

Science & Mathematics DIVISION



Ronald Meyers, Division Chair

Understanding the environment of human life, the center of God's creation, is an important task for the Christian. The physical, biological and mathematical sciences emphasize the study of our relationship to that complex environment. Majors and minors are equipped to understand, interact, and glorify God in these areas.

This division offers majors in Biology, Computer Science, Mathematics, and Pre-professional (Pre-dental, Pre-medical, Pre-veterinary), as well as group major in Science Studies for Teacher Education. Minors may be taken in Biology, Chemistry, Computer Science, General Science, and Mathematics. Students may also take coursework at AuSable Trails Institute of Environmental Studies (see page 55).

Degrees

- Bachelor of Arts (B.A.)
- Bachelor of Science (B.S.)

Majors

- Biology
- Biology - Health Sciences Emphasis
- Biology (Secondary Ed.)
- Computer Science
- Environmental Biology
- Mathematics
- Mathematics (Secondary Ed.)
- Pre-professional:
 - Pre-dental
 - Pre-medical
 - Pre-veterinary
- Science Studies Group -
(Elementary & Secondary Ed.)

Minors

- Biology
- Biology (Secondary Ed.)
- Chemistry
- Computer Science
- General Science
- Mathematics
(Elementary & Secondary Ed.)
- Physics - Secondary Teaching
(in consortium with Calvin College)
- Science Studies Group
(General Science Emphasis -
Elementary & Secondary Ed.)
- Science Studies Group
(Physical Science Emphasis -
Elementary & Secondary Ed.)

Programs

- AuSable Institute

Faculty

- Meyers, Ronald. Associate Professor of Science (1979) (Chair); B.A. (1971), Cedarville College; M.S. (1979), Ohio State University
- Atwood, Peter. Associate Professor of Mathematics (1975); B.S. (1966), Trinity College; M.A. (1968), Princeton University; Ph.D. Program, Western Michigan University, A.B.D.
- Franklin, Michael. Assistant Professor of Science (1996); B.S. (1988), Murray State University; M.S. (1992) Michigan State University; Ph.D. (1997) Michigan State University
- Fryling, James. Associate Professor of Science (1997); B.S. (1981) United States Air Force Academy; M.S. (1986), Ph.D. (1990) University of Arizona
- Gates, Raymond. Associate Professor of Science (1978); B.A. (1973), Spring Arbor College; M.S. (1976), Central Michigan University.
- Lillis, Gail. Assistant Professor of Science (1994); B.S. (1971), Eastern Kentucky University; M.Ed. (1973), Wright State University
- Rabbitt, Gerald. Associate Professor of Mathematics (1995); B.Ed. (1971), University of Toledo; M.Ed. (1972), University of Toledo; Ed.S. (1981), University of Toledo
- Sprague, Thomas. Associate Professor of Mathematics (1996); B.S. (1980), Central Michigan University; M.A. (1982), Dallas Theological Seminary; M.A. (1985), Michigan State University; Ph.D. (1990), Western Michigan University

Criteria for Graduation as a Division Major is listed in the Academic Information section under Graduation Requirements on page 51.

Degree information for the Bachelor of Arts and Bachelor of Science degrees along with major and minor listings by division can be found in the catalog section entitled Degree Information. (See page 65.)

Majors & Minors

BIOLOGY MAJOR (Bachelor of Arts)

General Education Core requirements for the Bachelor of Arts degree are listed in the Degree Information section. (See page 65.)

Required Courses	Credit Hours
BIO 151	Foundations of Biological Science 4
BIO 225	Botany 4
BIO 233	Zoology 4

BIO 351	Genetics	. . . . .	4
ECO 341	Ecology	. . . . .	4
SCI 380	Internship	. . . . .	3
BIO 451	Molecular Cell Biology	. . . . .	4
BIO 400	Biological Perspectives	2
	Electives in Biology (must be upper-level)	4
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			Total33

Required Cognates*

CHM 111	Principles of General Chemistry	4
CHM 112	Principles of Organic and Biochemistry	4
	Electives in Mathematics	. . . . .	6
			(Not MAT 096, 097, 107, 110, 211 or 212)

BIOLOGY MINOR

Required Courses		Credit Hours
BIO 151	Foundations of Biological Sciences	. . . . . 4
BIO 225	Botany 4
BIO 233	Zoology 4
	Electives in Biology (must be upper-level) 8
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Total20		

Required Cognate*

CHM 111	Principles of General Chemistry	4
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*A cognate is a course that supports the success of completing a major program.

BIOLOGY MAJOR FOR SECONDARY TEACHERS (Bachelor of Arts)

General Education Core requirements for the Bachelor of Arts degree are listed in the Degree Information section. (See page 67)

Required Courses		Credit Hours
BIO 151	Foundations of Biological Science	. . . . . 4
BIO 225	Botany	. . . . . 4
	One of the following:	. . . . . 4
	BIO 241 Anatomy and Physiology I	
	BIO 242 Anatomy and Physiology II	
BIO 233	Zoology	. . . . . 4
BIO 351	Genetics	. . . . . 4
ECO 341	Ecology	. . . . . 4
SCI 361	Origins 3
BIO 451	Molecular Cell Biology 4
BIO 400	Biological Perspectives 2
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Total33		

Required Cognates*

CHM 111	Principles of General Chemistry	4
CHM 112	Principles of Organic and Biochemistry	4
MAT 151	Statistics	3

*A cognate is a course that supports the success of completing a major program.

BIOLOGY MINOR FOR SECONDARY TEACHERS

Required Courses		Credit Hours
BIO 151	Foundations of Biological Sciences	4
BIO 225	Botany	4
One of the following:		4
BIO 241	Anatomy and Physiology I	
BIO 242	Anatomy and Physiology II	

Biology Major for Secondary Teachers Four Year Program Illustration

Freshman year

REL 100	Christian Foundations I	3
ENG 113	Freshman Rhetoric	4
MAT 123	Algebra/Trigonometry or	
MAT 131	Calculus I	3
SCI 100	Found.Scientific Inquiry	4
COR 100	Foundations of Inquiry	2
COM 111	Speech Communication	3
KIN 149	Principles of Wellness	2
PSY 232	Developmental Psychology	3
BIO 151	Foundations of Bio. Science	4
IDS 200	Rel.Communities & Culture	3
REL 101	Christian Foundations II	3
Total Freshman Hours (Approx.)		34

Sophomore year

EDU 282	Intro to Education	3
ENG 223	Intro to Literature	3
HIS 113	World Civilization	3
CHM 111	General Chemistry	4
BIO 225	Botany or	
BIO 241	Anatomy & Physiology I	4
EDU 283	School Observation Pract.	1
MAT 151	Statistics	3
BIO 233	Zoology	4
CHM 112	Organic & Biochemistry	4
BIO 242	Anatomy & Physiology II	4
(if BIO 241 not taken) or Minor Course		
EDU 232	Philosophical Foundations	3
Total Sophomore Hours (Approx.)		36

Junior year

EDU 344	Content Area Literacy	3
EDU 381	Educational Psychology	3
EDU 352	Christian Theology	3
BIO 351	Genetics	4
Minor Course		4
or BIO 225 Botany (if not taken previously)		
EDU 452	Secondary Instr. Strategy	3
One of the following:		3
FAR 211	Intro to Fine Arts	
HIS 114	World. Civ. I	
HIS 115	American Studies	
KIN XXX	Lifetime activity	1
SCI 361	Origins	3
BIO 451	Molecular Cell Biology	4
Total Junior Hours (Approx)		32

Senior year

EDU 262	Computers & Tech. in Edu.	3
SCI 465	Secondary Science Methods	3
ECO 341	Ecology	4
BIO 400	Biological Perspectives	2
EDU 484	Secondary Dir. Teaching	12
Minor course and/or elective		3
Total Senior Hours (approx.)		27

Science & Mathematics

BIO 233	Zoology	. . . . .	4
BIO 341	Ecology	4
			Total
			20

Required Cognate*

CHM 111	Principles of General Chemistry	4
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*A cognate is a course that supports the success of completing a major program.

