The primary objective of the biology department is to prepare knowledgeable, capable, caring, reflective, and globally-aware scientists. We provide the coursework and skills required by students through rigorous scholarly inquiry, research, community service and intensive laboratory experimentation and field work. Our department is working to build a scientifically informed citizenry who will be engaged in the broader community. Students in the biology department are prepared in:

- A broad understanding of the breadth of the field of biology and the nature of science
- The ways in which science and religion influence each other
- Molecular and cellular biology
- Ecological and environmental biology
- A systems approach to biology
- Research

Major in Biology

James Yoder, Douglas Graber Neufeld, advisors

Required biology courses (28-31 SH)

Biology majors start their coursework with either BIOL 173 or BIOL 155 depending on prior academic achievements (see course descriptions for more details).

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

Careers in Biology include environmental consultant, middle or high school teacher, physician, physical therapist, wildlife biologist, epidemiologist, immunologist, medical technologist, dentist, genetic counselor, veterinarian, biotechnologist, pathologist, and international agriculture consultant.
BIOL 245 Animal Form and Function ................... 4
BIOL 485 Faith Science and Ethics OR
*ENVS 325 Environmental Ethics ........ 2

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

**Molecular/Cellular requirement**

*Choose one of the following courses:
BIOCH 376 Foundational Biochemistry .............. 3
*BIOCH 398 Advanced Cell Biology ..................... 3
*BIOCH 438 Molecular Genetics ....................... 3
*BIOL 327 Advanced Microbiology ................... 3
BIOL 337 Immunology .................................. 3

**Physiology/Systems requirement**

*Choose one of the following courses:
BIOL 307 Developmental Biology ..................... 4
*BIOL 378 Plant Ecophysiology ....................... 3
*BIOL 388 Entomology .................................. 3
BIOL 437 Advanced Human Anatomy .................. 4
BIOL 447 Advanced Human Physiology ................. 4
*BIOL 478 Advanced Neurobiology .................... 3

**Ecology/Environment requirement**

*Choose one of the following courses:
*BIOL 358 Natural History of the Shenandoah Valley ........ 4
*BIOL 378 Plant Ecophysiology ....................... 3
*BIOL 388 Entomology .................................. 3
*BIOL 465 Topics in Advanced Ecology ................. 2
*CHEM 285 Environmental Chemistry ................. 4
*CHEM 305 Alternative Energy ....................... 2
*ENVS 235 Sustainable Food Systems .................. 2
*ENVS 335 Soil Science .................................. 2
*ENVS 365 Env. Risk Assessment and Policy ............. 2

**Research requirement (2 SH)**

BIOL 255 Biology Research Seminar .................. 1

*Choose one of the following courses:
BIOL 279 Introductory Biology Research .................. 1
BIOL 479 Independent Biology Research .................. 1
BIOCH/CHEM 479 Biochemistry/Chemistry Research ........ 1

The research requirement may be satisfied by completing an NSF REU (Research Experiences for Undergraduates) program (no credit hours received). Requirement may also be satisfied by internship/practicum style experiences.

In addition, the biology major includes CHEM 223, CHEM 224 and at least one semester each of the following: organic chemistry, physics with laboratory, and calculus. Coursework in statistics is not required, but highly recommended, particularly STAT 220.

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)**
Steve Cessa, Jeff Copeland, Greta Ann Herin, Kris Schmidt, and Tara Kishbaugh, advisors

Biology majors interested in biomedicine enroll in the Pre-Professional Health Sciences Program (PPHS), which is designed for students anticipating entrance into a professional health science school such as medicine, physician assistant, dentistry, physical therapy, veterinary medicine, pharmacy, surgical assistant, radiological technician, occupa-
tional therapy, optometry, podiatry, oste- 
opathy, radiology, or graduate education 
and research in any area of biomedicine. 
(For occupational therapy, see psychology 
section.) 

Whereas most of the students in this 
program are biology majors, it is pos- 
sible to major in biochemistry, chemis- 
try, mathematics or another area in the 
university and succeed in the program 
if the required courses are completed. 
Since course requirements for the vari-
ous pre-health programs vary, students 
should reference the advising guides on 
the Pre-Professional Health Sciences 
page (https://emu.edu/pphs/) for spe-
cific courses required for each program. 
Additional courses are required beyond 
those for the biology major. Because 
graduate schools value a broad education, 
a minor in a non-science area of interest 
is suggested. 

