

Biological and Physical Sciences

Dr. Joseph W. Francis

The Department of Biological and Physical Sciences spans the disciplines of Biology, Zoology, Botany, Chemistry, and Physical Science. The department seeks to produce in students the ability to carefully analyze any area of knowledge that intersects these diverse disciplines. The department strives to instill in students the desire to be professionally competent, to develop lifelong patterns of intellectual growth and to be uncompromising in their faith. This is accomplished by a consideration of historically tested facts and current perspectives in the various scientific disciplines in addition to the Word of God. The internally consistent outcome of these studies form a basis for the accurate evaluation of science past, present and yet future. The goal of all instruction is to send forth the saints with an understanding of science, so that through their professional, academic and spiritual testimony, the Master is presented and exalted.

Students in the Natural History/Environmental Biology Emphasis Courses can complete certifications as a certified naturalist, certified land resources analyst, certified water resources analyst, or certified environmental analyst in conjunction with The Master's College and the AuSable Institute. Interested students should coordinate their program early in their college years with Dr. Englin.

Career Opportunities

The training students receive at The Master's College in biological and physical sciences helps them prepare for the following careers:

- Biochemist
- Dietitian
- Laboratory Technician
- Dentist
- Physician
- Veterinarian
- Nurse
- Zoologist
- Ecologist
- Marine Biologist
- Pharmacist
- Microbiologist
- Park Ranger

Undergraduate Research Opportunities

Students are encouraged to pursue personalized scholarship opportunities with individual faculty in the department. A particular forte of our institution is the interest and emphasis of our faculty in creation science research. Students may translate such research opportunities into academic credit toward graduation in the form of practicums in in-

dustrial settings and/or scholarly articles presented to academic and professional societies.

Credit-By-Examination

Credit-by-examination in the department will be granted for certain course segments if the student has scored 4 or 5 on the Advanced Placement Program examination of the Educational Testing Service, or a score of 55 or above on the College Level Examination Program test. This applies to granting: Physics examination - 6 hours of PS251, 252 General Physics. (Students must take physics lab each semester; only lecture credit is granted.) Chemistry examination - 4 hours of CH151 General Chemistry. (Biology majors must take CH152 at college level.) Biology examination - 3 hours of LS151 Organismic Biology.

Comprehensive Exam

Students graduating with a Bachelor of Science in Biology will be required to take a comprehensive discipline-specific examination in their senior year, prior to graduation.

BIOLOGY CORE COURSES

CH151	General Chemistry I	4
CH152	General Chemistry II	4
CH351	Organic Chemistry I	4
CH352	Organic Chemistry II	4
LS151	Organismic Biology	4
LS220	Research Methods	1
LS252	Cell Biology	4
LS341	Ecology	4
LS342	Genetics	4
LS372	Origins	3
LS420	Seminar in Biology	1
LS422	Senior Capstone	1
MA121	Calculus I	4
MA262	Elementary Statistics	3
PS251	General Physics I	4
PS252	General Physics II	4
<i>Total core courses</i>		<i>53</i>

Biology Emphasis Courses

Biology Major Core Courses	53
Upper division Biology & Chemistry electives	8
<i>Total units required for emphasis</i>	<i>61</i>

Cellular & Molecular Biology Emphasis Courses

Biology Major Core Courses	53
<i>At least three of the following</i>	<i>12</i>
LS306 Developmental Biology	4

LS318	Conservation Biology & Sustainability	4
LS321	Human Anatomy.....	4
LS322	Human Physiology	4
LS351	Physiology I.....	4
LS352	Physiology II.....	4
LS361	Immunology	4
LS362	Medical Microbiology.....	4
LS464	Molecular Biology.....	3
CH461	Biochemistry.....	3
<i>Total units required for emphasis</i>		<i>65</i>

