BIOLOGY

FACULTY:
Marilyn Loveless, Chair
Patrick Crittenden
Dean Fraga (on leave 2013-2014)
Julie Heck
Seth Kelly
Richard Lehtinen
Sharon Lynn
William Morgan
Laura Sirot (on leave Spring 2014)
Craig Stevens
Stephanie Strand
James West

Biologists seek to understand the living world in all of its complexity through scientific methods of inquiry. The Department of Biology includes a group of committed faculty with expertise in diverse fields and sub-disciplines. Our curriculum provides majors with opportunities to explore the full breadth of biological organization and provides experiential learning opportunities that enhance students' understanding of content and techniques, as well as the strengths and limitations of scientific methods of inquiry.

The Biology curriculum is designed to give students a strong background in fundamental concepts of biology at the cellular, organismal, and population levels as well as the tools for understanding and carrying out biological research. Student-generated investigations are built into the structure of courses throughout the Biology curriculum beginning in the Gateway courses and continuing through Independent Study. Students collaborate and communicate with peers and faculty as they progress through their courses and Independent Study. These opportunities develop students' oral and written communication skills as well as their capacity for self-education and problem-solving. These abilities, combined with a liberal arts education, are essential for remaining competitive in the rapidly developing life sciences.

Through its curriculum, the Biology Department seeks to develop students who:

- comprehend foundational and unifying biological principles and their implications;
- retain the knowledge essential to a broad understanding of Biology;
- are familiar with scientific methods of inquiry and the philosophy of science, including methodologies for distilling biological information;
- are able to design and conduct an independent scientific investigation;
- can use scientific information to make reasoned decisions and critically evaluate the work of others;
- are able to communicate scientific information effectively;
- show evidence that they understand how knowledge changes; and
- are motivated to think, study and learn independently.

Major in Biology

Consists of fourteen courses:

- CHEM 12000
- One of the following courses: MATH 10700, 11100, CHEM 21100, PHYS 10100, or 20300
- BIOL 20000
- BIOL 20100

- BIOL 20200
- BIOL 20300
- Five elective 300-level Biology courses with at least three of them having laboratory components and at least one course from each of the two major subdivisions of biology
- Junior Independent Study: BIOL 40100
- Senior Independent Study: BIOL 45100
- Senior Independent Study: BIOL 45200

Minor in Biology

Consists of six courses:

- BIOL 20000
- BIOL 20100
- BIOL 20200
- Three elective 300-level Biology courses, one of which must have a laboratory component

Special Notes

- **The Breadth Requirement:** The Department of Biology feels that Biology majors should appreciate and understand a range of topics studied in the field of biology. Students are introduced to a diversity of biological topics in our Gateway course sequence (BIOL 20100 and 20200) and then develop additional depth in each subdivision by completing at least one course from each of the two major subdivisions, as organized below. Students are strongly recommended to complete the breadth requirement before beginning BIOL 45100 so that they can incorporate a range of biological concepts and tools into their Independent Study thesis project.

Molecular and Cellular Biology	Ecology, Evolution, and Organismal Biology
BIOL 30400. Human Physiology	BIOL 31100. Natural History of Vertebrates
BIOL 30500. Cell Physiology	BIOL 32300. Natural History of Invertebrates
BIOL 30600. Genes and Genomes	BIOL 34000. Field Botany
BIOL 30700. Development	BIOL 34400. Comparative Animal Physiology
BIOL 33500. Microbiology	BIOL 35000. Population and Community Ecology
BIOL 36600. Immunology	BIOL 35200. Animal Behavior
BCMB 30300. Techniques in BCMB	BIOL 35600. Conservation Biology
BCMB 33100. Principles of Biochemistry	BIOL 37700. Behavioral Endocrinology
BCMB 33200. Biochemistry of Metabolism	
BCMB 33300. Chemical Biology	
NEUR 38000. Neurobiology	

- BIOL 36000 - *Evolution* synthesizes the major organizational levels in biology for a deeper understanding of this essential biological principle. Thus, BIOL 36000 is not applicable to either subdivision but does count for credit towards the major.
- The Foundations course, BIOL 20000, must be taken as the first course by all Biology majors (unless the student has received advanced placement credit). The Gateway courses (BIOL 20100, 20200) may be taken in any order but should be completed by the end of the sophomore year and before enrolling in Junior Independent Study. One or both of the Gateway courses is a prerequisite to each upper-level course, although a student may be admitted to an upper-level course by permission of the instructor without having completed the prerequisite, when justifiable.

