Department of Biology – Clarkson University

I. General Information

Web Site: http://www.clarkson.edu/biologydept/
Administrative Secretary: Vicki Wilson
Email: vwilson@clarkson.edu
Phone: 1-800-527-6577 and ask for the Biology Department, or call 315-268-2342

Faculty:
- **Biology Department Chair**: Tom Langen
- **Professors**: Tom Langen, Craig Woodworth, Michael Twiss, Thomas Lufkin
- **Associate Professors**: Kenneth Wallace
- **Assistant Professors**: Cintia Hongay, Damien Samways, Shantanu Sur, Andrew David, Stefanie Kring, Petra Kraus
- **Instructor**: Patricia Burdick
- **Laboratory Coordinator**: Stefanie Kring
- **Bayard & Virginia Clarkson Endowed Chair of Biology**: Thomas Lufkin
- **Director of Graduate Studies**: Craig Woodworth
- **Premedical and Health Professions Advisor**: Carolyn Zanta

II. Mission:

As teachers of Biology, our goal is to convey a deep understanding of the natural world and the workings of life to our students. We aim to help students learn through instructor-guided mastery of information and also by teaching them to be independent thinkers. As life scientists, we strive to advance the frontier of knowledge in biology through original research that generates new insights and leads to discoveries that benefit humanity and preserve the environment. We are privileged to work as scholar-scientists and strive to be generous in serving our institution, our profession, and our community. We aim to train and graduate well-prepared students who have the ability and experience necessary to succeed and advance to the next level, whether the next level is graduate school, professional school in a health-related field, environmental work, employment in the biotechnology sector, or any other worthwhile goal that they wish to pursue. In pursuing a combined mission of education, research, and service, we hope to foster productive interpersonal interactions that inspire faculty, staff, and students alike to excel and accomplish great things.
III. Vision of a Biology Education:

Clarkson Biology students will have the opportunity to

- Become proficient in biology by mastering the core knowledge curriculum and specializing in various subfields of the life sciences represented by a wide array of course electives.

- Be active participants in acquiring knowledge and scientific skills through inquiry-based laboratories and a variety of practical learning experiences that include directed study and thesis-based courses.

- Develop the ability to think critically and solve problems though exposure to quantitative laboratory- and field-based research, the history of biological science, and the primary research literature.

- Learn how to use appropriate technology, methodology, and informational tools that accelerate progress in the workplace, field, and laboratory such as computer software, bioinformatics, genetic engineering, cell culture, microscopy, etc.

- Acquire oral and written communication skills essential for work in all fields of biology and the health professions.

- Develop social skills of interpersonal interaction including an awareness and appreciation of cultural diversity that enhances progress and enriches the pursuit of scientific endeavors.

- Gain an appreciation of the fundamental importance of professional ethical behavior in society and the workplace.

- Develop personal insight to current issues of bioethical concern ranging from preservation of global biodiversity to the improvement of human health through modern advances in biotechnology.

- Learn about career opportunities in the life sciences in preparation for seeking job opportunities and professional work after graduation.

Clarkson Biology faculty

- Strive for excellence in teaching and research through personal interactions with students and colleagues.

- Serve as mentors and advocates of our students as they journey through their undergraduate education and mature toward readiness to engage in fulfilling careers.

- Inspire students with a sense of the significance of knowledge, the excitement of research, and the thrill of scientific discovery.

- Foster an appreciation of the dynamism and beauty of living systems through our enthusiasm for the discipline of Biology.

- Share our scientific expertise in service to the campus community and society at large.
IV. REQUIREMENTS FOR A BIOLOGY DEGREE AT CLARKSON UNIVERSITY

1. Biology Core Requirements (17-19 credits)
2. Biology Elective Requirements (21-23 additional credits, to a total of 40 biology credits)
3. Clarkson Common Experience Requirements (22 credits)
   - First Year Seminar (1 credit)
   - The Clarkson Seminar (3 credits)
   - Knowledge Area/UC (15 credits)
   - Technology (3 credits)
   - Professional Experience in Biology
4. Physical Sciences (25 – 27 credits)
   - Chemistry (17 – 19 credits)
   - Physics (8 credits)
5. Mathematics/Computer Science: Includes calculus, statistics, and one additional math, statistics, or computer science course (9-10 credits)
6. Free electives (additional courses up to 120 overall credits)

V. REQUIRED AND ELECTIVE BIOLOGY COURSES

Core Biology Courses: 17-19 credits
These courses are required for all Biology majors:
BY140/142 Biology I - Inheritance, Evolution, and Diversity (3 cr.)/Biology I Laboratory (2 cr.)
BY160/162 Biology II - Cellular and Molecular Biology (3 cr.)/Biology II Laboratory (2 cr.)
BY214 Genetics
BY401 Professional Assessment
   Two BY lab courses numbered 200 or above not including BY405 or BY 410 (4-6 cr.)

Biology Electives: a minimum of 40 total credits of BY courses are required. 17-19 of these are covered in the core Biology courses, listed above. Therefore, a minimum of 21-23 additional Biology Elective credits are needed. No more than 6 credits of directed research can count toward these 40 credits (students may enroll for additional directed research credits in place of Free Elective credits).

Professional Experience and Directed Studies
Completion of one of the following:
405 Undergraduate Research in Bioscience
410 Undergraduate Thesis Research in Bioscience
495 Undergraduate Teaching Assistantship in Bioscience
498 Internship in Bioscience
499 Professional Experience in Bioscience
Additional Required and Recommended Courses for Certain Concentrations

This list is of courses, beyond those required for a Clarkson Biology degree, for students with defined career goals. Those listed as required are not required for a Clarkson degree, but may be required for acceptance into a professional program.

**Pre-Medical School:**
- English Literature and/or Composition (two courses)
- PY 151 Introduction to Psychology
- SOC 201 Introduction to Society

**Additional recommended courses:**
- BY 471/BY 473, BY 472/BY 474 Anatomy & Physiology I and II
- BY 320 or 448 Microbiology or Medical Microbiology

**Pre-Physical Therapy School:**
- BY 471/BY 473, BY 472/BY 474 Anatomy & Physiology I and II
- PY 151 Introduction to Psychology
- PY 370 Developmental Psychology
- Medical Terminology

**Pre-Occupational Therapy School:**
- BY 471/BY 473, BY 472/BY 474 Anatomy & Physiology I and II
- PY 151 Introduction to Psychology
- PY 370 Developmental Psychology
- PY 462 Abnormal Psychology
- Social Sciences (two courses, e.g. SOC 201 Introduction to Society)

**Additional recommended courses:**
- COMM 217 Introduction to Public Speaking
- English Composition/Critical Thinking (two courses)
- Scientific writing
- 3D skill/craft*
  * Example: Knitting, woodwork, sculpting, loom work, ceramics, sewing, beading