BIOLOGY MAJOR (Bachelor of Science)

General Education Core requirements for the Bachelor of Science degree are listed in the Degree Information section. (See page 65.)

Program Specific Core Additions:

PHI 211	Introduction to Philosophy	. . . . .	4
One of the following		. . . . .	3
PSY 111	General Psychology		
SOC 111	Introduction to Sociology		

Major Requirements

Required Courses		Credit Hours	
BIO 151	Foundations of Biological Science	. . . . . 4
BIO 225	Botany	. . . . . 4
BIO 233	Zoology	. . . . . 4
ECO 341	Ecology	. . . . . 4
BIO 351	Genetics	. . . . . 4
BIO 352	Microbiology	. . . . . 4
SCI 361	Origins	. . . . . 3
SCI 380	Internship	. . . . . 3
BIO 400	Biological Perspectives	. . . . . 2
BIO 451	Molecular Cell Biology	. . . . . 4
SCI 495	Senior Research Project & Seminar	. . . . . 2
Electives	BIO, ECO	. . . . . at least 4
			Total
			42

Required Cognates* (Satisfied minor requirement.)

Required Courses		Credit Hours
CHM 121	General Chemistry I	. . . . . 4
CHM 122	General Chemistry II	. . . . . 4
CHM 231	Organic Chemistry I	. . . . . 4
CHM 232	Organic Chemistry II	. . . . . 4
CHM 472	Biochemistry	. . . . . 4
PHY 211	General Physics I	. . . . . 4
PHY 212	General Physics II	. . . . . 4



MAT 151	Statistics	. . . . .	3
One of the following:		3(4)
MAT 124	Precalculus and Discrete Math		
MAT 131	Calculus I		
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Total			.34(35)

*A cognate is a course that supports the success of completing the major program.

BIOLOGY MAJOR - HEALTH SCIENCES EMPHASIS (Bachelor of Science)

General Education Core requirements for the Bachelor of Science degree are listed in the Degree Information section. (See page 65.)

Program Specific Core Additions:

PHI 111	Introduction to Philosophy	. . . . .	4
One of the following		. . . . .	3
PSY 111	General Psychology		
SOC 111	Introduction to Sociology		

Major

Required Courses		Credit Hours	
BIO 151	Foundations of Biological Science	. . . . . 4
BIO 241	Anatomy and Physiology I	. . . . . 4
BIO 242	Anatomy and Physiology II	. . . . . 4
BIO 233	Zoology	. . . . . 4
BIO 351	Genetics	. . . . . 4
BIO 352	Microbiology	. . . . . 4
SCI 361	Origins	. . . . . 3
SCI 380	Internship	. . . . . 3
BIO 451	Molecular Cell Biology	. . . . . 4
BIO 400	Biological Perspectives	. . . . . 2
SCI 495	Senior Research Project & Seminar	. . . . . 2
Electives	BIO chosen from:	. . . . . at least 4
	BIO 341	Anatomical Kinesiology	
	BIO 342	Exercise Physiology	
	BIO 343	Biomechanics	
	BIO 347	Introduction to Nutrition	
	SCI 362	Medical Bioethics	
	SCI 480	Advanced Topics (Biomedical Ethics)	
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Total			.42

Required Cognate*

Required Courses		Credit Hours
CHM 121	General Chemistry I 4
CHM 122	General Chemistry II	. . . . . 4
CHM 231	Organic Chemistry I	. . . . . 4
CHM 232	Organic Chemistry II	. . . . . 4
CHM 472	Biochemistry	. . . . . 4
PHY 211	General Physics I	. . . . . 4
PHY 212	General Physics II	. . . . . 4

MAT 151	Statistics	.3
One of the following:		.3(4)
MAT 124	Precalculus and Discrete Math	
MAT 131	Calculus I	
Total		.34(35)

*A cognate is a course that supports the success of completing the major program.

CHEMISTRY MINOR

Required Courses		Credit Hours
CHM 121	General Chemistry I	.4
CHM 122	General Chemistry II	.4
CHM 411	Perspectives in Chemistry	.2
Chemistry Electives		.12
Total		.22

COMPUTER SCIENCE MAJOR (Bachelor of Arts)

General Education Core requirements for the Bachelor of Arts degree are listed in the Degree Information section. (See page 65.)

Required Courses		Credit Hours
CSC 131	Computer Science I	.4
CSC 132	Computer Science II	.4
CSC 231	Data Structures and Algorithms	.3
CSC 351	Software and Hardware Concepts	.3
CSC 352	Data Communications	.3
CSC 325	Database Program Development	.3
CSC 421	Programming Languages	.3
CSC 451	Theory of Operating Systems	.3
CSC 380	Internship	.3
Two Electives from:		.6
CSC 221 Visual Basic		
CSC 331 Numerical Analysis		
CSC 435 Theory of Computing		
CSC 400	History of the Mathematical Sciences	.3
Total		.38

Required Cognate*

(to be completed no later than the Fall semester of the Sophomore year)

Required Courses		Credit Hours
One of the following:		.3(4)
MAT 243	Discrete Mathematics (3)	
MAT 131	Calculus I (4)	

*A cognate is a course that supports the success of completing the major program.

COMPUTER SCIENCE MINOR

Required Courses		Credit Hours
CSC 131	Computer Science I	.4
CSC 132	Computer Science II	.4
CSC 231	Data Structures and Algorithms	.3
CSC 351	Software and Hardware Concepts	.3
Two electives from:		.6
CSC 221	Visual BASIC	
CSC 222	COBOL	
CSC 223	FORTRAN	
CSC 325	Database Program Development	
CSC 331	Numerical Analysis	
CSC 332	Systems Analysis	
CSC 352	Data Communications	
CSC 431	Applied Software Project	
CSC 470	Advanced Readings	
CSC 480	Advanced Topics	
CSC 490	Independent Study	
		.20

ENVIRONMENTAL BIOLOGY MAJOR (Bachelor of Science)

General Education Core requirements for the Bachelor of Science degree are listed in the Degree Information section. (See page 65.)