**Major in Biochemistry**  
*Stephen Cessna, Tara Kishbaugh, advisors* 
See chemistry section. 

**Major in Biology, 
Teaching Endorsement for Grades 6-12**  
*Stephen Cessna and James Yoder, advisors* 
This program will prepare students to 
teach biology by instructing them in 
the standards of the National Science 
Teachers Association (NSTA). The cours-
es listed in the biology major (see previ-
ous pages) and the secondary education 
courses (see education section) make up 
the program for teacher licensure, grades 
6-12. 

Additional requirements for teacher 
endorsement include: 

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ENVS 135 Earth Science</td>
<td>2</td>
</tr>
<tr>
<td>STAT 220 Inferential Statistics</td>
<td>2</td>
</tr>
</tbody>
</table>

Enrollment in upper-level biology, 
biochemistry, chemistry and environ-
mental 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. 

**Major in Environmental Sustainability**  
*Douglas Graber Neufeld, Matthew Siderhurst and James Yoder, advisors for Environmental Science Concentration, Biology Department. Jenni Holsinger, advisor for Environmental and Social Sustainability Concentration, Applied Social Sciences Department.* 
The environmental sustainability major 
provides an interdisciplinary approach 
to sustaining the quality of our natural 
world with an emphasis on the inter-
relationships between the natural world 
and the social world. The environmental sustainability curriculum recognizes a 
balance between technical training and 
the broad education of a liberal arts phi-
losophy. 

The major is designed around an 
understanding that effectively address-
ing the pressing environmental problems 
of our times demands a multifaceted 
approach that requires both depth in an 
area of focus and breadth in understand-
ing the perspectives of different disci-
plines. Students gain depth by choosing 
to concentrate on either natural science 
or social science aspects of environmental 
sustainability while retaining breadth 
through coursework that combines essen-
tial elements from both social science and 
natural science to bring a holistic and 
integrated perspective. 

The environmental science concen-
tration is housed in the biology and
chemistry departments and focuses on the ecological 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. Completion of the environmental sustainability major equips students to work in fields of conservation, environmental monitoring, agriculture, alternative energy promotion and development, sustainable development, environmental advocacy, and environmental education. In addition, the curriculum prepares students for graduate work in many areas related to environmental science.

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.

The curriculum for environmental sustainability is conceptualized as three stages. Students from both concentrations begin their coursework together in three introductory courses, followed by a set of core integration courses, which set the foundation for further work. Students then take core 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 courses that serve to integrate the natural science and social science perspectives of sustainability. A major consists of 49 semester hours.

**Core Courses: Introduction to Sustainability (11 SH)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>SH</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 173</td>
<td>Concepts in Biology: Unity and Diversity of Life</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 235</td>
<td>Ecology: Adaptation &amp; Environment</td>
<td>4</td>
</tr>
<tr>
<td>SOC 245</td>
<td>Environment and Society</td>
<td>3</td>
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</tbody>
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**Core Courses: Integration (18 SH)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>SH</th>
</tr>
</thead>
<tbody>
<tr>
<td>*ENVS 205</td>
<td>Environmental Applications of GIS</td>
<td>3</td>
</tr>
<tr>
<td>*ENVS 385</td>
<td>Conservation Biology</td>
<td>4</td>
</tr>
<tr>
<td>*ENVS 325</td>
<td>Environmental Ethics</td>
<td>2</td>
</tr>
<tr>
<td>*ENVS 365</td>
<td>Environmental Risk and Policy</td>
<td>2</td>
</tr>
<tr>
<td>STAT 120</td>
<td>Descriptive Statistics OR Inferential Statistics</td>
<td></td>
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<tr>
<td>ENVS 429</td>
<td>Environmental Sustainability Internship</td>
<td>3</td>
</tr>
<tr>
<td>ENVS 430</td>
<td>Environmental Sustainability Capstone</td>
<td>2</td>
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</tbody>
</table>

**Required Supporting Courses (9 SH)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>SH</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 255</td>
<td>Biology Research Seminar</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 223</td>
<td>General Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>*CHEM 285</td>
<td>Environmental Chemistry</td>
<td>4</td>
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</tbody>
</table>