**Pre-Physicians Assistants School:**
- **Additional recommended courses:**
- BY 471/BY 473, BY 472/BY 474 Anatomy & Physiology I and II
- BY 320/BY 322 Microbiology or BY 448 Medical Microbiology

**Pre-Vet Students:**
*Most vet schools require the following:*
- English Composition (2 semesters)
- BY450 Biochemistry

*Some vet schools require:*
- Microbiology (BY 320/BY 322 Microbiology or BY 448 Medical Microbiology)

*A few schools (7 out of 53 US and Canadian schools) require:*
- Nutrition
- Physiology
- Animal Science

Last edited 8/15/16
Pre-Dental Students:
English Literature and/or Composition (2-3 courses)

Additional recommended courses (check with specific school for requirements):
BY 471/BY 473, BY 472/BY 474 Anatomy & Physiology I and II
BY 320/BY 322 Microbiology or BY 448 Medical Microbiology
BY450 Biochemistry

VI. REQUIREMENTS FOR A BIOLOGY SENIOR THESIS

This program provides an opportunity for you to work on a research problem with a member of the biology faculty. You will be expected to design experiments in consultation with your faculty advisor, and to perform and evaluate the results of these experiments. You will prepare a thesis describing the results of your research, and to present the results to biology faculty and students at the annual Clarkson Symposium for Undergraduate Research in the spring. The senior thesis can be a valuable experience. It will give you some appreciation of what biological research involves and illustrate how various skills can be used to solve real problems. Senior thesis work can be particularly helpful if you plan to enter professional or graduate school after you graduate from Clarkson.

Eligibility Requirements for Biology Senior Thesis Candidacy
• Biology Major
• Biology GPA and Overall GPA 3.0 or better
• Approved Thesis Proposal, signed by the Candidate, the Candidate’s Advisor, and the Senior Thesis Director

Requirements for Completion of the Biology Senior Thesis
• Completion of the Biology Major
• An equivalent of at least 6 credit hours of research, including at least 1 credit BY410 Undergraduate Thesis. (Summer research experience = 6 credit hour equivalents 1 credit hour equivalent = 4 hours research per week for 16 weeks = 64 hours research)
• Public presentation of the thesis research (e.g. SURE Conference)
• Approved Thesis, signed by the Candidate, the Candidate’s Advisor, a second Thesis Reader, and the Senior Thesis Director

VII. REQUIREMENTS FOR A BIOLOGY MINOR (at least 19 credits)

1. Core courses (9 credits)
   Students must take BY140 Biology I (3 credits) and BY160 Biology II (3 credits) and at least one of the following:
   • BY214 Genetics (3 credits)
   • BY222 Ecology (3 credits)
   • BY320 Microbiology (3 credits)
   • BY360 Physiology (3 credits)

2. Elective courses (9 credits)
   Students must take at least 9 credits of Biology courses numbered 300 or above. Examples in Section V.
3. Laboratory requirement (2 credits): Students must take at least 1 of the following laboratory courses:
   - BY224 General Ecology Laboratory (2 cr)
   - BY142 Biology I Lab (2 cr)
   - BY162 Biology II Lab (2 cr)
   - BY322 Microbiology Laboratory (2 cr)
   - BY362 Physiology Laboratory (2 cr)

VIII. MINOR IN COGNITIVE NEUROSCIENCE

Cognitive neuroscience is the study of the physiological and biochemical mechanisms underlying higher order human cognitive processes, such as attention, memory, perception, and emotion. The Cognitive Neuroscience minor will be of interest to students pursuing careers in the clinical health sciences (medicine, physical therapy, clinical psychology, neuropsychology) and those wishing to do basic and applied research on the central nervous system (CNS).

**REQUIREMENTS (beyond requirement for the Clarkson Biology degree)**

**Required Basic Science Courses**
- PY151 Introduction to Psychology (3 cr)
- BY140 Biology I: Inheritance, evolution and diversity (3 cr)
- BY142 Biology I Laboratory (2 cr)
- BY160 Biology II: Cellular and Molecular Biology (3 cr)
- BY162 Biology II Laboratory (2 cr)
- CM131 General Chemistry I (4 cr)
- CM132 General Chemistry II (4 cr)
- PH141 Physics for Life Sciences I (4 cr)
- PH142 Physics for Life Sciences II (4 cr)

**Required Cognitive Neuroscience Courses (9 credits)**
- PY458 Cognitive Neuroscience (3 cr)
- BY/PY454 Physiological Psychology (3 cr)
- BY/PY460 Neurobiology (3 cr)

**Elective Psychology Courses: 2 courses (6 credits) chosen from the following:**
- PY317 Psychology of Psychoactive Drugs (3 cr)
- BY/PY358 Animal Learning and Cognition (3 cr)
- PY/BY357 Human Cognitive Evolution (3 cr)
- PY359 Perception (3 cr)
- PY360 Learning and Memory (3 cr)
- PY462 Abnormal Psychology (3 cr)
- PY463 Health Psychology (3 cr)

**Elective Biology Courses: 2 courses (6 cr) chosen from the following:**
- BY360 Physiology (3 cr)
- BY214 Genetics (3 cr)
- BY310 Developmental Biology (3 cr)
- BY350 Comparative Anatomy (3 cr)
- BY471 Anatomy and Physiology I (3 cr)
- BY472 Anatomy and Physiology II (3 cr)

1 Biology majors taking the cognitive neuroscience minor cannot use PY/BY454 as one of their Biology elective courses.
## IX. BIOLOGY SAMPLE CURRICULUM

### Biology Major – Clarkson Common Experience

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<td>CM132 General Chemistry II or(CM104 Equilibrium/CM106 Chemistry II lab)</td>
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<td>STAT318 Biostatistics</td>
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Total Credits: 120
X. The Clarkson Trudeau Biomedical Scholars Program
The Clarkson Trudeau Biomedical Scholars Program is an intensive semester-long living and learning experience (the “Trudeau Semester”) and a separate summer research program that both take place off campus at the renowned Trudeau Institute in Saranac Lake, New York.

The 15-credit program Trudeau Semester is an undergraduate program designed to provide a select group of undergraduate students the opportunity to learn multidisciplinary aspect of bioscience related to the human health field. The program is specifically designed for students from the majors of Biology, Biomolecular Science, Chemistry and Chemical Engineering, and also serves as a professional experience. The Trudeau Semester is taught by Clarkson and Trudeau Institute faculty who are respective experts in their field. The academic program provides a range of disciplines that by design will each contribute to a related topic that is the focus of a semester-long, integrative project that aims to demonstrate how technology serves humanity, a core Clarkson value.