Program Specific Core Additions:

Required Courses		Credit Hours
PHI 211	Introduction to Philosophy	.3
One of the following:		.3
PSY 111	General Psychology	
SOC 111	Introduction to Sociology	

Major:

Required Courses		Credit Hours
BIO 111	Introduction to Biological Sciences	.4
BIO 151	Foundations of Biological Sciences	.4
BIO 225	Botany	.4
BIO 233	Zoology	.4
ECO 341	Ecology	.4
SCI 380	Internship (Environmental Biology related)	.3
BIO 300-400	Electives at Cornerstone University	.4
ECO 300-400	Electives at AuSable Institute	.8
BIO 400	Biological Perspectives	.2
One of the following:		.4
BIO 431	Vertebrate Zoology	
ECO 311	AuSable/Field Biology	

ECO 321	AuSable/Animal Zoology	
ECO 322	AuSable/Aquatic Biology	
ECO 346	AuSable/Winter Stream Ecology	
ECO 442	Advanced Field Studies	
One of the following:		.4
BIO 351	Genetics	
BIO 352	Microbiology	
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Total		.45

General Science Minor II (required)

Required Courses		Credit Hours
CHM 121	General Chemistry I	.4
CHM 122	General Chemistry II	.4
CHM 112	Prin. Of Organic/Biochemistry	.4
ECO 332	AuSable/Environmental Chem.	.4
SCI 262	Geology (or GEOL 216 at AuSable)	.4
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Total		.20

Required Cognate

Required Courses		Credit Hours
MAT 151	Statistics	.3
One of the following:		.3/4
MAT 123	Algebra/Trig (3)	
MAT 131	Calculus I (4)	
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Total		.71/72

AuSable Certificate strongly recommended from one of the following areas:

- Stewardship Ecologists
- Land Resources Analyst
- Environmental Analyst
- Water Resources Analyst
- Naturalist

GENERAL SCIENCE MINOR

Required Courses		Credit Hours
Two physical science courses (CHM, PHY, SCI designations)		.8
Two biological science courses (BIO, ECO designations)		.8
One other physical or biological science course		.4
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Total		.20

MATHEMATICS MAJOR (Bachelor of Arts)

General Education Core requirements for the Bachelor of Science degree are listed in the Degree Information section. (See page 65.)

Required Courses		Credit Hours
MAT 131	Calculus I	.4
MAT 132	Calculus II	.4
MAT 233	Differential Equations	.3
MAT 234	Multivariate Calculus	.3
MAT 241	Applied Linear Algebra	.3
MAT 245	Mathematical Proof	.3
MAT 252	Computer Statistics	.3
MAT 331	Numerical Analysis	.3
MAT 333	Real Analysis	.3
MAT 341	Modern Algebra	.3
MAT 380	Internship	.3
MAT 400	History of the Mathematical Sciences	.3
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Total		.35

Required Cognate

Required Courses		Credit Hours
CSC 131	Computer Science I	.4

MATHEMATICS MAJOR (Teaching – Bachelor of Arts)

General Education Core requirements for the Bachelor of Arts degree are listed in the Degree Information section. (See page 65.)

Required Courses		Credit Hours
MAT 131	Calculus I	.4
MAT 132	Calculus II	.4
MAT 233	Differential Equations	.3
MAT 234	Multivariate Calculus	.3
MAT 241	Applied Linear Algebra	.3
MAT 245	Mathematical Proof	.3
MAT 252	Computer Statistics	.3
MAT 333	Real Analysis	.3
MAT 341	Modern Algebra	.3
MAT 372	Geometry	.3
MAT 400	History of the Mathematical Sciences	.3
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Total		.32

Required Cognate

Required Courses		Credit Hours
CSC 131	Computer Science I	.4

MATHEMATICS MAJOR (Bachelor of Science)

General Education Core requirements for the Bachelor of Science degree are listed in the Degree Information section. (See page 65.)

Program Specific Core Additions:

Required Courses	Credit Hours
MAT 131 Calculus I	4
MAT 132 Calculus II	4
CSC 131 Computer Science I	4
CSC 132 Computer Science II	4
PHY 111 Physics for Scientists and Engineers I	4
PHY 112 Physics for Scientists and Engineers II	4
PHI 211 Philosophy	3
One of the following:	3
PSY 111 Psychology	
SOC 111 Sociology	
Total	30

Major

Required Courses	Credit Hours
MAT 233 Differential Equations	3
MAT 234 Multivariate Calculus	3
MAT 241 Applied Linear Algebra	3
MAT 243 Discrete Mathematics	3
MAT 245 Mathematical Proofs	3
MAT 252 Computer Statistics	3
CSC 231 Data Structures	3
MAT 331 Numerical Analysis	3
MAT 333 Real Analysis	3
MAT 341 Modern Algebra	3
MAT 400 History of the Mathematical Sciences	3
MAT 380 Internship	3
MAT 480 Advanced Topics	3
Total	39

MATHEMATICS MINOR

Required Courses	Credit Hours
MAT 131 Calculus I	4
MAT 132 Calculus II	4
MAT 234 Multivariate Calculus	3
MAT 241 Applied Linear Algebra	3
Three from the following:	9
MAT 233 Differential Equations	
MAT 252 Computer Statistics	
MAT 333 Real Analysis	

MAT 331	Numerical Analysis
MAT 341	Modern Algebra
MAT 400	History of the Mathematical Sciences

Total23

Required Cognate

Required Courses	Credit Hours
CSC 131 Computer Science I	4

MATHEMATICS MINOR FOR ELEMENTARY TEACHERS

Required Courses	Credit Hours
MAT 123 Algebra/Trigonometry	3
MAT 131 Calculus I	4
MAT 151 Statistics, or	
MAT 252 Computer Statistics	3
MAT 211 Math for the Elementary Teacher	3
MAT 212 Geometry for the Elementary Teacher	3
One elective from the following:	3
MAT 132 Calculus II (4)	
MAT 372 Geometry	
One computer programming course	3

Total (must be at least) .22

MATHEMATICS MINOR FOR SECONDARY TEACHERS

Required Courses	Credit Hours
MAT 131 Calculus I	4
MAT 132 Calculus II	4
MAT 234 Multivariate Calculus	3
MAT 241 Applied Linear Algebra	3
MAT 252 Computer Statistics	3
Two electives from the following:	6
MAT 233 Differential Equations	
MAT 333 Real Analysis	
MAT 341 Modern Algebra	
MAT 372 Geometry	
MAT 400 History of the Mathematical Sciences	

Total23

Required Cognate

Required Courses	Credit Hours
CSC 131 Computer Science I	4

PHYSICS MINOR FOR SECONDARY TEACHERS

Students wishing to pursue this consortium minor should meet with the certification officer from the Teacher Education Department during or before their sophomore year. Students will be evaluated by a Calvin advisor who will develop an appropriate program. Consortium minors are subject to final approval by Calvin College.

Required Courses	Credit Hours
PHY 111 Physics for Science and Engineering I . . . . .	.5
PHY 112 Physics for Science and Engineering II . . . . .	.5
PHYS 226 Introduction to Modern Physics4
PHYS 382 Modern Physics Laboratory2
Physics electives (approved)8
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Total24

PRE-PROFESSIONAL MAJOR (Pre-Medical, Pre-Dental, Pre-Veterinary) (Bachelor of Arts)

General Education Core requirements for the Bachelor of Arts degree are listed in the Degree Information section (See page 65.) Students electing a Pre-Professional major are not required to complete a minor. Students wishing to pursue this major must meet with the appropriate professional advisor to ensure that all graduate school requirements are met.