**Environmental Science electives (5 SH)**

Choose 5 SH of the following courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>SH</th>
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</thead>
<tbody>
<tr>
<td>BIOL 225</td>
<td>Molecules, Genes, and Cells</td>
<td>4</td>
</tr>
<tr>
<td>*BIOL 327</td>
<td>Advanced Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>*BIOL 358</td>
<td>Natural History of the Shen. Valley</td>
<td>4</td>
</tr>
<tr>
<td>*BIOL 378</td>
<td>Plant Ecophysiology</td>
<td>3</td>
</tr>
<tr>
<td>*BIOL 388</td>
<td>Entomology</td>
<td>3</td>
</tr>
<tr>
<td>*BIOL 465</td>
<td>Topics in Advanced Ecology</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 224</td>
<td>General Chemistry II</td>
<td>4</td>
</tr>
<tr>
<td>*CHEM 305</td>
<td>Alternative Energy</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 315</td>
<td>Organic Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 316</td>
<td>Organic Chemistry II</td>
<td>4</td>
</tr>
<tr>
<td>*CHEM 325</td>
<td>Analytical Chemistry I</td>
<td>2</td>
</tr>
<tr>
<td>*CHEM 345</td>
<td>Analytical Chemistry II</td>
<td>2</td>
</tr>
</tbody>
</table>
ENVS 135 Earth Science ............... 2
*ENVS 235 Sustainable Food Systems .2
*ENVS 335 Soil Science ................. 2

Environmental and Social Sustainability electives (6 SH)

Choose 6 SH of the following courses:
SOC 101 Introduction to Sociology .3
SOC 225 Theories of Social Change .3
SOC 336 Methods of Social Research .3
*PXD 261 Community & Conflict Analysis Tech. ................. 3
PXD 375 Globalization & Justice .... 3
SOC 210 Social Stratification ........... 3
SOC 255 Social Movements ............. 3
*SOC 350 Urban Sociology ............. 3
SOWK 360 Race & Gender ............. 3
BUAD 221 Principles of Management.3
BUAD 465 Project Management and Grantwriting ................. 3
ECON 201 Survey of Economics ....... 3
ECON 211 Principles of Microeconomics. ............... 3
ECON 212 Principles of Macroeconomics ............... 3
*ECON 300 Environ. and Ecological Economics ............... 3
*ECON 311 Contemporary Economic Issues ............... 3
*ECON 401 Development Economics 3
*ECON 411 International Economics .3
PXD 365 Social and Political Economy ............... 3
PXD 485 International Development .3

Concentration: Environmental and Social Sustainability (See Applied Social Sciences section.)

Major in Clinical Laboratory Science
Jeff Copeland, advisor

A major in clinical laboratory science consists of the 34 SH listed below followed by completion of the clinical program (usually one year) in an approved school of clinical laboratory science/mmediat medical technology. In this program the student completes three years of study (a minimum of 90 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 Sentara RMH Medical Center, 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.

Major Requirements (34 SH plus clinical program)

16 SH in Biology, including:
BIOL 173 Concepts in Biology ...... 4
BIOL 225 Molecules, Genes and Cells......................... 4
BIOL 205 Intro to Microbiology .2
OR
*BIOL 327 Advanced Microbiology .3
BIOL 337 Immunology ................. 3
Additional BIOL course to reach 16 SH

16 SH in Chemistry or Biochemistry, including:
CHEM 223 General Chemistry I .... 4
CHEM 224 General Chemistry II ... 4
CHEM 315 Organic Chemistry I .... 4
OR
BIOCH 152 Human Biochemistry .2
CHEM 325 Analytical Chemistry I OR
CHEM 345 Analytical Chemistry II .2
Additional CHEM or BIOCH to reach 16 SH

STAT 120 Descriptive Statistics OR
STAT 220 Inferential Statistics ...... 2

The following courses are recommended:
*BIOCH 438 Molecular Genetics ... 3
BIOL 447 Advanced Human Physiology ......................... 4
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.

**Minor in Biology**

A non-biology major may earn a minor in biology by taking at least 18 SH of biology courses. 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, two courses must be at the 300 or 400 level and up to two courses may be labeled as ENVS or BIOCH. Students are urged to consult with a biology faculty member in outlining a minor.

**Minor in Neuroscience** *(18-21 SH)*

Multiple disciplines have begun to incorporate neuroscientific methods to better understand human behavior (e.g., cognitive neuroscience, neuroeconomics, etc.). A minor in neuroscience will help prepare students for graduate studies in the neurosciences, but also help students to be savvy consumers in careers advocating “brain-based” practices.