- BIOL 20300 (Research Skills for Life Scientists) should be taken by prospective Biology majors in the fall of their sophomore year. BIOL 20000 and the Gateway courses (BIOL 20100 and BIOL 20200) are prerequisites for BIOL 20300, although one Gateway course may be taken concurrently with BIOL 20300. BIOL 20300 must be completed before enrolling in Junior Independent Study.
- CHEM 12000 must be taken before or with BIOL 20100 and is a prerequisite to several 300-level Biology courses; it should therefore be completed in the first year. Students should complete as many Biology courses as possible, but at minimum one 300-level course, before beginning Junior Independent Study.
- BIOL 40100 must be completed before the student enrolls in BIOL 45100, and is normally taken in the second semester of the junior year. Students planning a semester off campus should consult with a Biology adviser early in the planning stage. Off-campus study is best scheduled for the spring of the sophomore year or the fall of the junior year.
- Course sequence suggestions for majors:

First Year:	BIOL 20000, 20200 CHEM 11000, 12000
Sophomore Year:	BIOL 20100 and 20300 One or two 300-level electives
Junior Year:	BIOL 40100 Two 300-level electives
Senior Year:	BIOL 45100, 45200 One or two 300-level electives

- The Biochemistry and Molecular Biology courses (BCMB 30300, 33100, 33200, 33300) count toward the Biology major and minor and are considered Biology courses for purposes of determining departmental honors. BIOL 10000, 39500, 40000, 40200 and 40300 courses do not count toward the major or minor, nor do they apply to Honors calculations.
- Biology majors contemplating graduate or professional school are strongly encouraged to take a full year of Organic Chemistry (CHEM 21100, 21200), a full year of general physics (PHYS 10100, 10200 or 20300, 20400), AND at least one course in calculus.
- **Laboratory Grade Policy:** Biology courses with a laboratory will receive one grade that reflects performance in the classroom and laboratory components; the relative weight of the two components will be stated in each course syllabus. Because the Registrar requires a grade for both the course and the laboratory, the course grade and the laboratory grade recorded on student transcripts will be identical.
- **Advanced Placement:** Students receiving a score of 5 on the Advanced Placement Examination in Biology will receive credit for *Foundations of Biology* (BIOL 20000). With a score of 4 on the Biology AP exam a student can receive one course credit in BIOL 10000 *Topics in Biology*, or upon successful completion of the Biology Placement exam may receive one course credit for *Foundations of Biology* (BIOL 20000). Advanced placement credit cannot be substituted for any other Biology courses than those specified above. To receive appropriate

Biology credit for AP scores, please contact the Chairperson of the Biology department. The advanced placement policy of the College is explained in the section on *Admissions*.

- **Off-Campus Study:** Off-campus study can be a valuable and enriching part of the college curriculum, and we encourage our students to consider off-campus study as a means of augmenting and enhancing their study of biology. Students who would like to include this in their program of study are encouraged to talk with a departmental faculty member in their first year, and to think about scheduling choices that would make this possible. Biology courses taken at other institutions may count toward the major for up to two 300-level courses. Students should discuss their proposed course electives with the department chair prior to their study-abroad experience (or prior to enrolling in courses at other institutions), to determine whether the courses are equivalent to Wooster courses, and whether they will count toward the major.
- **Non-Science Majors:** Biological information has become increasingly important as citizens face crucial decisions on such issues as the environment, emerging diseases, genetic engineering, and our aging population as well as debate ethical questions rooted in science. To gain an appreciation of how biologists approach and understand life processes, non-science majors may enroll in either *Topics in Biology* (BIOL 10000) or *Foundations of Biology* (BIOL 20000). *Topics in Biology* (BIOL 10000) courses address specific topical issues in applied biology on a rotating basis (see catalogue description). *Foundations of Biology* (BIOL 20000) is intended as an entry course for students considering a major in one of the Biological Sciences, and focuses on a serious study of the conceptual underpinnings of genetics and evolution as they relate to the field of biology. For students interested in a more extensive laboratory experience, BIOL 20100 or 20200 would be appropriate after first completing BIOL 20000.
- A maximum of fifteen courses (including BCMB 30300, 33100, 33200 and 33300) from the Department of Biology may count toward the College's thirty-two course graduation requirement.
- Students are not permitted to count any courses taken for S/NC credit towards the major or minor.
- A student must earn a grade of C- or higher for a course to count toward the major or minor.

