Biology

Faculty:
Stephen Cessna
Jeffrey Copeland
Greta Ann Herin
Roman J. Miller
Douglas S. Graber Neufeld (chair)
James M. Yoder

Majors:
- Biology
- Biochemistry
- Clinical Laboratory Science
- Environmental Sustainability with concentrations in:
  - -Environmental Science
  - -Environmental and Social Sustainability

Minors:
- Environmental Sustainability
- Biology

Teaching Endorsement:
- Biology, Grades 6-12

Other program:
- Pre-professional Health Sciences (PPHS)

The primary objective of the biology department is to provide courses and skill training required by students earning B.A. or B.S. degrees, especially those majoring in biology. Additionally it emphasizes preparing students for graduate training in medicine, dentistry, veterinary sciences, clinical laboratory science, and allied health fields; teaching biology in secondary schools; sustainable agriculture; environmental science; and graduate work in other fields of biology.

Students majoring in biology, biochemistry and environmental science earn a Bachelor of Arts (B.A.) degree. However, students with multiple mathematics and science majors or minors have the option of earning a Bachelor of Science (B.S.) degree. Clinical laboratory science majors earn a Bachelor of Science (B.S.) degree. Students should consult the department chair for further information.

Major in Biology

Doug Graber Neufeld and James Yoder, Advisors

Required biology courses (29-32 SH):

BIOL 173 Concepts in Biology: Unity and Diversity of Life 4
BIOL 225 Molecules, Genes and Cells. 4
BIOL 235 Ecology: Adaptation and Environment 4
BIOL 245 Animal Form and Function 4
BIOL 485 Faith, Science, and Ethics. . . .2

Careers in Biology include medical technologist, physician, dentist, physical therapist, environmental consultant, genetic counselor, veterinarian, biotechnologist, epidemiologist, pathologist, wildlife biologist, international agriculture consultant, immunologist, and middle or high school teacher.

In addition to the core courses listed above, students are required to take upper-level electives in each of three areas:

Molecular/Cellular requirement:
Choose one of the following courses:
BIOCH 376 Foundational Biochemistry 4
*BIOCH 398 Advanced Cell Biology .3
*BIOCH 438 Molecular Genetics 3
*BIOL 337 Immunology 3
*BIOL 378 Plant Physiology 3

Physiology/Systems requirement:
Choose one of the following courses:
*BIOL 307 Developmental Biology . . .4
*BIOL 378 Plant Physiology 3
BIOL 437 Mammalian Anatomy. 4
BIOL 447 Mammalian Physiology. . . .4
*BIOL 478 Advanced Neurobiology . .3

Ecology/Environment requirement:
Choose one of the following courses:
*BIOL 318 Sustainable Agriculture . . .4
*BIOL 358 Natural History of the Shenandoah Valley. 4
*BIOL 388 Entomology 3
*BIOL 458 Advanced Ecology. 4
*CHEM 458 Topics: Chemical Ecology 3
*ENVS 345 Environmental Toxicology3

At least one course in the three categories above needs to be a plant course:
*BIOL 318 Sustainable Agriculture . . .4
*BIOL 358 Natural History of the Shenandoah Valley. 4
*BIOL 378 Plant Physiology 3

Research requirement:
Choose one of the following courses:
BIOL 355 Research Topics 2
BIOCH/CHEM 469 Biochemistry/ Chemistry Seminar and Research. . .2

In addition, the biology major includes CHEM 223, CHEM 224 and at least one semester each of the following: organic chemistry, physics and calculus. Coursework in statistics (MATH 240) is not required, but highly recommended.

Enrollment in upper-level biology, biochemistry, chemistry and environmental science courses (BIOL, BIOCH, CHEM, ENVS 300s and 400s) requires a minimum cumulative GPA of 2.0 in all science and math courses (BIOL, BIOCH, CHEM, ENVS, MATH, PHYS).

Students who fail to earn a C- in any coursework required for their major should promptly schedule a meeting with their advisor.

Pre-Professional Health Sciences Program (PPHS)

Jeffrey Copeland, Greta Ann Herin, and Roman J. Miller, Advisors

Biology majors interested in biomedicine enroll in PPHS, which is designed for students anticipating entrance into a professional health science school such as medicine, dentistry, veterinary medicine, physical therapy, exercise physiology, occupational therapy, optometry, podiatry, osteopathy, or graduate education and research in any area of biomedicine. (For occupational therapy, see Psychology page 156.) Whereas most of the students in this program are biology majors, it is possible to major in chemistry, mathematics or another area in the liberal arts and succeed in the program. Since course requirements for non-biology majors vary, students should check with their major department for specific details. Because graduate schools value a broad education, a minor in a non-science area of interest is suggested.