*BIOL 478 Advanced Neurobiology ... 3
PSYC 101 General Psychology ....... 3
PSYC 331 Abnormal Psychology .... 3
*PSYC/BIOL 451 Neuropsychology ... 3
Research in a neuroscience topic ... 2

Choose one of the following:
BIOL 255 Biology Research Seminar ... 1
PSYC 311 Psychological Research Design and Analysis ... 3

**Minor in Environmental Science**

The environmental science minor consists of the following courses for a total of 17-20 SH.

**Core Courses (14-17 SH)**

BIOL 173 Concepts in Biology .... 4
OR
ENVS 145 Environmental Science ... 2
*ENVS 385 Conservation Biology .... 4
SOC 245 Environment & Society ... 3
CHEM 223 General Chemistry .... 4
OR CHEM 155 Matter and Energy ... 3
ENVS 430 Environmental Sustainability Capstone ... 2

**Electives (minimum 3 SH)**

ENVS 135 Earth Science ... 2
*ENVS 205 Environmental Applications of GIS ... 3
*ENVS 235 Sustainable Food Systems ... 2
*ENVS 325 Environmental Ethics .... 2
*ENVS 335 Soil Science ... 2
*ENVS 365 Env. Risk Assessment and Policy ... 2
BIOL 235 Ecology: Adaptation & Environment ... 4
*BIOL 358 Natural History of the Shen. Valley ... 4
*BIOL 378 Plant Ecophysiology ... 4
*BIOL 388 Entomology ... 3
*BIOL 465 Topics in Advanced Ecology ... 2
*CHEM 285 Environmental Chemistry ... 4
*CHEM 305 Alternative Energy ... 2
Minor in Environmental Sustainability (17-19 SH)

Core Courses

BIOL 173 Concepts in Biology: Unity and Diversity .................. 4
OR
ENVS 145 Environmental Science ... 2
*ENVS 385 Conservation Biology .... 4
SOC 245 Environment and Society ... 3
ENVS 430 Environmental Sustainability Capstone .................. 2

Electives

Choose one course from each of the two sustainability major concentrations’ core or electives lists. ............. 6

Associate in Science Degree in Health Science

This program allows the student to combine the requirements from the EMU Core with a concentration in health sciences, which includes courses from the biology and chemistry departments. An associates degree in the health sciences could prepare students to enter a radiology program or pursue other health science degrees, such as a physical therapy assistant.

Students need to reach a total of 60 SH to earn the AS degree. In addition to the EMU Core Requirements (see the EMU Core section), the following courses are required:

BIOL 112 Human Anatomy and Physiology I . ............... 3
BIOL 122 Human Anatomy and Physiology II .......... 3
BIOL 145 Nutrition Fundamentals . . . . 2
BIOL 205 Introduction to Microbiology ................. 2
*BIOL 209 Medical Terminology ....... 2
BIOL 485 Faith, Science, & Ethics ... 2
CHEM 155 Matter & Energy ........ 3
OR CHEM 223 General Chemistry I . 4
MATH 114 College Algebra OR MATH 144 Precalculus ............ 2
STAT 120 Descriptive Statistics OR STAT 220 Inferential Statistics ....... 2
CS 105 Introduction to Computer Science ..................... 2

Additionally, 11-12 credits from the following are required: BIOCH 152, BIOL 173, BIOL 225, BIOL 245, CHEM 105, ENVS 235, PSYC 101 OR PSYC 202, SOC 201.

Biology (BIOL)

105 Science and Society 2

This course uses examples from recent news events as a means of introducing the nature of science and scientific inquiry and the role of science in society, culture, politics, and policy. This course meets for 7 weeks

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 155 and high school chemistry or CHEM 105 or CHEM 155 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.
145 Nutrition Fundamentals
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. This course meets for 7 weeks.

155 Biological Explorations
Introductory course to biological science, 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. Students interested in
a biology, chemistry, or environmental sustainability major place out of BIOL 155 by
achieving two of three indicators: high school GPA of 3.5 or higher, Math SAT score of
530 (ACT score of 22 math), or composite SAT score of 1080 (ACT score of 21 total). If
students are taking BIOL 155 as preparation for BIOL 173 they must achieve a B or greater
in this course.