Natural History/Environmental Biology Emphasis Courses

Biology Major Core Courses	53
<i>At least two of the following</i>	<i>7-8</i>
LS318 Conservation Biology & Sustainability	4
LS362 Medical Microbiology.....	4
LS348 Biological Field Studies (topics vary and can be repeated for credit).....	4
<i>Total units required for emphasis</i>	<i>60-61</i>

Pre-Medical/Pre-Dentistry/Pre-Allied Health Emphasis Courses

Biology Major Core Courses	53
<i>At least three of the following</i>	<i>12</i>
LS306 Developmental Biology.....	4
LS318 Conservation Biology & Sustainability.....	4
LS321 Human Anatomy	4
LS322 Human Physiology.....	4
LS351 Physiology I.....	4
LS352 Physiology II.....	4
LS361 Immunology.....	3
LS362 Medical Microbiology.....	4
LS464 Molecular Biology.....	3
CH461 Biochemistry.....	3
<i>Total units required for emphasis</i>	<i>65</i>

Secondary Teacher Education in Life Sciences Emphasis Courses

Complete requirements of Biological Emphasis Courses and Teacher Education Requirements described on pages 148-149.

Minor in Biology

For a minor in Biology, the student must complete:

LS151 Organismic Biology	4
LS252 Cell Biology.....	4
CH151, 152 General Chemistry I, II	4, 4
LS372 Origins.....	3
Upper division Biology and Chemistry electives.....	6
<i>Total units required for minor</i>	<i>25</i>

Course Offerings in Biological and Physical Sciences

BIOLOGICAL SCIENCE

LS140 Principles of Biology (4)

An analysis of the principles of life common to plant and animal study: the cell, intermediary metabolism, photosynthesis, cell reproduction, genetics, ecology and origins. 3 hours lecture, 3 hours laboratory. (Lab fee \$65)

LS151 Organismic Biology (4)

The first course for biology majors, emphasizing biological life forms, their physiology, origins and environmental relationships. 3 hours lecture, 3 hours laboratory. *Co-requisite* CH151. (Lab fee \$65.)

LS200 Foundations of Science (3)

An introduction to the history, development and influence of science on culture and other academic disciplines. The use of science in society and its limits will be emphasized and discussed. The impact of Christianity on science and a Christian view of science will be presented. Contemporary issues including energy development, the creation-evolution debate, the intelligent design movement, environmentalism, and human bioethics, among other topics will be presented and discussed. Sophomore standing suggested.

LS218 Tutorial Studies (1-3)

See LS418.

LS220 Research Methods (1)

An introduction to research writing with emphasis on the documentation and communication methods used in biological research. The student will be exposed to major aspects of scientific writing and presentation of scientific data, including library research, data analysis, evaluation of scientific writing, composition of a scientific paper and a prospective research proposal and presentation of scientific data in a poster format. 1 hour lecture. *Prerequisite:* Sophomore standing required.

LS221 Human Anatomy & Physiology I (4)

A study of the anatomy and physiology of the human integument, skeletal, muscular, and nervous systems. The laboratory consists of the use of some human materials and models, cat dissection, and exercises in human physiology. 3 hours lecture, 2-3 hours laboratory. (Lab fee \$65.)

LS231 Human Growth and Development (3)

A study of human development across the lifespan from birth to death with emphasis on the physical, cognitive,

emotional and social aspects of human life. Pre-Nursing

LS252 Cell Biology (4)

The molecular basis for the various structures and physiological functions of prokaryotic and eukaryotic cells. Topics include membrane structure-function, cellular energetics, receptors and cell-cell communication. 3 hours lecture, 3 hours laboratory. Concurrent laboratory registration required. *Prerequisite* CH151, LS151. (Lab fee \$65.)

LS302 Vertebrate Anatomy and Systematics (4)

A study of chordate systematics, comparative anatomy and morphogenesis. 3 hours lecture, 3 hours laboratory. *Prerequisite*: LS151. (Lab fee \$65.)