In addition to the required biology courses listed above, biology majors in PPHS (except pre-physical therapy) are also required to take:
CHEM 316 Organic Chemistry II. . . .4
PHYS 262 University Physics II. 4

Highly recommended elective courses include:

*BIOL 307 Developmental Biology . . .4
BIOL 447 Mammalian Physiology. . . .4
BIOCH 376 Foundational Biochemistry 4
*BIOCH 398 Advanced Cell Biology .3
*BIOCH 438 Molecular Genetics 3
*CHEM 335 Analytical Chemistry . . .4
MATH 240 Statistics for the Natural Sciences 3

Normally the pre-professional health sciences student will complete these courses by the end of the junior year in order to be fully prepared at that time to take a professional health science school entrance exam (MCAT, DAT, VET or GRE).

Major in Biochemistry

Stephen Cessna, Tara Kishbaugh, and Matthew Siderhurst, Advisors

See Chemistry, page 80.

Major in Biology, Teaching Endorsement for Grades 6-12

This program will prepare students to teach biology by instructing them in the standards of the National Science Teachers Association (NSTA).The courses listed in the biology major (pages 57-58) and the secondary education courses (page 89) make up the program for teacher licensure, grades 6-12.

Additional requirements for teacher endorsement include:

*ENVS 201 Earth Science. 3
MATH 240 Statistics for the Natural Sciences. 3

Major in Environmental Sustainability

Doug Graber Neufeld and James Yoder, Advisors for Environmental Science Concentration, Biology Department.

Terrence Jantzi and Gloria Rhodes, Advisors for Environmental and Social Sustainability Concentration, Applied Social Sciences Department.

The environmental sustainability major focuses on an interdisciplinary approach to sustaining the quality of our natural world, with an emphasis on the interrelationships between the natural world and humanity. The environmental sustainability major at EMU is designed around an understanding that effectively addressing the pressing environmental problems of our times demands a multifaceted approach that requires both depth in an area of focus, and breadth in understanding the perspectives of different disciplines. Students gain depth by choosing to concentrate on either natural science or social science aspects of environmental sustainability. Students gain breadth through coursework that combines essential elements from social science and from natural science to bring a holistic and integrated perspective to complex social and environmental issues pertaining to sustainability.

In addition, the environmental sustainability curriculum recognizes a balance between technical training and the broad education of a liberal arts philosophy. Completion of the environmental sustainability major equips students to work in fields of conservation, environmental monitoring, agriculture, international development, alternative energy promotion and development, sustainable development, agricultural extension, environmental advocacy, and environmental education. In addition, the curriculum prepares students for graduate work in many areas related to sustainability.

The curriculum for environmental sustainability is conceptualized as three stages. Students from both concentrations begin their coursework together in two introductory courses which set the foundation for further work. Students then take a set of required and elective

courses in their chosen concentration that gives depth in their area of focus, plus elective coursework in the alternative concentration which gives breadth to their understanding of sustainability. Finally, students from both concentrations come back together in a series of three courses that serve to integrate the natural science and social science perspectives of sustainability.

Core Courses: Introduction to Sustainability

BIOL 173 Concepts in Biology: Unity and Diversity of Life 4
*PXD 245 Environment and Society . . 3

Core Courses: Integration

*ENVS 328 Conservation Biology 3
SUST 419 Environmental Sustainability Practicum. 3
SUST 420 Environmental Sustainability Thesis. 2

Concentration: Environmental Science

This concentration focuses on the biological and chemical aspects of environmental sustainability. The solid coursework in natural sciences prepares students to work on such issues as biodiversity and loss of species, pollution and toxicology, land use and degradation, waste management, resource depletion and energy consumption, climate change, and alternative agriculture.

Environmental Science supporting courses required:

BIOL 235 Ecology: Adaptation and Environment 4
CHEM 223 General Chemistry I 4
CHEM 224 General Chemistry II. . . .4
*CHEM 285 Environmental Chemistry 4
OR
*ENVS 345 Environmental Toxicology3
*ENVS 205 Environmental Applications of GIS 3
MATH 240 Statistics for the Natural Sciences 3

Environmental Science electives

Choose a minimum of 6 SH from the following list.