BIOLOGY COURSES

BIOLOGY FOR THE NON-SCIENCE MAJOR

BIOL 10000-10005. TOPICS IN BIOLOGY (some sections cross-listed with: **Communication, Environmental Studies, Neuroscience**)
The course focuses on a selected topic in biology in order to demonstrate fundamental principles of biology and/or how biology influences human society. The precise nature of the topic will vary from year to year, but in general will focus on a clearly defined topic in biology, often with some discussion of how the topic intersects with human society. Topics taught in the past have included the following: human inheritance, disease, tropical biology, neuroscience, human ecology, animal behavior, and insect biology. All sections of the course are suitable for non-science majors and will feature discussion and lecture formats. *(1.0 course credits) Annually. [MNS]*

BIOLOGY FOR THE SCIENCE MAJOR

BIOL 14200. TROPICAL FIELD BIOLOGY
This course is an introduction to the ecology and conservation of tropical environments and their biota. Through lectures, field experiences and an independent research project, students will learn about such topics as ecological interactions, the natural history of locally important plant and animal species, biodiversity dynamics and human impacts on tropical ecosystems. Students will also receive instruction in data analysis and methodology in field biology. The course is taught in a tropical location during the summer for three intensive weeks. *Note: Biology majors seeking major credit will be required to complete additional assignments. (1.0 course credits) Summer. [MNS]*

BIOL 20000. FOUNDATIONS OF BIOLOGY (Biochemistry and Molecular Biology, Environmental Studies, Neuroscience)
This introductory course focuses on concepts considered central to understanding biology, including the nature of science, inheritance, gene expression, descent with modification and evolution by natural selection. This course is designed to provide potential biology majors with the fundamental concepts required for the study of biology. The course serves as a prerequisite for all biology courses numbered higher than 20000. Three class hours weekly. The course is also open to non-majors. *(1.0 course credits) Annually. Fall and Spring. [MNS]*

BIOL 20100. GATEWAY TO MOLECULAR AND CELLULAR BIOLOGY (Biochemistry and Molecular Biology, Neuroscience)
This course serves as an introduction to the major concepts in the fields of molecular and cellular biology. Topics include cellular structure, bioenergetics, metabolism, biosynthesis, photosynthesis, cell division and growth, and molecular genetics. In laboratory, students will learn specific laboratory techniques and will gain experience interpreting and communicating experimental results. This course is a pre-requisite for many upper level biology courses and must be completed with a C- or better before enrolling in BIOL 40100. *(1.25 course credits) Prerequisite: C- or better in BIOL 20000 and previous or concurrent registration in CHEM 12000. Annually. Fall and Spring. [Q, MNS]*

BIOL 20200. GATEWAY TO ECOLOGY, EVOLUTION, AND ORGANISMAL BIOLOGY (Environmental Studies)
An introduction to the major concepts in the fields of ecology, evolution, behavior and physiology. These biological disciplines are approached from the population and individual levels of biological organization. Through lecture, laboratory, in-class exercises and readings, this course focuses on individual organisms, and on as their behavior, interactions, evolution, and conservation. This course is a pre-requisite for many upper level biology courses and must be completed with a C- or better before enrolling in BIOL 40100. Three class hours and one laboratory period weekly. *(1.25 course credits) Prerequisite: C- or better in BIOL 20000. Annually. Fall and Spring. [W, Q, MNS]*

