BIOLOGY (Div III)

Chairs: Professor Steven Swoap (Fall) and Professor Lois Banta (Spring)


On leave Fall/Spring: Professor: J. Edwards. Assistant Professor: D. Turner.
On leave Fall only: Professors: L. Banta, M. Morales. Associate Professor: L. Maroja.
On leave Spring only: Professor: S. Swoap. Associate Professor: T. Lebestky.

The Biology curriculum has been designed to provide students with a broad base for understanding principles governing life processes at all levels, from biochemistry and cell biology to physiology to ecology and behavior. Courses emphasize fundamentals common to all sub-disciplines including the coupling of structure to function, the transfer of energy in living systems, communication, and the molding of diversity by the evolutionary process. In upper-level courses and in independent and honors research, students have the opportunity to investigate areas at the frontiers of modern biology.

Although the Biology major is specifically designed to provide a balanced curriculum in the broader context of the liberal arts, it is also excellent preparation for graduate studies in the life sciences and in the health professions.

MAJOR REQUIREMENTS

In order to make the major accessible to students with diverse interests, required courses are kept to a minimum. The Biology major is satisfied by nine courses, as follows:

- Biology 101 The Cell
- Biology 102 The Organism
- Biology 202 Genetics
- Any two 300-level courses, each of which must have a laboratory associated with it
- Any one 400-level course other than 493-494
- Any other three courses or any other two courses and two semesters of Organic Chemistry

Note: Independent study courses and AMS 311 (Same as Biology 231) do not fulfill the 300-level or 400-level course requirements. WIOX 316 Biology: Evolution, in the Williams Oxford Program qualifies for major credit at the 200-level.

Distribution Requirement

In order to ensure that majors broaden their knowledge of biology, one of the elective courses for the major must include an upper-level course covering biological processes at levels of organization above the cell. Courses that satisfy this distribution requirement are indicated in the individual course description.

COURSE SELECTION AND PLACEMENT

It is preferable for students who plan to major in biology, or think they may be interested in doing so, to take Biology 101, 102 during their first year at Williams. It is also possible to begin the Biology major during the sophomore year, although students should understand that it may require taking two or more biology courses during several semesters.

Students interested in biology, whether or not they intend to major in it, are encouraged to take Biology 101, 102. It is also possible, with permission of the instructor, to take Biology 203 Ecology, Biology 204 Animal Behavior and Biology 220 Field Botany without prerequisite. Other 100-level biology courses are designed specifically for students who do not intend to take additional upper-level courses in biology. All of these courses satisfy the Division III distribution requirement.

Beginning students should normally enroll in Biology 101 and 102. Students with unusually strong backgrounds in biology, such as those with outstanding performance on the College Board Biology Advanced Placement Test, may be permitted to elect a sophomore-level course in lieu of Biology 101 and/or Biology 102 upon successful completion of a departmental qualifying exam, administered during First Days.

COURSES RELATED TO THE BIOLOGY MAJOR

Students planning to pursue their interest in biology and related fields after completing their undergraduate degrees are strongly encouraged to
take one year of chemistry, at least one semester of mathematics (a course in statistics is recommended), and one semester of physics. Students may wish to check the requirements for graduate admission at relevant universities, and are also encouraged to consult with the Biology Department’s graduate school advisor about prerequisites for admission to graduate programs.

BIOCHEMISTRY AND MOLECULAR BIOLOGY
Students interested in Biochemistry and Molecular Biology (BIMO) should consult the general statement under Biochemistry and Molecular Biology.

BIOINFORMATICS, GENOMICS AND PROTEOMICS
Students interested in Bioinformatics, Genomics and Proteomics (BiGP) should consult the general statement under Bioinformatics, Genomics and Proteomics. Biology majors interested in this field are strongly encouraged to enroll in Integrative Bioinformatics, Genomics, and Proteomics (Biology 319).

NEUROSCIENCE
Students interested in Neuroscience (NSCI) should consult the general statement under Neuroscience.

PUBLIC HEALTH
Students interested in Public Health (PH) should consult the general statement under Public Health.

ENVIRONMENTAL STUDIES
Students interested in Environmental Studies (ENVI) should consult with Biology faculty members associated with the program and the general statement under Environmental Studies.

THE DEGREE WITH HONORS IN BIOLOGY
In order to be recommended for the degree with honors, a Biology major is normally expected to have completed the equivalent of two semesters and a winter study (031) of independent research culminating in a thesis which demonstrates outstanding achievement of an original and innovative nature. Although the presentation of a thesis and associated oral presentation in the fall and poster defense in the spring are required for consideration for a degree with honors, their completion should not be interpreted as a guarantee of a degree with honors. The principal considerations in admitting a student to the program of independent honors research will be mastery of fundamental material and skills, ability to pursue independent study successfully, and demonstrated interest and motivation. Students interested in participating in the honors program should consult with the department early in the spring semester of the junior year; approval must be received before spring registration in the junior year. The number of Biology Department faculty available to mentor research students and the number of students each can accommodate in her/his lab vary from year to year. Although the department will make every effort to provide an opportunity for students to conduct Honors research, you should be aware that it may not be possible to assign all applicants to a laboratory.

The minimum course requirements for a degree with honors in Biology are Biology 101, Biology 102, Biology 202, two 300-level biology courses (each of which must have a laboratory associated with it), one 400-level biology course, Biology 493, Biology 494, WSP 031, and any other two courses in biology (or any other one course and two semesters of Organic Chemistry). Note: A student who has a double major cannot count any course twice. For example, if a student is a Biology and Chemistry major, Organic Chemistry can only be counted in one of the two majors.

In addition to the normal honors route, which includes two semesters (Biology 493-494) and a winter study of research (WSP 031) during senior year, students have the option, subject to the approval of their thesis advisor, to begin the honors research during winter study junior year or during the second semester junior year. In general, thesis students who start during WSP or spring semester of their junior year are working on a project that requires winter or spring field work. Students beginning honors in winter study of junior year would take Biology 494 in the spring of their junior year followed by Biology 493 in the fall of their senior year; students beginning honors during the second semester of junior year would take Biology 494 that semester, followed by Biology 493 in the fall of senior year and winter study research in the winter of the senior year.

STUDY ABROAD
Students planning on majoring in Biology are strongly advised to take Biology 202 before going abroad, since Biology 202 is required for the major and is a prerequisite for many upper-level courses; a Genetics course taken while studying away cannot substitute for Biology 202. Biology majors studying abroad may receive credit toward the major for at most two 200-level electives; the departmental distribution requirement can be satisfied through an appropriate course taken during study abroad. Students should meet with the Department's study abroad advisor to discuss study abroad options.

FAQ
Students MUST contact departments/programs BEFORE assuming study away credit will be granted toward the major or concentration.

Can your department or program typically pre-approve courses for major/concentration credit?
Yes, in many cases, if appropriate course information is available in advance (e.g. syllabi and/or course descriptions), though students should be sure to contact the department. We usually want to see a syllabus.
What criteria will typically be used/required to determine whether a student may receive major/concentration credit for a course taken while on study away?

Course title and description, ideally complete syllabus including readings/assignments.

Does your department/program place restrictions on the number of major/concentration credits that a student might earn through study away?

Yes. Only two of the nine major course credits can be taken somewhere other than Williams.

Does your department/program place restrictions on the types of courses that can be awarded credit towards your major?

Yes. Courses taken for major credit anywhere other than Williams will only count as 200-level credit, regardless of the level or format of the course.

Are there specific major requirements that cannot be fulfilled while on study away?

Yes. BIOL 202 Genetics, 300-level lab courses, and 400-level senior seminar.

Are there specific major requirements in your department/program that students should be particularly aware of when weighing study away options? (Some examples might include a required course that is always taught in one semester, laboratory requirements.)

Yes. Genetics is only offered in the fall. Those late to the major need to be aware of this as Genetics is a prerequisite for most upper division courses.

Give examples in which students thought or assumed that courses taken away would count toward the major or concentration and then learned they wouldn’t:

Courses that are focused on clinical areas of study, and courses in environmental studies that focus on policy or sociology rather than biology, would not be granted credit in biology.

CREDIT FOR COURSES AT OTHER INSTITUTIONS

Students who enroll in study away programs may receive credit for up to two 200-level electives towards the biology major. Courses must be pre-approved by the Biology Department Study Away Advisor.