†BIOL 161 Food and Population 3
*BIOL 191 Physical Anthropology . . .3
BIOL 202 Microbiology 4
BIOL 225 Molecules, Genes, and Cells. 4
*BIOL 318 Sustainable Agriculture . . .3
*BIOL 378 Plant Physiology 4
*BIOL 388 Entomology 3
*BIOL 458 Advanced Ecology. 4
BIOL 485 Faith, Science, and Ethics . .2
†CHEM 102 Matter and Energy. 3
*CHEM 285 Environmental Chemistry 4
CHEM 315 Organic Chemistry I 4
CHEM 316 Organic Chemistry II. . . .4
*CHEM 335 Analytical Chemistry . . .4
†ENVS 181 Environmental Science. . .3
*ENVS 201 Earth Science 3
*ENVS 345 Environmental Toxicology3

† Denotes courses that may only satisfy elective requirements for students in the Environmental and Social Sustainability concentration.

Environmental and Social Sustainability electives

Choose a minimum of 6 SH from the supporting courses and electives list on page 37.

Concentration: Environmental and Social Sustainability

This concentration focuses on the social, economic and political aspects of environmental sustainability. The solid coursework in the various social sciences prepares students to work on such issues as environmental advocacy, conservation and sustainable development, land use and degradation, environmental education and agricultural extension, climate change, waste management, and alternative energy.

Environmental and Social Sustainability supporting courses required:

ECON 201 Survey of Economics 3
ECON 401 Economic Development . .3
PXD 151 Exploring Conflict and Peace 3
PXD 225 Theories of Social Change . .3
*PXD 261 Community and Conflict Analysis Techniques 3
PXD 375 Globalization and Justice . . .3
SOC 336 Methods of Social Research .3

Environmental and Social Sustainability electives

Choose a minimum of 6 SH from the electives list on page 37.

Environmental Science electives

Choose a minimum of 6 SH from the supporting courses and electives list above.

Major in Clinical Laboratory Science

Jeffrey Copeland, Advisor

A major in clinical laboratory science consists of the 38 SH listed below followed by completion of the clinical program (usually one year) in an approved school of clinical laboratory science/medical technology. In this program the student completes three years of study (a minimum of 96 SH) at Eastern Mennonite University and a fourth year at the school of clinical laboratory science/medical technology. EMU has articulation agreements with Clinical Laboratory Science programs at Rockingham Memorial Hospital, Augusta Health Center and Virginia Commonwealth University. Alternatively a student may elect to complete the biology major and enter the clinical program following receipt of the baccalaureate degree. The following courses are prerequisites for entrance into a clinical program:

BIOL 173 Concepts in Biology: Unity and Diversity of Life 4
BIOL 202 Microbiology 4
BIOL 225 Molecules, Genes and Cells . .4
BIOL 245 Animal Form and Function. 4
*BIOL 337 Immunology 3
CHEM 223 General Chemistry I 4
CHEM 224 General Chemistry II 4
CHEM 315 Organic Chemistry I 4
*CHEM 335 Analytical Chemistry . . .4
MATH 240 Statistics for the Natural Sciences 3

The following courses are recommended:

*BIOCH 398 Advanced Cell Biology .3
*BIOCH 438 Molecular Genetics 3
*BIOL 307 Developmental Biology . . .4
BIOL 447 Mammalian Physiology . . .4
CHEM 316 Organic Chemistry II . . .4
PHYS 251 University Physics I 4

Minor in Biology

A non-biology major may earn a minor in biology by taking at least 18 SH of biology courses. One course must be at the 300 or 400 level. Because students of other majors will have a variety of reasons for desiring a biology minor, a fixed sequence of courses is not specified. However, students are urged to consult with a biology faculty member in outlining a minor.

Minor in Environmental Sustainability

The environmental sustainability minor consists of the following courses for a total of 17-18 SH.

BIOL 173 Concepts in Biology: Unity and Diversity 4
OR
ENVS 181 Environmental Science . . .3
*ENVS 328 Conservation Biology 3
SUST 420 Environmental Sustainability Thesis. 2
*PXD 245 Environment and Society . .3
One course from each of the two concentrations' core or electives list 6

Biology (BIOL)

101 Biological Explorations **3**

Introductory course to biological science designed for non-majors, with an emphasis on organism adaptations and life cycles (plant and animal, including human). The course also covers the philosophical and methodological foundations of biology, the scientific method, and an introduction to evolutionary biology. The course consists of lectures, interactive workshops, laboratory experiences, and discussions of current science news and issues.