Required Courses	Credit Hours
BIO 151 Foundations of Biological Science . . . . .	.4
BIO 241 Anatomy and Physiology I . . . . .	.4
BIO 242 Anatomy and Physiology II . . . . .	.4
BIO 233 Zoology . . . . .	.4
BIO 351 Genetics . . . . .	.4
BIO 352 Microbiology . . . . .	.4
SCI 380 Internship . . . . .	.3
BIO 451 Molecular Cell Biology . . . . .	.4
BIO 400 Biological Perspectives . . . . .	.2
SCI Electives from the following: . . . . .	.4
BIO 431 Vertebrate Zoology	
SCI 361 Origins	
SCI 480 Advanced Topics Seminar	
SCI 362 Biomedical Ethics	

Required Cognates

Required Courses	Credit Hours
MAT 131 Calculus I . . . . .	.4
MAT 132 Calculus II . . . . .	.4
CHM 121 General Chemistry I . . . . .	.4
CHM 122 General Chemistry II . . . . .	.4
CHM 231 Organic Chemistry I . . . . .	.4
CHM 232 Organic Chemistry II4
PHY 211 General Physics I4
PHY 212 General Physics II4
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Total69

SCIENCE STUDIES GROUP MAJOR FOR ELEMENTARY AND SECONDARY TEACHERS (Bachelor of Arts)

General Education Core requirements for the Bachelor of Arts degree are listed in the Degree Information section. (See page 65.)

Required Courses	Credit Hours
SCI 111 Physical Science . . . . .	.4
BIO 151 Foundations of Biological Science . . . . .	.4
BIO 225 Botany . . . . .	.4
CHM 111 General Chemistry . . . . .	.4
BIO 242 Anatomy & Physiology II . . . . .	.4
BIO 233 Zoology . . . . .	.4
ECO 241 Environmental Science (Elementary), or	
ECO 341 Ecology (Secondary)4
SCI 261 Astronomy4
SCI 262 Geology4
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Total36

Students who exempt out of any course should select electives from CHM 112 Organic & Biochemistry or BIO 241 Anatomy and Physiology I.

SCIENCE STUDIES GROUP MINOR FOR ELEM. AND SEC. TEACHERS

General Science Emphasis

Required Courses	Credit Hours
SCI 111 Physical Science . . . . .	.4
BIO 151 Foundations of Biological Science . . . . .	.4
ECO 241 Environmental Science . . . . .	.4
SCI 262 Geology . . . . .	.4
One additional biological science4
One additional physical science4
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Total24

Physical Science Emphasis (For Biology majors only)

Required Courses	Credit Hours
CHM 121 General Chemistry I . . . . .	.4
CHM 122 General Chemistry II . . . . .	.4
SCI 261 Astronomy4
SCI 262 Geology4
PHY 211 Physics I4
PHY 212 Physics II4
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Total24

Science & Mathematics

Course Descriptions

Course Frequency Key

- 1 = Every Semester
- 2 = Alternate Semesters
- 3 = Every Third Semester
- 4 = Alternate Years
- 5 = Every Three Years
- 6 = As Needed

BIOLOGY

BIO 111 Introduction to Biological Sciences 4/1

An introductory course in Biology in which plants and animals are used to illustrate basic biological principles. The course will examine the relationships among living organism, including man, and his environment. It is designed to increase student awareness and appreciation of organisms in nature as well as the natural history of selected plants and animals. The laboratory includes the identification of common organisms living in West Michigan during field trips. This course is for non-science majors and minors and satisfies the core requirement for Lab Science.

BIO 151 Foundations of Biological Science 4/1

This course is designed to provide a natural science foundation for all science majors and minors. Foundational concepts in cell biology/chemistry, genetics (classical and molecular) and microbiology will be stressed in both lecture and lab. This course satisfies the core requirement for Lab Science.

BIO 225 Botany 4/2

Studies basic plant science, including the structure, reproduction, and ecological relationships among plants. Lecture and lab. This course satisfies the core requirement for Lab Science. Prerequisite: An advanced high school biology course or BIO 111 or BIO 151.

BIO 233 Zoology 4/2

Introduction to the basic principles of zoology, including development, distinguishing characteristics and interactions of the major animal kinds, with special emphasis on the invertebrates. Lecture and lab. This course satisfies the core requirement for Lab Science. Prerequisites: BIO 111 or BIO 151 or advanced high school biology course.

BIO 241 Anatomy and Physiology I 4/2

A systems approach to the structure and function of the human body with special emphasis on disease process as it relates to dysfunction along with practical applications for a life-style of healthful living. Includes integumentary, skeletal, muscular, nervous, and endocrine systems. Laboratory experiences will use microscopic and lab animal investigation. Stresses the homeostatic function and intricacy of the body and its analogies to the Body of Christ, the Church. Lecture and lab. This course satisfies the core requirement for Lab Science.

- BIO 242 Anatomy and Physiology II** 4/2
A systems approach to the structure and function of the human body with special emphasis on disease process as it relates to dysfunction, along with practical applications for a life-style of healthful living. Includes cardiovascular, digestive, respiratory, lymphatic, urinary, and reproductive systems. Laboratory experiences will use microscopic and lab animal investigation. Stresses the homeostatic function and intricacy of the body and its analogies to the Body of Christ, the Church. Lecture and lab. This course satisfies the core requirement for Lab Science.
- BIO 331 Ornithology** 4/5
Study of bird anatomy, behavior, life cycles, migration, distribution, and economic relations. Field work is concerned with identification by sight and song and observing the habitat requirements of each species. Lecture and lab. Prerequisite: BIO 233
- BIO 341 Anatomical Kinesiology (KIN 341)** 3/2
This course is designed as a functionally specific approach to the musculoskeletal system. Emphasis will be placed on the qualitative analysis and description of human movement. Prerequisite: BIO241
- BIO 342 Exercise Physiology (KIN 342)** 4/2
A study of the physiological responses of the healthy human body to exercise. This course includes topics such as energy systems, nutrition, conditioning, exercise testing, and exercise prescriptions. Prerequisites: BIO 241 and BIO 242.
- BIO 343 Biomechanics (KIN 343)** 4/2
The study of the internal and external forces that act upon a human body during movement and the effects produced by these forces. Special emphasis will be given to sport-related movements. Prerequisite: BIO 241 and BIO 242.
- BIO 347 Introduction to Nutrition (KIN 347)** 3/2
This course is designed to study foods and their effects upon health, development, and performance of the human. Students will develop an understanding of healthful and performance nutrition as it relates to optimal health and physical performance. Also, students will study energy pathways in the body and the six basic nutrients related to performance. Additionally, the students will investigate body composition and weight control. Prerequisite: BIO 242.
- BIO 351 Genetics** 4/2
A study of classical Mendelian genetics, as well as the current molecular basis of gene expression. Lab investigations include inherited traits studies with a variety of organisms from bacteria to humans. Prerequisites: CHM 112, BIO 233, MAT 151.
- BIO 352 Microbiology** 4/4
A survey study of the structure and function of micro-organisms, with an emphasis on bacteria. Lab included basic techniques in the isolation, identification and culture of micro-organisms. Lecture and lab. Prerequisite: BIO 151 or BIO 233.