Students wishing to satisfy prerequisites for courses offered by the Biology Department with courses taken at other institutions should consult, in person, with a member of the Biology Department, prior to registering for the course that requires a prerequisite. Such consultations will include a review of the course syllabi and the transcripts of the relevant previous college work, and students should bring these materials with them.

RESEARCH AND THESIS COURSES

Individual research projects must be approved by the department. Application should be made to the department prior to spring registration.

Note: Senior thesis and independent study courses do not count as 300-level or 400-level course requirements for the major. Only one research course (i.e., BIOL 297, BIOL 298, BIOL 493, or BIOL 494) may be counted towards the major requirements.

BIOL 101 (F) The Cell

This course investigates cell structure and function as a consequence of evolutionary processes, and it stresses the dynamic properties of living systems. Topics include an introduction to biological molecules and enzyme action, membrane structure and function, energy exchange and design of metabolic systems, expression of genetic information, cell signaling, cell trafficking, the cell cycle, and cancer. Student-designed laboratory experiments and discussions based on primary biology literature will highlight how biological knowledge is created and understood.

Class Format: Lecture, 3 hours per week; laboratory and discussion, 3 hours per week

Requirements/Evaluation: evaluation will be based on hour tests, a final exam, lab reports, discussion assignments, and discussion participation

Extra Info: may not be taken on a pass/fail basis

Prerequisites: none

Enrollment Limit: 96/Lecture

Enrollment Preferences: first year students

Expected Class Size: 192

Distributions: (D3)

Attributes: BIMO Required Courses; NSCI Required Courses
BIOL 102 (S) The Organism
This course focuses upon the developmental and evolutionary processes that have given rise to a wide diversity of multicellular organisms. We consider many levels of biological organization, from molecular and cellular to individuals and populations in our examination of evolutionary concepts. Topics include meiosis and sexual reproduction, developmental and evolutionary mechanisms, and speciation with representative examples from a diversity of plants and animals. Readings are drawn from a variety of sources, including the recent primary literature.

Class Format: lecture/discussion/laboratory, six hours per week
Requirements/Evaluation: evaluation will be based on hour tests, a final exam and laboratory reports
Extra Info: may not be taken on a pass/fail basis
Prerequisites: BIOL 101 or permission of instructor
Enrollment Limit: none
Expected Class Size: 152
Distributions: (D3)
Attributes: BIMO Required Courses;

BIOL 133 (F) Biology of Exercise and Nutrition
This class, intended for the non-scientist, focuses on the impact of exercise and nutrition on the human body. We will discuss topics such as how different types of training influence exercise performance; the changes that occur in the cardiovascular system during an exercise routine; the inherent limits of the body to perform aerobic and anaerobic tasks; and the long-term health consequences of a lifetime of activity of inactivity. We will also examine how nutrition and metabolism affect body composition. For example, we will rigorously and scientifically scrutinize the use of "fad" diets as a means to lose weight.

Class Format: lecture 3 hours per week
BIOL 134 (S) The Tropics: Biology and Social Issues
Crosslistings: BIOL134 / ENVI134

Primary Crosslisting

Intended for the non-scientist, this course explores the biological dimensions of social issues in tropical societies, and focuses on specifically on the peoples and cultures of tropical regions in Africa, Asia, Latin America, Oceana, and the Caribbean. Tropical issues have become prominent on a global scale, and many social issues in the tropics are inextricably bound to human ecology, evolution, and physiology. The course begins with a survey of the tropical environment of humans, including major climatic and habitat features. The next section focuses on human population biology, and emphasizes demography and the role of disease particularly malaria and AIDS. The final part of the course covers the place of human societies in local and global ecosystems including the challenges of tropical food production, the importance of organic diversity, and the interaction of humans with their supporting ecological environment.

Class Format: lecture/debate, three hours per week

Requirements/Evaluation: evaluation will be based on two hour exams, a short paper, panel preparation, and a final exam

Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option

Prerequisites: none

Enrollment Limit: 60

Enrollment Preferences: seniors, juniors, sophomores, and first-year students--in that order

Expected Class Size: 60

Department Notes: does not count for major credit in Biology; does not satisfy the distribution requirement in the Biology major

Distributions: (D3)

Attributes: ENVI Natural World Electives; EVST Living Systems Courses; GBST African Studies Electives; PHLH Biomedical Determinants of Health; SCST Elective Courses

Not offered current academic year

BIOL 202 (F) Genetics (QFR)

Genetics, classically defined as the study of heredity, has evolved into a discipline whose limits are continually expanded by innovative molecular technologies. This course covers the experimental basis for our current understanding of the inheritance, structures, and functions of genes. It introduces approaches used by contemporary geneticists and molecular biologists to explore questions in areas of biology ranging from evolution to medicine. The laboratory part of the course provides an experimental introduction to modern genetic analysis. Laboratory experiments include linkage analysis, bacterial transformation with plasmids and DNA restriction mapping.

Class Format: lecture/laboratory, six hours per week

Requirements/Evaluation: evaluation will be based on bi-weekly problem sets, weekly laboratory exercises and laboratory reports, and examinations

Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option

Prerequisites: BIOL 101 and 102

Enrollment Limit: none

Expected Class Size: 84
**Department Notes:** does not satisfy the distribution requirement in the Biology major

**Distributions:** (D3) (QFR)

**Attributes:** BGNP Recommended Courses; BIMO Required Courses;

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**Fall 2018**

**LEC Section:** 01  
**Day & Time:** MWF 11:00 am - 11:50 am  
**Instructor:** David W. Loehlin

**LAB Section: 02**  
**Day & Time:** M 1:00 pm - 4:00 pm  
**Instructor:** Derek Dean

**LAB Section: 03**  
**Day & Time:** T 1:00 pm - 4:00 pm  
**Instructor:** Derek Dean

**LAB Section: 04**  
**Day & Time:** W 1:00 pm - 4:00 pm  
**Instructor:** Derek Dean

**LAB Section: 05**  
**Day & Time:** R 1:00 pm - 4:00 pm  
**Instructor:** Derek Dean

**BIOL 203 (F) Ecology**  
**Crosslistings:** BIOL203 / ENVI203

**Primary Crosslisting**

This course combines lectures with field and indoor laboratory exercises to explore factors that determine the distribution and abundance of plants and animals in natural systems. The course begins with an overall view of global patterns and then builds from the population to the ecosystem level. An emphasis is given to basic ecological principles and relates them to current environmental issues. Selected topics include population dynamics (competition, predation, mutualism); community interactions (succession, food chains and diversity) and ecosystem function (biogeochemical cycles, energy flow).

**Class Format:** lecture/laboratory, six hours per week

**Requirements/Evaluation:** evaluation will be based on problem sets, lab reports, hour exams, and a final exam

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** BIOL 101 and 102, or ENVI 101 or 102, or permission of instructor

**Enrollment Limit:** none

**Expected Class Size:** 35

**Department Notes:** satisfies the living system course requirement for the major in Environmental Studies; satisfies the distribution requirement in the Biology major

**Distributions:** (D3) (QFR)

**Attributes:** ENVI Natural World Electives; EVST Environmental Science; EVST Living Systems Courses;

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**Fall 2018**

**LEC Section:** 01  
**Day & Time:** MWF 10:00 am - 10:50 am  
**Instructor:** Ron D. Bassar

**LAB Section: 02**  
**Day & Time:** T 1:00 pm - 4:00 pm  
**Instructor:** Ron D. Bassar

**LAB Section: 03**  
**Day & Time:** W 1:00 pm - 4:00 pm  
**Instructor:** Ron D. Bassar

**BIOL 204 (S) Animal Behavior**

**Crosslistings:** NSCI204 / BIOL204

**Primary Crosslisting**

Making sense of what we see while watching animals closely is both an enthralling pastime and a discipline that draws on many aspects of biology. Explanations can be found on many levels: evolutionary theory tells us why certain patterns have come to exist, molecular biology can help us understand how those patterns are implemented, neuroscience gives insights as to how the world appears to the behaving animal, endocrinology provides information on how suites of behaviors are regulated. The first part of the course focuses upon how descriptive studies provide the basis for formulating questions about behavior as well as the statistical methods used to evaluate the answers to these questions. We then consider the behavior of individuals, both as it is mediated by biological mechanisms and as it appears from an evolutionary perspective. The second half of the course is primarily concerned with the behaviors of groups of animals from a wide variety of vertebrate and invertebrate species, concentrating upon the stimuli, responses, and internal mechanisms that maintain social systems and on the selection pressures that drive animals toward a particular
BIOL 205 (S) Physiology

This lecture-based course examines principles, patterns, and mechanisms of biological function from the level of cells and tissues to the whole organism. The themes of the course include structure and function, mechanisms of regulation, control and integration, and adaptation to the environment. Examples of these themes are taken from a wide variety of organisms with a focus on vertebrates. Laboratories provide practical experience in measurement and experimental elucidation of physiological phenomena and functional analysis of gross structure.