Students study and conduct a research project at the Trudeau Institute located approximately one mile from their townhouse residences in Saranac Lake. At the Trudeau Institute there is dedicated laboratory space for instruction and study offices, as well as an office for a faculty member. Each course is 3 weeks in duration, with the exception of the Term Integrated Research Project, which the students are involved with the entire semester. Students present their research findings at the Symposium for Undergraduate Research Experiences conference that takes each semester on the Clarkson University Campus, in addition to a public presentation.

For additional information see the Trudeau Semester web site at

http://www.clarkson.edu/trudeauscholar/.

To be considered a Clarkson Trudeau Scholar a biology major must declare this to the department Chair. In turn the student will be provided the opportunity to

1. Experience (semester or summer) at the Trudeau Institute.
   a. Clarkson Trudeau Semester in Biomedical Sciences Program (“Trudeau Semester”)
   b. Clarkson Trudeau Summer Biomedical Research Program (“Trudeau Summer Research Program”)

2. Annual Clarkson Trudeau Biomedical Scholar Invited Research Seminar in Biomedicine and Reception

3. Annual Graduate School & Bioscience Professional Career Panel

Requirements to be a Clarkson Trudeau Biomedical Scholar, i.e. guaranteed acceptance to a Clarkson Trudeau Experience

Complete with a B grade or better:

- Cell and Molecular Biology and Lab (BY160/162)
- Genetics (BY 214)
- Chemistry I, II (CM 131/132 or CM 103/106)
- Organic Chemistry I (CM 241)

Maintain an overall GPA of 3.0 or better.

These requirements are the minimum to be maintained to be guaranteed an experience, but students who do not meet these requirements will be considered on a per case basis.
XI. HEALTH-RELATED CAMPUS ORGANIZATIONS

Animal Science Club
Advisor: Andrew David
President: Erica Baldwin

Doctors Without Borders
Advisor: Dr. JoAnn Rogers

EMS Club
Advisor: David Delisle

Humane Society Club
Advisor: Dr. Carolyn Zanta

Minority Association of Premedical Students (MAPS)
Advisor: Dr. Carolyn Zanta

Phi Delta Epsilon (Medical Fraternity)
Advisors: Dr. Stephen Casper
            Dr. Carolyn Zanta

Pre-PA Club
Advisor: Terri Joyce

Pre-PT Club
Advisor: Dr. Vicki LaFay

Tri-Beta Biological Honor Society
Advisor: Dr. Shantanu Sur

XII. PROPOSED Awards for Biology Undergraduates

Biology Department Outstanding Senior Award: This award is presented to an outstanding senior biology major. It is the most prestigious award that the department provides and the recipient is chosen by a vote of faculty in the Biology Department. The criteria considered for this award includes; high GPA, participation in undergraduate research or corresponding professional experience, involvement in extracurricular activities and community service, and demonstration of leadership skills. The recipient is expected to excel in more than one of these areas.

Biology Department Outstanding Research Award: The recipient of this award is chosen by a panel of faculty from the Biology Department who evaluate undergraduate senior and Honors Program research projects. The recipient should have conducted original research and should be in the process of synthesizing a thesis.
**Biology Department Undergraduate Teaching Award:** This award is presented to an undergraduate biology major who has demonstrated excellence in teaching or tutoring biology. The recipient of this award will be chosen by the Director of Freshman Biology in consultation with other biology faculty.

**Biology Department Outstanding Leadership and Service Award:** The recipient of this award will be chosen by faculty from the Biology department based on the candidate's participation in departmental events (Open House, Tri-Beta, teaching assistant or tutoring) and by demonstration of leadership in campus organizations including clubs, fraternities and athletic teams.

**Biology Department Sophomore Award:** Given to the sophomore biology major who has attained the highest overall GPA in his/her first three semesters at Clarkson.
XIII. COURSE DESCRIPTIONS

BY110 Biology and Society - Credits (3)
Definition of science, the scientific method, overview and scope of modern biology, introduction to biomolecules and cell structure, Mendelian inheritance and genetics, human physiology, evolution, and ecology. Course topics are presented from the perspective of current issues in biotechnology, medicine, and human impact on the biosphere. This course is intended for students who are not majoring in the biological sciences and may not be taken by biology majors or minors with credit for BY100 or BY140.

BY112 Laboratory for Biology and Society - Credits (1)
Companion laboratory course to BY110 introducing students to the scientific method of laboratory and field experimentation used by contemporary biologists. Co-requisite: BY110.

BY130 Contemporary Issues in Environmental Sciences for Non-Majors - Credits (3)
This course examines how human activity impacts the environment. Topics include air and water pollution, environmental systems management, industrial ecology and environmental policy with emphasis on the multidimensional aspects of currently environmental issues. Case studies of chemical exposures, life cycle assessments, and integrated resources management will be used to discuss the process of environmental decision making.

BY140 Biology I – Inheritance, Evolution, and Diversity - Credits (3)
Corequisites: BY142.
Introduction to the scientific method, mitotic and meiotic cell division, genetic inheritance, evolution of species, phylogenetics, systematics, paleobiology, survey of the tree of life, population biology, ecology and behavior.

BY142 Biology I Laboratory - Credits (2)
Corequisites: BY140
Companion laboratory course to BY140 providing practical exposure to the scientific method of hypothesis testing, presentation and statistical analysis of biological data, writing scientific reports and papers in the context of field and laboratory experimentation related to BY140. Offered fall semester.

BY160 Biology II – Cellular and Molecular Biology (Sci) - Credits (3)
Corequisite: BY162
Introduction to biomolecules, organelles, and cytoarchitecture of cells, energy metabolism and photosynthesis, DNA replication, transcription of RNA, protein synthesis, gene regulations, development and differentiation with a view towards biotechnology.

BY162 Biology II Laboratory - Credits (2)
Corequisite: BY160
Companion laboratory course to BY160 providing a hands-on experience to put your knowledge to the test. Here you will be introduced to the scientific method and you will be describing, analyzing, and reporting your results the way a scientist would in a real laboratory setting. Experiments include chemical properties of the molecules of life, enzymatic analyses, microscopy and micro-dissections, photosynthesis and respiration, mitosis and meiosis, Drosophila genetics, molecular biology of nucleic acids and bacteriology. You will be presenting your results both orally and in writing.
BY214 Genetics – (STS) Credits (3)
Prerequisites: BY160 or consent of the instructor
The overall goal of this course is to provide a comprehensive introduction to the science of genetics. Classical principles of Mendelian genetics will be covered, however, the emphasis will be placed on fundamentals of molecular genetics and recent advances. Major topics include gene structure and function, genetic recombination, genetic engineering, genomics, gene and chromosome mutations, regulation of gene transcription, cell cycle and cancer genetics, developmental genetics, and an introduction to population genetics.