BIO 400 **Biological Perspectives** 2/6
This course is a senior capstone course for Biology and Pre-Professional Majors, and investigates the ethical and theological issues confronting one choosing a biology-related career. Emphasis will be placed upon constructing a personal, Christian philosophical framework. Students will address these concepts as they investigate and evaluate relevant biological issues. Prerequisite: Upper-class Biology or Pre-Professional Major.

BIO 431 **Vertebrate Zoology** 4/4
Introduction to the characteristics of the seven classes of vertebrate animals, their structure and life history. Lecture and lab. Prerequisite: BIO 233

BIO 451 **Molecular Cell Biology** 4/4
Examines the structure, function, differentiation and reproduction of cells at all levels of organization with special emphasis on current research in biological problems. Lab experience includes modern techniques in molecular analysis. Lecture and lab. Prerequisite: BIO 351

CHEMISTRY

CHM 111 **Principles of General Chemistry** 4/2
Investigation of the composition and properties of substances and the changes they can undergo. Special emphasis on laws of chemical combination, theories of atomic structure, periodic trends, kinetic theory, and chemical and physical equilibria as well as activities to communicate the centrality of chemistry to historical development, modern civilization, and life itself. Explores proper biblical stewardship in chemical manufacturing, disposal, and use. Lecture and lab. This course satisfies the core requirement for Lab Science. Prerequisite: MAT 123 Algebra/Trigonometry or equivalent.

CHM 112 **Principles of Organic and Biochemistry** 4/2
Study of the structure, properties, reactions, and interactions of the compounds of carbon and the molecules of life. Special emphasis upon the relationship of macromolecular structure and function to their components. Explores and utilizes chemical theory in the understanding of simple and complex molecular behavior. Laboratory exercises concentrate on synthesis, identification and investigation of both natural and man-made products. Lecture and lab. Prerequisite: CHM 111

CHM 121 **General Chemistry I** 4/2
Investigation of the composition and properties of substances and the changes they can undergo. Special emphasis on laws of chemical combination, theories of atomic structure, periodic trends, and chemical and physical equilibria as well as activities to communicate the centrality of chemistry to historical development, modern civilization, and life itself. Explores proper biblical stewardship in chemical manufacturing, disposal, and use. Lecture and lab. This course satisfies the core requirement for Lab Science. Prerequisite: MAT 123 Algebra / Trigonometry or its equivalent.

- CHM 122 General Chemistry II** 4/2
A continuation of CHM 121 with emphasis on reaction types and rates, electrochemistry, equilibria, group properties, nuclear chemistry, and qualitative analysis. Addresses environmental concerns and safe handling and disposal of chemicals. Chemical demonstrations as well as laboratory experiments are used throughout the course. Lecture and lab. This course satisfied the core requirement Lab Science. Prerequisite: CHM 121.
- CHM 231 Organic Chemistry I** 4/4
A study of carbon compounds including nomenclature, physical and chemical behavior, synthesis, reactions and mechanisms. Laboratory investigations will include micro as well as macro techniques for synthesis and analysis. Lecture and lab. Prerequisite: CHM 122 or equivalent.
- CHM 232 Organic Chemistry II** 4/4
A continuation of CHM 231 with special emphasis on the biological significance of the functional groups studied in that course. Natural products and polymers will also be covered. Laboratory investigations will include micro as well as macro techniques for synthesis and analysis. Lecture and lab. Prerequisite: CHM 231.
- CHM 411 Perspectives in Chemistry** 2/4
Investigation in the history, philosophy, curricular structure, methodology, key ideas and concepts of chemistry. Emphasis will be given to the central role in technology and society as well as stewardship issues of production, utilization, and disposal. Prerequisites: Minimum of three chemistry courses and at least junior standing.
- CHM 472 Biochemistry** 4/4
Investigation of biologically important molecules including proteins, lipids, carbohydrates, and nucleic acids. Metabolic and biochemical problems will be explored. Lecture and lab. Prerequisite: CHM 232.
- COMPUTER INFORMATION SYSTEMS**
- CSC 110 Computer Introduction** 3/1
A survey course that introduces computer hardware and software concepts as applied to computer information systems. Students will be introduced to experience using word processing, spreadsheet, database, and graphics applications. Not applicable to Business Division majors or minors.
- CSC 111 Introduction to Word Processing** 1/6
A course that provides the student with a basic understanding of word processing using MS Word. Topics include use of keyboard, file retrieval and merging, inserting, moving and deleting text, and formatting a document.
- CSC 112 Introduction to Spreadsheets** 1/1
An understanding of spreadsheets and their use in financial applications.

- CSC 131 Computer Science I** 4/2
 This is a first course for students in science, mathematics, and computing, and introduces both programming and Computer Science. Topics include the design, coding, testing, and documentation of programs written in a modern high-level language. Fundamental issues of Computer Science, such as procedural abstraction, program efficiency and algorithmic complexity are introduced in the context of programming and problem solving. Prerequisite: 2 years of high school algebra or permission.
- CSC 132 Computer Science II** 4/2
 This is a second course for students in science, mathematics, and computing, and is a continuation of Computer Science I. Students gain a thorough knowledge of a high level language, and a disciplined approach to program design, coding, testing, and documentation. An introduction to the analysis of algorithms, data structures, and data abstraction receive increased emphasis over Computer Science I. Prerequisite: CSC 131
- CSC 211 Desktop Publishing** 3/2
 An introduction to desktop publishing software applied to the designing and producing of a variety of professional-quality documents (such as newsletters, brochures, forms, and presentations) that combine text and graphics features. Major topics will include composition, formatting, planning and layout, and selection and manipulation of graphics and type styles/sizes.
- CSC 221 Visual Basic** 3/2
 An introduction to programming using Visual Basic. This course introduces programming concepts specifically applied to the object-oriented environment of Windows. Prerequisite: Experience with Windows based applications.
- CSC 222 COBOL** 3/4
 A structured programming course applied to the business environment. Program design, structured programming documentation, creating COBOL code, and program testing in a sequential file environment. Prerequisite: CSC 131, CSC 221 or some previous programming.
- CSC 224 C++ Programming** 3/4
 An introduction to the C++ programming language. Students will gain programming skill through writing several programs in the C++ language. The course assumes previous programming experience preferably in an object-oriented language. Prerequisite: CSC 131 or substantial knowledge of some high-level programming language.
- CSC 231 Data Structures and Algorithms** 3/6
 A study of data structures such as stacks, lists, queues, trees, and graphs. Analysis of algorithms and complexity. Programming techniques and implementation of data structures and algorithms. Prerequisite: CSC 132 and MAT 131 or permission.
- CSC 280 Topics in Computing** 1-3/6
- CSC 325 Database Program Development** 3/4
 A study of the relational database model and the SQL programming language as applied to Business Information Systems. Prerequisite: CSC 332 and any programming course.