BIOL 20300. RESEARCH SKILLS FOR LIFE SCIENTISTS
This course is an introduction to experimental design, data analysis and other important research skills in the life sciences. In addition to sound statistical and experimental practice, emphasis will also be placed on other important skills for life scientists such as how to find and read the literature and how to communicate scientific information effectively. Covered topics also include descriptive statistics, probability theory and many of the commonly used parametric and non-parametric statistical tests. A final group project will allow students to apply what they've learned by designing, carrying out, analyzing and interpreting data from an original research project of their design. *Prerequisites: C- or better in BIOL 200, BIOL 201 and BIOL 202. Note: Students may also register for this course if they have two of the three prerequisites and are concurrently registered for the third. Annually. Fall.*

BIOL 30400. HUMAN PHYSIOLOGY (Biochemistry and Molecular Biology, Neuroscience)
This course focuses on human physiology at the cellular and organ system levels. An emphasis is placed on neural control of movement, metabolism and organ system function. Topics include studies of nerves and muscle excitability, regulation of heart rate and blood pressure, respiration, and renal control of salt and volume. *(1.0 course credits) Prerequisite: C- or better in BIOL 20100 and CHEM 12000. Annually.*

BIOL 30500. CELL PHYSIOLOGY (Biochemistry and Molecular Biology, Neuroscience)
This course focuses on the cellular and molecular basis for complex physiological processes such as aging, disease pathologies, tissue formation and maintenance, and intracellular communication. Specific concepts covered include, signal transduction, membrane biology, cell division, maintaining cellular organization, and motility. The laboratory will include student-led investigations, using model organisms to explore complex cellular processes. Three lectures and one laboratory/discussion section a week. *(1.25 course credits) Prerequisite: C- or better in BIOL 20100 and CHEM 12000 or permission of the instructor. Annually. Fall and Spring. [W†]*

BIOL 30600. GENES AND GENOMES (Biochemistry and Molecular Biology, Neuroscience)
Genetic analysis has been transformed by the ability to investigate not only single genes, but also complete genomes. This course examines the structure, function, and variation of genes and genomes and provides an introduction to the fundamental methodologies for the modern analysis of genes and genomes. Three classroom meetings and one laboratory/recitation period weekly. *(1.25 course credits) Prerequisite: C- or better in BIOL 20100 and CHEM 12000 or permission of instructor. Annually. Fall and Spring.*

BIOL 30700. DEVELOPMENT (Biochemistry and Molecular Biology, Neuroscience)
Consideration of selected developmental programs, especially those of multicellular animals, with particular reference to molecular and cellular phenomena involved in determination, morphogenesis and differentiation.

Descriptive and analytical laboratory experience. Three lectures weekly. *(1.0 course units) Prerequisite: C- or better in CHEM 12000 and BIOL 20100 or permission of instructor. Annually. Fall.*

BIOL 31100. NATURAL HISTORY OF THE VERTEBRATES
This course covers the major lineages of extinct and extant vertebrates. Emphasis in lecture is on ecology, behavior, conservation and the evolutionary history of each clade. The laboratory component has two foci: field based experiences (accommodated through numerous field trips) and identification. Students will learn to identify many common vertebrates of Ohio by sight and sound. Three classroom meetings and one laboratory period weekly. One and one-fourth course credits. *(1.25 course credits) Prerequisite: C- or better in BIOL 20200 or permission of instructor. Annually. Spring.*

BIOL 32300. NATURAL HISTORY OF THE INVERTEBRATES
More than 1,000,000 species of invertebrates swim, crawl, fly, and float upon the earth. What explains this incredible diversity? In this course, we will investigate the diverse and fascinating world of invertebrates with emphases on ecology, behavior, evolutionary history, and conservation. The laboratory-field period of the course will emphasize identification of taxonomic groups and exploring the rich ecology and behavior of invertebrates in their natural environment. Three classroom meetings and one laboratory-field period weekly. (1.25 course credits). *Prerequisite: C- or better in BIOL 20200 or permission of instructor. Alternate years. Fall.*

BIOL 33500. MICROBIOLOGY (Biochemistry and Molecular Biology)
Study of the morphology, classification, physiology, biochemistry, and genetics of bacteria and viruses, and resistance to diseases caused by these organisms. The laboratory provides training in current technology using bacteria and viruses. Three classroom meetings and two laboratory periods. Recommended: Organic Chemistry. *(1.25 course credits) Prerequisite: C- or better in CHEM 12000 and BIOL 20100 or permission of instructor. Annually. Spring.*