BY216 Classical Genetics Laboratory Theory and Practice-Credits (4)
Hands-on experimental testing of genetic concepts using D. melanogaster as a model organism. Objectives: to learn how to develop testable hypotheses and use the scientific method to interpret and analyze data and write a scientific manuscript of experimental findings. Outcomes: students will become proficient in using their knowledge from previous biology courses, especially BY214 (required) as well as newly acquired knowledge from lectures and literature searches to design experiments, include proper controls, objectively analyze data, use statistical methods to evaluate their results, and gain experience in presenting their findings both orally and in written form.

BY222 Ecology – (C1) Credits (3)
Prerequisite: BY140 or Corequisite: BY140
Ecology is the study of factors that control the distribution and abundance of species in nature. Ecological interactions will be explored at the individual through ecosystem level in terrestrial, freshwater, and marine habitats. Emphasis will be on fundamental ecology, but applications to human-related problems will be explored.

BY224 Ecology Lab – (C1) Credits (2)
Corequisite: BY222.
Field and laboratory exploration of physical, chemical, and biological factors influencing animal and plant species, populations, and communities in upstate New York. Students will learn field and laboratory techniques in ecology and general identification of some organismal groups. Course will include required field trips to surrounding habitats and laboratory experiments.

BY 240 Environmental Science and Policy of American Rivers – (UNIV: STS, CGI) Credits (3)
Prerequisites: None
The objectives of the course are to (1) understand how rivers function; (2) become familiar with the organisms and natural communities of the Hudson River watershed; and (3) understand how humans impact rivers, and how those impacts can be managed to minimize the negative consequences of the environmental impacts.

BY300 Recent Advances in Biological Research – (C1) Credits (1)
Prerequisites: BY140 and BY160
The objective of this course is to present recent advances in biological and biomolecular research, and to describe opportunities for graduate study and undergraduate summer research. Students will receive one credit for attending biology seminars (6 per semester), reading a journal article prior to each presentation, writing short review of each seminar, and participating in discussions. This course can be taken for credit more than once.
BY 302 Introductory Botany - Credits (3)
Prerequisites: BY140/142 and BY160/162, or consent of the instructor.
In this course we will undertake a comparative survey of the major groups of fungi, nonvascular and vascular plants. Emphasis is placed on the structure, function and ecology of various groups. The role of plants in the biosphere as well as the reciprocal interactions with human activities and civilizations will be addressed.

BY304 Introductory Zoology - Credits (3)
Prerequisites: BY140/142 and BY160/162, or consent of the instructor
In this course, we will conduct a diversity survey of animal life with emphasis on invertebrates. Course content will primarily consist of comparing the major animal phyla emphasizing integration of form, function, ecology, and phylogeny.

BY310 Developmental Biology - Credits (3)
Prerequisites: BY160 or consent of the instructor.
The course will focus on how an organism develops into a complex multicellular organism from a single cell. We will begin with the genetics of development and discuss mechanisms by which genes become sequentially activated as embryogenesis proceeds. The mechanics and genetics of both invertebrate and vertebrate development will be discussed beginning with fertilization and ending as embryogenesis is completed. We will also discuss some of additional developmental events that occur during embryogenesis and later in adults. Because of technological advances in developmental biology, topics in this field have also become important societal issues. Throughout the semester, we discuss the ethical implications of using these advances and their impact on society.

BY312 Adirondack Ecology and Environmental Science - (TECH) Credits (3)
Prerequisites: Enrollment is limited to those students participating in the Adirondack Semester Program.
This course introduces ecological and environmental science concepts relevant for understanding the structure and function of terrestrial, aquatic, and human systems in the Adirondack Park. Students will learn to identify important plant and animal species representative of the Adirondack Mountains, and learn major features of ecological systems in the Park. The course will also provide the students an assessment of human impacts on the ecology of the Adirondack Park.

BY313 Biogeochemical Earth Systems Science - (TECH) Credits (3)
Prerequisites: CM132 (or CM104), or consent of the instructor
This course will investigate the key concepts and principles of environmental science emphasizing the earth's biogeochemical cycles and how they have been perturbed by human activities. Quantitative analysis or air, soil and water quality on local, regional and global scales will be a significant component of the course. Emerging principles in environmental science, including sustainability, industrial ecology, risk assessment and the precautionary principle will be introduced. In addition to the quantitative aspects, the course will consider the historical, social, and political contexts in which the practice of environmental science takes place.

BY314 (CM314) Bioinformatics – (TECH) Credits (4)
Prerequisites: BY160 and BY214
This course and companion lab provides students with an introduction to the theory and methods of DNA and protein sequence analysis. Students receive experience retrieving information from sequence and genome databases. Methods of sequence alignments include dynamic programming and statistical methods of molecular evolutionary change are outlined. Emphasis is also placed on calculating the statistical significance of results. Protein structural alignments and displays, and structural prediction are covered. Gene prediction algorithms, methods of phylogenetic analysis and database similarity
searching are explained. The course introduces students to the analysis of genomes for protein families and domains and to the analysis of gene expression patterns.

**BY315 Bioinformatics for Disease Research-(TECH, STS) Credits (3)**
This course will provide students with an introduction to the theory and methods of DNA, RNA, and protein sequence analysis in the context of disease biology. Integrated computer laboratory exercises will give students significant experience retrieving, manipulating, and analyzing information from sequence and genome databases. Enrollment is limited to students participating in the Trudeau Semester.

**BY319 Current Readings in Animal Behavior- Credits (1)**
Prerequisites: BY222 or PY151
The field of animal behavior is a rapidly advancing one, especially at the interface of neurobiology and cognition, and the interface of cognition and functional analysis of behavior (behavioral ecology and sociobiology). This one credit hour course is designed as a 'journal club' with a focus on the latest developments in theory and empirical research on animal behavior. The course is intended for any student who has a sincere interest in integrative animal behavior.

**BY320 Microbiology - Credits (3)**
Pre-requisites: BY160, BY214 and CM132 or CM104, or consent of instructor.
This course will provide a fundamental introduction to the study of microbial life forms. The diverse biology of these organisms will be reviewed and application to human health and society, the natural environment, and biotechnology will be emphasized. Upon completion of the course, students will be capable of assessing microbial growth and metabolism and understand its applications in natural and engineered environments.

**BY322 Microbiology Laboratory –(C2) Credits (2)**
Pre-requisites: BY162, CM132 or CM104, or consent of instructor.
Laboratory exercises will stress the classical techniques for handling bacteria and demonstrate concepts presented in the lecture series: both clinical and environmental aspects of applied microbiology will be explored. Upon completion of the course, students will be capable of safely manipulating microbes in a laboratory setting, as well as competent in techniques used to observe and culture microbes.