Requirements/Evaluation: evaluation will be based on hour exams, laboratory reports, and a final exam

Prerequisites: BIOL 101 and 102; open to first-year students with permission of the Biology department

Enrollment Limit: 72

Enrollment Preferences: seniors, then juniors, then sophomores

Expected Class Size: 72

Department Notes: satisfies the distribution requirement in the Biology major

Distributions: (D3)

Attributes: COGS Interdepartmental Electives; NSCI Group A Electives

Spring 2019

LEC Section: 01  MWF 9:00 am - 9:50 am  Matt E. Carter
LAB Section: 02  M 1:00 pm - 4:00 pm  Matt E. Carter
LAB Section: 03  T 1:00 pm - 4:00 pm  Matt E. Carter
LAB Section: 04  W 1:00 pm - 4:00 pm  Jenna L. MacIntire
LAB Section: 05  R 1:00 pm - 4:00 pm  Jenna L. MacIntire

BIOL 210 (S) Mathematical Biology (QFR)

Secondary Crosslisting

This course will provide an introduction to the many ways in which mathematics can be used to understand, analyze, and predict biological dynamics. We will learn how to construct mathematical models that capture essential properties of biological processes while maintaining analytic tractability. Analytic techniques, such as stability and bifurcation analysis, will be introduced in the context of both continuous and discrete time models. Additionally, students will couple these analytic tools with numerical simulation to gain a more global picture of the biological dynamics. Possible biological applications include, but are not limited to, single and multi-species population dynamics, neural and biological oscillators, tumor cell growth,
and infectious disease dynamics.

**Class Format:** tutorial

**Requirements/Evaluation:** problem sets, weekly meetings, final project and paper

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** MATH 250, MATH 209 or 309, permission of instructor

**Enrollment Limit:** 10

**Enrollment Preferences:** if over-enrolled, will have students submit reasons for taking class; preference to those with interest in both subjects

**Expected Class Size:** 10

**Distributions:** (D3) (QFR)

**Distribution Notes:** QFR: The course will introduce methods for developing and analyzing mathematical models.

**Attributes:** PHLH Methods in Public Health;

Spring 2019

**TUT Section:** T1 TBA Julie C. Blackwood

**BIOL 211 (S) Paleobiology**

Crosslistings: BIOL211 / GEOS212

**Secondary Crosslisting**

The fossil record is a direct window into the history of life on Earth and contains a wealth of information on evolution, biodiversity, and climate change. This course investigates the record of ancient life forms, from single-celled algae to snails to dinosaurs. In addition to the intellectual discovery of fossils as organic relics and the ways in which fossils have been used to support conflicting views on nature, geologic time, and evolution, we will cover a range of topics central to modern paleobiology. These include: how the fossil record informs our understanding of evolutionary processes including speciation; the causes and consequences of mass extinctions; how fossils help us tell time and reconstruct the Earth's climactic and tectonic history; statistical analysis of the fossil record to reconstruct biodiversity through time; analysis of fossil morphology to recreate the biomechanics of extinct organisms; and using fossil communities to reconstruct past ecosystems. Laboratory exercises will take advantage of Williams' superb fossil collections as well as published datasets to provide a broad understanding of fossils and the methods we use to study the history of life on Earth. We will also view a diversity of fossils in their geologic and paleo-environmental context on our field trip to Eastern New York.

**Class Format:** lecture/laboratory; field trip to the the Paleozoic of New York State

**Requirements/Evaluation:** evaluation will be based on lab assignments, short quizzes and writing assignments, and a final exam

**Prerequisites:** any 100-level GEOS course or BIOL 102, 203 or 205

**Enrollment Limit:** 15

**Enrollment Preferences:** sophomores and juniors

**Expected Class Size:** 12

**Department Notes:** does not satisfy the distribution requirement in the Biology major

**Distributions:** (D3)

**Attributes:** MAST Interdepartmental Electives

Spring 2019

**LEC Section:** 01 TR 9:55 am - 11:10 am Phoebe A. Cohen

**LAB Section:** 02 W 1:00 pm - 4:00 pm Phoebe A. Cohen

**BIOL 212 (F) Neuroscience**

Crosslistings: PSYC212 / BIOL212 / NSCI201

**Secondary Crosslisting**

A study of the relationship between brain, mind, and behavior. Topics include a survey of the structure and function of the nervous system, basic neurophysiology, development, learning and memory, sensory and motor systems, consciousness and clinical disorders such as schizophrenia,
autism, Parkinson's disease, and addiction. The laboratory focuses on current topics in neuroscience.

**Class Format:** lecture, three hours a week; laboratory, every other week

**Requirements/Evaluation:** evaluation will be based on a lab practical, lab reports, two hour exams and a final exam

**Extra Info:** not available for the fifth course option

**Prerequisites:** PSYC 101 or BIOL 101; open to first-year students only with permission of instructor

**Enrollment Limit:** 72

**Enrollment Preferences:** sophomores and Biology and Psychology majors

**Expected Class Size:** 72

**Department Notes:** does not satisfy the distribution requirement in the Biology major

**Distributions:** (D3)

**Distribution Notes:** meets Division 3 requirement if registration is under PSYC

**Attributes:** COGS Interdepartmental Electives; NSCI Required Courses; PSYC 200-level Courses

**Fall 2018**

LEC Section: 01    TR 9:55 am - 11:10 am    Heather Williams, Matthew M. Clasen

LAB Section: 02    M 1:00 pm - 4:00 pm    Martha J. Marvin

LAB Section: 03    T 1:00 pm - 4:00 pm    Martha J. Marvin

LAB Section: 04    W 1:00 pm - 4:00 pm    Martha J. Marvin

**BIOL 214 (S) Mathematical Ecology** (QFR)

Crosslistings: BIOL214 / MATH410

**Secondary Crosslisting**

Using mathematics to study natural phenomena has become ubiquitous over the past couple of decades. In this tutorial, we will study mathematical models comprised of both deterministic and stochastic differential equations that are developed to understand ecological dynamics and, in many cases, evaluate the dynamical consequences of policy decisions. We will learn how to understand these models through both standard analytic techniques such as stability and bifurcation analysis as well as through simulation using computer programs such as MATLAB. Possible topics include fisheries management, disease ecology, control of invasive species, and predicting critical transitions in ecological systems.

**Class Format:** tutorial

**Requirements/Evaluation:** written and programming assignments, oral presentations, and exams

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** MATH 250 or permission of instructor; Math 209 preferred

**Enrollment Limit:** 10

**Enrollment Preferences:** programming experience, students with interests in the intersection of math and biology

**Expected Class Size:** 10

**Department Notes:** Does not satisfy the distribution requirement in the Biology major

**Distributions:** (D3) (QFR)

**Attributes:** ENVI Natural World Electives; EVST Methods Courses; PHLH Methods in Public Health;

**Not offered current academic year**

**BIOL 219 (S) Dangerous Exposures: Environment, Immunity, and Infectious Disease** (WI)

Global reports of emerging infectious diseases and old diseases with new pathogenic properties incite fears for personal safety as well as national security. The specter of a contagious pandemic has captured the public imagination through the mass news media, movies, and even popular online and board games. In this tutorial course, we will explore the ecology and evolution of several recently emergent diseases such as Ebola hemorrhagic fever, dengue, and AIDS. Topics to be considered include transmission dynamics, epidemiological modeling of vaccination strategies, and wildlife reservoirs that contribute to human virus exposure. We will examine progress in preventing the parasitic disease malaria and why such diseases have proven so refractory. We will also discuss the science behind the recent development of the vaccine against the human papillomavirus, which causes
cervical cancer, and the intriguing and highly unusual transmissible cancers in dogs and Tasmanian devils. Finally, we will think about the
contributions of inadequate diagnostic capacities world-wide and broader issues of resource shortages in driving the global emergence of drug
resistance in tuberculosis and other diseases. One common theme in each of these case studies will be the interplay between the host immune
response and the evolution of the pathogen. Although the primary focus of the course is on biology rather than policy, each week's readings will have
implications for public health and/or conservation biology.