173 Concepts in Biology: Unity and Diversity of Life
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 challenge of
infectious diseases. Lecture and laboratory experiences use these two issues as a springboard
for learning fundamental concepts and methods in biology. In addition, the study of
evolutionary biology is interwoven throughout the course, including issues related to the
intersection of science and faith. 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. Students are eligible to take BIOL 173 if they have achieved
two of three indicators: high school GPA of 3.5 or higher, Math SAT score of 530 or higher
(ACT score of 22 math), or composite SAT score of 1080 or higher (ACT score of 21 total).
If two of these three are not met, students must take BIOL 155, MATH 114, and CHEM
155 and earn a B or higher before enrolling in BIOL 173 and CHEM 223.

205 Introduction to Microbiology
An introduction to the biology and the medical impact and of viruses, bacteria, algae, fungi
and protozoa, with laboratory emphasis on bacteria. Prerequisite: BIOCH 152 or BIOL
173.

*209: Medical Terminology
This course is designed to provide the medical language and nomenclature background for
students who plan to enter health care professions. Study of the uses of prefixes, suffixes,
and word roots to formulate words describing meaningful medical conditions is emphasized
as well as learning their definitions, correct pronunciation, and spelling. Using major body
systems as a guide, students will learn the basic anatomic and medical terms related to the
muscular, skeletal, respiratory, circulatory, digestive, reproductive, and urinary systems. No
prerequisite. (Fall 2019)

219 Life Science Practicum
Experiential community learning in areas related to future vocation is coordinated with
classroom instruction and reflection. Assigned shadowing or interactive experiences require
25-30 hours/semester outside of class. Typical experiences may involve hospitals, biomedical
organizations, clinics, health departments, or life science education. Prerequisite: satisfactory
completion of at least two biology courses and instructor permission.
225 Molecules, Genes and Cells  
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  
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.

245 Animal Form and Function  
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.

255 Biology Research Seminar  
This course is intended for sophomores but may be taken during the second semester of the first year. It is designed to provide an overview of the fundamental and theoretical aspects of research as well as the nature of science. Students will learn to evaluate primary literature, how to assess and interpret data and how to develop hypotheses from that data. Students will learn to how to design a research project to fill the gaps in the existing work and write a research proposal. Students will be evaluated on their interpretative skills as well as their scientific reading, writing, and oral presentations. This course meets for 7 weeks.

279 Introductory Biology Research  
This course is the standard way that students will complete their second required credit in research. It is a single-semester research experience with significant laboratory skill-building in a technique. Pre- or co-requisite: BIOL 255.

307 Developmental Biology  
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.

*327 Advanced Microbiology  
A comprehensive study of the field of microbiology, emphasizing the principles of medical microbiology and human symbioses. Included in the discussion will be additional focus on disease, treatment, emerging infectious diseases, biotechnology and global public health. Topics will be discussed using lectures, short lab periods, case studies and problem-based learning. Prerequisite: BIOL 225. (Spring 2019)

337 Immunology  
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. Prerequisite: BIOL 225.
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 2020)

Teaching of Biology
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 Ecophysiology
A study of plant function (photosynthesis, energy partition, transpiration, nutrient acquisition, and growth), with a particular focus on plant responses to abiotic stresses (light, temperature, water, and mineral nutrient deficiency and excess) and biotic challenges (including herbivory, disease, and navigating mutualisms). Prerequisite: BIOL 225 or 235. (Spring 2019)

*388 Entomology
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 2018)

437 Advanced Human Anatomy
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. Prerequisite: BIOL 245 or instructor permission.

447 Advanced Human Physiology
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
Survey of the anatomy and physiology of the nervous system, including loss of function studies. Emphasis is placed on the role of general physiological principles that affect human behavior. (PSYC 451) (Spring 2020)

*465 Topics in Advanced Ecology
An advanced ecology course emphasizing population ecology and investigative field techniques. Extended field work focuses on topics such as animal behavior, population surveys, vegetative sampling, and landscape ecology. Specific topics covered vary depending on instructor. Also includes an introduction to ecological research design and data analysis. Prerequisite: BIOL 235. This course meets for 7 weeks. (Fall 2018)

*478 Advanced Neurobiology
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 112 or BIOL 173. (Spring 2019)
479 Independent Biology Research 1-3
Multi-semester research under the direction of a faculty member. Pre- or co-requisite: BIOL 255. Instructor permission required and dependent on student application. Student application is due 3 days before course registration period and includes: a resume with GPA and prior experience as well as suggested project description or interest in a particular lab and potential available time blocks. Students are placed in research labs or projects by the department.

