evolution; c) intra- and interspecific interactions among individuals; and d) large-scale patterns and processes at the landscape-level. Three hours lecture.
Prerequisite(s): BIOL 130

ESCI 334 Environmental Chemistry 3 Credit Hours
Description of the concepts, principles, practices, and current problems in the chemistry of natural waters, the soil, and the atmosphere. Three hours lecture. (AY,W).
Prerequisite(s): CHEM 344 and (CHEM 225 or CHEM 325)

ESCI 349 Environmental Chemistry Lab 1 Credit Hour
Collection and analysis of air, water, soil, and organisms for pollutants such as noxious gases, heavy metals, and trace organics. EPA-approved methods are emphasized. Four hours laboratory. (AY,W).
Prerequisite(s): ESCI 348 or CHEM 348

ESCI 352 Introduction to Toxicology 3 Credit Hours
An introduction to the principles of toxicology with an emphasis on environmental toxicology. Major topics include toxic agents, toxicological mechanisms, and use of toxicological reference literature. Discussion of chemical carcinogenesis, genetic toxicology, immunotoxicology, teratology, and toxic responses of the skin, eyes and nervous system. Three hours lecture. (AY,W).
Prerequisite(s): CHEM 225
ESCI 370  Environmental Geology  3 Credit Hours
Interactions between people and the physical environment. Geological hazards and natural processes, such as earthquakes, volcanism, floods, landslides, and coastal processes. Relationships between geology and environmental health, including chronic disease, water use and pollution, waste disposal, mineral resources, and energy use. Three hours lecture. (AY).
Prerequisite(s): GEOL 118

ESCI 372  Energy Resources  3 Credit Hours
Origin and development of fossil fuels (petroleum, coal, natural gas) and of radioactive ores used in nuclear power. Renewable and alternative energy sources, including hydro, solar, wind, biomass, and geothermal power. Environmental impacts of energy use. Three hours lecture. (OC).
Prerequisite(s): GEOL 118 or ESCI 275 or ESCI 301

ESCI 390  Topics in Environmental Sci  1 to 3 Credit Hours
A course in special topics current to environmental science. Topics and format may vary. See current Schedule of Classes.

ESCI 395  Sem on Environmental Issues  1 Credit Hour
Readings, discussions, and presentations which examine current environmental issues. One hour seminar. Permission of instructor. (FW).

ESCI 414  Limnology  4 Credit Hours
The study of the structural and functional relationships and productivity of organisms in lakes and streams as they are regulated by their physical, chemical and biotic environments. Laboratories will emphasize field study of area lakes and streams. Three hours lecture, four hours laboratory. BIOL/ESCI 304 or ESCI 275 recommended.
Prerequisite(s): BIOL 130 and (CHEM 136 or CHEM 146)
Corequisite(s): ESCI 414L

ESCI 416  Stream Ecology  4 Credit Hours
A study of the physical, chemical and biological characteristics of streams and rivers. Three hours lecture, four hours laboratory. (OC).
Prerequisite(s): BIOL 304

ESCI 420  Advanced Field Ecology  4 Credit Hours
An intense study of behavioral ecology and field-oriented research at an advanced level, utilizing ecological habitats on campus and in surrounding urban areas. Focus will be on plant/animal interactions and will include pollination ecology, reproduction and distribution ecology, optimal foraging theory, as well as hypothesis testing of animal migration and distribution of species in extreme urban environments. Three hours lecture, four hours laboratory. (OC).
Prerequisite(s): BIOL 304 or BIOL 320 or ESCI 320

ESCI 422  Conservation Biology  3 Credit Hours
This course is a study of the historical and current preservation of global biodiversity. The value of biodiversity, extinction, threats to biodiversity, and both ex situ and in situ conservation strategies are considered. (F, AY)
Prerequisite(s): BIOL 304 or ESCI 304
Restriction(s):
Can enroll if Class is Junior or Senior
Can enroll if Level is Undergraduate

ESCI 485  Spatial Analysis  3 Credit Hours
Full Title: Spatial Analysis and the Environment The statistical methods behind analyzing spatial datasets is covered in detail, with a strong emphasis on environmental sciences and human populations. This course complements courses in remote sensing, geographic information systems, and geographic principles and is designed to quantitatively evaluate the relationships between objects and their surroundings. (S)
Prerequisite(s): GEOL 305 or ESCI 305 or GEOL 340 or ENST 340 or GEG 302 or GEOG 302 or GEOG 305
Restriction(s):
Can enroll if College is Education, Health, and Human Services or Business or Engineering and Computer Science or Arts, Sciences, and Letters

ESCI 490  Topics in Environmental Sci  1 to 3 Credit Hours
A course in special topics of current interest in environmental science. Topics and course format may vary; see current Schedule of Classes for availability. (OC)

ESCI 490A  Topics in Environmental Sci  3 Credit Hours
Topic: Conservation Biology. A scientific study of the concept of conservation biology, including its ecological, economic, ethical, and cultural components. Lectures, assigned readings, and class discussions will explore the major threats to biodiversity, the complexities of conservation issues, and the tools, strategies, and techniques conservation biologists use to implement policies for the protection and preservation of ecosystems from local to global and short-to-long-term scales.
Prerequisite(s): BIOL 130
Restriction(s):
Can enroll if Class is Junior or Senior

ESCI 492  Capstone Research Experience  3 Credit Hours
An approved research experience with a full-time Environmental Science faculty member. Research results are reported in a seminar presentation and in a poster, thesis, or a manuscript submitted for publication. (F, W, S)
Restriction(s):
Cannot enroll if Class is Freshman or Sophomore or Junior

ESCI 497  Seminar in Environmental Sci.  1 Credit Hour
Readings, discussion, and presentation of research in selected areas of study. One hour seminar. Permission of instructor. (OC).

ESCI 498  Indep Study in Environ Sci  1 to 3 Credit Hours
Library research and independent study performed under the guidance of a faculty member. Four to twelve hours readings. Permission of instructor. (FWS).

ESCI 499  Lab Research in Environ Sci  1 to 3 Credit Hours
Directed laboratory or field research performed under the guidance of a faculty member. Four to twelve hours laboratory. Permission of instructor. (FWS).

* An asterisk denotes that a course may be taken concurrently.

Frequency of Offering
The following abbreviations are used to denote the frequency of offering:
(F) fall term; (W) winter term; (S) summer term; (F, W) fall and winter terms; (YR) once a year; (AY) alternating years; (OC) offered occasionally