**Class Format:** tutorial

**Requirements/Evaluation:** six 4- to 5-page papers; tutorial presentations, and the student's progress towards intellectual independence and
creativity as a presenter and a respondent

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** BIOL 101 and 102

**Enrollment Limit:** 10

**Enrollment Preferences:** sophomores who have taken BIOL 202, students interested in public health

**Expected Class Size:** 10

**Distributions:** (D3) (WI)

**Attributes:** PHLH Biomedical Determinants of Health;

Spring 2019

TUT Section: T1  R 11:20 am - 2:00 pm   Lois M. Banta

**BIOL 220 (S) Field Botany and Plant Natural History**

**Crosslistings:** BIOL220 / ENVI220

**Primary Crosslisting**

This field-lecture course covers the evolutionary and ecological relationships among plant groups represented in our local and regional flora. Lectures
focus on the evolution of the land plants, the most recent developments in plant systematics, characteristics of plant families, and cultural-economic
uses of plants, especially native species. The labs cover field identification, natural history, and ecology of local species.

**Class Format:** lecture

**Requirements/Evaluation:** evaluation will be based on exams, field quizzes, field notebook and a class project

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** none

**Enrollment Limit:** 30

**Enrollment Preferences:** seniors, Biology majors, and Environmental Studies majors & concentrators

**Expected Class Size:** 25

**Department Notes:** satisfies the distribution requirement in the Biology major

**Distributions:** (D3)

**Attributes:** ENVI Natural World Electives; EVST Living Systems Courses; EXPE Experiential Education Courses; PHLH Nutrition,Food
Security+Environmental Health

Spring 2019

LEC Section: 01   MWF 9:00 am - 9:50 am   Henry W. Art

LAB Section: 02   T 1:00 pm - 4:00 pm   Henry W. Art

LAB Section: 03   W 1:00 pm - 4:00 pm   Henry W. Art

**BIOL 222 (S) Essentials of Biochemistry (QFR)**

This course will explore the biochemistry of cellular processes and contextualize these processes in healthy and diseased states. Lecture topics in this
one semester course will include the structure and function of proteins (enzymes and non-enzymatic proteins), lipids, and carbohydrates. Lectures will
also survey the major metabolic pathways (carbohydrates, lipids, and amino acids) with particular attention to enzyme regulation and the integration of
metabolism in different tissues and under different metabolic conditions. In the discussion/laboratory component of the course a combination of primary literature, hypothesis-driven exercises, problem solving, and bench work will be used to illustrate how particular techniques and experimental approaches are used in biochemical fields.

Class Format: lecture/discussion/laboratory, six hours per week

Requirements/Evaluation: regular quizzes, final exam, writing assignments (including problem sets), and lab assignments

Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option

Prerequisites: BIOL 101 and CHEM 156; not open to students who have taken BIOL 321 or BIOL 322

Enrollment Limit: 24

Enrollment Preferences: seniors who need to fulfill the biochemistry requirement for premedical school

Expected Class Size: 24

Department Notes: does not satisfy the distribution requirement for the major; cannot be counted towards the biology major in addition to either BIOL 321 or BIOL 322; cannot be counted towards the BIMO concentration

Distributions: (D3) (QFR)

Distribution Notes: QFR: The laboratory program is quantitative covering data analyses, numerical transformations, graphical displays.

Spring 2019

LEC Section: 01  MWF 11:00 am - 11:50 am  Daniel V. Lynch
LAB Section: 02  T 1:00 pm - 4:00 pm  Daniel V. Lynch
LAB Section: 03  W 1:00 pm - 4:00 pm  Daniel V. Lynch

BIOL 231 (F) Marine Ecology

Crosslistings: BIOL231 / MAST311

Secondary Crosslisting

Using the principles of evolutionary biology and experimental ecology, this course examines the processes that control the diversity, abundance and distribution of marine organisms. Major marine communities, including estuaries, the rocky shore, sandy beaches, salt marshes, coral reefs, and the deep sea are discussed in detail.

Class Format: lecture/laboratory, including coastal and near-shore field trips, 10 days offshore, and a laboratory or field research project

Requirements/Evaluation: two tests, a research project, and a presentation

Extra Info: offered only at Mystic Seaport

Prerequisites: BIOL 101 or GEOS/MAST 104, or permission of instructor

Distributions: (D3)

Attributes: ENVI Natural World Electives; EVST Living Systems Courses; EXPE Experiential Education Courses

Fall 2018

LEC Section: 01  TBA  Tim J. Pusack

Spring 2019

LEC Section: 01  TBA  Tim J. Pusack

BIOL 234 (S) Biology of our Sexes: The Genetic and Epigenetic Regulation of Sex Determination (WI)

Many physical and behavioral characteristics that are associated with male and female anatomy, physiology, and behavior are initially the products of molecular choices arising from the action of our chromosomes in early development. The embryonic assignment of sex can also lead to intersex or hermaphroditic outcomes in many different organisms with extraordinary and illuminating biological effects. We will explore the molecular mechanisms and evolutionary basis of sex determination in both plants and animals, as well as the physical and behavioral expression of sex by the organism discussed, and experiments that create and characterize traits and behavior of mosaic/intersex organisms. Additionally, the epigenetic regulation of the X chromosome in mammals has a canonical role in our understanding of sex determination, but whole genome studies and investigations of autosomes and the Y chromosome have raised new layers of complexity for understanding the molecular basis of human sex and sexuality.
Class Format: tutorial
Requirements/Evaluation: six 5-page papers; six 1-page response papers; tutorial presentations; discussion skills/investment
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: BIOL 202 (Genetics), or permission of instructor
Enrollment Limit: 10
Enrollment Preferences: sophomores and juniors, with preference to Biology majors
Expected Class Size: 10
Distributions: (D3) (WI)
Not offered current academic year

BIOL 297 (F) Independent Study: Biology
Biology 200-level independent study. Each student carries out independent field or laboratory research under the supervision of a member of the department.
Class Format: independent study
Distributions: (D3)

Fall 2018
IND Section: 01 TBA Joan Edwards

BIOL 298 (S) Independent Study: Biology
Biology 200-level independent study. Each student carries out independent field or laboratory research under the supervision of a member of the department.
Class Format: independent study
Distributions: (D3)

Spring 2019
IND Section: 01 TBA Joan Edwards

BIOL 302 (F) Communities and Ecosystems (QFR)
Crosslistings: BIOL302 / ENVI312
Primary Crosslisting
An advanced ecology course that examines how species interact with each other and their environment with a focus on conservation implications. This course emphasizes phenomena that emerge in complex ecological systems, building on the fundamental concepts of population biology, community ecology, and ecosystem science. This foundation will be used to understand specific topics relevant to conservation including the functional significance of diversity for ecosystem stability and processes. Lectures and labs will explore how to characterize the emergent properties of communities and ecosystems, and how theoretical, comparative, and experimental approaches are used to understand their structure and function. The lab component of this course will emphasize hypothesis-oriented field experiments but will also include some laboratory microcosm experiments. The laboratory component of the course will culminate with a self-designed independent or group project.
Class Format: lecture/laboratory, six hours a week
Requirements/Evaluation: evaluation will be based on lab reports, a midterm exam, a term project presentation, and a final project paper
Prerequisites: BIOL/ENVI 203 or 220
Enrollment Limit: 28
Enrollment Preferences: Biology majors and Environmental Studies majors and concentrators
Expected Class Size: 24
Department Notes: satisfies the distribution requirement in the Biology major
BIOL 305 (S) Evolution (QFR)

This course offers a critical analysis of contemporary concepts in biological evolution. We focus on the relation of evolutionary mechanisms (e.g., selection, drift, and migration) to long term evolutionary patterns (e.g., evolutionary innovations, origin of major groups, and the emergence of diversity). Topics include micro-evolutionary models, natural selection and adaptation, sexual selection, speciation, the inference of evolutionary history among others.