- CSC 331 Numerical Analysis** **3/6**
 The numerical solution of nonlinear equations, ordinary differential equations, and systems of linear equations. Numerical approximation of functions, derivatives, and integrals. The analysis of errors. Introduction to writing efficient and reliable numerical software. Prerequisite: CSC 131 and MAT 132, and MAT 241 or permission
- CSC 332 Systems Analysis** **3/2**
 A study of the process of analyzing and designing Business Information Systems. The system design life cycle is applied using CASE tools. Prerequisite: Previous programming or accounting courses.
- CSC 341 Decision Support Systems** **3/6**
 An analysis of the highest level of information support systems that serve the managerial user. This system provides quantitative-based information derived from one or more databases within and/or external to an organization and is used to aid managers in the decision-making process. Prerequisite: SSC 241 and ACC 221.
- CSC 351 Software and Hardware Concepts** **3/4**
 A survey of technical topics related to computer systems with emphasis on the relationships between hardware architecture, system software, and applications software. The architecture of processors and storage systems is explored and the implications for systems software design are covered along with the impact of hardware and system software design on the development of application programs. Prerequisite: CSC 131 or a programming language
- CSC 352 Data Communications** **3/4**
 A study of technical topics related to data communications and networks. This course will cover transmission media, analog and digital signals, data transmission, multiplexing, local area and wide area network protocols, and network topologies. There will also be some coverage of network operating systems and computer telephony integration. Prerequisite: CSC 351.
- CSC 380 Internship** **1-6/1**
 Practical work experience in a situation where decisions are made concerning equipment or programming or workflow operations. Prerequisite: Permission of instructor.
- CSC 400 History of the Mathematical Sciences (MAT 400)** **3/6**
 The development of the mathematical sciences historically and logically. Examines their influences on modern western culture, as well as major vocational issues and trends from a Christian worldview. Project portfolio requires research, problem solving, and exposition, demonstrating technical competence and personal Christian philosophy. Prerequisites: CSC 231, CSC 351, MAT 131 or 243, and on additional upper-level CSC course.
- CSC 421 Principles of Programming Languages** **3/6**
 A survey of the properties of various programming languages, as an introduction to the general principles of programming language design and implementation. Topics include a study of language syntax (e.g., lexical properties and parsing), language processors (compilers, interpreters, and direct execution), language representations (e.g., data and control structures, binding, and semantic models), and language styles (procedural, functional, object, logic, and modular programming). Prerequisite: CSC 231 and proficiency in at least 2 approved programming languages.

ECO 342 **Field Biology** **4/6**

First two weeks: Instruction and experience in the use of the tools of the field biologist, trips to different types of ecosystems: forest, field, stream, pond, lake, marsh, and bog. Final week: Travel experience covering points of interest in the Upper Peninsula and Lower Peninsula of Michigan, or the student may elect to work on a field problem in the Grand Rapids area. Prerequisite: BIO 111 or equivalent.

ECO 442 **Advanced Field Studies** **variable credit/6**

A field-oriented course in the study of the relationships of the fauna and flora of special segment of the biosphere such as Yellowstone National Park or the Florida peninsula. Students spend most of the time on location experiencing the ecology of the area.

MATHEMATICS

MAT 096 **Pre-Algebra** **2/2**

An individualized review of applied arithmetic. Patterns leading to operations with fractions, decimals, percents and proportions. Graphing, drawing, probability and spreadsheet tools are used in technology activities to learn problem-solving strategies, numerical geometry, pre-algebra, and basic statistics concepts. Prerequisite: Credits earned for this course do not count toward graduation. Computer software and/or a graphing calculator (TI-83 Plus recommended) is a required tool for this course.

MAT 097 **Elementary Algebra** **2/2**

Introduction to the language of algebra. Topics include: variables, operations in algebra, linear sentences, slopes, exponents, and quadratic equations. Emphasis on the reading and writing of mathematics, problem solving, and using technology. Projects in polynomials, linear systems, factoring, functions, BASIC and calculator programming. Prerequisite: A continuation of MAT 096. Satisfactory score on the math placement test. Computer software and/or a graphing calculator (TI-83 Plus recommended) is a required tool for this course. Credits earned for this course do not count toward graduation.

MAT 110 **College Math** **3/1**

Applications of functions to number properties, graphs, equations, inequalities, probability, and statistics. Graphic, numeric, and symbolic methods to solve equations with technology. Computer explorations extend the geometric and algebraic understandings and problem-solving skills. Graphing calculator (TI-83 Plus) and/or computer software is a required tool for this course. Prerequisites: Two years of high school algebra and one year of geometry or satisfactory score on the placement test.

MAT 123 **Functions and Trigonometry** **3/2**

A study of polynomial, exponential, logarithmic, and trigonometric functions, and their properties, graphs and transformations. Emphasis on graphic, numeric, and symbolic methods to solve problems. Applications in statistics, economics, and the sciences. Graphing calculator required: TI-83 Plus or TI-92 preferred. Prerequisites: MAT 110 or the equivalent of two years of high school algebra and one year of geometry with mathematical reasoning or satisfactory score on the placement test.

MAT 124 **Precalculus with Discrete Mathematics** **3/2**

This course emphasizes mathematical logic and reasoning including programming investigations such as limits and differentiation commands. Function analysis, equations and inequalities, polynomials, rational, trigonometric identities, recursion,

- MAT 233** **Differential Equations** **3/4**
The study of equations involving derivatives by methods of algebra, series, or computer approximations. Graphing calculators and computers will graph solutions, phase planes, and chaotic systems. Prerequisite: MAT 132.
- MAT 234** **Multivariate Calculus** **3/4**
Derivatives and integrals of functions of several variables such as $z=f(x,y)$, Jacobian determinants, volumes, and surface areas. Three-dimensional graphs and chaotic systems will be investigated on graphing calculators and computers. Computer software and/or graphing calculator (TI-89 or TI-92 Plus preferred) is a required tool for this course. Prerequisite: MAT 132.
- MAT 241** **Applied Linear Algebra** **3/4**
The algebra of matrices, determinants, vectors, inverting matrices, diagonalizing matrices, eigenvalues, computer programs, and their applications. Computer software and/or graphing calculator (TI-89 or TI-92 Plus) will be used for calculations and applications to chaotic systems. Prerequisite: MAT 132.
- MAT 243** **Discrete Mathematics** **3/4**
A study of fundamental principles of discrete mathematics, with applications to computing. Topics such as sets, functions, relations, counting methods, graph theory, matrix theory, and number theory. An introduction to operation counts and algorithmic complexity. Computer software and/or graphing calculator (TI-89 or TI-92 Plus preferred) is a required tool. Prerequisite: MAT 123 or permission of the instructor.
- MAT 252** **Computer Statistics** **3/4**
Probability simulations and statistical procedures on graphing calculators and computer statistics programs: random sampling, normal and binomial probability distributions, descriptive statistics and graphs, linear regression and/or ANOVA. Graphing calculator required. Computer software and/or graphing calculator (TI-89 or TI-93 Plus preferred) is a required tool. Prerequisite: MAT 132 and CSC 131.
- MAT 331** **Numerical Analysis** **3/4**
The numerical solution of nonlinear equations, ordinary differential equations, and systems of linear equations. Numerical approximation of functions, derivatives, and integrals. The analysis of errors. Introduction to writing efficient and reliable numerical software. Prerequisite: CSC 131 and MAT 132. In addition, MAT 241, or permission.
- MAT 333** **Real Analysis** **3/4**
Construction of the Real Number Field, its properties, proofs and consequences; Infinite sequences and series; continuous and differentiable functions and otherwise; Riemann integrals. Computer software and/or graphing calculator (TI-89 or TI-92 Plus preferred) is a required tool. Prerequisite: MAT 234 and MAT 241.
- MAT 341** **Modern Algebra** **3/4**
Groups, rings, and fields and their substructures with examples from transformation groups, matrix rings, and number fields. Computer software and/or graphing calculator (TI-89 or TI-92 Plus preferred) is a required tool. Prerequisite: MAT 234 and MAT 241.