LS306 Developmental Biology (4)

Students become familiar with the stages of fertilization and the early developmental patterns of representative animals. Emphasis is placed on the genetic basis of differential gene expression during the various stages of development. The lab involves microscopic examination of prepared serial slides of frog, chick, and pig embryos at various stages of development. 3 hours lecture and 2 hours lab. *Students are expected to be enrolled in the lecture concurrently. Prerequisite*: LS252 Cell Biology. (Lab fee \$65)

LS312 Animal Physiology (4)

Animal physiological systems and regulatory mechanisms are studied in the context of various types of ecosystems. Consideration is given to regulatory adjustments to seasonal and environmental variations within an ecosystem. Laboratory is a research oriented study of the physiological adjustments of invertebrates and amphibians in seasonal streams, and laboratory studies of invertebrates. 3 hours lecture and 3 hours lab. (Lab Fee\$65)

LS318 Conservation Biology and Sustainability (4)

This is a comprehensive study of ecological legal issues and the stewardship of sustainability of ecological quality of life and diversity. The bulk of the laboratory will be outdoors. 3 hours lecture, 3 hours laboratory and field work. *Prerequisite* LS341. (Lab fee \$65.)

LS321 Human Anatomy (4)

A study of human micro and gross anatomy from a systematic approach. The laboratory consists of the use of human models, cats, mammalian body parts and human histology slides. 3 hours lectures and 2 1/2 hours lab. (Lab Fee \$65)

LS332 Population Genetics (4)

Classic Mendelian genetics and non-Mendelian genetics are covered in the context of populations in their natural environment. Genetic variations within populations and their impacts upon acclimatizations are studied in detail. Modern molecular genetics are used in identification of

pure lines and population interactions. The laboratory involves the study of *Drosophila melanogaster* populations and identification of allelic frequencies in successive generations and non-Mendelian interactions.

LS341 Ecology (4)

Organisms in relation to the environmental complex; the composition, dynamics succession and growth of plant and animal communities including field study. 3 hours lecture, 3 hours laboratory. *Prerequisites*: LS140 or LS151 and MA262. (Lab fee \$65.)

LS342 Genetics (4)

Serves as an introduction to Mendelian, non-Mendelian and modern molecular genetics. Topics covered include, but are not limited to, fundamental aspects of inheritance, bacterial and viral genetics, chromosomal linkage and mapping in pro-and eukaryotes, DNA structure, DNA metabolism and gene expression. The lab includes experiments in transduction, conjugation, transformation, plasmid prep, restriction analysis, cloning, polyacrylamide and agarose gel electrophoresis and others. 3 hours lecture and 3 hours lab. *Prerequisite*: LS252 (Lab fee \$65)

LS348 Biological Field Studies (3-4)

The topics for this course are usually taken from wildlife biology, conservation biology, freshwater biology and marine biology depending upon demand. It also includes courses taught at the Au Sable Institute of Field Biology. The course may be repeated for credit with different topics. *Prerequisite*: LS341. (Lab fee \$65 if taken for lab credit.)

LS352 Advanced Physiology (3)

Is designed for pre-medical, pre-dental, and pre-veterinarian students. The course starts with aspects of cellular physiology, particularly cell transport and osmosis, then endocrine physiology with particular attention paid to cell-surface receptors and second messenger pathways, then physiology of each of the following systems: neural, skeleto-muscular, cardiovascular, respiratory, renal/acid-base, gastrointestinal and reproductive are covered. Particular attention is given to the regulation of these systems and their integration into a functioning whole. Computer simulations of various physiological processes involving these systems are performed. 3 hours lecture. *Prerequisite* LS252

LS361 Immunology (4)

Topics include the adaptive and innate immune systems and cell biology of cells and tissues involved in immunity, immunogenetics, antibody structure-function, immunotechniques, complement, autoimmunity, tolerance and tumor immunology. 3 hours lecture, 3 hours laboratory. *Prerequisite*: LS252. (Lab fee \$65.)