Class Format: lecture/discussion/laboratory, six hours per week

Requirements/Evaluation: evaluation will be based on independent research project, problem sets, participation in discussions and exams

Prerequisites: BIOL 202

Enrollment Limit: 24

Enrollment Preferences: Seniors and biology majors

Expected Class Size: 24

Department Notes: satisfies the distribution requirement in the Biology major

Distributions: (D3) (QFR)

Attributes: BGNP Recommended Courses; BIMO Interdepartmental Electives; COGS Related Courses;

Spring 2019

LEC Section: 01  MWF 10:00 am - 10:50 am  Luana S. Maroja
LAB Section: 02  W 1:00 pm - 4:00 pm  Luana S. Maroja
LAB Section: 03  R 1:00 pm - 4:00 pm  Luana S. Maroja

BIOL 308 (F) Integrative Plant Biology: Fundamentals and New Frontiers

Plants are one of the most successful groups of organisms on Earth and have a profound impact on all life. Successful use of plants in addressing global problems and understanding their role in natural ecosystems depends on fundamental knowledge of the molecular mechanisms by which they grow, develop, and respond to their environment. This course will examine the molecular physiology of plants using an integrative approach that considers plants as dynamic, functional units in their environment. Major emphasis will be on understanding fundamental plant processes, such as photosynthesis, growth and development, water transport, hormone physiology, and flowering, from the molecular to the organismal level.

Environmental effects on these processes will be addressed in topics including photomorphogenesis, stress physiology, mineral nutrition, and plant-microbe interactions. Discussions of original research papers will examine the mechanisms plants use to perform these processes and explore advances in the genetic engineering of plants for agricultural, environmental, and medical purposes. Laboratory activities stress modern approaches and techniques used in investigating plant physiological processes.

Class Format: lecture/discussion/laboratory, six hours per week

Requirements/Evaluation: evaluation will be based on lab reports, a term paper, and exams

Extra Info: may not be taken on a pass/fail basis

Prerequisites: BIOL 202

Enrollment Limit: 24

Enrollment Preferences: Biology majors

Expected Class Size: 24

Department Notes: satisfies the distribution requirement in the Biology major

Distributions: (D3)

Attributes: BIMO Interdepartmental Electives; PHLH Nutrition, Food Security + Environmental Health

Fall 2018
Development can be seen as a tradeoff between genetically-determined processes and environmental stimuli. The tension between these two inputs is particularly apparent in the developing nervous system, where many events must be predetermined, and where plasticity, or altered outcomes in response to environmental conditions, is also essential. Plasticity is reduced as development and differentiation proceed, and the potential for regeneration after injury or disease in adults is limited; however some exceptions to this rule exist, and recent data suggest that the nervous system is not hard-wired as previously thought. In this course we will discuss the mechanisms governing nervous system development, from relatively simple nervous systems such as that of the fruitfly, to the more complicated nervous systems of humans, examining the roles played by genetically specified programs and non-genetic influences.

Class Format: lecture
Requirements/Evaluation: exams
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: BIOL 212 (same as PSYC 212 or NSCI 201) and BIOL 202 (or permission of instructor)
Enrollment Limit: 24
Enrollment Preferences: Biology majors; Neuroscience concentrators; Psych majors
Expected Class Size: 24
Department Notes: does not satisfy the distribution requirement in the Biology major
Distributions: (D3)
Attributes: BIMO Interdepartmental Electives; NSCI Group A Electives
Not offered current academic year

This course will examine the functional organization of the vertebrate brain, emphasizing both neuroanatomy and neurophysiology. How do specific populations of neurons and their connections analyze sensory information, form perceptions of the external and internal environment, make cognitive decisions, and execute movements? How does the brain produce feelings of reward/motivation and aversion/pain? How does the brain regulate homeostatic functions such as sleep, food intake, and thirst? We will explore these questions using a holistic, integrative approach, considering molecular/cellular mechanisms, physiological characterizations of neurons, and connectivity among brain systems. Laboratory sessions will provide experience in examining macroscopic and microscopic neural structures, as well as performing experiments to elucidate the structure and function of neural systems using classical and cutting-edge techniques.

Class Format: lecture/lab, six hours per week
Requirements/Evaluation: class participation, laboratory notebooks and posters, hour exams and a final exam
Prerequisites: BIOL 212 (same as PSYC 212 or NSCI 201) or BIOL 205
Enrollment Limit: 24
Enrollment Preferences: Biology majors and Neuroscience concentrators
Expected Class Size: 24
Department Notes: does not satisfy the distribution requirement in Biology
Distributions: (D3)
Attributes: NSCI Group A Electives
BIOL 313 (S) Immunology
The rapidly evolving field of immunology examines the complex network of interacting molecules and cells that function to recognize and respond to agents foreign to the individual. In this course, we will focus on the biochemical mechanisms that act to regulate the development and function of the immune system and how alterations in different system components can cause disease. Textbook readings will be supplemented with current literature.

Class Format: lectures, three hours a week; laboratory, three hours a week
Requirements/Evaluation: evaluation will be based on exams, laboratory reports, and a research paper
Prerequisites: BIOL 202
Enrollment Limit: 24
Enrollment Preferences: senior and then junior Biology majors
Expected Class Size: 24
Department Notes: does not satisfy the distribution requirement in the Biology major
Distributions: (D3)
Attributes: BIMO Interdepartmental Electives; PHLH Biomedical Determinants of Health
Not offered current academic year

BIOL 315 (F) Microbiology: Diversity, Cellular Physiology, and Interactions
Bioterrorism and the alarming spread of antibiotic resistant bacteria are but two of the reasons for the resurgence of interest in the biology of microorganisms. This course will examine microbes from the perspectives of cell structure and function, genomics, and evolution. A central theme will be the adaptation of bacteria as they evolve to fill specific ecological niches, with an emphasis on microbe:host interactions that lead to pathogenesis. We will consider communication among bacteria as well as between bacteria and their environment. Topics include: microbial development, population dynamics, metagenomics, bioremediation, plant and animal defenses against infection, and bacterial strategies to subvert the immune system. In the lab, major projects will focus on horizontal gene transfer, metagenomics, and the isolation and characterization of bacteria from natural environments. The lab experience will culminate in multi-week independent investigations. Readings will be supplemented by articles from the primary literature.

Class Format: lectures, three hours a week; laboratory, three hours a week
Requirements/Evaluation: evaluation will be based on three exams/writing assignments, responses to thought questions on readings, a lab report/notebook, and a poster presentation
Extra Info: not available for the fifth course option
Prerequisites: BIOL 202
Enrollment Limit: 24
Enrollment Preferences: senior and then junior Biology majors
Expected Class Size: 24
Department Notes: does not satisfy the distribution requirement in the Biology major
Distributions: (D3)
Attributes: BIMO Interdepartmental Electives; PHLH Biomedical Determinants of Health
Not offered current academic year

BIOL 319 (F) Integrative Bioinformatics, Genomics, and Proteomics Lab (QFR)
Crosslistings: BIOL319 / CHEM319 / MATH319 / PHYS319 / CSCI319
Primary Crosslisting
What can computational biology teach us about cancer? In this capstone experience for the Genomics, Proteomics, and Bioinformatics program,
computational analysis and wet-lab investigations will inform each other, as students majoring in biology, chemistry, computer science, mathematics/statistics, and physics contribute their own expertise to explore how ever-growing gene and protein data-sets can provide key insights into human disease. In this course, we will take advantage of one well-studied system, the highly conserved Ras-related family of proteins, which play a central role in numerous fundamental processes within the cell. The course will integrate bioinformatics and molecular biology, using database searching, alignments and pattern matching, phylogenetics, and recombinant DNA techniques to reconstruct the evolution of gene families by focusing on the gene duplication events and gene rearrangements that have occurred over the course of eukaryotic speciation. By utilizing high through-put approaches to investigate genes involved in the MAPK signal transduction pathway in human colon cancer cell lines, students will uncover regulatory mechanisms that are aberrantly altered by siRNA knockdown of putative regulatory components. This functional genomic strategy will be coupled with independent projects using phosphorylation-state specific antisera to test our hypotheses. Proteomic analysis will introduce the students to de novo structural prediction and threading algorithms, as well as data-mining approaches and Bayesian modeling of protein network dynamics in single cells. Flow cytometry and mass spectrometry will be used to study networks of interacting proteins in colon tumor cells.

**Class Format:** two afternoons of lab, with one hour of lecture, per week

**Requirements/Evaluation:** lab participation, several short homework assignments, one lab report, a programming project, and a grant proposal

**Prerequisites:** BIOL 202; students who have not taken BIOL 202 but have taken BIOL 101 and CSCI 315 or PHYS 315, may enroll with permission of instructor. No prior computer programming experience is required.