MAT 372	Geometry	3/4
<p>Models and proofs in Euclidean and non-Euclidean geometry. Emphasis on communicating mathematical arguments with technology. The language and logic of geometry for representing and solving visual problems; points, lines, angles, circles, perimeter, area, 3-D figures, transformations, congruence, and similarity. Manipulative and computer explorations. Internet, graphing and drawing tool applications appropriate for the secondary classroom. Computer software and/or a TI-92 Plus graphing calculator required. Prerequisite: MAT 234 and MAT 241 or permission.</p>		
MAT 380	Internship	1 - 6/1
MAT 400	History of the Mathematical Sciences	3/4
<p>The development of the mathematical sciences historically and logically. Examines their influences on modern western culture, as well as major vocational issues and trends from a Christian worldview. Project portfolio requires research, problem solving, and exposition, demonstrating technical competence and personal Christian philosophy. Computer software and/or graphing calculator (TI-89 or TI-92 Plus preferred) is a required tool. Prerequisite: Completed MAT 333 or MAT 341.</p>		
MAT 470	Readings in Math	1- 3/1
MAT 471	Secondary Math Methods	3/4
<p>Prospective teachers implement a secondary mathematics curriculum that models NCTM curriculum, teaching, and evaluation standards. They plan, implement, and evaluate a unit and lessons in algebra, geometry, functions, probability and statistics, trigonometry, precalculus and discrete mathematics. Explorations with manipulatives, computers, multimedia technologies, Internet, BASIC, calculator programming; statistics, graphing, and drawing tools. Computer software and/or a TI-92 Plus graphing calculator is a required tool. Prerequisites: EDU 452, MAT 234, MAT 241.</p>		
MAT 480	Advanced Topics	3/6
MAT 490	Independent Study	1 - 3/1
PHYSICS		
PHY 111	Physics for Scientists and Engineers I	5/6
<p>An introductory survey of the basic concepts of mechanics, heat, sound, and wave motion. Appropriate for students in the mathematical sciences and engineering. Lecture and lab. This course satisfies the core requirement for Lab Science. Corequisite: MAT 131 Calculus I or equivalent.</p>		
PHY 112	Physics for Scientists and Engineers II	5/6
<p>An introductory survey of the basic concepts of electricity, magnetism, light, and modern physics. Appropriate for students in the mathematical sciences and engineering. Lecture and lab. Corequisite: PHY 111 or equivalent and MAT 132 Calculus II or equivalent.</p>		

PHY 211 **General Physics I** **4/2**
An introduction survey of the basic concepts of mechanics, heat, sound, and wave motion. Appropriate for students in life sciences. Lecture and lab. This course satisfies the core requirement for Lab Science. Prerequisite: MAT 123 Algebra/Trigonometry or equivalent.

PHY 212 **General Physics II** **4/2**
An introductory survey of the basic concepts of electricity, magnetism, light and modern physics. Appropriate for students in life sciences. Lecture and lab.
Prerequisite: PHY 211 or equivalent.

SCIENCE

SCI 100 **Foundations of Scientific Inquiry** **4/1**
This course is designed to introduce students to the role and importance of the sciences in studying God's general revelation in both nature and themselves. A Christian philosophy of science is developed that demonstrates to the student the utility and value as well as the limitations of the natural and social sciences as tools for the empirical investigation of God's creation. Through both classroom and laboratory experience, the student is introduced to the scientific method as a means of knowing from the perspective of a Christian worldview. Integrated lecture and lab.

SCI 111 **Physical Science** **4/1**
Introduction to the explanation and understanding of the natural, non-living world. The processes of information gathering and organizing will be stressed as they relate to the fields of physics, chemistry, geology and astronomy. Emphasis will be given to the biblical framework for each of these disciplines. Lecture and lab. This course satisfies the core requirement for Lab Science. Prerequisite: Core requirement in mathematics.

SCI 261 **Astronomy** **4/2**
A study of the distinctive qualities of the planets, their moons, the stars, and galaxies through laboratory exercises in observations and calculations. Lecture and lab. This course satisfies the core requirement for Lab Science. Prerequisite: MAT 123 Algebra/Trigonometry.

SCI 262 **Geology** **4/2**
A study of the materials and processes of the earth, leading to a responsible Christian appreciation for it and its use. Explores basic principles through a survey of the history of the ideas about the earth. Applies basic insights of chemistry, biology, physics, and mathematics to the solution of problems such as earthquakes, volcanic eruptions, floods, marine erosion, the nature and distribution of fossil fuels, metals, ground water, and other mineral resources. Studies man-imposed and natural boundaries to characterize geographic regions. Lecture and lab. This course satisfies the core requirement for Lab Science.

SCI 361 **Origins** **3/4**
A scientific investigation of the feasibility of various origin theories with special emphasis on the creation vs. evolution debate. Explores the difference between origins science and operation science and analyzes the conflict in the Christian scientific community as well as the population at large. Prerequisites: SCI 111, BIO 111 or equivalents.

SCI 362	Biomedical Ethics (PHI 362)	3/4
A study of the ethical issues in modern medicine from a biblical, historical, theological and scientific perspective. The course surveys the current literature on reproductive medicine, organ transplants, genetic technologies, medical research and end-of-life concerns, with particular emphasis upon students developing a biblically-based model for ethical decision making.		
SCI 380	Internship	1- 6
This course provides an opportunity to work in a supervised biological setting (e.g., DNR, nature center, public health agency). The experience must include opportunities to apply the theories and concepts learned in the discipline or to enhance biological science research skills.		
SCI 461	Philosophy of Science	3/6
Analytical study of the philosophical bases of science and various interdisciplinary relationships.		
SCI 465	Secondary Science Methods	3/2
This course focuses on specific knowledge, skills, and attitudes that are demonstrated by effective science teachers in the secondary schools. Students will learn to design, organize, present, and evaluate the learning of science subject matter utilizing various instructional models and methods of teaching science. Prerequisite: EDU 452		
SCI 470	Readings in Science	1-3/1
SCI 480	Advanced Topics Seminar	3/6
SCI 490	Independent Study	1-3/1
SCI 495	Senior Research Project and Seminar	2/2
Independent laboratory and/or field research of an important scientific problem of interest to researcher and faculty mentor. Student will report findings of research before departmental faculty and science peers. Prerequisites: Senior status, majority of major field of study completed.		