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 majoring in the biology/chemistry departments or by instructor permission. This course meets for 7 weeks.

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 104 OR 2 years of high school chemistry (or AP Chemistry). This course meets for 7 weeks

318 Biochemistry- Molecular Biology Lab 2
A hands-on overview of several major biochemistry and molecular biology laboratory techniques, including protein and nucleic acid purification, expression, and characterization; enzyme kinetics; gene amplification, cloning, and manipulation; and protein and gene bioinformatics. Each student will undertake a short research project. Prerequisites: BIOL 225 and CHEM 315.

376 Foundational Biochemistry 3
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. 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. Prerequisite: BIOL 225. (Fall 2018)

*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. Prerequisite: BIOL 225. (Spring 2020)
479 Biochemistry/Chemistry Research  
Research under the direction of a faculty member. Permission required since enrollment is limited.

499 Independent Study

Environmental Science (ENVS)

135 Earth Science  
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. This course meets for 7 weeks.

145 Environmental Science  
Survey of the human impact on natural and cultural ecosystems, including the processes by which the scientific data are collected and analyzed and theories describing our environmental impact formed. Focuses on problems associated with human population growth; the use of energy and other natural resources; and water, air and solid-waste pollution. Also presents interdisciplinary techniques for investigating and solving some of these problems. This course meets for 7 weeks.

*205 Environmental Applications of GIS  
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 10.3 software 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 students in the environmental science track of the environmental sustainability major. (Fall 2019)

*235 Sustainable Food Systems  
This course explores questions of sustainability in global food systems. Agricultural, food transportation, food storage, and food processing and production systems are compared with regard to energy-use relative to nutrient-production efficiency, as well as social, cultural and economic sustainability aspects of food systems including international food commodity trade and food trade policy, food islands, farm-to-table restaurants, and small local organic production. This course meets for 7 weeks. Core Natural Science designate. Prerequisite: BIOL 173, SOC 245 or instructor approval. (Spring 2020)

*325 Environmental Ethics  
Different ethical theories concerning the environment will be articulated, with a focus on Anabaptist theological perspectives, and the role of ethics in civic society. Ethical perspectives are examined through their application to contemporary issues in sustainability. This course meets for 7 weeks. Prerequisite: BIOL 173. (Spring 2019)

*335 Soil Science  
This course is an introduction to the fundamental concepts of soil science, including soil genesis, classification and morphology, physics, chemistry, and hydrology. Particular emphasis is placed on soil maintenance and improvement for sustainable food production and mitigation of environmental problems. The course involves several short hands-on lab and field activities. This course meets for 7 weeks. Prerequisite: CHEM 223. (Fall 2019)
*365 Environmental Risk and Policy  
This course addresses principles of risk assessment, perception and management, using issues in environmental contaminants as a frame. Examines how people individually and as a society perceive risk, and how risk is dealt with through policy options. This course meets for 7 weeks. Prerequisite: BIOL 173. (Spring 2019)

*385 Conservation Biology  
A study of global biodiversity, its importance, and the environmental, social and economic factors that affect it. Current threats to biodiversity, including species extinction, habitat degradation, invasive species, and over exploitation of natural environments are examined. The class also focuses on efforts to manage and maintain biodiversity, including how human development, culture and social systems impact conservation efforts. Laboratory work will emphasize population ecology and animal and plant survey techniques as well ecological and economic modeling used to make management decisions. Prerequisite: BIOL 235 or instructor permission. (Fall 2019)

429 Environmental Sustainability Internship  
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 internship 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.

430 Environmental Sustainability Capstone  
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.

499 Independent Study  
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Science, Technology, Engineering, Mathematics (STEM)

219 Science and Engineering Practicum  
Experiential community learning related to future STEM vocations is coordinated with classroom instruction and reflective writing based on readings and experiences. Typical experiences include formal conversations with STEM alumni, tours of regional STEM business or laboratories, presentations by STEM professionals. Students will develop potential career plans and expand their understanding of possible vocations within STEM. This course will not discuss health science vocations. Open to first year and second year STEM majors only.

*Indicates courses offered in alternate years.