112 Human Anatomy and Physiology I **3**

Lecture and laboratory study of the cellular, histological, structural and functional aspects of human body systems. Homeostasis and regulatory principles are emphasized in illustrating normal physiological systems. Laboratory sessions utilize physiologic instrumentation, dissection of laboratory animals and observation of cadavers to demonstrate anatomic and physiological concepts. High school advanced biology or BIOL 101 and high school chemistry or CHEM 102 are recommended as preparation for this course.

122 Human Anatomy and Physiology II **3**

A continuation of BIOL 112. Courses may be taken out of sequence only with instructor permission.

161 Food and Population **3**

An examination of the biological and demographic aspects of the world food and population problems, including economic, political, ethical and theological contributions to the problems and solutions. Current international events that shape global food and population problems will also be addressed.

173 Concepts in Biology: Unity and Diversity of Life **4**

Introductory course for biology majors or those interested in the biology major, emphasizing science as a method of learning about life. This course focuses on two biological issues of current interest to society—the impact of invasive species on ecosystems, and the promise and challenge of the human genome project. Lecture and laboratory experiences use these two issues as a springboard for learning fundamental concepts and methods in biology. Emphasis is placed on applying the scientific method, using instrumentation and basic laboratory skills for experimentation, writing scientific reports, and using computers for data analysis and presentation. This course is required for students continuing in the biology major.

***191 Physical Anthropology** **3**

Studies classical themes in physical (biological) anthropology, including fossil evidence of prehistoric plant and animal species and dating technologies. Emphasizes the study of human evolutionary development including the emergence of culture. Field trips to archeological sites and museums and laboratory experiences supplement the course content. (Fall 2012)

202 Microbiology **4**

Study of the biology and the medical impact of viruses, bacteria, algae, fungi and protozoa, with laboratory emphasis on bacteria. Prerequisite: BIOCH 152 or BIOL 173.

219 Life Science Practicum **1**

Experiential community learning in areas related to future vocation is coordinated with classroom instruction and reflection. Assigned shadowing or interactive experiences require 20-30 hours/semester outside of class. Typical experiences may involve hospitals, biomedical organizations, clinics, rescue squads, health departments, or life science education. Prerequisite: satisfactory completion of at least two college level biology courses and instructor permission.

225 Molecules, Genes and Cells **4**

An examination of various aspects of cell biology, introducing basic understandings of biochemistry, cell biology, and genetics. Through classroom discussions and laboratory experimentation, students will become familiar with the current techniques and technological advances for the study of the biology of living cells. Prerequisite: BIOL 173.

235 Ecology: Adaptation and Environment **4**

A foundation course in basic ecology and evolutionary biology with an emphasis on adaptations of animal and plants to their environment. The role of natural and sexual selection, species interactions, population dynamics, and landscape and community processes are investigated through a variety of projects, simulations, experiments, and field trips to representative ecosystems. Required for students continuing in the biology major, building on the experimental and investigative skills introduced in BIOL 173. Prerequisite: BIOL 173.

242 Nutrition Fundamentals **3**

Basic principles of normal human nutrition with emphasis on energy and the nutrients—their properties, sources, functions and dietary requirements. Current and controversial issues in nutrition are included.

245 Animal Form and Function **4**

A survey of the diversity of animals in nature including their classification and grouping characteristics. A comparative physiology approach is coupled with microanatomic investigations introducing the function and structure of major vertebrate body systems. Laboratory sessions involve mini-research projects that focus on animal physiology, bioassays, and histology. Prerequisite: BIOL 173.

***307 Developmental Biology** **4**

An investigative study of the topics of gametogenesis, fertilization, embryogenesis and organogenesis. Molecular influences and cell interactions involved in differentiation and development are emphasized. Laboratory investigations use both descriptive and experimental approaches to study amphibian, bird and mammal development. A mini research project and paper are required. Prerequisite: BIOL 112 or 173 or equivalent. (Fall 2012)

***318 Sustainable Agriculture** **4**

This course studies basic agriculture principles from the perspective of using sustainable techniques to lessen the impact of agriculture on the environment. Focus is on small agricultural operations and agriculture as practiced in the local context and in developing countries. Themes include agroecology, integrated pest management, and soil conservation. Prerequisite: BIOL 173 and CHEM 223 (Fall 2011)

***337 Immunology** **3**

Survey of immunology including the nature of antigens and antibodies, the reactions between them, applications of these reactions to clinical diagnosis and the cellular events which occur during the immune response. Beneficial and pathological aspects of immunity are included. Prerequisites: BIOL 225. (Fall 2011)

355 Research Topics **2**

A laboratory-intensive course with topics that vary according to instructor availability.