**BY324 Parasitology-Credits (3)**
The natural history, ecology and molecular biology of parasites are explored with an emphasis on life cycles, host/parasite interactions and evolution of parasitism. Basic principles of epidemiology, transmission, diagnosis, treatment and prevention are examined in parasites of medical, veterinary, and economic importance. Lectures will be supplemented by demonstrations of fixed materials and by exercises in identification and diagnoses.

**BY328 Conservation Biology - Credits (3)**
Prerequisites: BY222 or consent of the instructor.
Conservation biology is about how human-provoked environmental changes impact biodiversity, and what can be done to ameliorate these impacts. Major topics of this course will include the problems of small population size on the long-term persistence of a species, habitat fragmentation and nature reserve design, invasive species, consequences of extinctions on ecosystem processes and community structure, and the possible effects on biodiversity of global climate change.

**BY330 Great Lakes Water Protection- (C1, UNIV: CGI,STS) Credits (3)**
Prerequisite: sophomore or greater standing
The Laurentian Great Lakes contain 20% of the world's surface fresh water and serve both water supply and waste disposal services for over 30 million residents in the United States and Canada. Technological
advances have controlled the outflow of the Great Lakes at the St. Lawrence River and this has brought with it social benefits and environmental costs. The United States and Canada share the management of this resource and have shared notable success controlling environmental consequences of development yet are faced with emerging issues. The LGL/SLR system will be examined from a multidisciplinary, multinational perspective to illustrate that a shared resource can be maintained. Students will be able to understand the forces (geomorphic, biological, chemical, social, economic, and political) that have shaped and impacted a globally significant resource.

**BY340 (PY340) Behavioral Ecology and Sociobiology- (IG) Credits (3)**
Prerequisites: BY140 or PY151 or consent of instructor.
This course is concerned with the adaptive functions of animal behavior, emphasizing ecological and evolutionary perspectives. Topics covered include foraging behavior, sexual selection, social systems, parental care, and cooperation and conflict. One major focus will be on evaluating the arguments of proponents and critics of sociobiology on whether the fields are useful at explaining human behavior.

**BY350 Comparative Vertebrate Anatomy- Credits (3)**
Pre-requisites: BY160 or consent of instructor.
Co-requisite: BY 352
This course compares anatomical structures throughout different classes of vertebrates. We begin by defining anatomical terms and identifying what constitutes a vertebrate. We will also learn how vertebrate organ systems develop and the physical constraints placed on development of these systems. The anatomical study will be broken down into major organ systems that will be discussed one at a time. For each of the organ systems, there will be a discussion of relevant structure and function followed a description of the major changes in form and function throughout vertebrate evolution. Since there are numerous classes of vertebrates, we will concentrate on representatives from some of the better studied examples.

**BY352 Comparative Vertebrate Anatomy Laboratory-Credits (2)**
Pre-requisites: BY160 or consent of instructor.
Co-requisite: BY 350
Through the use of dissection and histological observation, we will observe and make direct comparisons of anatomical structures from representative vertebrates. The organ systems that are dissected in this course will follow the topics presented in BY350. After the first two introductory labs, you will dissect specific organ systems one at a time in each of your specimens. This will allow you to make direct comparisons between comparable structures in different vertebrates. The animals that will be dissected (*Necturus*- Mud Puppy, Dogfish shark, pigeon, and cat) are representative vertebrates chosen to illustrate changes to the organ systems as vertebrates became more complex.

**BY 357 (PY 357) Human Cognitive Evolution- Credits (3)**
Prerequisites: PY 151 or junior or senior standing
Evolutionary psychology is concerned with the adaptive problems and selective pressures our ancestors encountered in their environments, the psychological mechanisms that evolved to help them solve those problems, and the way those evolved mechanisms function in current environments. This way of thinking about the brain, mind, and behavior is changing how scientists approach old topics, and is opening up new ones. This course will focus on current developments and selected topics in evolutionary psychology (e.g., foraging, mate choice, parental investment, cooperation and culture) and explore the evolution of cognition from a broad comparative perspective.
BY358 (PY358) Animal Learning and Cognition- Credits (3)
Prerequisites: BY140 or PY151 or consent of the instructor
This course focuses upon how animals acquire, process, store and recall information about their environment and social partners. Topics that will be examined include how animals perceive and classify stimuli; how they learn and remember: how they orient and navigate; how they measure time, number, and amount; how they acquire abstract concepts; how they perceive social relationships; and how they communicate. A diversity of in-vertebrate and vertebrate organisms will be included (sea slugs to primates!), and there will be an emphasis on understanding taxon-specific specializations as well as general patterns across animals.

BY/PY 359 Perception-Credits (3)
Prerequisites: PY 151 or junior or senior standing
Perception deals with our conscious experience of the world, ourselves and each other. This course will examine how perceptions are measured (psychophysics); how visual, auditory, touch and pain sensory stimulation is actively organized into conscious perceptions; developmental aspects of perception; the role of cognitive factors, such as attention; and how altered conscious states (e.g., achieved through meditation, hallucinogenic drugs) affect perception. Fundamental principles of perception discussed in this course will be used to explain how we experience the world, ourselves, and each other.

BY360 Comparative Physiology- Credits (3)
Prerequisites: BY160 or consent of the instructor.
Physiology is concerned with the vital functions of living organisms. The central question of this course is: How does the human body work? We will attempt to answer this question through an exploration of the major organ systems. An examination of physiological processes at the cellular and molecular level will be used to elucidate the basis of various human diseases.

BY362 Comparative Physiology Laboratory- (C1) Credits (2)
Corequisite: BY360.
Laboratory exercise designed to provide practical exposure to basic physiological research techniques and clinical applications. Examples of class activities include: microscopy of vertebrate tissues, computer modeling of action potentials, electromyography, electrocardiogram, blood pressure, pulse monitoring and physiological effects of exercise.

BY368 Mathematical Biology Seminar- Credits (1)
Prerequisites: BY140 and BY160; MA181 or MA131 (or equivalent), or consent of the instructor
The objective of this course is to present recent advances in research that combines biological and mathematical analysis, and to describe opportunities for interdisciplinary summer research in biology and mathematics. Students will receive one credit for attending seminars (6 per semester), reading a journal article prior to each presentation, writing a short review of each seminar, and participating in discussions. This course can be taken for credit more than once.