BIOL 34000. FIELD BOTANY AND SYSTEMATICS
Introduction to the principles of field botany and plant systematics. Topics covered include floral and vegetative morphology, plant family characteristics, the use of keys, and basic collecting techniques. We will discuss current methods of biological systematics, traits useful for making phylogenetic inferences, and the evolutionary history of vascular plant groups, especially angiosperms. Topics will include floral biology and pollination, hybridization and speciation, molecular phylogenetics, ethnobotany, and biogeography. Three classroom meetings and one laboratory weekly. *(1.25 course credits) Prerequisite: C- or better in BIOL 20200. Alternate years. Fall.*

BIOL 34400. COMPARATIVE ANIMAL PHYSIOLOGY (Neuroscience)
A detailed study of selected aspects of the physiological ecology of vertebrates and invertebrates, with emphasis on circulatory systems, respiratory systems, energetics, thermoregulation, salt and water balance, and chemical regulation. The laboratory component emphasizes techniques in organismal physiology and experimental design. Three classroom meetings and one lab meeting weekly. *(1.25 course credits) Prerequisite: C- or better in BIOL 20100 and 20200 and in CHEM 12000 or permission of instructor. Annually.*

BIOL 35000. POPULATION AND COMMUNITY ECOLOGY (Environmental Studies)
A study of ecological principles as they apply to populations, communities, and ecosystems. Topics include physiological ecology, population growth, competition, predation, community structure, patterns of energy and nutrient cycling, and species diversity. Laboratory exercises emphasize experimental techniques used to investigate ecological questions. Three classroom meetings and one laboratory weekly. *(1.25 course credits) Prerequisite: C- or better in BIOL 20200 or permission of the instructor. Annually. Fall.*

BIOL 35200. ANIMAL BEHAVIOR (Environmental Studies, Neuroscience)
Why do animals behave the way they do? In this course, we will study this question from a variety of angles including: development, mechanistic causes, functional significance, and evolution. We will draw examples from a wide taxonomic spectrum of animals. The laboratory-field period of the course will emphasize how to address animal behavior questions by involving students in studies in which they learn techniques and tools used for observation, experimental design, conducting experiments, and analyzing and presenting results. Three classroom meetings and one laboratory-field period weekly. *(1.25 course credits) Prerequisite: C- or better in BIOL 20200, or permission of the instructor. Annually. Spring.*

BIOL 35600. CONSERVATION BIOLOGY (Environmental Studies)
This course examines the theory, methods, and tools by which biologists attempt to understand and to protect biological habitats and their attendant natural populations of organisms. Topics included demographic and genetic conservation, invasive species, fragmentation and habitat loss, design of nature reserves, management for conservation, and sustainable development within a conservation context. We also examine economic, social, and political pressures that influence conservation decision-making. Laboratory exercises include com-

puter simulations, field trips, and group projects. Three classroom meetings and one three-hour laboratory weekly. *(1.25 course credits) Prerequisite: C- or better in BIOL 20200, and C- or better in one 300-level class in ecology or organismal biology prior to enrolling. Alternate years. Spring.*

BIOL 36000. EVOLUTION (Geology)
This course provides an in-depth introduction to evolutionary theory using both molecular and organismal approaches. Topics include: natural and sexual selection, population genetics, speciation, phylogenetics, and adaptation. The history of evolutionary thought and its place in human tradition will also receive emphasis. Three classroom meetings weekly. *(1.0 course credits) Prerequisite: C- or better in BIOL 20100 and 20200 or GEOL 25000 and BIOL 20200 or permission of instructor. Annually. Fall.*

BIOL 36600. IMMUNOLOGY
This course will investigate concepts in immunology from a physiological and molecular perspective. Topics to be covered include the lymphatic system and the lymphoid organs, immune cell development and function, antibody structure and function, specific and nonspecific response to infections, allergy, hypersensitivity and other immunological disorders, transplantation immunology, vaccination, and immunological applications in biotechnology. Laboratory exercises will focus on basic immunological techniques such as antibody-antigen interactions, antibody production, and cellular response to infection. Recommended: Organic Chemistry. *(1.0 course credits) Prerequisite: C- or better in CHEM 12000 and BIOL 20100 or permission of instructor. Annually. Fall.*