***358 Natural History of the Shenandoah Valley** **4**

This course focuses on identification and understanding of the flora, fauna, and geology of the Shenandoah Valley. Students investigate general principles of natural history while simultaneously developing a sense of "place" in the local region. Laboratories rely heavily on field trips. Prerequisite: BIOL 173 or permission of instructor. (Spring 2012)

369 Teaching of Biology **1-2**

Practical experience in teaching of biology by working with a faculty member in a biology course. May include proctoring in self-paced courses, tutoring, assisting in the preparation and supervision of laboratories, or other teaching functions. A written self-evaluation is required. Prerequisite: consent of the instructor.

***378 Plant Physiology** **3**

A modern molecular approach to classical plant physiology. Topics include water relations and transport, photosynthesis and respiration, nutrient assimilation, plant growth and development, plant responses to herbivory and disease, and plant environmental physiology. Prerequisite: BIOL 225. (Spring 2013)

***388 Entomology** **3**

This course explores the morphology, development, taxonomy, behavior and physiology of insects and related groups such as spiders. The impact of insects on human health and agriculture is addressed as well as insect control. Laboratory work focuses on insect behavior, physiology and the classification of insects to orders and common families. An insect collection is required and multiple collection techniques are introduced. Two lecture periods and one lab per week. Prerequisite: BIOL 173 or permission of the instructor. (Fall 2012)

437 Mammalian Anatomy **4**

Anatomical study of body systems using mammalian and human cadaver materials. Histological studies are correlated with the above anatomical studies. Laboratory work includes dissection, osteology and microscopy.

447 Mammalian Physiology **4**

Investigative study of selected body systems including neuro-muscular, cardiovascular, respiratory, renal and endocrine physiology. Extensive laboratory work emphasizes quantification and experimentation while using live materials and physiologic instrumentation. Prerequisite: BIOL 112 or 173.

***451 Neuropsychology** **3**

Survey of the anatomy and physiology of the nervous sytem, including the function of sensory receptors and hormones. Emphasis is placed on the role of general physiological principles that affect human behavior. (PSYC 451) (Spring 2012)

***458 Advanced Ecology and Field Biology** **4**

An advanced ecology course emphasizing population ecology and investigative field techniques. Extended field projects focusing on animal behavior, population surveys, vegetative sampling, and landscape ecology will be combined with population dynamic modeling and simulations. Also includes an introduction to ecological research design and data analysis. Prerequisite: BIOL 235. (Fall 2012)

469 Biology Research **1-3**

Research under the direction of a faculty member. Permission required since enrollment is limited.

***478 Advanced Neurobiology** **3**

This course explores the interdisciplinary field of neuroscience with an emphasis on the biology of the nervous system. It includes the structure of the nervous system, how neurons communicate electrically and chemically, sensory systems, motor systems, and the neural basis of behavior. Two lecture periods and one lab per week. Prerequisites: BIOL 101, BIOL 173 or BIOL 451. (Fall 2011)

485 Faith, Science, and Ethics **2**

Explores the relationship between science and Christian faith by investigating the philosophical foundations of science and their interactions with theology. Issues such as the "Big Bang," creation/evolution, chance and complexity, human nature, environmental ethics, and bioethics are examined. A "worldview" term paper is required. Restricted to students who have completed 20 SH in biology or chemistry.

499 Independent Study **1-3**

A research or honors program that may be initiated at any point in the student's studies upon approval by the department chair. The student registers only during the term when credit is to be granted and upon the approval of the research advisor. Highly recommended for biology majors.

Biochemistry (BIOCH)

152 Human Biochemistry **2**

Study of organic and inorganic compounds, especially those important in cellular intermediary metabolism and other biological processes. Prerequisite: CHEM 102, 2 years of high school chemistry (or AP Chemistry), or EMU chemistry placement exam.