BY369 Conducting Interdisciplinary Research in Biology and Mathematics-Credits (1)
Prerequisites: Prerequisites: BY140 and BY160; MA181 or MA131 (or equivalent), or consent of the instructor
This course will provide introductory training in biological and mathematical research. Topics covered include enhancing interdisciplinary communication, understanding research principles and ethics, and developing student knowledge interests. Course meetings will include a variety of small-group discussions, student oral presentations, lectures, and readings of selected literature in mathematics and biology.
BY380 Techniques in Immunological Research-(TECH) Credits (3-6)
This course will provide students with a basic understanding of molecular, cellular and imaging techniques used at the Trudeau Institute to help researchers study the immune system. Students will learn principles and procedures relating to molecular biology, cellular biology, histology, flow cytometry, light microscopy, and cell sorting. The course will cover basic quantification of gene expression at the transcriptional and post-translational level. The course will also cover basic quantification of cell populations using flow cytometers to collect and analyze subpopulations of cells from tissues. Histology and light microscopy techniques will be used to locate similar cell populations within a tissue section. Students will gain confidence in the selection and application of the appropriate cell imaging techniques required to assess mammalian cell tissues.

BY383 Molecular Genetics and Human Disease-Credits (3)
The goal of this course is to learn detailed information related to the structure, packaging and expression of genes within the genome of both prokaryotic and eukaryotic organisms. Not only will the material be discussed in class, but there will be discussion about how the research was performed with critical analysis of current biotechnological techniques and results. A textbook will be used for the course but this there will also be regularly spaced journal articles related to the topic. We will also discuss health related issues caused by defects in each of these processes.

BY400 Directed Study in Bioscience- Credits (1-4)
Prerequisites: consent of instructor.
Students study specialized topics in bioscience not otherwise available in formal courses. Under supervision of a faculty member, a semester-long course of study tailored to professional interests is designed based on reading from relevant texts and primary literature.

BY 401 Professional Assessment – Credits (0)
Pre-requisite: Senior standing or consent of the Biology Department Chair.
This course is designed to assess the professional development of biology majors by (1) completion of a standardized test to assess their level of knowledge in the field of biology, (2) submission of a professional resume, and (3) submission of a personal statement for graduate/professional school or employment.

BY405 Undergraduate Research in Bioscience- Credits (0-6)
Prerequisites: consent of instructor
Students conduct and original bioscience research project based on investigation of a specific problem related to areas of faculty expertise. Research methodology may involve field, laboratory, computational, or theoretical approaches. Presentation of research results at a scientific meeting or local symposium is strongly encouraged.

BY410 Undergraduate Thesis Research in Bioscience -Credits (1-6)
Prerequisites: consent of instructor.
A formal thesis project is arranged under supervision of a faculty member who guides the student in planning and execution of original research work and preparation of a written thesis. This course is primarily intended for junior or senior biology majors who wish to pursue graduate or professional studies in bioscience. Work done in satisfaction of the requirements for a degree will be assigned a grade when the thesis is submitted and approved.
BY412 Molecular Biology Laboratory - (TECH, C1) Credits (4)
Pre-requisites: BY214 or consent of instructor.
This course will provide students with a hands-on introduction to modern molecular biology techniques. Students will learn techniques such as bacterial transformation and plasmid DNA purification, restriction digest and gel electrophoresis, isolation of DNA and RNA from eukaryotic cells, Southern hybridization, reverse transcription, polymerase chain reaction, and cloning PCR products, and web-based analytical programs. The lectures and reading will cover the theory and applications of these molecular techniques.

BY 415 Recent Advances in Immunology Research- (C1) Credits (1)
Prerequisite: BY 160 and BY 162, Instructor Consent Required
The objective of this course is to present recent advances in immunological and microbiological research. Students will receive one credit for attending seminars (9 per semester), reading a journal article prior to each presentation, writing short review of each seminar, and participating in discussions.

BY416 (IH416) Principles of Toxicology and Epidemiology- Credits (3)
Prerequisites: IH309 or consent of instructor.

BY419 Immunology- (C1) Credits (3)
Prerequisites: BY140, BY160 or BY214 or consent of instructor
An overview of the immune system, with emphasis on current concepts and literature. Topics covered include: cells and tissues of the immune system; structure and function of antibodies; genetic basis of antibody diversity; humoral and cellular immunity; cellular interactions; major histocompatibility complex; the complement system; transplantation; tumor immunity.

BY420 Evolution Credits (3)
Prerequisites: BY214.
This course is organized into three sections: History of Life, which covers abiogenesis and the fossil record; Development of Evolutionary Theory, which reviews the origin of evolutionary thought, emphasizing Darwin and the synthesis of genetics and natural history; and Population Biology, which covers the mechanisms by which populations adapt to environmental change.

BY425 Biological Systems and Environmental Change- (UNIV: CGI, STS) Credits (3)
Prerequisites: BY222 or graduate standing
Human activities are resulting in dramatic global environmental change, in the forms of biodiversity loss, altered biogeochemical cycles, introduced invasive species, chemical toxification of the environment, climate change, unsustainable exploitation of natural resources, and habitat loss, degradation, and fragmentation. In this course, we will examine how these forms of environmental change disturb biological systems by critically reading key research papers, and discussing their implications for future research and policy action.

BY431 Limnology – Credits (3)
Pre-requisites: BY222, CM 132 (or CM 104)
Co-requisite: BY432
Limnology (aquatic science) is the study of physical, chemical, and biological properties of fresh water bodies, e.g. lakes, rivers, reservoirs, and wetlands. This introductory course will provide an array of topics that will, by the multi-disciplinary nature of limnology, call upon students' knowledge of biology, chemistry and physics and place them within the context of aquatic science. The focus of the instruction will be aquatic ecology at all levels of biological organization. Upon completion of the course, the
student will be able to characterize the physical, chemical and biological/ecological properties of a freshwater through the selection and application of appropriate sampling methods.

**BY432 Limnology laboratory – Credits (2)**
Co-requisite: BY431
This co-requisite of Limnology (aquatic science) will provide students the opportunity to engage in water sampling of regional lakes and rivers, analysis of samples in the laboratory, introduction to data synthesis, and report writing. Some fieldwork will be required.

**BY440 Introduction to Biomedical Rehabilitation Engineering and Science- Credits (3)**
Prerequisites: MA131/132, PH131/132, junior or senior standing
This interdisciplinary course will introduce students to basic principles of biomedical rehabilitation engineering. The course will present principles of disability and the diverse roles of engineering in medicine and rehabilitation. Students will use engineering methods to study anatomical and physiological systems including applications in rehabilitation engineering, bioinstrumentation, biosignal and image processing, biomechanics, and biomaterials.

**BY 448 Medical Microbiology- (C1) Credits (3)**
Prerequisites: BY 160 and BY 214 (or instructor approval)
This course will systematically examine human pathogens with a focus on why the biologic properties of organisms are important to disease in humans, including the basic principles of the host immune response, laboratory diagnosis, bacteriology, virology, mycology and parasitology. This class will emphasize basic science with clinical practice to understand the clinical relevance of the organisms examined using clinical cases from literature reports to illustrate the epidemiology, diagnosis, and treatment of infectious diseases. The course will emphasize student interaction and exploration of the scientific literature.