AUSABLE INSTITUTE COURSES

The following courses are offered through the AuSable Trails Institute of Environmental Studies. See p.58 for further details.

ECO 301	Land Resources	4
Systems-level perspective on land forms and ecosystems. Includes analysis and interpretation of on-site data recorded in the field, remote-sensing data derived from satellite and low-altitude aerial imagery and geographic information systems (GIS). Field trips to and analysis of forests, bogs, marshes, dunes, and rivers. Includes application to policy and land use planning. Prerequisite: One year of introductory science.		
ECO 302	Water Resources	4
Field study of lakes and streams with applications to planning and management. Includes an introduction to limnology and investigation of representative lakes and streams of the region. Prerequisite: One year of general biology and one year of general chemistry.		

- ECO 303 Ecological Agriculture** 4
 Environmental analysis and natural resources in relation to people and policy. The focus is on ethnobotany, ecological agriculture, and land stewardship. It employs a discussion format both in classroom and field settings. Its emphasis is grappling with difficult practical and ethical problems and issues that require deep and persistent thought.
- ECO 304 Natural Resources Practicum** 4
 Global Development and Ecological Stewardship: Environmental analysis and natural resources in relation to society and development issues. The focus is on ecological sustainability and sustainable society in the context of the various factors that are bringing environmental degradation and impoverishment of people and cultures. It deals with topics of tropical agriculture, hunger, poverty, international debt, appropriate technology, relief programs, missionary earthkeeping, conservation of wild nature, land tenure, and land stewardship. It employs a discussion format both in classroom and field settings. Its emphasis is grappling with difficult practical and ethical problems and issues that require deep and persistent thought.
- ECO 305 Ornithology** 4
 Biology, behavior, ecology and identification of birds. Work is primarily conducted in the field and covers the major habitats of northern lower Michigan, including wetlands, lakes, rivers, forests, dunes, and open field communities. Emphasis will be placed on identification of the spring bird fauna of northern lower Michigan by sight and by call. Prerequisite: One course in introductory biology or zoology.
- ECO 310 Winter Biology** 4
 Biology and environment of Northern Michigan plants and animals in winter condition. Lectures, films, and field experience. Prerequisite: One course in biology.
- ECO 311 Field Botany** 4
 Field identification and ecology of vascular plants as components of natural communities in Michigan. Emphasis is placed upon on-site examination of plants in communities such as bog, dune, forest, marsh, meadow, and swamp. Plants difficult to study under field conditions are brought to the laboratory for microscopic examination and identification. Ecological features such as community stratification and plant zonation along ecological gradients are examined. Prerequisite: One year of general biology or one semester of botany.
- ECO 312 Insect Biology and Ecology** 4
 A study of insect taxonomy, ecology, life histories, and economic importance. Special attention is given to environmental stewardship issues including use of insecticides, biological control, integrated pest management, and impact of cultivation on formation of pest faunas. Field methods are stressed.
- ECO 315 Woody Plants** 4
 Taxonomy, ecology, management, and stewardship of trees and scrubs. Presents the systematic botany of local woody flora including identification by foliage, twigs, wood and bark, and trees of major economic importance worldwide. Given in the context of ethical and global questions of deforestation, global warming trends, old growth forest values, lumbering, forest ecosystem restoration, and land stewardship. Prerequisite: One year of general biology or one semester of botany.

- ECO 321 Animal Ecology** 4
Interrelationships between animals and their biotic and physical environments emphasizing behavioral aspects. A field course that centers on the ecology of northern Michigan fauna from a stewardship perspective. Included are individual student projects. Prerequisite: One year of introductory science.
- ECO 322 Aquatic Biology** 4
Ecology, identification, systematics, culture and care of aquatic plants and animals, and adaptations to freshwater environments. Aquatic life is studied in lakes, ponds, bogs, marshes, streams, and in the laboratory. The course assesses human impact on aquatic species and ecosystems, presents procedures for the stewardship of aquatic habitats, and introduces aquatic restoration ecology. Prerequisite: One year of general biology or one semester each of general zoology and general botany.
- ECO 332 Environmental Chemistry** 4
Principles and analysis of chemical movement and distribution both natural and human-induced in natural environments. Sampling and analytical methods are included for water, soil, and air. Work is conducted both on site in natural habitats and the laboratory. Prerequisite: One year of general chemistry and one semester of either biochemistry or organic chemistry.
- ECO 346 Winter Stream Ecology** 4
Geological, physical and chemical features of streams in winter with a focus on ecological interactions and applications to the stewardship of streams and watersheds. Not open to students who have taken ECO 322.
Prerequisite: One year of general biology.
- ECO 350 Winter Stream Ecology** 4
Contemporary problems of environmental stewardship are investigated, including use of renewable and non-renewable natural resources, pollution, appropriate land use and development, their world concerns and preservation of wild nature. These problems are set in a historical perspective of human relationships to the natural environment, especially as this relationship is viewed in the light of Christian thought and doctrine. Current attempts to develop a theology of nature and principles of Christian stewardship are considered.
- ECO 361 Natural History in Spring** 4
Springtime plants and animals, their field identification, field biology, behavior and landscape context with a focus on spring flora, amphibia, and birds.
- ECO 411 Advanced Field Botany** 4
Extended field identification and ecology of vascular plants as components of natural communities. Selection and study of a specific plant community for intensive taxonomic and ecological research and preparation of herbarium specimens according to established museum techniques. Taught concurrently with ECO 311. Students who take this as their only course during a given academic session must also enroll in ECO 499 Research for two credits. Prerequisite: Biol 311 Field Botany taken at another Au Sable Institute location.

ECO 471 Conservation Biology 4

Principles of conservation biology with applications to sustainable human society and biospheric integrity. An integrative approach to biology and society that interrelates population biology, ecological principles, biogeochemical cycles, ecosystem functions, and human society in the context of biospheric degradation. The course develops a stewardship perspective rooted in biological principles and directed at conservation of plant and animal species, biotic communities, ecosystems, and human society. Included are topics of human development, poverty, and economic growth.

Prerequisite: One year in biology and one course in ecology, or permission of professor.

ECO 482 Restoration Ecology 4

Ecological foundations and techniques for ecosystem and biotic community restoration. This course applies ecological principles and environmental ethics to redeeming and restoring degraded and damaged ecosystems and endangered species. Field studies include analysis of restoration and rehabilitation work with the Kirtland Warbler, an officially designated wild river, coastal dunes, kettlehole bogs, old growth forest, deforested lands, degraded residential and farming sites, and abandoned oil wells. A practical field laboratory is included in which techniques are applied to a specific site.

ECO 499 Directed Independent Research 4

Field or laboratory study of a problem selected by the student in consultation with a professor and presented as a written proposal in advance of the session in which the study is to be conducted. Normally, problems are outgrowths of previous coursework with a given professor. Prerequisite: Permission of professor.