LS362 Medical Microbiology (4)

The classification, cultivation, physiology, growth, morphology, genetics and economic significance of microorganisms with special emphasis on the pathogenic bacteria. 3 hours lecture, 3 hours laboratory. (Lab fee \$65.)

LS372 Origins (3)

An introduction to the classical and modern concept of evolution with critical discussion of proposed mechanisms involved and with evaluation of special creation and other alternative origins positions. *Prerequisite: LS252.*

LS388 Special Topics in Plant Sciences (2-4)

Basic principles, processes, and theories of the topic being presented. Possible topics include medicinal plant biology, economic botany, herbaceous plants or specific taxonomic plant groups. Instruction is by lecture, laboratory, class project or combination. This course may be repeated for credit with varying topics. *Prerequisite: Junior standing*

LS418 Tutorial Studies (1)

This course will consist of topics not included in the regular curriculum. This course may be based upon independent studies, conferences and the preparation of a term paper. The topic of the course will be announced prior to the term in which it is to be offered. *Prerequisite: permission of the instructor. Offered upon demand. May be repeated for credit with varying topics.* (Lab fee possible.)

LS420 Senior Seminar in Biology (1)

Designed to give students the experience in presenting a scientific study to an audience of their peers. Students prepare and present two professional 25 minute visual presentations to students and faculty. One presentation is in the area of biochemistry/cell biology/molecular biology and the other in the area of ecology/population biology/ evolution/ wildlife biology. Information for the presentation is derived from reading the primary literature

LS422 Senior Capstone (1)

Designed to review major concepts that are foundational to the life sciences. It also serves as a prelude to the major field exam given toward the end of the semester.

LS428 Research in Biology (3-4)

Library and laboratory study on various topics in contemporary biology to be selected. Report required. (Lab fee possible.)

LS464 Molecular Biology (3)

A lecture course which covers nucleic acid structure, replication and metabolism. The course focuses particular attention on various aspects regarding the regulation of gene expression both in prokaryotes and eukaryotes. Including examinations of epigenetic factors involved in gene regulation. Additionally, attention is given to the theory and underlying principles for many of the popular

techniques used in studying DNA/RNA, gene regulation and expression. *Prerequisite: LS342 Genetics*

CHEMISTRY**CH151 General Chemistry I (4)**

A course covering fundamental chemical principles and theories. Topics include properties and states of matter, development of atomic theory, atomic structure and periodicity, chemical bonding, stoichiometry, inorganic nomenclature and chemical reactions. 3 hours lecture, 3 hours laboratory. (Lab fee \$65.)

CH152 General Chemistry II (4)

A continuation of CH151: an introduction to solution equilibria, electrochemistry, kinetics, chemical thermodynamics, organic chemistry, nuclear chemistry and environmental chemical applications. 3 hours lecture, 3 hours laboratory. *Prerequisite: CH151 or its equivalent with a grade of C or better.* (Lab fee \$65.)

CH351 Organic Chemistry I (4)

Introduction to the chemistry of carbon-containing compounds. Particular emphasis is given to Lewis acid-base theory and structure-reactivity relationships as predictive tools. The chemistry of aliphatic hydrocarbons, stereochemistry, alkenes, alkynes, substitution and elimination reactions, radicals, alcohols and ethers is discussed. 3 hours lecture, 3 hours laboratory. *Prerequisites include CH152 or its equivalent with a C or better.* (Lab fee \$65.)

CH352 Organic Chemistry II (4)

A continuation of CH351: conjugated systems, aromatic compounds and their reactions, spectroscopy, synthesis and reactions of carbonyl compounds, including carboxylic acids, esters, amides, beta-dicarbonyl compounds, phenols, and amines. The philosophy of organic synthesis and a brief introduction to natural products and biochemistry are included. 3 hours lecture, 3 hours laboratory. *Prerequisite: CH351 or its equivalent with a grade of C or better.* (Lab fee \$65.)