**BY450 (CM460) Biochemistry I- Credits (3)**
Prerequisites: CM241 or consent of instructor.
This course is a one semester introduction to the molecular basis of biological processes. The first part of the course will cover the structure and function of the four major classes of biomolecules – proteins, carbohydrates, lipids, and nucleic acids. The second part covers the organization and regulation of the major energy generating and biosynthetic pathways.

**BY451 (CM461) Biochemistry II -Credits (3)**
Prerequisites: BY450.
A continuation of Biochemistry I focusing on autotrophic and anabolic metabolism.

**BY452 Pharmacology- Credits (3)**
Prerequisites: BY160 and CM241 or consent of instructor
The science of Pharmacology concerns the molecular mechanisms by which drugs act on the human body and the applications of drugs in clinical therapy. This course will introduce students to general principles of drug action and survey selected classes of drugs according to their physiological effects and uses in the treatment of certain diseases.

**BY453 Pharmacology Lab-Credits 2**
The goal of this course is to facilitate a greater understanding of key concepts in pharmacodynamics, pharmacokinetics that are discussed in the lecture component and observe how they are applied in the context of the clinical environment. The lab will be simulation based, employing virtual organ bath experiments to derive and interpret dose-response curves, and virtual patient software to investigate drug pharmacokinetics and dosing strategies.
BY454 (PY454) Physiological Psychology- Credits (3)
A comprehensive investigation of the physiological foundation of behavior. Topics include: perception, motivation, emotion, states of consciousness, learning, memory and mental illness. Only one course with this designator may be used as a Foundation Curriculum Science course.

BY455 Cell and Molecular Biology of Cancer- (C1) Credits (3)
Prerequisites: BY160 and BY214 or consent of the instructor.
This course will focus on the cellular and molecular alterations that cause human cancer. Topics include cell cycle regulations, oncogenes and tumor suppressor genes, cancer viruses, multi-step tumorigenesis, invasion and metastasis, and new developments in cancer diagnosis and therapy. Emphasis will be placed on student interaction and exploring the scientific literature.

BY458 Cognitive Neuroscience- Credits (3)
Prerequisites: PY151 or junior or senior standing
This course introduces a sampling of the theories and research concerning how various mental processes are accomplished within the brain. Emphasis will be placed on developing an understanding of both the physiological bases of the techniques and the issues involved in relating measures of brain activity to cognitive functioning. Students will be exposed to current topics of study in a number of areas of cognition: perception, language, memory, among others. In this course we will study a number of different techniques for studying the brain, including electrophysiological recording techniques, functional imaging techniques, and methods that involve brain lesions and disrupting neural activity.

BY460 (PY460) Neurobiology- Credits (3)
Prerequisites: BY160 or BY360 or consent of the instructor.
Neurons are electrically excitable cells that initiate or control many complex functions such as sensory perception, locomotion, memory, and learning. This course introduces the study of neuronal mechanisms at the cellular and molecular level. Topics include: membrane biophysics, ion channels, electrical signaling, synaptic transmission, glia, sensory transduction, neuromodulation, and neuronal plasticity.

BY470 (CM470) Biochemistry & Biotechnology Laboratory--(C2) Credits (3)
Prerequisites: BY312 or BY450/CM460 or consent of the instructor.
This course is a one semester course in the fundamental laboratory approaches for biochemistry and biotechnology. While largely a hands-on course, laboratory experiments will be supplemented with lectures that integrate the theoretical and practical principals covered in the exercises. Topics include protein purification, characterization and analysis, enzyme kinetics and molecular modeling.

BY 471 Anatomy and Physiology I – Credits (3)
Pre-requisites: BY140, BY160, and CM104 or CM132. In addition, must be of junior or senior standing, or with permission of the instructor.
This course is the first course in a two semester sequence that studies the anatomy and physiology of the human body in detail. Topics covered in this semester include basic cellular activities, anatomy and physiology of skeletal, muscular, circulatory and cardiovascular systems. This course is appropriate for students in the pre-PT program as well as pre-health majors in any other health-related fields that require a two-semester Anatomy and Physiology sequence.

BY 472 Anatomy and Physiology II – Credits (3)
Pre-requisites: BY471 and BY473, or consent of the instructor. Co-requisite: BY474.
This course is the second course in a two semester sequence that studies the anatomy and physiology of the human body in detail. Topics covered in this semester include the anatomy and physiology of major organ systems as well as homeostasis. This course is appropriate for students in the pre-PT program as
well as pre-health majors in any other health-related fields that require a two-semester Anatomy and Physiology sequence.

**BY473 Anatomy and Physiology I Laboratory-Credits (2)**
Pre-requisites: BY140, BY160, and CM104 or CM132. In addition, must be of junior or senior standing, or with permission of the instructor.

**BY474 Anatomy and Physiology II Laboratory- (TECH) Credits (2)**
Prerequisite: BY471 and BY473, or consent of the instructor
Corequisite: BY472
Companion laboratory course to Anatomy and Physiology II, introducing students to anatomical terminology and histology. The student will focus on human physiology of the major organ systems.

**BY 476 Current Topics in Biology and Medicine-(C1) Credits (3)**
Prerequisites: BY160 or BY214 or consent of instructor.
This is a discussion-based seminar course that broadly examines advances and implications of modern biology of interest to society, scientists, and students planning a career in medicine, research, or teaching. Students are required to read a variety of current texts, participate in class discussions, and write a substantive essay. Example topics include the discovery of DNA, genome sequencing, applications of bioinformatics, the revolution in applied biotechnology, human physiology under extreme conditions, intellectual history of biology and medicine as explored by prominent science writers, the prognosis for life on earth.

**BY480 Advanced Cell Biology – (C1) Credits (3)**
Prerequisites: BY160/162 and BY214 or consent of instructor.
This course will focus on understanding how cells function normally, and how cell dysfunction can cause human disease. Topics include DNA replication and repair, cell cycle control and cancer, cell communication and intracellular signaling, regulation of gene expression, the cell surface and the cytoskeleton. Current methods used in cell and molecular biology research will be discussed. The course will emphasize student interaction and exploration of the scientific literature.

**BY482 Molecular Genetics- Credits (3)**
Prerequisites: BY160, BY214, BY450, CM103 or 131, and CM104 or 132.
This course will provide students with detailed information on the structure, packages, and expression of genes within the genome of both prokaryotes and eukaryotes. Topics will include chromatin packaging and structure; DNA replication mutation and repair; transcription; RNA splicing; translation; and control of gene expression. Included with each of these topics will be primary research papers, which will discussed during class. During discussions, experiments in the papers will be analyzed as to how they work (focusing on current biotechnology) and critical analysis of the conclusions. Evaluation will involve exams based on material presented during the course as well as participation in discussions and written analysis of presented research papers. This course contains advanced topics and is designed primarily for graduate or advanced undergraduate students.