**Enrollment Limit:** 12

**Enrollment Preferences:** seniors, then juniors, then sophomores

**Expected Class Size:** 12

**Department Notes:** does not satisfy the distribution requirement in the Biology major

**Distributions:** (D3) (QFR)

**Attributes:** BGNP Core Courses; BIMO Interdepartmental Electives;

**Not offered current academic year**

**BIOL 321 (F) Biochemistry I: Structure and Function of Biological Molecules (QFR)**

**Crosslistings:** BIOL321 / CHEM321 / BIMO321

**Secondary Crosslisting**

This course introduces the basic concepts of biochemistry with an emphasis on the structure and function of biological macromolecules. Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The laboratory provides a hands-on opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays.

**Class Format:** lecture, three hours per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation is based on quizzes, a midterm exam, a final exam, problem sets and performance in the laboratories including lab reports

**Extra Info:** may not be taken on a pass/fail basis

**Prerequisites:** BIOL 101 and CHEM 251/255 and CHEM 155/256

**Enrollment Limit:** 16/lab

**Enrollment Preferences:** junior and senior Biology and Chemistry majors and BIMO concentrators

**Expected Class Size:** 16/lab

**Department Notes:** does not satisfy the distribution requirement in the Biology major

**Distributions:** (D3) (QFR)

**Attributes:** BGNP Related Courses; BIMO Required Courses;

Fall 2018

LEC Section: 01    MWF 10:00 am - 10:50 am    Katie M. Hart
BIOL 322 (S)  Biochemistry II: Metabolism  (QFR)

Crosslistings: CHEM322 / BIMO322 / BIOL322

Secondary Crosslisting

This lecture course provides an in-depth presentation of the complex metabolic reactions which are central to life. Emphasis is placed on the biological flow of energy including alternative modes of energy generation (aerobic, anaerobic, photosynthetic); the regulation and integration of the metabolic pathways including compartmentalization and the transport of metabolites; and biochemical reaction mechanisms including the structures and mechanisms of coenzymes. This comprehensive study also includes the biosynthesis and catabolism of small molecules (carbohydrates, lipids, amino acids, and nucleotides). Laboratory experiments introduce the principles and procedures used to study enzymatic reactions, bioenergetics, and metabolic pathways.

Class Format: lecture, three hours per week; laboratory, three hours per week

Requirements/Evaluation: evaluation is based on several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative and/or graphic analysis of the data generated

Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option

Prerequisites: BIOL 101 and CHEM 251/255 or permission of instructor

Enrollment Limit: 64

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 64

Department Notes: does not satisfy the distribution requirement in the Biology major

Distributions:  (D3) (QFR)

Attributes: BGPN Related Courses; BIMO Required Courses;

Spring 2019

LEC Section: 01    MWF 11:00 am - 11:50 am    Pei-Wen Chen
LAB Section: 02    T 1:00 pm - 4:00 pm    Janis E. Bravo
LAB Section: 03    W 1:00 pm - 4:00 pm    Janis E. Bravo
LAB Section: 04    R 1:00 pm - 4:00 pm    Janis E. Bravo

BIOL 326 (F)  Cellular Assembly and Movement

This course will focus on how multi-protein complexes are assembled to control key cellular processes in eukaryotic systems: 1) protein sorting and trafficking, 2) establishment and maintenance of cell architecture, and 3) mitosis, cell migration and tissue morphogenesis that require coordination of the membrane transport and cytoskeleton. The course will highlight involvement of these processes in pathological conditions. Laboratories will use mammalian tissue culture as a model system to study cellular functions. Important techniques in cell biology will be introduced in the first half of the semester; in the second half of the term, students will conduct a multi-week independent project. Textbook readings will be supplemented with primary literature.

Class Format: lectures, three hours a week; laboratory, three hours a week, the laboratory projects will require additional time outside of class hours

Requirements/Evaluation: three exams, in-class discussion of papers, lab reports, an oral presentation and research paper based on an independent lab research project

Extra Info: may not be taken on a pass/fail basis
**Prerequisites:** BIOL 202

**Enrollment Limit:** 24

**Enrollment Preferences:** senior and junior Biology majors

**Expected Class Size:** 24

**Department Notes:** does not satisfy the distribution requirement in the Biology major

**Distributions:** (D3)

**Attributes:** BIMO Interdepartmental Electives;

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**BIOL 329 (F) Conservation Biology (QFR)**

Conservation biology is an interdisciplinary field that develops scientific and technical means for the protection, maintenance, and restoration of diversity at all levels of biological organization. This course provides an overview of the discipline including the causes and consequences of biodiversity loss as well as approaches and strategies used to combat biodiversity threats such as climate change, habitat fragmentation, and invasive species. Particular emphasis is placed on the ecological dimension of conservation and the application of biological principles (derived from physiological and behavioral ecology, population genetics, population ecology, community ecology, and systematics) to the conservation of biodiversity. The course combines lectures, readings, in-class discussion, and a laboratory that includes both field and lab projects.

**Class Format:** lecture and discussion three hours per week; lab three hours per week

**Requirements/Evaluation:** lab assignments, two exams, and discussion participation

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** BIOL 203, or BIOL 202, or permission of instructor

**Enrollment Limit:** 24

**Enrollment Preferences:** biology majors, seniors, and juniors

**Expected Class Size:** 24

**Department Notes:** satisfies the distribution requirement for the Biology major

**Distributions:** (D3) (QFR)

**Distribution Notes:** QFR: This course uses quantitative and statistical analyses in both the laboratory and lecture portion of the course. In lectures, mathematical models will be covered to understand conservation dynamics. In lab, students will collect and analyze data and present results in graphical and statistical forms.

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**BIOL 330 (S) Genome Architecture**

Biologists have only recently learned to read the complete genome sequence of organisms, and figuring out how to interpret these "texts" is now the focus of much of contemporary research in molecular biology and genetics. This course will concentrate on the origin, function, and evolution of central features of eukaryotic genomes, including gene structure, genome size, repeated sequences, and the complexity of gene regulation. Students will develop the ability to evaluate the contribution of neutral and adaptive processes in shaping genome complexity through: (1) critical evaluation of the primary research literature, (2) investigation of genome structural variation using wet-lab approaches and publicly available genomic data, and (3) an original research project.

**Class Format:** lectures, three hours a week; laboratory, three hours a week; the laboratory projects will require additional time outside of class hours
BIOL 402 (S)  Rapid Evolution in Ecology
Darwin believed that evolution was a slow process. Until recently, the impact of evolutionary changes on short-term ecological studies was considered to be minimal. However, empirical documentation of rapid, directly observed evolution has changed this view and has led to an increased focus on the joint dynamics of evolution and ecology including community genetics, niche construction, and evolutionary rescue. In this course, we first focus on the literature presenting the evidence for rapid evolutionary change in natural and experimental populations. Then, we explore the consequences of rapid evolutionary change for our understanding of population, community, and ecosystem ecology including the impacts that evolutionary changes have for conservation efforts and predicting the response of organisms to global environmental and climate change.

Class Format: seminar
Requirements/Evaluation: Evaluation will be based on participation in discussions, several short papers and presentations.
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: BIOL 202
Enrollment Limit: 12
Enrollment Preferences: Biology seniors who have not yet taken a 400-level course
Expected Class Size: 12
Department Notes: satisfies the distribution requirement in the biology major
Distributions: (D3)
Not offered current academic year

BIOL 405 (F)  Sociobiology  (WI)
Sociobiology, or the study of social behavior, has challenged the limits of evolutionary theory since Darwin described the non-reproducing castes among social insects (i.e., eusociality) as "one special difficulty." Inclusive fitness theory and Hamilton's rule—that an altruistic act can evolve where the benefit to related individuals exceeds the cost to the actor—potentially resolves Darwin's paradox. Nevertheless, explanations including delayed fitness benefits and ecological constraints have been suggested as alternatives to inclusive fitness theory. Moreover, the theoretical justification for inclusive fitness theory has recently been vigorously challenged. This course will use readings from the primary literature to examine the evidence for inclusive fitness as a potential explanation for topics including the evolution of helping behavior, eusociality and its relationship to extraordinary sex ratios, and spiteful behavior. Other topics that we will cover include the evolution of deceit and self deception.