CH461 Biochemistry (4)

Proteins, structures and functions, and enzymes, kinetics and regulation, as well as biological oxidation-reduction, thermodynamics of living systems and a focus on intermediary metabolism and its integration and regulation. Laboratory includes application of the theory underlying many common biochemical techniques, including chromatography, enzyme assaying, binding specificity of proteins, enzyme kinetics, protein fingerprinting among others. 3 hours lecture and 3 hours lab. Concurrent laboratory registration required. *Prerequisite: CH352 (Lab fee \$65)*

CH463 Biochemistry (4)

Investigates proteins: structures and functions, enzymes: kinetics and regulation, biological oxidation-reduction and thermodynamics of living systems. Particular attention is given to the integration and regulation of intermediary metabolism. In the lab students learn the theory underlying many common biochemical techniques. Students also gain practical, hands-on experience for several of these techniques such as gel filtration chromatography, ion exchange chromatography, affinity chromatography, thin-layer chromatography techniques in enzyme kinetic assays, determination of the binding specificity of proteins, protein fingerprinting, SDS-PAGE and molecular weight determination, agarose gel electrophoresis, peptide mapping and Western blotting. 3 hours lecture and 3 hours lab. *Concurrent laboratory registration required. Prerequisite: CH352 Organic Chemistry II (Lab Fee \$65).*

PHYSICAL SCIENCE**PS222 Earth Science for Elementary Teachers (2)**

A general survey of the Earth as a planet in the Solar System, its interior and a study of its crust and atmosphere. This course is designed to meet the requirements of liberal studies students seeking a teaching credential. 2 hours lecture. *Prerequisite: approval of instructor or teacher education department*

PS231 Physical Science for Elementary Teachers (2)

A survey of topics from the physical sciences including areas of study relating to modern problems and advances in science and technology. This course is designed to meet the requirements of liberal studies students seeking a teaching credential. 2 hours lecture. *Prerequisite: approval of instructor or teacher education department.*

PS242 Earth Science (4)

A survey of the Earth as a planet in the Solar System, its interior and a detailed study of its crust and atmosphere to serve as a broad-based course for liberal studies majors. Fulfills the general education laboratory science requirement. 3 hours lecture, 3 hours laboratory. (Lab fee \$65.)

PS251 General Physics I (4)

A calculus-based introduction to classical physics including Newton's laws of motion, work, energy, power, conservation laws and classical waves. 3 hours lecture, 3 hours laboratory. *Prerequisite: MA121 (may be taken concurrently).* (Lab fee \$65.)

PS252 General Physics II (4)

A continuation of PS251. Topics include electricity, magnetism and optics. 3 hours lecture, 3 hours laboratory. *Prerequisite: MA121.* (Lab fee \$65.)

PS261 Physical Science (4)

A treatment of topics from the physical sciences to serve as a broad-based course for liberal studies majors. Course will cover a broad area of study relating to modern problems and advances in science and technology. 3 hours lecture, 3 hours laboratory. Fulfills the general education laboratory science requirement. (Lab fee \$65.)

PS338 Astronomy (4)

Methods of measurement and observation in astronomy are studied from a historical perspective. The solar, stellar and galactic systems are studied in detail accompanied by observations. Various cosmological viewpoints and their underlying assumptions are presented. 3 hours lecture, 3 hours laboratory. (Lab fee \$65)

LS420 Senior Seminar in Biology (1)

Designed to give students the experience in presenting a scientific study to an audience of their peers. Students prepare and present two professional 25 minute visual presentations to students and faculty. One presentation is in the area of biochemistry/cell biology/molecular biology and the other in the area of ecology/population biology/ evolution/ wildlife biology. Information for the presentation is derived from reading the primary literature in these two areas and choosing one paper in each to present. Alternatively, a student may present original laboratory research they have done at TMC. The presenter must do background literature research for their topic and be able to address questions asked by the class or professor. *Students must have a senior status.*