**BY485 Neural Engineering-Credits (3)**
Cross-listed with EE 485, ES 485] This course applies engineering principles to the study of neuroscience and to the design of devices or techniques intended to replace missing or augment existing functions such as seeing, hearing, speaking, and walking. The course provides a detailed overview of sensorimotor systems, neurophysiology, neuroanatomy, neuropathology and clinical neurology. The class sequences through the various sensory and movement systems, providing a quantitative basis for how the nervous systems works for these systems, for how it dysfunctions, for the disability produced,
and finally for how function can be restored by neuroprostheses. Students will prepare and present a
paper on a neural engineering topic.

**BY486 Molecular Biotechnology- Credits (3)**
Molecular biotechnology is a rapidly evolving scientific discipline impacting on many aspects of our
daily life. This course will review basic concepts and methodologies in recombinant DNA technology,
cover the use of molecular biotechnology for the production of useful products in areas of microbial,
plant and animal biotechnology and address social and economic issues rising with the availability of
these technologies.

**BY488 Stem Cells and Regenerative Medicine-Credits 3**
This course will cover biological and medical perspectives of stem cells from their fundamental basic
biology and mechanisms of organ regeneration through the use of induced-pluripotent stem cells
(iPSCs) for therapeutic benefit. It will deal with mammalian and human embryonic stem cells (hESCs)
and focus on how iPSCs generate distinct fates during human development and how this can be used for
regenerative therapy of common human diseases.

**BY495 Undergraduate Teaching Assistantship in Bioscience- Credits (1-2)**
Prerequisites: Consent of instructor
Students obtain teaching experience by assisting a faculty member in teaching a lecture or laboratory
course. Pedagogical activities may include leading laboratory or discussion sections, designing and
testing laboratory exercises, and assisting in student assessment.

**BY498 Internship in Bioscience- Credits (0 cr., P/NP)**
Prerequisites: Consent of instructor
During the fall semester, spring semester, or summer break, students may receive credit for an approved
internship or co-op work experience with a private organization or company with a mission related to
bioscience. Typical examples include internships at a hospital or medical clinic, work at a
biotechnology company, and field or office work at an ecological conservation society. Internships are
expected to involve a minimum of 120 hours of work and must be pre-approved in consultation with a
faculty member. A formal report upon completion of the internship is required.

**BY499 Professional Experience in Bioscience- Credits (0 cr, P/NP)**
This course is used to assign credit for alternative experimental learning activities that meet the
requirement of undergraduate Biology majors to complete a professional experience in their major under
the Clarkson Common experience curriculum. Examples of appropriate activities include participation
in a summer undergraduate research program or training course at other institutions such as a national or
foreign bioscience laboratory, field station, or research institute. The program experience must be pre-
approved in consultation with a faculty member and a formal report is required upon completion.
XIII. Clarkson University Biology Major – Clarkson Common Experience
120 Total Credits Minimum to Graduate / Average Course Load 15 credits per semester

<table>
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<tr>
<th>Biology – Required Core Courses – 13 Credits</th>
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<tbody>
<tr>
<td>BY140/BY142 fall</td>
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<tr>
<td>BY160/BY162 spring</td>
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<tr>
<td>BY214 spring</td>
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<tr>
<td>BY401 spring</td>
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<tr>
<td>Two Biology Lab Courses numbered 200 or above not including BY405 or BY410 – 4-6 Credits Minimum</td>
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<tr>
<th>Biology Electives – additional BY credits</th>
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<tbody>
<tr>
<td>BY240 when needed</td>
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<tr>
<td>BY300 fall and spring</td>
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<tr>
<td>BY304 Given when needed</td>
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<tr>
<td>BY310 spring</td>
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<tr>
<td>BY312 Given when needed</td>
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<td>BY313 fall</td>
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<td>BY319 fall</td>
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<td>BY368 fall</td>
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<td>BY400 fall &amp; spring</td>
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<td>BY412 fall</td>
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<td>BY 415 fall</td>
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<td>BY420 fall</td>
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<td>BY425 alt spring</td>
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<tr>
<td>BY431 &amp; BY432 alt falls</td>
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<td>BY440 fall</td>
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<td>BY448 spring</td>
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<td>BY450 &amp; BY451 fall/spring</td>
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<td>BY452 &amp; BY 453 fall</td>
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<td>BY 454 even springs</td>
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<td>BY455 alt spring</td>
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<td>BY458 alt spring</td>
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<tr>
<th>Professional Experience Courses - 1 Credit Minimum</th>
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<tbody>
<tr>
<td>BY405 fall &amp; spring</td>
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<tr>
<td>BY410 fall &amp; spring</td>
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<td>BY495 fall &amp; spring</td>
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<tr>
<th>Chemistry – 19 (or 17) Credits</th>
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<tr>
<td>CM131 fall</td>
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<td>CM103/105 (alternative to above)</td>
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<td>CM132 spring</td>
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<td>CM106/106 (alternative to above)</td>
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<td>CM241 fall</td>
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<td>CM244 spring</td>
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<th>Physics – 8 Credits</th>
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<tr>
<td>PH141 fall (or PH131)</td>
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<td>PH142 spring (or PH132)</td>
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<tr>
<th>Mathematics – 9-10 Credits (includes calculus, statistics, and one additional math, statistics, or computer science course numbered 100 or above )</th>
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<tr>
<td>MA180 (optional precursor course)</td>
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<tr>
<td>MA181 (or MA131 spring)</td>
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<tr>
<td>MA132 Calculus II, MA239 Linear Algebra or other MA or CS elective</td>
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<tr>
<td>STAT318 Biostatistics (or STAT282/383 General/Appil Statistics)</td>
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### CCE Requirements – 22 Credits

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<tr>
<th>Course Code</th>
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<tr>
<td>FY100</td>
<td>First Year Seminar</td>
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<tr>
<td>UNIV190</td>
<td>The Clarkson Seminar</td>
<td>3</td>
</tr>
<tr>
<td>Knowledge Area / UC Courses</td>
<td>5 elective courses covering 4 KA</td>
<td>15</td>
</tr>
<tr>
<td>Technology Course</td>
<td>BY412, IS/CS110, ES300, ES305, COMM442, BY431, BY474</td>
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### Free Electives – additional courses up to 120 overall credits

<table>
<thead>
<tr>
<th>Course Description</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Special topics of personal interest</td>
<td>~7 elective courses</td>
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</tbody>
</table>

Notes: Student must also meet CCE communication requirement of 6 total points (C1 or C2 courses) and fulfill Dept of Biology Professional Experience Requirement.