BIOL 37700. BEHAVIORAL ENDOCRINOLOGY (Neuroscience)
A study of the interrelationships of the endocrine system and behavior of animals. Topics include reproduction, parental behavior, aggression, biological rhythms, mood, and stress. Special emphasis will be placed on endocrine and neuroendocrine mechanisms of behavior. Laboratory exercises include an introduction to endocrine techniques, experimental investigations of hormones and behavior, and comparative anatomy of the endocrine system. Three hours of lecture and three hours of laboratory weekly. *(1.25 course credits) Prerequisite: C- or better in BIOL 20100 and BIOL 20200 or NEUR 38000/BIOL 38000, and in CHEM 12000, or permission of instructor. Annually. Fall or Spring.*

BIOL 39500-39505. SPECIAL TOPICS IN BIOLOGY
A seminar for advanced students in the life sciences to further explore interdisciplinary topics in biology, such as Biological Rhythms, Bioinformatics, Plant-Animal Interactions, and Biogeography. Prerequisites: Junior or senior standing with significant coursework in biology, as determined by the course instructor. This course does not count toward a major or minor in Biology. *(0.5 course credits) Offered as appropriate.*

BCMB 30300. TECHNIQUES IN BIOCHEMISTRY AND MOLECULAR BIOLOGY

BCMB 33100. PRINCIPLES OF BIOCHEMISTRY

BCMB 33200. BIOCHEMISTRY OF METABOLISM

BCMB 33300. CHEMICAL BIOLOGY

NEUR 38000. NEUROBIOLOGY (Biochemistry and Molecular Biology, Biology)
This course focuses on cellular and molecular aspects of nervous system function. Topics include functional implications and physiological basis of neuronal impulse conduction and neurotransmission, sensation and perception (e.g. pain and vision), neuronal plasticity, and the cellular and molecular basis of common neurological diseases. Three lecture periods and one laboratory period weekly. Recommended: one upper-level Biology course or NEUR 32300. *(1.25 course credits) Prerequisite: C- or better in BIOL 20100 and in CHEM 12000, or permission of instructor. Annually.*

BIOL 40000. TUTORIAL
Evaluation of the student's accomplishment will be based on a contract with the supervising professor. Normally, laboratory exercises constitute at least one-quarter of the tutorial. Students will apply to the departmental chair for this option. This course does not count toward a major or minor in Biology. *(0.5 - 1.0 course credits) Prerequisite: The approval of both the supervising faculty member and the chairperson is required prior to registration.*

BIOL 40100. INDEPENDENT STUDY AND BIOSTATISTICS
An introduction to the techniques and practices of biological research. One classroom meeting weekly will focus specifically on the design of experiments and the analysis of biological data. An additional weekly meeting with the student's advisor will focus on project design and exploration of the literature related to the proposed I.S. thesis. A written I.S. thesis proposal is due at the end of the semester. *Prerequisite: A grade of C- or better in BIOL 20000, 20100, 20200, 20300, and one 300-level Biology course. Annually.*

BIOL 45100. SENIOR INDEPENDENT STUDY – SEMESTER ONE
The thesis in Biology is based on a laboratory or field investigation in which data are collected and analyzed in comparison with the literature related to the project. A student should devote the same amount of time to the

research and the subsequent thesis in BIOL 45100 and 45200 as that required for two major laboratory courses. The work is ordinarily done in two terms, one of which may be completed in the summer session. Data may be collected off campus if suitable supervision can be arranged. Normally, a student will have one research adviser. *Prerequisite: BIOL 40100.*

BIOL 45200. SENIOR INDEPENDENT STUDY – SEMESTER TWO

The research adviser, together with a second professor, reads the thesis and conducts an oral examination of the student on the field of research. The evaluation of the thesis will be determined by these two readers in consultation with the department as a whole. *Prerequisite: BIOL 45100.*

BIOLOGY SEMINAR

The seminar series provides group experiences in oral communication and criticism. In addition to student presentations, guest speakers and departmental staff present their recent research activities. All students pursuing thesis research or enrolled in Independent Study courses are required to attend a weekly departmental seminar. Biology majors are urged to attend these seminars in anticipation of thesis research and as a means of broadening their perspectives.