376 Foundational Biochemistry **4**

A survey of structure – function relationships of biological molecules and systems. Emphasis is placed on enzymology, intermediary metabolism, and metabolic control. Laboratory focuses on protein chemistry and involves an extended independently guided research project in which students develop their own hypotheses and test them using the techniques learned early in the course. Three lecture periods and one lab per week. Prerequisite: CHEM 316.

***398 Advanced Cell Biology** **3**

A study of cellular architecture, communication, transport, motility, division, growth and death. Particular emphasis is placed on the study of cancer at the cellular level, and on a quantitative (mathematical) understanding of cellular movements. Students read and report on research articles. Laboratory involves light and fluorescence microscopy, and directed research projects of the student's choosing. Two lecture periods and one lab per week. Prerequisite: BIOL 225. (Fall 2012)

***438 Molecular Genetics** **3**

A study of the mechanisms of gene structure, stability, replication, transmission, and expression in eukaryotes. Themes include molecular evolution, viruses (including HIV), and heritable diseases. Students read and report on research articles. The laboratory involves an introduction to common techniques employed in molecular biology followed by directed research projects of the student's choosing. Two lecture periods and one lab per week. Prerequisite: BIOL 225. (Spring 2012)

469 Biochemistry/Chemistry Seminar and Research **2**

An investigation of a research topic, including designing, conducting, analyzing and reporting an independent investigation in science. Students meet with the instructor to develop the research project and to read, discuss and critique research articles related to the field of inquiry. Students write an extended review article on the topic. Prerequisites: CHEM 316 and departmental approval.

499 Independent Study **3**

Environmental Science (ENVS)

181 Environmental Science **3**

Survey of the human impact on natural and cultural ecosystems. Focuses on problems associated with population growth; the use of energy and other natural resources; and water, air and solid-waste pollution. Also attempts to present interdisciplinary techniques for solving some of these problems.

***201 Earth Science** **3**

An introduction to the study of the planet earth, including the processes by which we have synthesized the data and theories describing our planet. A major portion of the course is devoted to topics normally included in a geology course, but the course also includes an introduction to meteorology, climatology and oceanography. (Spring 2013)

***205 Environmental Applications of GIS** **3**

This course introduces Geographic Information Systems (GIS) with an emphasis on their role in environmental and conservation practices. Students first learn basic GIS skills in ESRI's ArcGIS 9.2 and then conduct an independent research project using GIS techniques. Projects may include but are not limited to local natural resource or landscape issues. Independent projects require an oral and poster presentation. Required for the environmental science major but open to non-majors with an interest in learning GIS. (Spring 2012)

***328 Conservation Biology** **3**

A study of global biodiversity and its importance. Examines the current threats to biodiversity, including species extinction, habitat degradation, invasive species, and over exploitation of natural environments. Considers efforts to manage and maintain biodiversity, including how human activity impacts conservation efforts. Prerequisite: BIOL 235 or instructor permission. (Fall 2011)

***345 Environmental Toxicology** **3**

Highlights the interdisciplinary nature of the field of environmental toxicology, centering on what happens to organisms when they are exposed to toxic compounds. Toxicological responses and how to measure them will be considered on various levels from biochemical to the ecosystem. Considers how society responds to these threats to human and ecosystem health, emphasizing the interconnectedness of the chemical/physical, the biological, and the social aspects of environmental science. Additional focus is given to how toxicological responses are used for contaminant monitoring, and to the system-level and indirect effects of contaminants in the environment (ecotoxicology). Prerequisites: BIOL 173 and CHEM 223. (Spring 2012)

469 Environmental Science Research **1-3**

499 Independent Study **1-3**

Environmental Sustainability (SUST)

419 Environmental Sustainability Practicum **3**

This course serves as a practical application of environmental principles and knowledge within a specific discipline of interest and as a way of gaining experience outside of EMU in an area of concentration. The practicum will vary with a student's particular interest but typically involves either working on a research project or participating in an internship at an appropriate organization (e.g. environmental consulting firm, government agencies, conservation organization, agricultural research center or farm utilizing alternative/ sustainable methods). Open to junior or senior level environmental sustainability majors only.

420 Environmental Sustainability Thesis **2**

An integrative capstone for all majors in environmental sustainability. A cohort of students apply their learning in the areas of natural sciences and social sciences to an environmental issue that has multidisciplinary components. Processing and reflection occur through weekly meetings with faculty and peers. Students write a substantial thesis centered on the environmental issue chosen. Seniors from related majors may participate with permission of instructor.

**Indicates courses offered in alternate years.*