Class Format: tutorial
Requirements/Evaluation: evaluation will be based on five (4-5-page) papers; tutorial presentations, & the student's effectiveness as a critic
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: BIOL 202 and either BIOL/ENVI 203 or 204 or 302 or 305 or permission of instructor; open to juniors and seniors
Enrollment Limit: 10
Enrollment Preferences: senior Biology majors who have not taken a 400-level course
**Expected Class Size:** 10  
**Department Notes:** satisfies the distribution requirement in the Biology major  
**Distributions:** (D3) (WI)  
Not offered current academic year

**BIOL 407 (S) Neurobiology of Emotion**  
Crosslistings: NSCI347 / BIOL407  
Primary Crosslisting

Emotion is influenced and governed by a number of neural circuits and substrates, and emotional states can be influenced by experience, memory, cognition, and many external stimuli. We will read and discuss articles about mammalian neuroanatomy associated with emotion as defined by classic lesion studies, pharmacology, electrophysiology, fMRI imaging, knockout mouse studies, as well as new opto-genetic methods for investigating neural circuit function in order to gain an understanding of the central circuits and neurotransmitter systems that are implicated in emotional processing and mood disorders.  
**Class Format:** discussion, three hours per week  
**Requirements/Evaluation:** evaluation will be based on class participation and several short papers  
**Prerequisites:** BIOL 202 and 212; open to juniors and seniors  
**Enrollment Limit:** 12  
**Enrollment Preferences:** senior Biology majors who have not taken a 400-level Biology course; then to eligible NSCI concentrators  
**Expected Class Size:** 12  
**Department Notes:** does not satisfy the distribution requirement in the Biology major  
**Distributions:** (D3)  
**Attributes:** BIMO Interdepartmental Electives; NSCI Group A Electives  
Not offered current academic year

**BIOL 408 (S) RNA Worlds**  
Ribonucleic acids (RNAs) serve as genomes, catalysts, messengers, adaptors, regulators, structural components, and evolutionary substrates. Non-coding RNAs such as microRNAs, ribozymes, and small interfering RNAs control a diverse range of biological processes including plant and animal development, translation, epigenetic chromosome silencing, and cancer. This course explores recently discovered non-coding RNAs and considers evidence for their mechanisms of action. Through extensive reading of primary literature, we will analyze experimental investigations that reveal our current understanding of the functions and evolution of non-coding RNAs in all three domains of life.  
**Class Format:** discussion, three hours per week  
**Requirements/Evaluation:** evaluation will be based on class participation and several short papers  
**Prerequisites:** BIOL 202; open to juniors and seniors  
**Enrollment Limit:** 12  
**Enrollment Preferences:** senior Biology majors who have not taken a 400-level course & BIMO concentrators  
**Expected Class Size:** 12  
**Department Notes:** does not satisfy the distribution requirement in the Biology major  
**Distributions:** (D3)  
**Attributes:** BIMO Interdepartmental Electives;  
Not offered current academic year

**BIOL 409 (F) Cultural Evolution in Biological Systems** (WI)  
The evolution of genetically transmitted traits has been the subject of extensive study since the "modern synthesis" combined Darwin's and Mendel's ideas–later enriched by molecular approaches to developmental biology. More recently, the study of evolution has been extended to traits that are transmitted via social learning. The cultural evolution that occurs in such behavioral traits has many parallels with evolution based on genes: errors and innovation correspond to genetic mutations, immigration may bring in new forms of the behavior, and population bottlenecks can result in loss of ...
behavioral traits. However, there is also a crucial difference between genetic and social transmission of traits: social learners can potentially acquire traits from many members of their population, including unrelated individuals. This difference has many implications, including the acceleration of the evolutionary time scale. We will explore the ways socially learned behaviors evolve, using systems such as tool use (primates, crows), vocal learning (songbirds, orcas), and social organization (baboons). Among the topics we will consider are the role of neutral models and random processes, how neural constraints guide social learning, how social status influences the choice of tutors, and how competition and sexual selection drive changes in learned behavior. We will also consider how these processes interact and how they generate differences as well as parallels between cultural and genetic evolution.

**Class Format:** tutorial

**Requirements/Evaluation:** five 4- to 5-page papers; five 1-2 page response papers; tutorial presentations; contribution to the intellectual enterprise

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** BIOL 305 or BIOL 204

**Enrollment Limit:** 10

**Enrollment Preferences:** senior Biology majors

**Expected Class Size:** 10

**Department Notes:** satisfies the distributional requirement for the Biology major

**Distributions:** (D3) (WI)

**Not offered current academic year**

**BIOL 410 (S) Nanomachines in Living Systems**

Through reading and discussing the primary literature, this course will explore how nanometer-sized biological molecules like proteins perform functions that require integration of information and transmission of force at much larger scales, microns and above. These nanoscale proteins will be considered as nanomachines that can transform a chemical energy into a mechanical one. We will focus on the cytoskeleton, which gives cells their shape, organizes the internal parts of cells and provides mechanical support for essential cellular processes like cell division and movement. An emphasis will be placed on how the biochemical properties of actin, actin-binding proteins and motors are used to generate mechanical force necessary for the respective biological function. Topics will include some controversial and emerging hypotheses in the field: sliding versus depolymerizing hypotheses for constriction of the contractile ring in cytokinesis, roles of cytoskeleton in pathogen entry and propagation, organelle dynamics, polarity establishment in cell migration, immunological synapse and neuronal function.

**Class Format:** discussion, three hours per week

**Requirements/Evaluation:** class participation and several short papers

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** BIOL 202; open to juniors and seniors

**Enrollment Limit:** 24

**Enrollment Preferences:** senior Biology majors who have not taken a 400-level course, then juniors

**Expected Class Size:** 24

**Department Notes:** does not satisfy the distribution requirement in the Biology major

**Distributions:** (D3)

**Attributes:** BIMO Interdepartmental Electives;

**Not offered current academic year**

**BIOL 412 (S) Neural and Hormonal Basis of Hunger**

Crosslistings: NSCI342 / BIOL412

**Primary Crosslisting**

Hunger and satiety are highly regulated behavioral states that maintain energy homeostasis in animals. This course will focus on readings from the primary literature to track numerous recent advances in how the brain and endocrine systems regulate appetite. Topics include how organ systems communicate with the brain to regulate appetite, how different populations of neurons in the brain interact to regulate appetite, how brain systems that regulate appetite affect other behaviors, and how the neural and hormonal basis of hunger compare with brain systems that regulate other homeostatic systems such as thirst. By tracing the advances in appetite regulation within the past decade, we will also trace the advent of cutting-edge
molecular, genetic, and optical-based tools that are transforming multiple fields within physiology and neuroscience. Students in this class will have the opportunity to improve skills in written and oral scientific presentation.

**Class Format:** seminar

**Requirements/Evaluation:** evaluation will be based on written assignments, oral presentations, and participation

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** BIOL 205 or BIOL/PSYC 212, or permission of instructor

**Enrollment Limit:** 12

**Enrollment Preferences:** seniors who have not taken a 400-level course

**Expected Class Size:** 12

**Department Notes:** does not satisfy the distribution requirement for the Biology major

**Distributions:** (D3)

**Attributes:** NSCI Group A Electives

Not offered current academic year

**BIOL 413 (S)  Global Change Ecology  (WI)**

Plants and animals are increasingly faced with rapid environmental change driven by human activities across the globe. How do they cope with challenges imposed by climate change, altered nutrient cycling, biological invasions, and increased urbanization? What are the impacts of organismal responses at the population and community level? This course uses an integrative approach to understand the impacts of global change at multiple levels of biological organization in both aquatic and terrestrial environments. We examine how global-scale environmental changes affect the distribution and abundance of species and alter community organization. We also consider the physiological and behavioral mechanisms underlying species responses and the role of acclimation versus adaptation in coping with rapid environmental change. Finally, we learn the analytical tools used to predict future responses to global change. Class discussions will focus on readings drawn from the primary literature.

**Class Format:** seminar

**Requirements/Evaluation:** class participation and several short papers

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** BIOL 203 or MAST 311 or BIOL 305 or permission of instructor

**Enrollment Limit:** 12

**Enrollment Preferences:** senior Biology majors who have not yet taken a 400-level course

**Expected Class Size:** 12

**Department Notes:** Satisfies the distribution requirement for the Biology major

**Distributions:** (D3) (WI)

Spring 2019

SEM Section: 01  TR 9:55 am - 11:10 am  Sonya K. Auer
SEM Section: 02  TR 11:20 am - 12:35 pm  Sonya K. Auer

**BIOL 414 (S)  Life at Extremes: Molecular Mechanisms**

All organisms face variability in their environments, and the molecular and cellular responses to stresses induced by environmental change often illuminate otherwise hidden facets of normal physiology. Moreover, many organisms have evolved unique molecular mechanisms, such as novel cellular compounds or macromolecular structural modifications, which contribute to their ability to survive continuous exposure to extreme conditions, such as high temperatures or low pH. This course will examine how chaperonins, proteases, and heat- and cold-shock proteins are regulated in response to changes in the external environment. We will then consider how these and other molecular mechanisms function to stabilize DNA and proteins- and, ultimately, cells and organisms. Other extreme environments, such as hydrothermal vents on the ocean floor, snow fields, hypersaline lakes, the intertidal zone, and acid springs provide further examples of cellular and molecular responses to extreme conditions. Biotechnological applications of these molecular mechanisms in areas such as protein engineering will also be considered. Class discussions will focus upon readings from the primary literature.

**Class Format:** discussion, three hours per week
BIOL 417 (F) Translational Immunology: From Bench to Bedside

Recent advances in the field of immunology have led to the development of new approaches to prevent and treat diseases that affect millions of people worldwide. Drugs that modulate the body's natural immune response have become powerful tools in treating the world's major diseases--infection, autoimmunity and cancer. This course will use readings from the primary literature to explore central themes involved in translating basic research to new clinical and therapeutic approaches. Topics will include vaccine development, transplantation immunology, autoimmunity and cancer immunotherapy.

Class Format: seminar/conference
Requirements/Evaluation: evaluation will be based on class participation and several short papers
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: BIOL 202; open to juniors and seniors
Enrollment Limit: 12
Enrollment Preferences: senior Biology majors who have not taken a 400-level course; then juniors
Expected Class Size: 12
Department Notes: does not satisfy the distribution requirement in the Biology major
Distributions: (D3)
Attributes: BIMO Interdepartmental Electives; MAST Interdepartmental Electives

BIOL 418 (F) Signal Transduction to Cancer

Division of normal cells is a highly regulated process based on input from both intrinsic and extrinsic signals. The cell's response to its environment affects all aspects of cell behavior: proliferation, death, differentiation and migration. The goal of the course is to understand the molecular mechanisms of signal transduction that guide normal cell behavior and how disruptions in this process can lead to cancer. We will focus on the Hedgehog-Gli signaling pathway that is activated in 30% of all known cancers. Genetic studies will serve as an introduction to the components of the pathway, followed by an examination of the molecular mechanisms of signal reception, transduction of intracellular information, scaffolding and transcriptional targets. The final section of the course will investigate how high throughput screens, medicinal chemistry studies and mouse models are used to identify small molecular inhibitors of pathway components. We will consider the effectiveness of these inhibitors in pharmacological studies, clinical trials and potential cancer treatments.

Class Format: seminar
Requirements/Evaluation: four papers
Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option
Prerequisites: BIOL 202 or permission of instructor
Enrollment Limit: 12
Enrollment Preferences: seniors and then juniors

Expected Class Size: 12

Department Notes: does not satisfy the distribution requirement in Biology

Distributions: (D3)

Attributes: BIMO Interdepartmental Electives;

Fall 2018

SEM Section: 01    TR 8:30 am - 9:45 am     Robert M. Savage

SEM Section: 02    TR 9:55 am - 11:10 am     Robert M. Savage

BIOL 422 (F)  Ecology of Sustainable Agriculture

Crosslistings: ENVI422 / BIOL422

Primary Crosslisting

A seminar/field course investigating patterns, processes, and concepts of stability in human-dominated, food production ecosystems. As a capstone course, the course will draw upon the experiences that students have had in biology and environmental studies courses. Topics will include: the relationships among diversity, ecosystem function, sustainability, resilience, and stability of food production, distribution systems, nutrient pools and processing in human dominated ecosystems. Two extensive field trips will be taken to agricultural operations in the region. Each student will present a seminar on a topic requiring extensive reading of primary resources and is responsible for leading the discussion that ensues. Reading question paper assignments will be due prior to the seminar. Criticism paper assignments will be made at approximately bi-weekly intervals and due two days after the seminar to which they relate.

Class Format: seminar; two 75 minute sessions per week

Requirements/Evaluation: evaluation will be based on writing assignments, seminar presentation, and course participation

Extra Info: may not be taken on a pass/fail basis; not available for the fifth course option

Prerequisites: BIOL/ENVI 203 or BIOL 302 or permission of instructor

Enrollment Limit: 16

Enrollment Preferences: senior Biology and Environmental Studies Majors and Environmental Studies Concentrators; then Junior majors/concentrators, then seniors, then juniors

Expected Class Size: 12

Department Notes: Satisfies the distribution requirement in Biology; the ENVS biology track; the Natural World distributional requirement of the Environmental Studies program

Distributions: (D3)

Attributes: ENVI Natural World Electives; PHLH Nutrition, Food Security + Environmental Health

Fall 2018

SEM Section: 01    MWF 8:30 am - 9:45 am     Henry W. Art

BIOL 430 (F) Genome Sciences: At the Cutting Edge  (WI)

Research in genomics has integrated and revolutionized the field of biology, including areas of medicine, plant biology, microbiology, and evolutionary biology. Moreover, recent developments in "metagenomics" (genomic studies of entire communities of microorganisms in natural environments, such as the mammalian gut and the deep sea) and "metatranscriptomics" (studies of genome wide changes in expression and mRNA levels in natural communities of organisms) have generated unprecedented knowledge about the genomic potential of a community and the in situ biological activity of different ecological niches. In this course we will explore how research in these and related areas, including proteomics, have advanced our fundamental understanding of (1) organisms in the three domains of life, and their interactions and evolutionary relationships; (2) biological systems and environments, such as the human body, extreme environments, and the oceans; (3) strategies for solving global challenges in medicine, agriculture, energy resources, and environmental sciences. During the course, students will meet each week for one hour with a tutorial partner and the instructor. Every other week, students will present a written and oral critical analysis of the assigned research articles. On alternate weeks, students will question/critique the work of their colleague.
BIOL 432 (F) Evolutionary Genetics
The synthesis of evolutionary processes with the mechanistic understanding of genetics has lent insight into many mysteries of life. The goal of this course is to explore the interface between evolution and genetics to make sense of fundamental biological processes. For example, why do we expect that male and female offspring occur in 50:50 ratios? How and why do unusual sex-ratios occur? Other topics include: conflict among genes, evolution of allelic dominance, adaptation at the molecular level, and genetics of speciation. Class discussion and written assignments will emphasize critical evaluation and synthesis of the scientific literature.

BIOL 493 (S) Senior Thesis Research: Biology
Each student prepares a thesis under the supervision of a member of the department. Thesis work can begin either in the spring of the junior or the fall of the senior year, and includes the Winter Study period of the senior year. The number of Biology Department faculty available to mentor research students and the number of students each can accommodate in her/his lab vary from year to year. Although the department will make every effort to provide an opportunity for students to conduct Honors research, you should be aware that it may not be possible to assign all applicants to a laboratory.

BIOL 494 (S) Senior Thesis Research: Biology
Each student prepares a thesis under the supervision of a member of the department. Thesis work can begin either in the spring of the junior or the fall of the senior year, and includes the Winter Study period of the senior year. The number of Biology Department faculty available to mentor research students and the number of students each can accommodate in her/his lab vary from year to year. Although the department will make every effort to provide an opportunity for students to conduct Honors research, you should be aware that it may not be possible to assign all applicants to a laboratory.
of the senior year, and includes the Winter Study period of the senior year. The number of Biology Department faculty available to mentor research students and the number of students each can accommodate in her/his lab vary from year to year. Although the department will make every effort to provide an opportunity for students to conduct Honors research, you should be aware that it may not be possible to assign all applicants to a laboratory.

**Class Format:** independent study

**Extra Info:** this is part of a full-year thesis (493-494)

**Distributions:** (D3)

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Spring 2019

HON Section: 01    TBA    Joan Edwards

**BIOL 499 (S) Biology Colloquium**

Scientists from around the country who are on the cutting edge of biological research come to talk about their work. Students of Biology at any level are welcome.

**Class Format:** lecture

**Extra Info:** this is not a for-credit course; registration is not necessary to attend

**Distributions:**

Not offered current academic year